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MINISTRY OF WATER RESOURCES AND METEOROLOGY
KINGDOM OF CAMBODIA

# SPECIAL ASSISTANCE FOR PROJECT FORMATION FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT IN THE KINGDOM OF CAMBODIA

# FINAL REPORT

# VOLUME-I
# MAIN REPORT

NOVEMBER 2009

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**NIPPON KOEI CO., LTD.**

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# PREFACE

The Study on the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project in the Kingdom of Cambodia was carried out as Special Assistance for Project Formation (SAPROF) commissioned and financed by Japan International Cooperation Agency (JICA). The SAPROF Study was conducted from July 2009 to December 2009 in cooperation with the Ministry of Water Resources and Meteorology (MOWRAM).

The objective of the SAPROF Study is to upgrade irrigation and drainage development plan prepared under the Basin-wide Basic Irrigation and Drainage Master Plan Study conducted by JICA and MOWRAM from January 2007 to Match 2009 in order to contribute to stabilization and increase of the rice production in the Western Region of the Tonle Sap Lake.

This SAPROF Report consists of two volumes: (i) Volume-I Main Report and (ii) Voume-II Supporting Report, elaborating (i) necessity and justification of the project, (ii) project scope, (iii) project implementation plan and O&M plan, (iv) cost estimate, (v) project evaluation and (vi) environmental assessment.

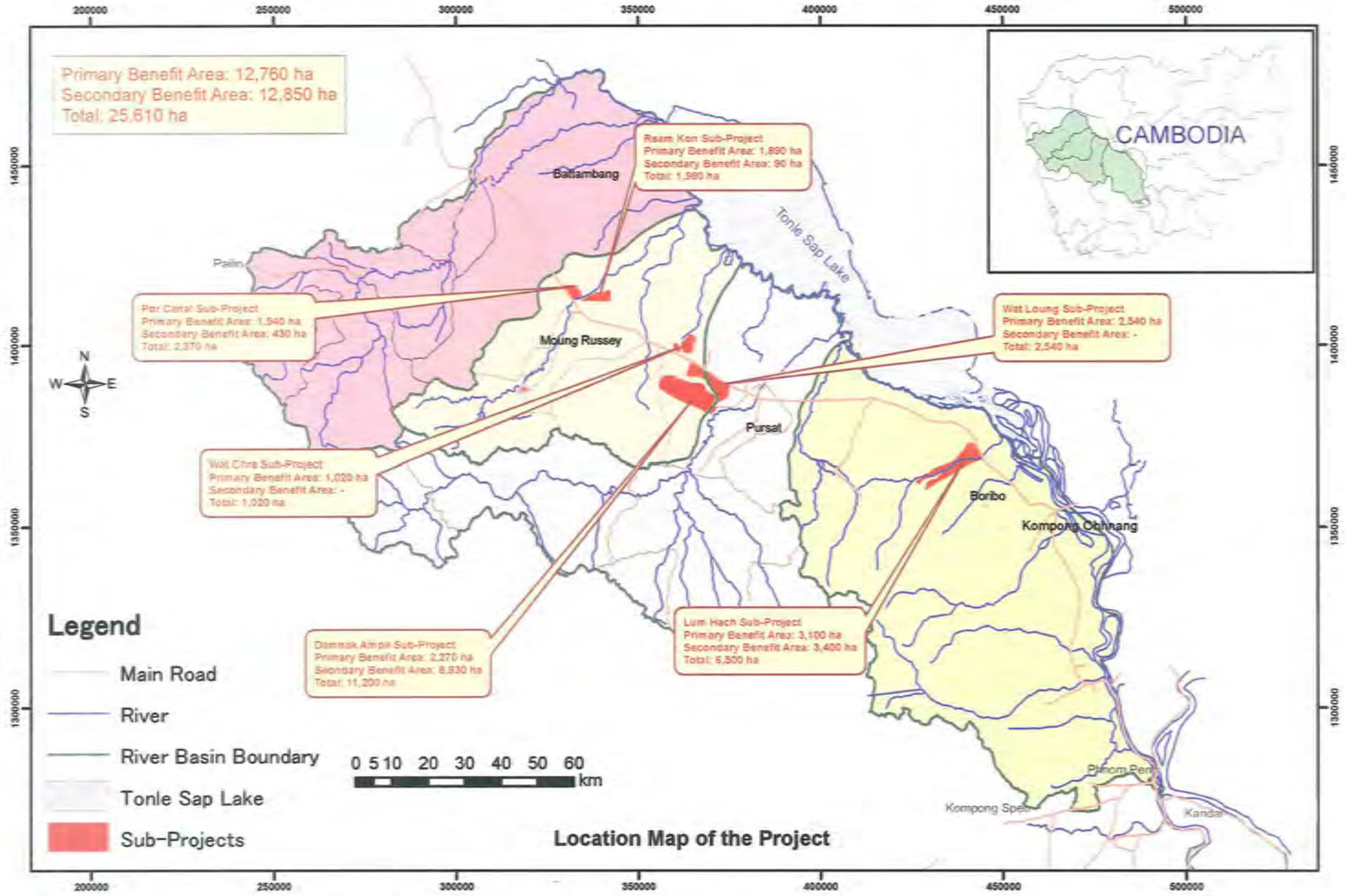
The SAPROF Study Team earnestly hopes that this Report will be utilized as a help of defining the scope and means to implement the Project smoothly and successfully.

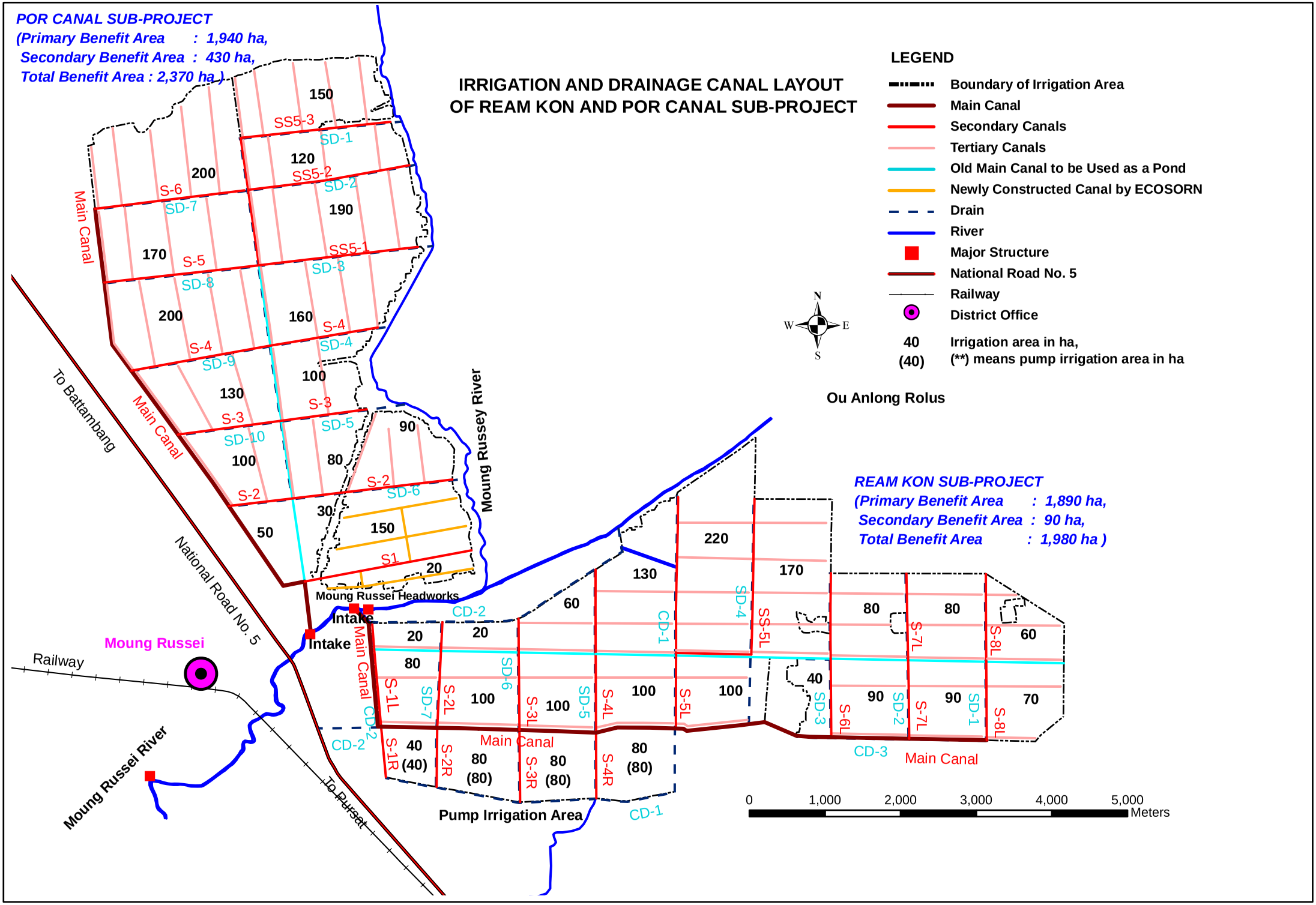
Finally, the SAPROF Study Team wish to express our sincere appreciation to the officials concerned of the Royal Government of Cambodia for their close cooperation extended to us during the period of the study.

November 2009

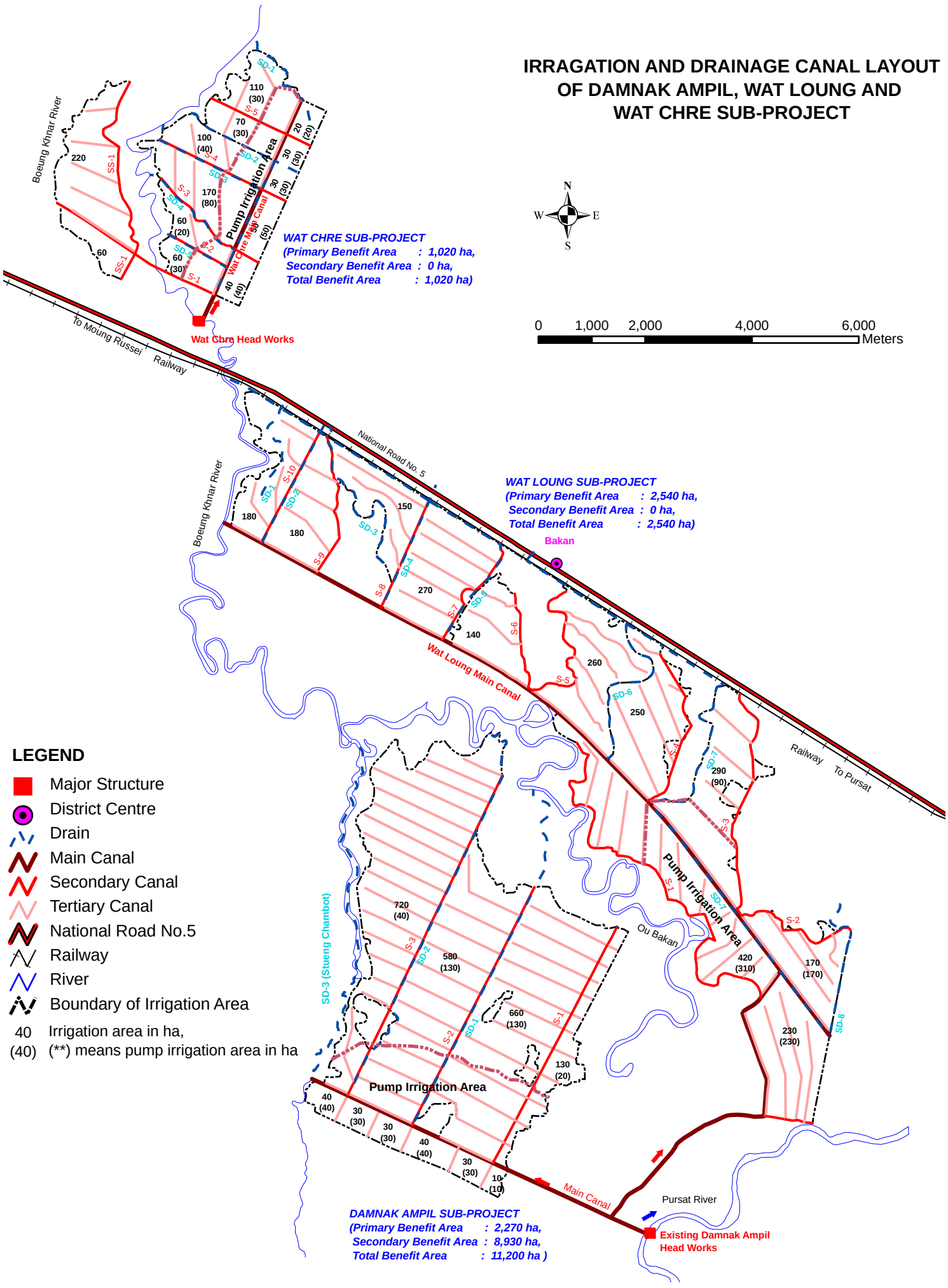
Very truly yours,

TOYA Yusaku,
Team Leader for the SAPROF Study Team for West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project
Nippon Koei Co., Ltd.

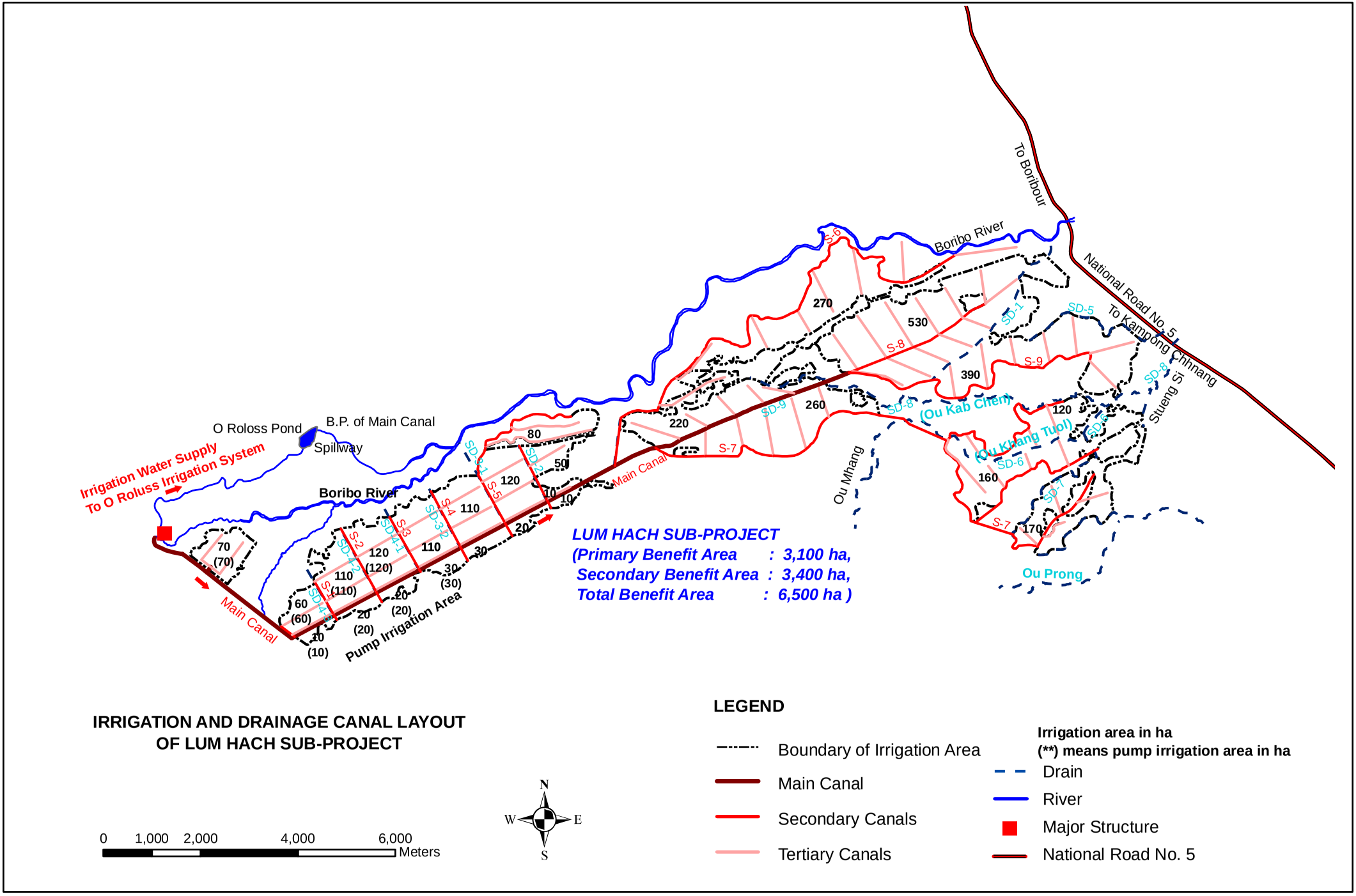

Primary Benefit Area: 12,760 ha
Secondary Benefit Area: 12,850 ha
Total: 25,610 ha
CAMBODIA
Battambang
Pailin
Moung Russey
Pursat
Boribo
Kompong Chhnang
Tonle Sap Lake
Phnom Penh
Kompong Speu
Kandal
Ream Kon Sub-Project
Primary Benefit Area: 1,890 ha
Secondary Benefit Area: 90 ha
Total: 1,980 ha
Por Canal Sub-Project
Primary Benefit Area: 1,940 ha
Secondary Benefit Area: 430 ha
Total: 2,370 ha
Wat Loung Sub-Project
Primary Benefit Area: 2,540 ha
Secondary Benefit Area: -
Total: 2,540 ha
Wat Chre Sub-Project
Primary Benefit Area: 1,020 ha
Secondary Benefit Area: -
Total: 1,020 ha
Dommak Ampil Sub-Project
Primary Benefit Area: 2,270 ha
Secondary Benefit Area: 8,930 ha
Total: 11,200 ha
Lum Hach Sub-Project
Primary Benefit Area: 3,100 ha
Secondary Benefit Area: 3,400 ha
Total: 6,500 ha
N
W
E
S
200000
250000
300000
350000
400000
450000
500000
1450000
1400000
1350000
1300000
Legend
Main Road
River
River Basin Boundary
Tonle Sap Lake
Sub-Projects
0 5 10 20 30 40 50 60
km
Location Map of the Project




**Irrigation and Drainage Canal Layout of Ream Kon and Por Canal Sub-projects**




# Irrigation and Drainage Canal Layout of Damnak Ampil, Wat Loung and Wat Chre Sub-projects




**Irrigation and Drainage Canal Layout of Lum Hach Sub-project**

**PHOTOGRAPHS**
**WEST TONLE SAP IRRIGATION AND DRAINAGE**
**REHABILITATION AND IMPROVEMENT PROJECT (1/3)**

**Existing Ream Kon Headworks**
**(Ream Kon Sub-project)**
Concrete structure is highly deteriorated and gates do not function. Construction of a new headworks is proposed under the Project. (August 10th 2009)

**Present Condition of Main Canal**
**(Ream Kon Sub-project)**
Water is not available since the existing headworks do not function at present.
(August 10th 2009)

**Rehabilitated Secondary Canal**
**(Por Canal Sub-project)**
One secondary canal was rehabilitated by ECOSORN funded by EU. Since water level is too low, portable pump is utilized to irrigate paddy field. (August 10th 2009)

**Paddy Field Condition with Pump Irrigation**
**(Por Canal Sub-project)**
Paddy cultivation with pump irrigation is practiced where water is available in nearby existing canals.
(August 10th 2009)

**Existing Damanak Ampil Headworks**
**(Damnak Ampil Sub-project)**
Existing headworks was constructed by MOWRAM in 2006. Automatic gates need to be improved since they do not function properly.
(August 11th 2009)

**Rehabilitated Secondary Canal**
**(Damnak Ampil Sub-project)**
Secondary canal No.2 was rehabilitated by DANIDA in 2008. Improvement of this canal is, therefore, excluded from the scope of the Project.
(August 11th 2009)

**PHOTOGRAPHS**
**WEST TONLE SAP IRRIGATION AND DRAINAGE**
**REHABILITATION AND IMPROVEMENT PROJECT (2/3)**

**Present Condition of Secondary Canal**
**(Wat Chre Sub-project)**
Secondary canal was entirely deteriorated. Farmers construct temporary embankment to store water and irrigate with the use of water pumps (August 11th 2009)

**Construction Site for Wat Chre Headworks.**
**(Wat Chre Sub-project)**
Proposed headworks site is located 1.7km upstream from the existing weir on Boeung Khnar River.
(August 11th 2009)

**Present Condition of Main Canal**
**(Wat Loung Sub-project)**
Side slope of existing main canal is severely eroded. Existence of dispersible soil is one of the technical problems of the Project.
(August 11th 2009)

**Present Condition of Command Area.**
**(Wat Loung Sub-project)**
Rainfed paddy cultivation is dominant because irrigation system does not function. No secondary and/or tertiary canals are developed. (August 11th 2009)

**Proposed Site for Lum Hach Headworks**
**(Lum Hach Sub-project)**
Proposed headworks on Boribo River is to supply irrigation water to Lum Hach Sub-project (3,100ha) on the right bank and O Roluss Canal Irrigation System (3,400ha) on the left bank. (August 12th 2009)

**Present Condition of Main Canal**
**(Lum Hach Sub-project)**
No water is delivered to the main canal due to lack of headworks. Farmers only pump up water standing in the main canal for irrigation.
(August 12th 2009)

**PHOTOGRAPHS**
**WEST TONLE SAP IRRIGATION AND DRAINAGE**
**REHABILITATION AND IMPROVEMENT PROJECT (3/3)**

**Road under Construction within Command Area**
**(Lum Hach Sub-project)**
A road connecting National Road No.5 and the main canal in the command area is under construction by the Ministry of Public Works and Transport.
(August 12th 2009)

**Geo-Technical Investigation**
**(Lum Hach Sub-project)**
Geo-technical Investigation (left bank of proposed headworks site on Boribo River) was carried out to confirm foundation conditions of headworks. (under Part-I of SAPROF Study) (July 2009)

**Balloon Aerial Photo Shooting and Topographic Survey**
**(Lum Hach Sub-project)**
The topographic survey was carried out for the proposed site of headworks to prepare detailed plan of headworks. (August 2009)

**Agricultural Marketing Survey**
**(Por Canal Sub-project)**
The marketing survey was carried out to confirm present rice farming and marketing conditions.
(August 10th 2009)

**Interview of Social and Environmental Consideration**
**(Por Canal Sub-project)**
The social and environmental impact by the Project is confirmed with farmers.
(August 26th 2009)

**Meeting on Findings of Field Survey**
**(Phnom Penh)**
Discussion among key staffs of MOWRAM and PDOWRAM and SAPROF study team is made over findings of field survey. (September 10th 2009)

# SAPROF DESIGN MATRIX (SDM)

☐ Preparation
☐ Inception
☐ Draft Final
☒ Final

## Project Frame

Country: The Kingdom of Cambodia

Project Name: West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project

National Development Plan and Target:

National Poverty Reduction Strategy (NPRS) 2003-2005:

1. Eight priority actions for poverty reduction are established, out of which action 2 "improving rural livelihoods" is closely related with agriculture development including irrigation development.

National Strategy Development Plan (NSDP) 2006-2010:

1. Rectangular strategy described under NSDP (2006-2010) has four pillars: (i) Enhancement of Agriculture Sector, (ii) Further Rehabilitation and Construction of Physical Infrastructure, (iii) Private Sector Development and Employment Generation and (iv) Capacity Building and Human Resource Development. By following the same concept , "Rectangular Strategy" Phase II (2009-2013) was announced.
2. One of four pillars for strategic growth rectangles, "Enhancement of Agriculture Sector" stresses the importance of agriculture and irrigation development.
3. The Royal Government of Cambodia (RGC) sets following quantitative targets:

| Indicator | 2005 | 2010 |
|---|---|---|
| Paddy planted area (million ha) | 2.37 | 2.50 |
| Yield (ton/ha) | 1.97 | 2.40 |
| Irrigated area including supplemental irrigation (million ha) | 0.59 | 0.65 |

Agriculture Sector Strategic Development Plan 2006-2010

1. The food security, productivity and diversification are given top priority among seven objectives set out in the Plan, to which irrigation development can significantly contribute.

Policy for Participatory Irrigation Management and Development (PIMD)

1. On the basis of decentralization and deconcentration policy, MOWRAM promotes participatory irrigation management and development in the country through hardware and software component in irrigation development and management.

Present Condition of the Project Area:

1. Rural areas in three provinces where six sub-projects are located are in higher poverty headcount ratio.
2. Irrigation and drainage facilities are highly deteriorated, therefore, farmers are largely dependent on rain-fed agriculture.

Project Target:

1. Effective utilization of available resources in the Project area through the rehabilitation of irrigation and drainage facilities
2. Establishment of sustainable O&M system to increase agricultural productivity in the sub-project areas and to enhance living standard of beneficiaries

Project Plan Proposed in the Basin-Wide Basic Irrigation and Drainage Master Plan Study(JICA): 2007 January to 2009 March:

Implementing Organization: Northwestern Area Unit of the National Project Management Office (NPMO) under the Ministry of Water Resources and Meteorology (MOWRAM)
Project Area: Six sub-projects located in Battambang, Pursat and Kampong Chhnang Provinces
Project Cost: US$ 97.54 million (10.53 billion Japanese yen) (US$ 1=107.99 Japanese yen)
Project Component:

1. Hardware Component: Rehabilitation of irrigation and drainage facilities
2. Software Component: (i) FWUC establishment and strengthening and (ii) Agriculture extension activities
3. Project Supporting Programs: (i) Meteo-hydrological observation strengthening, (ii) Capacity development of MOWRAM staff and (iii) Capacity development of PDOWRAM staff
4. Project Formation Study for Other Potential Areas

Environmental Category based on JICA Guideline : Category B

Poverty Alleviation ☒Yes ☐No

Economic and Social Capital Development ☒Yes ☐No

| | |
|---|---|
| Organizational and Institutional Development ☒Yes ☐No | Peace Building ☐Yes ☒No |
| IT Relation ☐Yes ☒No | Capacity Building ☒Yes ☐No |

Issues for Appraisal:

<Necessity of the Project>
- Justification of the Project based on agriculture and irrigation development policy of Cambodia and quantitative data
- Ripple effect with technical cooperation

<Project Scope and O&M>
- Project components and those justification
- Project cost, implementation schedule, operation and effect indicators and EIRR
- Necessity of consulting services
- O&M organization

## SAPROF FRAMEWORK

Output from the Study:

1. Justification of the Project
   1) The Project is consistent with development policy and plan of the RGC.
   2) The Project conforms to development policy of JICA.
   3) The necessity of the Project is justified by quantitative data.
2. Project Scope
   1) Project Area: six sub-projects, each of which consist of primary benefit area and secondary benefit area as shown in the right table:

**Project Area**

| Sub-Project | Primary Benefit Area (ha) | Secondary Benefit Area (ha) | Total (ha) |
|---|---|---|---|
| Ream Kon | 1,890 | 90 | 1,980 |
| Por Canal | 1,940 | 430 | 2,370 |
| Damnak Ampil | 2,270 | 8,930 | 11,200 |
| Wat Loung | 2,540 | 0 | 2,540 |
| Wat Chre | 1,020 | 0 | 1,020 |
| Lum Hach | 3,100 | 3,400 | 6,500 |
| Grand Total | 12,760 | 12,850 | 25,610 |

   2) Following development plan is prepared.
      a) Hardware component: (i) Rehabilitation of irrigation and drainage facilities
      Work Volume: (i) Area: 25,610 ha consist of primary benefit area (12,760 ha) and secondary benefit area (12,850 ha), (ii) Construction of headworks 3 nos., (ii) Rehabilitation of irrigation canals: 196 km (main 58 km, secondary 138 km)、(iii) construction of tertiary canals for 12,760 ha, (iv) construction of drainage 148 km (main 13 km, secondary 135 km)
      b) Software Component: (i) FWUC establishment and strengthening and (ii) Agriculture Support Services
      c) Project Supporting Programs: (i) Meteo-hydrological Observation Strengthening, (ii) Capacity Development of MOWRAM staff and (iii) Capacity Development of PDOWRAM staff
      d) Project Formation Study for Other Potential Areas: eight sub-projects covering 24,050 ha
   3) Project cost: US$ 49.1 million (4.75 billion Japanese yen) (US$ 1=96.8 Japanese yen), Project period: 6 years, Economic analysis: EIRR13.3%
3. Project Implementation and O&M Organization
   1) Implementing organization for the Project is planned. (Project Management Unit Japan Support Fund under MOWRAM will take responsibility on the Project implementation.)
   2) Implementing procedure for each component is prepared.
4. Environmental management
   1) Environmental evaluation is carried out and, on this basis, environmental management plan is prepared.

Description of the Study

1. TOR 1: Review and confirm the necessity and viability of the Project and formulate the Project Scope
   - ♦ Review and confirmation of irrigation facilities to be rehabilitated
   - ♦ Review of agriculture-related data and information
   - ♦ Preparation of Technical Assistance Plan
   - ♦ Confirm the importance and viability of the Project
   - ♦ Formulation of Project Scope based on above-listed Study
2. TOR 2: Examine the detail of the project component and the basic plan and design
   - ♦ Study and review of design criteria for irrigation facilities
   - ♦ Review of preliminary design prepared under Basin-Wide Basic Irrigation and Drainage Master Plan Study
   - ♦ Preparation of annual implementation plan and cost estimate
   - ♦ Review of unit construction cost
   - ♦ Overall cost estimate
   - ♦ Preparation of budget plan
   - ♦ Study on Consulting Services necessary for the Project
   - ♦ Study on procurement plan
   - ♦ Confirmation on implementation organization
   - ♦ Study on O&M plan
3. TOR 3: The environmental and social consideration
   - ♦ Preparation of environmental checklist based on relevant guidelines
   - ♦ Social consideration
4. TOR 4: Project evaluation and study of project monitoring system
   - ♦ Preparation of operation and effect indicators (baseline, target, procedure etc.)
   - ♦ Confirmation on intangible benefit from the Project
   - ♦ Study on Economic Internal Rate of Return (EIRR) and financial analysis

Necessity of SAF:

- The proposed Project is consistent with the assistance policy of JICA stressing the poverty reduction through agriculture development in the rural area of developing countries.
- JICA has been implementing technical cooperation in irrigation sector of Cambodia. Coordination among the loan project and technical cooperation will significantly contribute to the food security as well as poverty reduction in Cambodia.
- In order to conclude loan agreement (L/A) by March 2010, preparation on appraisal need to be carried out based on the SAPROF Report by the beginning of December 2009.

Project Risk (Tentative):

1. No large scale resettlement is necessary, instead land acquisition is required for the construction of main, secondary and tertiary facilities. Appropriate procedure for land acquisition is required based on the regulation of the RGC through consensus building among stakeholders in this process.
2. Project Management Unit (PMU) Japan Support Fund is primarily in charge of Project implementation. It is necessary to establish officient implementation mechanism by coordination with relevant organizations including local administration such as provincial government and commune councils.
3. O&M budget necessary for the rehabilitated facilities needs to be arranged by both Government and FWUCs based on the analysis in the SAPROF Report.
4. Implementation of the Project will be jeopardized by drastic price increase of construction works-related items in Cambodia

Operation and Effect Indicators (Tentative):

1. Operation Indicators

| Indicator | Unit | Without Project | With Project |
|---|---|---|---|
| Irrigated area | ha | 760 | 12,760 |
| Cultivated area of paddy | ha | 14,260 | 16,800 |
| Cropping intensity | % | 104 | 132 |
| Number of FWUGs | nos. | 0 | 52 |
| Collection ratio of water charge | % | 0 | 80 |

2. Effect Indicators

| Indicator | Unit | Without Project | With Project |
|---|---|---|---|
| Paddy production | ton | 22,000 | 54,000 |
| Paddy yield | ton/ha | 1.5 | 3.2 |
| Annual income of farmer | Riel 1,000 | 785 | 2,069 |

Procedure of Data Collection

1. Statistical data, 2. Socio-economic survey 3. Report to be prepared by MOWRAM, 4. Progress Report to be prepared by technical consultant

Input (Expert /MM):

| | |
|---|---|
| ♦ Team Leader: | 1.30 M/M |
| ♦ Irrigation & Drainage Facilities: | 2.20 M/M |
| ♦ Irrigation & Drainage Plan and O&M: | 3.04 M/M |
| ♦ Agriculture: | 1.17 M/M |
| ♦ Project Evaluation: | 1.13 M/M |
| ♦ Environmental & Social Consideration: | 1.00M/M |
| ♦ Cost Estimate: | 0.67M/M |
| Total: | 10.50M/M |
| Local Consultant (2 numbers): | 1.50 M/M |

Feedback from Final Evaluation of Other Projects:

- Small-scale Irrigation Management Project (SSIMP-I: 1990-1995, SSIMP-II: 1995-1998, SSIMP-III: 1998-2002) (JBIC): In parallel with facilities development, establishment of O&M system is the key to materialize Project effect as planned. Therefore, proposed Project consist of both hardware and software activities.

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA

# FINAL REPORT

Location Map of the Project
Layout of Six Sub-Projects
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## Abbreviations

| | |
|---|---|
| ACLEDA | Association of Cambodian Local Economic Development Agencies |
| ADB | Asian Development Bank |
| AEO | Agricultural Extension Offices |
| AEWs | Agricultural Extension Workers |
| APIP | Agricultural Productivity Improvement Project |
| AQIP | Agricultural Quality Improvement Project |
| ASEAN | Association of South East Asian Nations |
| AusAID | Australian Agency for International Development |
| B/C | Benefit-Cost Ratio |
| BRPC | Battambang Rice Promotion Committee |
| CARDI | Cambodian Agricultural Research and Development Institute |
| CC | Commune Council |
| CCF | Construction Conversion Factor |
| CDRI | Cambodia Development Research Institute |
| CDC | Council for Development of Cambodia |
| CEC | Cation Exchange Capacity |
| CEDAC | Centre d'Etude de Development Agricole Cambodgien |
| CMAC | Cambodia Mine Action Center |
| CNMC | Cambodian National Mekong Committee |
| CS | Construction Supervision |
| DAALI | Department of Agronomy and Agricultural Land Improvement |
| DAFF | Department of Agriculture, Forestry and Fisheries, MAFF |
| DAE | Department of Agriculture Extension |
| DAFO | District Agriculture and Forestry Office |
| DANIDA | Danish International Development Agency |
| DAO | District Agricultural Office |
| DD | Detail Design |
| DHRW | Department of Hydrology and River Works |
| DOM | Department of Meteorology |
| ED | Engineering Department, MOWRAM |
| EDC | Electricite du Cambodia |
| EDP | External Development Partner |
| EIA | Environmental Impact Assessment |
| EIRR | Economic Internal Rate of Return |
| EPP | Extension Program Package |
| EU | European Union |
| FAO | Food and Agriculture Organization of the United Nations |
| FFS | Farmer Field School |
| FG | Farmers Group |
| FO | Farmers' Organization |
| F/S | Feasibility Study |
| FWUC | Farmer Water User Community |
| FWUG | Farmer Water User Group |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| GOC | Government of Cambodia |
| GOJ | Government of Japan |
| H.E | His Excellency |

| | |
|---|---|
| HH | Household |
| HYV | High Yielding Variety |
| IBRD | International Bank for Reconstruction and Development |
| IDD | Irrigation and Drainage Department, MOWRAM |
| IEE | Initial Environmental Examination |
| IEAD | International Fund for Agricultural Development |
| IEIA | Initial Environmental Impact Assessment |
| IFAD | International Fund for Agricultural Development |
| IFFS | Intensive Farmer Field School |
| ILO | International Labor Organization |
| IMF | International Monetary Fund |
| IMT | Irrigation Management Transfer |
| IO | International Organization |
| IPM | Integrated Pest Management |
| IRC | Inter-Ministerial Resettlement Committee |
| ISF | Irrigation Service Fee |
| IWRM | Integrated Water Resource Management |
| JICA | Japan International Cooperation Agency |
| L/C | Letter of Credit |
| MAFF | Ministry of Agriculture, Forestry and Fisheries |
| MDG | Millennium Development Goal |
| MEF | Ministry of Economics and Finance |
| M & E | Monitoring and Evaluation |
| MIS | Market Information System |
| MLMUPC | Ministry of Land Management, Urban Planning and Construction |
| MOE | Ministry of Environment |
| MOI | Ministry of Interior |
| MPWT | Ministry of Public Works and Transport |
| MOWRAM | Ministry of Water Resources and Meteorology |
| M/P | Master Plan Study |
| MRC | Mekong River Commission |
| MRD | Ministry of Rural Development |
| NCCD | National Coordination Committee for Decentralization |
| NPRS | National Poverty Reduction Strategy |
| NGO | Non Government Organization |
| O&M | Operation and Maintenance |
| PCM | Project Cycle Management |
| PDA | Provincial Department of Agriculture |
| PDE | Provincial Department of Environment |
| PDOWRAM | Provincial Department of Water Resources and Meteorology, MOWRAM |
| PICD | Planning and International Cooperation Department, MOWRAM |
| PIF | Provincial Investment Fund |
| PIMD | Participatory Irrigation Management and Development |
| PO | Project Owner |
| PRDC | Provincial Rural Development Committee |
| PRASAC II | Support Program for the Agricultural Sector in Cambodia |
| PSDD | Project to Support Democratic Development through Decentralization and Deconcentration |
| RGC | Royal Government of Cambodia |
| RRA | Rapid Rural Appraisal |

| | |
|---|---|
| SAW | Strategy on Agriculture and Water |
| SCF | Standard Conversion Factor |
| SEILA | Foundation Stone in Khmer: This word is used as national rural development program to 1- alleviate poverty and 2- Strengthen local governance and ownership of local government. (The Program ended in 2007) |
| SPFS | Special Program for Food Security |
| SAPROF | Special Assistance for Project Formation |
| SRI | System of Rice Intensification |
| SWR | Shadow Wage Rate |
| TWG | Technical Working Group |
| TOT | Training of Trainers |
| TSC | Technical Service Center for Irrigation and Meteorology |
| TSBR | Tonle Sap Biosphere Reserve |
| UN | United Nations |
| UNDP | United Nations Development Program |
| UNICEF | United Nations Children's Fund |
| UXO | Unexploded Ordnance |
| VDC | Village Development Committee |
| VEW | Village Extension Worker |
| WFP | World Food Program |
| WMO | World Meteorological Organization |
| WUG | Water User Group |

## Khmer Words Used in the Report

| | |
|---|---|
| Khet | Province |
| Srok | District |
| Khum | Commune |
| Phum | Village |
| Krom | Group or Sub-Group |
| Krom Samiki | Solidarity Group |
| Provasdai | Mutual Help |

## Measurement Units

**Extent**

$cm^2$ = square-centimeters (1.0 cm × 1.0 cm)
$m^2$ = square-meters (1.0 m × 1.0 m)
$km^2$ = square-kilometers (1.0 km × 1.0 km)
a = Are(100 $m^2$ or 0.01 ha.)
ha = hectares (10,000 $m^2$)
ac = acres (4,046.8 $m^2$ or 0.40468 ha.)

**Volume**

$cm^3$ = cubic-centimeters (1.0 cm × 1.0 cm × 1.0 cm or 1.0 m-lit.)
$m^3$ = cubic-meters (1.0 m × 1.0 m × 1.0 m or 1.0 k-lit.)
lit l = liter (1,000 $cm^3$)
MCM = million cubic meter

**Length**

mm = millimeters
cm = centimeters (cm = 10 mm)
m = meters (m = 100 cm)
km = kilometers (km = 1,000 m)

**Weight**

gr = grams
kg = kilograms (1,000 gr.)
ton = metric ton (1,000 kg)

**Power and Energy**

A = Ampere
V = Volt
W = Watt
kWh = kilowatt hour
HP = horse power

**Others**

ppm = parts per million
°C = degree centigrade
% = percent

**Currency**

US$ 1.0 = ¥ 96.8 = 4,114 Riel
(As instructed by JICA for Japanese ODA loan appraisal)
US$ = United State Dollars
¥ = Japanese Yen
R, Riel = Cambodian Riel

**Time**

sec = seconds
min = minutes (60 sec.)
hr = hours (60 min.)

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap*

*Irrigation and Drainage Rehabilitation and Improvement Project*

*Draft Final Report*

# *PART I*
# *SUMMARY*

# STUDY

## I. INTRODUCTION

### *Authority*

01. This Final Report is prepared in accordance with the Minutes of Discussion on the JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project (hereinafter referred to as SAPROF Study) between the Japan International Cooperation Agency (hereinafter referred to as JICA) and the Ministry of Water Resources and Meteorology (hereinafter referred to as MOWRAM) on March 26th, 2009. ***(1.1)***

### *Background*

02. In the National Poverty Reduction Strategy (NPRS) and the National Strategic Development Plan (NSDP), the Royal Government of Cambodia (RGC) put higher priority on the agriculture sector in order to alleviate poverty and achieve economic growth in the country. The country achieved food self-sufficiency in 1995. Unit yield and harvested area, however, remains to have sluggish growth, which needs to be improved. The West Tonle Sap Region, the target area of the Study, is one of the important granaries of the country, and therefore, the stabilization and increase of rice production in this area is of great importance to the country. Although the area has existing paddy fields extending to 420,000 ha, the irrigation rate is only less than 10%. Consequently agriculture production is in an unstable conditions. ***(1.2)***

03. Responding to such situation, JICA together with MOWRAM carried out Basin-Wide Basic Irrigation and Drainage Master Plan Study from January 2007 to March 2009. This study aimed to prepare the irrigation and drainage development master plan and action plan towards year 2020 for four river basins, namely (i) Battambang, (ii) Moung Russey, (iii) Pursat and (iv) Boribo. In addition, six irrigation areas consisting of (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach, were selected as priority projects, for which Pre-Feasibility Study (F/S) was carried out under the Study. Six irrigation systems were packaged into one Project, which is the **West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**. ***(1.2)***

04. The Study aims to upgrade the irrigation and drainage development plan prepared under the Basin-wide Basic Irrigation and Drainage Master Plan Study carried out by JICA and MOWRAM from January 2007 to March 2009 in order to contribute to the stabilization and increase of rice production in the western region of the Tonle Sap Lake. ***(1.3)***

05. Based on the Minutes of Discussion on the preparatory study, the scope of the SAPROF Study described in the Terms of Reference (TOR) prepared by JICA is summarized as follows: (i) TOR 1 - Review and confirm the necessity and viability of the Project and formulate the Project Scope, (ii) TOR 2 - Examine the details of the project components

and the basic plan and design, (iii) TOR 3 - The environmental and social consideration and (iv) TOR 4 - Project evaluation and study of project monitoring system. ***(1.4)***

## II. BACKGROUND

***National, Agricultural and Irrigation Policies***

06. The importance of agriculture, specifically irrigation development is elaborated in relevant policies and guidelines such as the: (i) National Poverty Reduction Strategy 2003-2005 (NPRS), (ii) National Strategy Development Plan (NSDP 2006-2010) and Agricultural Sector Strategic Development Plan 2006-2010. Based on such policies, the RGC established the Technical Working Group on Agriculture and Water (TWGAW) to meet one of the specific targets of NSDP 2006-2010. To achieve the over-arching goal, the TWGAW determined to implement the following five development programs during 2006-2010: (i) Institutional capacity building and management and support program for agriculture and the water sector, (ii) Food security support program, (iii) Agriculture and agri-business (value-chain) support program, (iv) Water resources, irrigation and land management program and (v) Agricultural and water resources education and extension program. ***(2.1.1, 2.1.2, 2.1.3 and 2.1.4)***

07. MOWRAM issued the Action Plan on Water Resources and Meteorology Management and Development based on the Rectangular Strategy Phase 2 (2009-2013). The plan has the purpose of elaborating actions to be taken in 2009-2013 in the irrigation sector based on the review of the lessons learnt and achievement in the past five years (2004-2008) so as to contribute to the stabilization and increase of food production in the country. The plan primarily indicates the (i) achievement in implementing water resources and meteorology in five years (2004-2008), (ii) strategy and action plan on water resources and meteorology (2009-2013), and (iii) on-going and future priority projects list. ***(2.1.5)***

08. In addition, MOWRAM prepared and issued six modules for Participatory Irrigation Management and Development (PIMD) in October 2003, stating that the crucial issues for sustainability of operation and maintenance of irrigation system are: (i) to establish efficient, sustainable, reliable and environment friendly irrigation systems, (ii) to promote irrigated agriculture ensuring food security and growth of the national economy, (iii) to increase gradually the role and responsibility of organized beneficiary-farmers in every stage of the implementation program to reduce the government's responsibility in irrigation development, (iv) to enhance the capability of FWUC in managing and safeguarding the irrigation systems, (v) to promote awareness of the beneficiary-farmers in taking over the management responsibility of the government managed irrigation schemes and expedite the transfer process to FWUC, (vi) to encourage the donor agencies to increase funding in developing and managing the irrigation systems with active involvement of the beneficiary-farmers, and (vii) to bring about uniformity in the selection and implementation process of irrigation development and management among the government institutions and supporting national and international agencies involved in

irrigation extension. ***(2.1.6)***

***Food Balance and Food Security***

09. Although rice production in Cambodia has been fluctuating, the country has achieved food-self-sufficiency in 1995. Based on the rice production data from 2002 to 2005, the production share of the West Tonle Sap Region[1] in the country's total rice production is 17% on average. By assuming that the current production contribution from the region to the country is to be maintained to catch up with population growth, the future production volumes of the region to be expected in years 2010, 2015 and 2020 are respectively estimated using different assumptions, as follows:

**Results of Food Balance using Different Assumptions**

(Unit: ton)

| Assumptions/ | Paddy Requirements 1/ | | | Contribution 2/ | | | Balance 3/ | | |
|---|---|---|---|---|---|---|---|---|---|
| Consumption | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 |
| Assumption 1 (Seed and post harvest loss: 13 %, Conversion rate to milled rice: 64 %: the figure utilized for the Food Balance Sheet of 2001 afterward) | | | | | | | | | |
| 143 kg/person (MAFF) | 4,302 | 4,821 | 5,406 | 731 | 820 | 919 | 71 | -18 | -117 |
| 155 kg/person (FAO) | 4,449 | 4,985 | 5,591 | 756 | 847 | 950 | 46 | -45 | -148 |
| 167 kg/person (Vietnam) | 4,793 | 5,371 | 6,023 | 815 | 913 | 1,023 | -13 | -111 | -222 |
| Assumption 2 (Seed and post harvest loss: 17 %, Conversion rate to milled rice: 62 %: the figure utilized for MAFF Food Balance Sheet before 2000) | | | | | | | | | |
| 143 kg/person (MAFF) | 4,696 | 5,261 | 5,901 | 798 | 894 | 1,003 | 4 | -92 | -201 |
| 155 kg/person (FAO) | 4,814 | 5,394 | 6,049 | 818 | 917 | 1,028 | -16 | -115 | -226 |
| 167 kg/person (Vietnam) | 5,187 | 5,811 | 6,517 | 882 | 988 | 1,108 | -80 | -186 | -306 |

1/: Estimated national paddy requirements for self-sufficiency

2/: 17% of the national requirements; expected contribution of the West Tonle Sap river basins to national production

3/: Paddy production increases required from the present level (802,000 tons) in the West Tonle Sap region

Note: Population increase is based on Population Projection published by the Ministry of Planning.

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

As shown in the table, even in the minimum level case assumed by the MAFF Food Balance Sheet, the increase in production required for the West Tonle Sap Region is 117,000 tons/year by 2020. Therefore, an increase in rice production in the region is necessary to maintain its granary status in the country in order to sustain national food security. ***(2.2)***

***Summary of Completed and On-going Projects***

10. The Government of Japan and JICA has been assisting the RGC through both hardware and software improvement approach in agriculture and irrigation sectors. Major projects are presented in the following table. ***(2.3)***

**Completed and On-going Projects related to the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**

| Fund | Project |
|---|---|
| Government of Japan and JICA | (i) Kandal Stung Irrigation Development Project (Grant Assistance)<br>(ii) Technical Service Centre Project (Technical Cooperation) |

[1] The West Tonle Sap Region covers: four river basins: (i) Battambang, (ii) Moung Russei, (iii) Pursat and (iv) Boribo, administratively covering three provinces: (i) Battambang, (ii) Pursat and (iii) Kampong Chhnang.

| Fund | Project |
|---|---|
| | (iii) Battambang Agriculture Productivity Enhancement Project (Technical Cooperation)<br>(iv) Battambang Rural Area Nurture and Development Project (Technical Cooperation)<br>(v) Bassac Reservoir Rehabilitation Project (Non-project Grant Assistance)<br>(vi) Toul Kou Irrigation Project (Grant Assistance for Grass-roots Project) |
| International Organizations and Donor Countries | (i) Northwest Irrigation Sector Project (ADB)<br>(ii) Tonle Sap Lowland Stabilization Project (ADB)<br>(iii) Multi-purpose Water Resources Development in Krang Ponley River Basin (KOICA)<br>(iv) Master Plan of Water Resources Development in Cambodia (KOICA)<br>(v) Water Resources Management Sector Project (ADB)<br>(vi) Feasibility Study on Stung Pursat Dam No. 3 and No. 5 Development Project (China) |
| RGC's Budget | (i) Damnak Ampil Weir Construction Project<br>(ii) Char Rek Weir Construction Project<br>(iii) Thlea Maom Irrigation Rehabilitation Project |

Prepared by JICA SAPROF Study Team

## III. SUMMARY OF THE PROJECT PROPOSED IN THE PREVIOUS STUDY

### *Background*

11. The Basin-Wide Basic Irrigation and Drainage Master Plan (M/P) Study was carried out from January 2007 to March 2009 to formulate the irrigation development master plan and action plan toward year 2020 for four river basins: (i) Battambang, (ii) Moung Russei, (iii) Pursat and (iv) Boribo. In addition, a Pre-Feasibility Study (Pre-F/S) was executed for priority projects selected in the M/P, which is the basis of this SAPROF Study. In the M/P, 21 irrigation projects were formulated, ranked and prioritized. On the basis of the prioritization result, the Road Map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020 (The Road Map 2020) was elaborated for three terms consisting of: (i) the short term (2008-2010), (ii) the medium term (2011-2015) and (iii) the long term (2016-2020) with the thematic target. The point stressed in The Road Map 2020 was "Learning Process" proposing the stepwise approach with gradual expansion in irrigation development and management. Periodic revision and update of the road map was also stressed based on the new data and lessons to be gained from project execution are utilized to improve for further implementation. ***(3.1.1, 3.1.2)***

### *Project Component*

12. In the M/P, six irrigation areas consisting of (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach, were selected as priority projects, for which Pre-F/S was carried out under the Study. The proposed Project is summarized as follows: ***(3.2.1)***

**West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project Proposed in the Basin-Wide Basic Irrigation and Drainage Master Plan**

| | Contents |
|---|---|
| Purpose | The Project aims to increase agriculture production and thereby alleviate poverty by promotion of irrigation rehabilitation as stressed in National Poverty Reduction Strategy and National Strategic Development Plan. |

| | Contents |
|---|---|
| Target | (1) Effective utilization of available resources in the Project area<br>(2) Contribution to national food security<br>(3) Vitalization of local economy<br>(4) Poverty alleviation of the country |
| Area | Six sub-projects located along the western coast of the Tonle Sap Lake<br>(1) Moung Russei River basin: (i) Ream Kon Sub-Project and (ii) Por Canal Sub-Project (Battambang Province)<br>(2) Pursat River basin: (i) Damnak Ampil Sub-Project, (ii) Wat Loung Sub-Project and (iii) Wat Chre Sub-Project (Pursat Province)<br>(3) Boribo River basin: Lum Hach Sub-Project (Kampong Chhnang Province) |
| Component | (1) Hard Component: Rehabilitation of irrigation and drainage facilities covering 12,760 ha<br>(2) Soft Component: (i) FWUC establishment and strengthening and (ii) agriculture extension activities<br>(3) Project Supporting Programs: (i) Meteo-hydrological Observation Strengthening Program, (ii) Capacity Development Support Program for MOWRAM and (iii) Capacity Development Support Program for PDOWRAM<br>(4) Project Formulation Study for other Potential Areas<br>(5) Consulting Services: (i) Detailed Design, (ii) Assistance to Tender, (iii) Construction Supervision, (iv) Support to Environmental Monitoring, (v) Support to O&M etc. |
| Period | 9 years in total (Hard Component: 5 years, Soft Component: 6 years) |
| Cost | US$ 98 million in total<br>(1) Hard Component: US$ 90 million,<br>(2) Soft Component: US$ 8 million |
| Project Evaluation | Economic Internal Rate of Return (EIRR): 12.8 %<br>B/C Ratio 1.62 |
| Executing Agency | Ministry of Water Resources and Meteorology (MOWRAM) |

Prepared by JICA SAPROF Study Team

## IV. PROJECT SCOPE

### *Necessity and Justification*

13. Water is the key limiting factor for agriculture and food production in Cambodia. Thus, the supply, quality and efficient use of water dominates agricultural production, and irrigation infrastructure is vital for the process as stressed in Cambodia's national and sectoral development policies. In order to supplement the NPRS in paving the way to poverty reduction and economic growth of the country, the National Strategic Development Plan (NSDP 2006-2010) describes rectangular strategies. Out of the four strategies, the increase of paddy planted area from 2.37 million ha in 2005 to 2.5 million ha in 2010 is set as one of the quantitative development targets in the Rectangular 1: Enhancement of Agriculture Sector. Improvement of yield from 1.97 ton/ha in 2005 to 2.4 ton/ha in 2010 is also elaborated. Through the review of activities so far, "Rectangular Strategy" Phase II were disclosed in 2008, which continuously support agriculture sector as one of the most important mission of the country. Although the detailed provincial level policy is not available, the importance of the agriculture sector including irrigation development in Battambang, Pursat and Kampong Chhnang provinces is emphasized in the provincial annual report document. In decentralized development programs such as SEILA and PSDD, irrigated agriculture development is one of the most important

activities to meet community needs as well as political targets. Therefore, the Project supporting the irrigation sector by integrating hardware and software components significantly contributes to the achievement of the targets set out in NSDP. ***(4.1.1)***

14. In its country assistance strategy to Cambodia, the Japanese Government addresses: (i) realization of sustainable economic growth and safe society, (ii) assistance to socially vulnerable groups, (iii) global issue, and (iv) alleviation of economic gap with other ASEAN countries. Based on the policy, the Government of Japan has been assisting Cambodia in: (i) social and economic infrastructure development, (ii) health and medical care, (iii) agriculture and rural development, (iv) human resource development and so forth through various assistance schemes such as Grant Assistance and technical assistance. JICA addresses driving vision, "*Inclusive and Dynamic Development*" with the following four missions of (i) addressing global agenda, including climate change, water, food, energy, infectious diseases and financing, (ii) reducing poverty through equitable growth, (iii) improving governance and (iv) achieving human security. Among others, reducing poverty through equitable growth is one of the most important agenda for many developing countries including Cambodia. JICA put emphasis on agricultural development as one of the important sectors in development assistance for poverty alleviation. Since the poverty rate in the rural area of Cambodia is significantly high, the proposed Project based on hardware and software component-integrated approach adequately conforms to the policy. ***(4.1.2)***

***Summary of Examination of the Project Scope***

15. The agriculture development plan in the previous study has been examined from the viewpoint of soil suitability for, and marketability of, upland crops/vegetables. As a result, the previous crop production plan has been slightly modified in consideration of the availability of irrigation water resources in the respective river sources, as follows ***(4.2.2)***

**Modified Crop Production Plan**

| Sub-project | Physical Area (ha) | Pre-F/S | | | | | | SAPROF | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Irrigation Status | Early | | Wet | Dry | | Irrigation Method | Early Wet | Wet |
| | | | Rice (ha) | V'ble (ha) | Rice (ha) | Rice (ha) | V'ble (ha) | | Rice (ha) | Rice (ha) |
| Ream Kon | 1,890 | Irrigated | 1,080 | 0 | 1,180 | 0 | 0 | Gravity | 960 | 1,610 |
| | | | | | | | | Pump | 170 | 280 |
| | | Rain-fed | 0 | 0 | 710 | 0 | 0 | Rain-fed | 0 | 0 |
| Por Canal | 1,940 | Irrigated | 1,120 | 190 | 1,220 | 0 | 0 | Gravity | 1,200 | 1,940 |
| | | Rain-fed | 0 | 0 | 720 | 0 | 0 | Rain-fed | 0 | 0 |
| Damnak Ampil | 2,270 | Irrigated | 0 | 340 | 2,270 | 0 | 0 | Gravity | 130 | 1,770 |
| | | | | | | | | Pump | 40 | 500 |
| Wat Loung | 2,540 | Irrigated | 0 | 380 | 2,540 | 0 | 0 | Gravity | 130 | 1,740 |
| | | | | | | | | Pump | 60 | 800 |
| Wat Chre | 1,020 | Irrigated | 150 | 150 | 1,020 | 0 | 0 | Gravity | 50 | 620 |
| | | | | | | | | Pump | 30 | 400 |
| Lum Hach | 3,100 | Irrigated | 1,200 | 210 | 3,100 | 100 | 410 | Gravity | 1,090 | 2,660 |
| | | | | | | | | Pump | 180 | 440 |
| Total | 12,760 | | 3,550 | 1,270 | 12,760 | 100 | 410 | | 4,040 | 12,760 |

Prepared by JICA SAPROF Study Team

16. The purpose of the Project is to establish equitable and timely irrigation water supply system by rehabilitating irrigation and drainage facilities to contribute to the stabilization of agricultural production of the sub-projects' command areas and consequently, to the alleviation of poverty in the target rural areas. On this basis, the components of the Project previously proposed are justified consisting of:

- Hardware Component: Rehabilitation of Irrigation and Drainage Facilities
- Software Component: FWUC Establishment and Strengthening and Agriculture Extension Activities
- Project Supporting Programs, and
- Project Formulation Study for Other Potential Areas ***(4.2.7)***

**Summary of Irrigation and Drainage Plan**

| No. | Description | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|---|
| 1. | Sub-project area (ha) | 1,890 | 1,940 | 2,270 | 2,540 | 1,020 | 3,100 | 12,760 |
| | (Pump irrigation area included above) | 280 | 0 | 500 | 800 | 400 | 440 | 2,420 |
| 2. | Annual irrigation area (ha) | 3,020 | 3,140 | 2,440 | 2,730 | 1,100 | 4,370 | 16,800 |
| | - Early wet season paddy (ha) | 1,130 | 1,200 | 170 | 190 | 80 | 1,270 | 4,040 |
| | - Medium wet season paddy (ha) | 1,890 | 1,940 | 2,270 | 2,540 | 1,020 | 3,100 | 12,760 |
| | - Dry season paddy (ha) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. | Major water source | Moung Russei River | | Pursat River | | | Boribo River | |
| | - Name of headworks | Moung Russei Headworks | | Damnak Ampil Headworks | | Wat Chre Headworks | Lum Hach Headworks | |
| | - Intake water level (EL. m) | 15.50 | 15.00 | 17.00 | 17.00 | 13.00 | 36.00 - 38.00 | |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.66 | 2.74 | 7.93 | 3.45 | 1.39 | 6.60 | |
| 4. | Main canals (nos.) | 1 | 1 | - | 1 | 1 | 1 | 5 |
| | - Total length (km) | 9.9 | 6.8 | - | 20.3 | 4.7 | 16.4 | 58.1 |
| 5. | Nos. of secondary/ sub-secondary canals | 13 | 9 | 3 | 10 | 6 | 11 | 52 |
| | - Total length (km) | 18.3 | 19.1 | 12.6 | 31.1 | 14.7 | 42.4 | 138.2 |
| 6. | Number of tertiary blocks (No.) | 45 | 42 | 50 | 54 | 27 | 69 | 287 |
| | Total length of tertiary canals (km) | 54 | 55 | 85 | 81 | 27 | 69 | 369.0 |
| 7. | Main drains | - Moung Russei, - Ou Anlong Rolus | - Moung Russei, - MD-1 | Ou Bakan/ Boeung Khnar River | Boeung Khnar River | - Boeung Khnar River, - Ta Paong stream | Boribo River | |
| | - Total length (km) | 7.2 | 5.6 | - | - | - | - | 12.8 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 | 7.17 | 6.32 | 6.32 | 6.32 | 6.83 | |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 | 19~25 | 18~25 | 18~25 | 18~25 | 19~25 | |
| 8. | Secondary drains (nos.) | 7 | 10 | 3 | 8 | 5 | 9 | 42 |
| | - Total length of seconday drains (km) | 13.4 | 14.8 | 21.8 | 37.7 | 11.5 | 35.7 | 134.9 |
| 9. | Collector drains (nos.) | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| | - Total length of collector drain (New, km) | 21.8 | 0.0 | 0 | 0 | 0 | 0 | 21.8 |

Prepared by JICA SAPROF Study Team

# IMPLEMENTATION PROGRAM

## I. PROJECT AREA

### *Project Area*

17. The location and administrations of each of the sub-projects are presented below : ***(1.1)***

**Location and Administration of Sub-project Areas**

| Sub-Project | River Basin | Province | Commune | No. of Villages | Population |
|---|---|---|---|---|---|
| Ream Kon | Moung Russei | Battambang | Kear, Chrey, Prey Svay | 6 | 4,667 |
| Por Canal | | | Chrey, Kear, Ta Loas, Kor Koah | 13 | 4,739 |
| Damnak Ampil | Pursat | Pursat | Lorlok Sar, Snam Preah, Trapeang Chong, Phteah Rung, Bak Chenhchien | 6 | 10,401 |
| Wat Loung | | | Lorlok Sar, Trapeang Chong, Snam Preah, Khnar Totueng, Boueng Khnar | 5 | 9,232 |
| Wat Chre | | | Boueng Khnar, Me Tuek | 4 | 3,797 |
| Lum Hach | Boribo | Kampong Chhnang | Krang Skear, Anchanh Rung, Prasneb, Phsar | 6 | 9,624 |
| Total | | | | 40 | 42,460 |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia (SEILA Database 2005)

### *Natural Conditions*

18. Meteo-hydrological conditions are tabulated as follows: ***(1.2.1, 1.2.2 and 1.2.3)***

**Meteo-hydrological Conditions of the Project Area**

| River Basin | Moung Russei | Pursat | Boribo |
|---|---|---|---|
| Sub-Project | Ream Kon and Por Canal | Damnak Ampil, Wat Loung and Wat Chre | Lum Hach |
| Average Annual Rainfall (mm) | 1,387 | 1,624 | 1,615 |
| Temperature (degrees Celsius) | | | |
| ♦ Annual | 28.1 | 28.0 | 28.4 |
| ♦ Maximum | 30.2 | 29.9 | 30.4 |
| ♦ Minimum | 24.0 | 25.4 | 26.4 |
| Five-day discharges (2001 to 2005 for Moung Russei and Pursat, and 1998 to 2007 for Boribo) | 3.23 $m^3$/sec or 102 MCM/year at the Basak Reservoir and 1.00 $m^3$/sec or 32 MCM/year at residual area between the Basak Reservoir and the National Road No. 5. | 76.4 $m^3$/sec or 2,426 MCM/year at existing headworks | 15.4 $m^3$/sec or 487 MCM/year at proposed headworks on the assumption that the 50 % of the water is allocated to the Pursat Province and the remaining is to the Kampong Chhnang Province at the Bomnak Station |

Prepared by JICA SAPROF Study Team based on MOWRAM

**Peak Flood Discharge at the Moung Russei Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 100 | 110 | 120 | 130 | 160 | 190 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Peak Flood Discharge at the Bac Trakoun Station located near Damnak Apil Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 710 | 970 | 1,130 | 1,270 | 1,440 | 1,560 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Peak Flood Discharge at the Proposed Lum Hach Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 220 | 270 | 290 | 320 | 380 | 430 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

## *Socio-Economic Conditions*

19. According to the definition by "A Poverty Profile of Cambodia 2004", poverty in Cambodia is estimated based on: (i) food poverty line and (ii) non-food allowance. The former is estimated to be Riel 1,684 (US$ 0.42) per day while the latter is Riel 440 (US$ 0.10) per day. Therefore, the total poverty line is Riel 2,124 (US$0.53) per day in average 2004 Phnom Penh prices. Provincial poverty headcount ratio is summarized in the above table showing that two provinces, Kampong Chhnang and Pursat indicate higher poverty ratio than the national average. On the other hand, Battambang Province is slightly better than the country's average. ***(1.3.2)***

**Provincial Level Poverty Headcount Ratio**

| Province | Poverty head count index (%) |
|---|---|
| Phonm Penh | 4.60 |
| Battambang | 33.69 |
| Kompong Chhnang/ Pursat | 39.57 |
| Cambodia | 35.13 |

Extracted from the Ministry of Planning (2006), A Poverty Profile of Cambodia 2004

20. Comparison of the poverty situation between urban and rural areas is summarized below. The table indicates that the country's poverty is rooted largely in rural areas where people primarily depend upon the agricultural sector that is currently lower productivity due to insufficient irrigation facilities. Although a share of agriculture sector in GDP is in declining trend in country's economy, more than 70% of the people are living in rural areas to support food security of the country. ***(1.3.2)***

**Poverty Headcount Ratio, Urban and Rural Areas**

| Region | Head Count Index (%) | | % of all Poor (%) | |
|---|---|---|---|---|
| | 1993/94 | 2004 | 1993/94 | 2004 |
| Poverty Line | | | | |
| Phom Penh | 11.39 | 4.6 | 3.1 | 2.3 |
| Other urban areas | 36.62 | 20.54 | 10.3 | 9.4 |
| Rural areas | 43.12 | 33.66 | 86.5 | 88.3 |
| Cambodia | 39.00 | 27.97 | 100.0 | 100.0 |
| Food poverty line | | | | |
| Phom Penh | 6.19 | 2.55 | 3.3 | 2.5 |
| Other urban areas | 19.63 | 12.5 | 10.8 | 11.3 |
| Rural areas | 21.95 | 16.66 | 85.9 | 86.2 |
| Cambodia | 20.00 | 14.18 | 100.0 | 100.0 |

Extracted from Ministry of Planning (2006), A poverty profile of Cambodia

21. In Cambodia, there are generally some gender issues pointed out such as: (i) unbalance in workloads due to more burden on women, particularly in housekeeping, (ii) income gap between men and women resulting from differences of opportunities in economic activities, (iii) difference in participation in social activities, and so forth. According to the socio-economic survey carried out in the previous study, activities of men and women are comparatively different. Women generally engage in housekeeping, farming and care of children, while men are in charge of other economic activities including manual labor for construction works. Both genders take charge of farm management. It was observed that women's participation to the workshop in the previous Study were comparatively

active, and there were no significant gender problems essentially addressed by the community members. The survey result showed that both men and women have equal access to and control of properties such as water source, land, livestock, and water source in all the sub-project areas. ***(1.3.3)***

### *Agriculture*

22. The present land use condition in command areas of the six sub-projects consists of an extensive distribution of paddy field. Due to prolonged malfunctioning of the existing irrigation systems in all sub-project areas, major parts of paddy fields are tilled under rain-fed condition, and some farmers are using portable pumps to get water from puddles for supplemental irrigation purposes. In general, farmers grow vegetables and other upland crops in their home yards in the residential places within villages. The current land use is summarized below. ***(1.4)***

**Present Land Use Condition of Sub-project Areas**

| Soil Sub-unit / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|
| Supplementally irrigated paddy field | 50 | 100 | 500 | 130 | 60 | 200 | 1,040 |
| Rain-fed paddy field | 1,970 | 1,970 | 1,930 | 2,590 | 1,030 | 3,120 | 12,610 |
| Paddy field total | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| Right-of-ways | 150 | 160 | 180 | 200 | 80 | 250 | 1,020 |
| Command area total | 2,170 | 2,230 | 2,610 | 2,920 | 1,170 | 3,570 | 14,670 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

23. A single cropping of rice under rain-fed condition for the wet season prevails in all the sub-project areas. Other crops, like watermelon, cucumber, gourd and pumpkin are grown by a few farmers either during early wet season or dry season. As shown below, therefore, the cropping intensity ranges between 101% and 120%. ***(1.4)***

**Cropping Pattern and Cropping Intensity in Sub-project Areas**

| Cropping Pattern / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|
| Total paddy field (ha) | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| Early wet season | 210 | 410 | 0 | 0 | 15 | 40 | 675 |
| - Pumping irrigated rice (ha) | *200* | *410* | *0* | *0* | *0* | *0* | *610* |
| - Other crops | *10* | *0* | *0* | *0* | *15* | *40* | *65* |
| Wet season | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| - Supplemental irrigated rice (ha) | *50* | *100* | *0* | *0* | *0* | 0 | *150* |
| - Rain-fed rice (ha) | *1,970* | *1,970* | *2,430* | *2,720* | *1,090* | *3,320* | *13,500* |
| Dry season | 0 | 0 | 60 | 75 | 15 | 0 | 150 |
| - Supplemental irrigated rice (ha) | *0* | *0* | *60* | *45* | *0* | *0* | *105* |
| - Other crops (ha) | *0* | *0* | *0* | *30* | *15* | *0* | *45* |
| Annual cropped area (ha) | 2,230 | 2,480 | 2,490 | 2,795 | 1,120 | 3,360 | 14,475 |
| Cropping intensity (%) | 110 | 120 | 102 | 103 | 103 | 101 | 106 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

### *Irrigation and Drainage*

24. Ream Kon Sub-Project: Originally, the Ream Kon irrigation system was developed in 1978 during the Pol Pot regime. Although headworks had been constructed on the Moung Russei River for the irrigation of both Ream Kon and Por Canal command areas, it has already deteriorated due to frequent flooding. In addition, the canal network has also

significantly damaged and is not functioning at present. ***(1.5)***

25. Por Canal Sub-Project: The system was constructed in 1978 during the Pol Pot regime, the command area of which is serviced by the Ream Kon Headworks. At present, only a part of the area is irrigated by gravity because the Ream Kon Headworks has not been functioning. Since the year 2007, the main canals were rehabilitated by MAFF under the Project ECOSORN, which is financially supported by the EU. The rehabilitated canals are thus in moderate conditions. ***(1.5)***

26. Damnak Ampil Sub-Project: The system was originally constructed in 1976 during the Pol Pot regime. The headworks and the canal systems, however, are seriously damaged by floods in 1979. New headworks was constructed in 2006 and the upstream portion of the main canal (7.3 km out of 23 km) together with checks and off-take structures, were rehabilitated by MOWRAM so as to irrigate the command area of 2,270 ha in total. Since then, one secondary canal was already rehabilitated in 2008, with the assistance of DANIDA, although no structures are provided or equipped. In addition, MOWRAM is planning to extend the main canals up to the connection with Svay Don Keo River. This is aimed to provide supplemental water from the Pursat River to several irrigation systems located along the Svay Done Keo River. ***(1.5)***

27. Wat Loung Sub-Project: The sub-project is located at the right bank of the Ou Bakan and Boeng Khnar Rivers. The irrigation system was originally developed in 1977 durring the Pol Pot regime. The system, however, was damaged in 1979 by the floods and has not been functioning until now. At present, only ruins of the headworks are observed on the Pursat River, approximately 3.5 km downstream of the Damnak Ampil headworks, which have no diversion functions. Thus, there is no water coming from the Pursat River at present. ***(1.5)***

28. Wat Chre Sub-Project: The Wat Chre sub-project was constructed along the Boeung Khnar River in 1977; however, it was damaged in 1979 and 1980 due to a series of floods in the area. The headworks had already been flushed away and the canal network is seriously deteriorated at present. No water is provided to the command area from the water source. The system's command area consists of: 1,020 ha at the right bank of the Boeng Khnar River and 480 ha at the left bank of the River. ***(1.5)***

29. Lum Hach Sub-Project: The Lum Hach irrigation system was completed in 1977 to utilize the Boribo River water for irrigation purpose. The system was damaged in 1981 and 1982, therefore, only some 300 ha are provided with water using pumps. There are two main irrigation systems along the Boribo River, one is the Lum Hach system located on the right bank of the river and the other is the O Roluss system on the left bank. The main canal of the O Roluss system was rehabilitated by MOWRAM in 2007. However, since the catchment of the existing O Roluss pond is too small, covering only 12.8 km2, the proposed Lum Hach headworks is expected to provide water to both the Lum Hach and the O Roluss systems. The road between the National Road No. 5 and the main canal is under rehabilitation by the Ministry of Public Works and Transport (MPWT). The

rehabilitated road is expected to contribute to the improvement of accessibility within the command area of the sub-project. ***(1.5)***

## II. THE PROJECT

### *Scope and Objective of the Project*

30. The target area of the Project is the six irrigation systems (hereinafter called sub-projects) located in the western region of the Tonle Sap Lake. The Project scope is summarized in the following table: ***(2.1.1)***

**Scope of the Project**

| Area | | | | Scope of the Project |
|---|---|---|---|---|
| **No.** | **Sub Project** | **River Basin** | **Province** | |
| 1 | Ream Kon | Moung Russei | Battambang | For the six Sub-Project Areas<br>*Hardware Component:*<br>(i) Rehabilitation of Irrigation and Drainage Facilities<br>*Software Component:*<br>(i) FWUC Establishment and Strengthening<br>(ii) Agriculture Support Services<br>For the Six Sub-Project Areas and Related River Basins<br>*Project Supporting Program:*<br>(i) Meteo-hydrological Observation Strengthening Program<br>*Project Formulation Study for Other Potential Areas*<br>For the Entire Country, including Related Provinces of the Sub-Projects<br>*Project Supporting Program:*<br>(ii) Capacity Development of MOWRAM Staff<br>(iii) Capacity Development of PDOWRAM Staff |
| 2 | Por Canal | | | |
| 3 | Damnak Ampil | Pursat | Pursat | |
| 4 | Wat Loung | | | |
| 5 | Wat Chre | | | |
| 6 | Lum Hach | Boribo | Kampong Chhnang | |

Prepared by JICA SAPROF Study Team

31. Summary of the Project design is tabulated as follows: ***(2.1.2, 2.1.3 and 2.1.4)***

**Summary of Project Design**

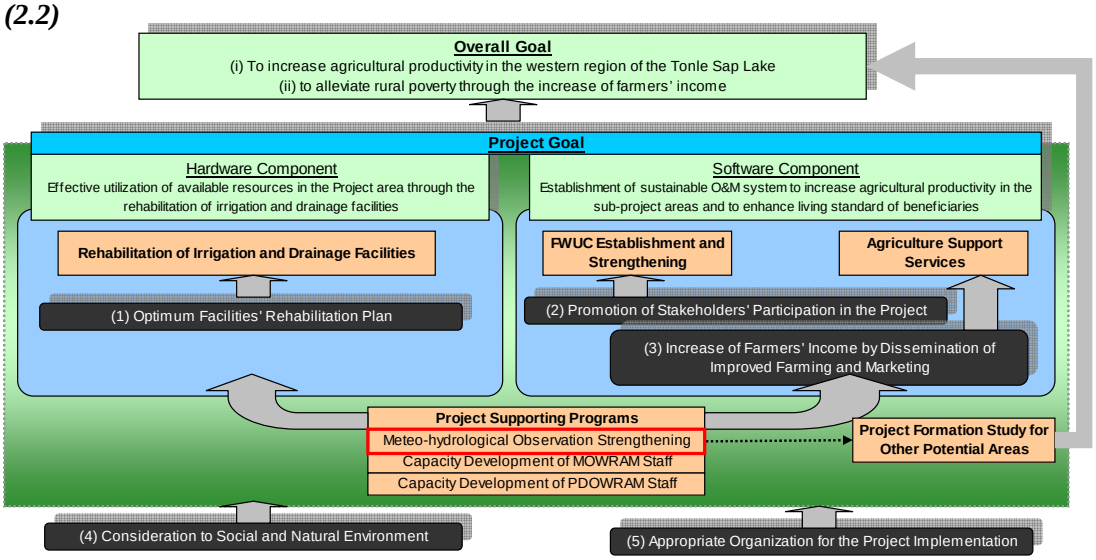
| |
|---|
| **Overall Goal**<br>(i) To increase agricultural productivity in the western region of the Tonle Sap Lake, and<br>(ii) To alleviate rural poverty through the increase of farmers' income. |
| **Objective**<br>(i) Effective utilization of available resources in the Project area through the rehabilitation of irrigation and drainage facilities.<br>(ii) Establishment of sustainable O&M system to increase agricultural productivity in the sub-project areas and to enhance the living standard of beneficiaries. |
| **Expected Output and Outcome**<br>(i) Materialization of equitable and efficient irrigation water distribution using rehabilitated irrigation and drainage facilities.<br>(ii) Increase of irrigated areas and cropping intensity under the six sub-projects.<br>(iii) Improvement of collection ratio of water charge among farmers' groups.<br>(iv) Increase of agricultural productivity contributing to the alleviation of rural poverty.<br>(v) Vitalization of rural economy. |

Prepared by JICA SAPROF Study Team

### *Approach and Strategy of the Project*

32. Effective utilization of three resources: (i) water, (ii) land and (iii) human is critically important to ensure the success of the irrigation and drainage development project. This

needs to be supported by the combination of hardware and software components in the development activities. The approach and strategy of the Project is illustrated as follows: ***(2.2)***

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**Approach and Strategy of the Project**

### *Project Component*

33. The proposed development areas and a summary of the crop production plan are as follows: ***(2.3.1)***

**Target Development Area under the Hardware Component**

| Sub-Project | Primary Benefit Area (ha)<br>Areas serviced by the main, secondary and tertiary irrigation facilities that are rehabilitated and constructed under the project | Secondary Benefit Area (ha)<br>Areas to be supplied with irrigation water from the water source through the rehabilitated main facilities under the project | Total (ha) |
|---|---|---|---|
| Ream Kon | 1,890 | 90 | 1,980 |
| Por Canal | 1,940 | 430 | 2,370 |
| Damnak Ampil | 2,270 | 8,930 | 11,200 |
| Wat Loung | 2,540 | 0 | 2,540 |
| Wat Chre | 1,020 | 0 | 1,020 |
| Lum Hach | 3,100 | 3,400 | 6,500 |
| Grand Total | 12,760 | 12,850 | 25,610 |

Prepared by JICA SAPROF Study Team

**Summary of Crop Production Plan under the Six Sub-Projects**

| Sub-Project | Irrigation Method | Irrigation Area (ha) | Cropping Season | |
|---|---|---|---|---|
| | | | Early Wet (ha) | Wet (ha) |
| Ream Kon | Gravity | 1,610 | 960 | 1,610 |
| | Pump | 280 | 170 | 280 |
| | Rain-fed | - | 0 | 0 |
| Por Canal | Gravity | 1,940 | 1,200 | 1,940 |
| | Rain-fed | - | 0 | 0 |
| Damnak Ampil | Gravity | 1,770 | 130 | 1,770 |
| | Pump | 500 | 40 | 500 |
| Wat Loung | Gravity | 1,740 | 130 | 1,740 |
| | Pump | 800 | 60 | 800 |
| Wat Chre | Gravity | 620 | 50 | 620 |
| | Pump | 400 | 30 | 400 |

| Sub-Project | Irrigation Method | Irrigation Area (ha) | Cropping Season | |
|---|---|---|---|---|
| | | | Early Wet (ha) | Wet (ha) |
| Lum Hach | Gravity | 2,660 | 1,090 | 2,660 |
| | Pump | 440 | 180 | 440 |
| Total | | 12,760 | 4,040 | 12,760 |

Prepared by JICA SAPROF Study Team

*Preparatory Works*

34. In the initial stage of the Project, topographic maps were prepared covering the command areas of the six sub-projects. An orthophoto, with the scale of 1:10,000, was already prepared during the Basin-Wide Basic Irrigation and Drainage Master Plan Study under JICA, thus, the result of the topographic survey will be overlaid on this photograph. The project office for MOWRAM staff and the Consultant is established, the location of which is within the MOWRAM headoffice space or nearby. Necessary equipment will also be procured, such as computer, photocopy machine, stationery, etc. In addition, the following vehicles will be acquired for the implementation of the Project: (i) four-wheel drive station wagon (4 nos.), (ii) four-wheel drive pick-up truck (6 nos.) and (iii) motorcycle (24 nos.). Different from the ordinary budgetary arrangement, a special account will be open for the Project after the loan agreement (L/A) is effective. MOWRAM will the prepare the annual financial expenditure plan based on the estimate of the cost necessary for the Project in detail and request this from the Ministry of Economy and Finance (MEF). ***(2.3.2)***

*Ream Kon Sub-Project*

35. In line with the project concept, the proposed crop production plan is focused on the promotion of double cropping of shorter maturity rice varieties during the wet season by fully utilizing the natural flow of the water source river. Assuming that improved pre- and post-harvest technologies of irrigated rice cultivation, including the proper use of water at the on-farm level are put into practice for the three-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Ream Kon sub-project are set up as shown below. ***(2.3.3)***

**Modified Cropping Area and Predicted Crop Production in Ream Kon Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 960 | 3.0 | 2,880 |
| | Pumping | Direct sowing | 170 | 3.0 | 510 |
| | Sub-total | | 1,130 | | 3,390 |
| Wet | Gravity | Transplanting | 960 | 3.3 | 3,168 |
| | Gravity | Direct sowing | 650 | 3.3 | 2,145 |
| | Pumping | Transplanting | 170 | 3.3 | 561 |
| | Pumping | Direct sowing | 110 | 3.3 | 363 |
| | Sub-total | | 1,890 | | 6,237 |
| Total | | | 3,020 | | 9,627 |

Prepared by JICA SAPROF Study Team

36. Facilities to be rehabilitated or reconstructed under the Project are as follows: ***(2.3.3)***

**List of Facilities under the Project (Ream Kon Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,890 |
| | (Pump irrigation area included above) | (280) |
| 2. | Annual irrigation area (ha) | 3,020 |
| | - Early wet season paddy (ha) | 1,130 |
| | - Medium wet season paddy (ha) | 1,890 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Moung Russei River |
| | - Name of headworks | Moung Russei Headworks (New) shared with Por Canal Sub-Project, dimensions of which are summarized afterward |
| | - Intake water level (EL. m) | 15.50 |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.66 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 9.9 |
| | - Turnout (nos.) | 14 |
| 5. | Nos. of secondary/ sub-secondary canals | 13 |
| | - Total length (km) | 18.3 |
| | - Turnout (nos.) | 43 |
| 6. | Number of Tertiary Blocks (No.) | 45 |
| | Total length of tertiary canals (km) | 54.0 |
| 7. | Main drains | - Moung Russei,<br>- Ou Anlong Rolus |
| | - Total length (km) | 7.2 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 7 |
| | - Total length of secondary drains (km) | 13.4 |
| 9. | Collector drains (nos.) | 3 |
| | - Total length of collector drain (New, km) | 21.8 |

Prepared by JICA SAPROF Study Team

**Moung Russei Headworks and Major Facilities**

| Items | Description |
|---|---|
| Moung Russei Diversion Weir<br>♦ Design Flood Discharge: Q=180$m^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 17.2m<br>♦ with Fish Ladder: B:2.0m x H:3.5m x L:35m (Half Cone Type) | ♦ Floating type weir with gates<br>♦ width x height x length (B:33.5m x H:10.7m x L:37.0m)<br>♦ Flood Gate: Fixed wheel gate (B:11.5m x H:3.8m x 2 nos.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m x H:3.8m x 1 no.) |
| Ream Kon Intake<br>♦ Design Discharge: Q=2.66$m^3$/s | ♦ -width x height x length: B3.5m x H:3.5m x L:7m<br>♦ -Slide Gate: B:1.0m x H:1.2m x 2nos. |

Prepared by JICA SAPROFStudy Team

*Por Canal Sub-Project*

37. Following the project concept, the proposed crop production plan is to be prepared focusing on the promotion of double cropping of shorter maturity rice varieties throughout the wet season by fully utilizing the natural flow of the Moung Russei River. Assuming that improved pre- and post-harvest technologies of rice cultivation are to be put into practice among beneficiary-farmers for the three-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Por Canal sub-project are made as shown bellow. ***(2.3.4)***

**Modified Cropping Area and Predicted Crop Production in Por Canal Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 1,200 | 3.0 | 3,600 |
| | Sub-total | | 1,200 | | 3,600 |
| Wet | Gravity | Transplanting | 1,200 | 3.3 | 3,960 |
| | Gravity | Direct sowing | 740 | 3.3 | 2,442 |
| | Sub-total | | 1,940 | | 6,402 |
| Total | | | 3,140 | | 10,002 |

Prepared by JICA SAPROF Study Team

38. Facilities to be rehabilitated and/or reconstructed under the Project are as follows: ***(2.3.4)***

**List of Facilities under the Project (Por Canal Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,940 |
| | (Pump irrigation area included above) | 0 |
| 2. | Annual irrigation area (ha) | 3,140 |
| | - Early wet season paddy (ha) | 1,200 |
| | - Medium wet season paddy (ha) | 1,940 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Moung Russei River |
| | - Name of headworks | Moung Russei Headworks (New) shared with Ream Kon Sub-Project |
| | - Intake water level (EL. m) | 15.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.74 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 6.8 |
| | - Turnout (nos.) | 8 |
| 5. | Nos. of secondary/ sub-secondary canals | 9 |
| | - Total length (km) | 19.1 |
| | - Turnout (nos.) | 44 |
| 6. | Number of Tertiary Blocks (No.) | 42 |
| | Total length of tertiary canals (km) | 55.0 |
| 7. | Main drains | - Moung Russei,<br>- MD-1 |
| | - Total length (km) | 5.6 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 10 |
| | - Total length of secondary drains (km) | 14.8 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0.0 |

Prepared by JICA SAPROF Study Team

*Damnak Ampil Sub-Project*

39. Considering the seasonal discharge limitation of the Pursat River as the irrigation water source for the Damnak Ampil, Wat Loung and Wat Chre sub-projects, the proposed crop production plan is to focus on single cropping of rice for the wet season in 93% of the irrigation command area. Thus, the double cropping area covers only 7%. Early ripening rice varieties are to be selected for the early wet season, while medium and medium late varieties will be grown for the wet season. Under the limited water resource of the Pursat River, farming practices for irrigated rice cultivation needs to be more improved than the other three sub-project areas in Batambang and Kampong Chhnang. Providing beneficiaries with intensive training programs in terms of pre- and post-harvest

technologies for the three-year period after irrigation water can be distributed to each farm plot, the target paddy yield and production in the command area of Damnak Ampil sub-project are prepared as shown below. ***(2.3.4)***

**Modified Cropping Area and Predicted Crop Production in Damnak Ampil Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 130 | 3.0 | 390 |
| | Pumping | Direct sowing | 40 | 3.0 | 120 |
| | Sub-total | | 170 | | 510 |
| Wet | Gravity | Transplanting | 1,770 | 3.3 | 5,841 |
| | Pumping | Transplanting | 500 | 3.3 | 1,650 |
| | Sub-total | | 2,270 | | 7,491 |
| Total | | | 2,440 | | 8,001 |

Prepared by JICA SAPROF Study Team

40. The facilities to be rehabilitated or reconstructed under the Project are as follows: ***(2.3.4)***

**List of Facilities under the Project (Damnak Ampil Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 2,270 |
| | (Pump irrigation area included above) | (500) |
| 2. | Annual irrigation area (ha) | 2,440 |
| | - Early wet season paddy (ha) | 170 |
| | - Medium wet season paddy (ha) | 2,270 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |
| | - Name of headworks | Damnak Ampil Headworks (Existing) Gate improvement works and fish ladder under the project is summarized below. |
| | - Intake water level (EL. m) | 17.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 7.93 |
| 4. | Main canals (nos.) | - |
| | - Total length (km) | - |
| | - Turnout (nos.) | 3 |
| 5. | Nos. of secondary/ sub-secondary canals | 3 |
| | - Total length (km) | 12.6 |
| | - Turnout (nos.) | 44 |
| 6. | Number of Tertiary Blocks (No.) | 50 |
| | Total length of tertiary canals (km) | 85.0 |
| 7. | Main drains | Ou Bakan/Boeung Khnar River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 3 |
| | - Total length of secondary drains (km) | 21.8 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

**Improvement Works for Damnak Ampil Weir Flood Gate System**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new hoist system (Replacement of present hoist) | 7 sets | ♦ 1-motor, 2-drum winch type with clutch for counter weight<br>♦ Local control panels w/ cable network system, hoist deck<br>♦ Generator 75 kVA<br>♦ Lightening rods with earthing network |

| Items | Contents | Remarks |
|---|---|---|
| Change of bushing (Replacement of present bushing) | 7 sets | Bushing with larger diameter and oil-less bearing for long durability since the existing bushings do not have enough strength for the proposed mechanical lifting |

Prepared by the JICA SAPROF Study Team

**Improvement Works for Damnak Ampil Weir Scouring Sluice Gate System**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new hoist system (Replacement of present hoist) | 4 sets | ♦ Rack type hoist with motor<br>♦ Local control panel |

Prepared by JICA SAPROF Study Team

**Dimension of Fish Ladder**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new fish ladder | 1 no. | ♦ Discharge: 4.71 m3/sec (maintenance flow + D&I flow) + residual<br>♦ Width: B=5.0m (common for above types)<br>♦ Slope: I = 1/10 (commonly for above types)<br>♦ Height: H=4.5m (Gate height-inlet water depth)<br>♦ Inlet elevation:EL.16.50m(Water depth=0.5m)<br>♦ Outlet elevation:EL.12.00m(Existing River Bed)<br>♦ Length: L6=45 m (=4.5/(1/10) ) |

Prepared by JICA SAPROF Study Team

*Wat Loung Sub-Project*

41. With the same concept on rice variety selection, the practice of double cropping system during the wet season because of limited discharge available in the Pursat River, and for fair opportunity of irrigation water use adopted for the Damnak Ampil sub-project, the modified cropping pattern of Wat Loung Sub-project is prepared. Similar attention has to be paid on how to improve farming practices on irrigated rice cultivation in the Wat Loung sub-project area. With the implementation of agricultural supporting activities for the three-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Wat Loung sub-project are drawn up as shown below. ***(2.3.5)***

**Modified Cropping Area and Predicted Crop Production in Wat Loung Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 130 | 3.0 | 390 |
| | Pumping | Direct sowing | 60 | 3.0 | 180 |
| | Sub-total | | 190 | | 570 |
| Wet | Gravity | Transplanting | 1,740 | 3.3 | 5,742 |
| | Pumping | Transplanting | 800 | 3.3 | 2,640 |
| | Sub-total | | 2,540 | | 8,382 |
| Total | | | 2,730 | | 8,952 |

Prepared by JICA SAPROF Study Team

42. Facilities to be rehabilitated or reconstructed under the Project are as follows: ***(2.3.5)***

**List of Facilities under the Project (Wat Loung Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 2,540 |
| | (Pump irrigation area included above) | (800) |
| 2. | Annual irrigation area (ha) | 2,730 |
| | - Early wet season paddy (ha) | 190 |
| | - Medium wet season paddy (ha) | 2,540 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |
| | - Name of headworks | Damnak Ampil Headworks (Existing) |

| No. | Description | Quantity |
|---|---|---|
| | - Intake water level (EL. m) | 17.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 3.45 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 20.3 |
| | - Turnout (nos.) | 12 |
| 5. | Nos. of secondary/ sub-secondary canals | 10 |
| | - Total length (km) | 31.1 |
| | - Turnout (nos.) | 52 |
| 6. | Number of Tertiary Blocks (No.) | 54 |
| | Total length of tertiary canals (km) | 81.0 |
| 7. | Main drains | Boeung Khnar River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 8 |
| | - Total length of secondary drains (km) | 37.7 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

*Wat Chre Sub-Project*

43. The modified cropping pattern for Wat Chre sub-project is made based on the same concept on rice variety selection, practice of double cropping system during the wet season because of limited discharge available in the Pursat River, and for fair opportunity of irrigation water use adopted for the Damnak Ampil sub-project. Transplanting method is to be fully practiced for the wet season cropping, while direct sowing method is put into practice for the early wet season cropping. With the implementation of agricultural supporting activities to improve pre- and post-harvest practices for irrigated rice cultivation for the three-year period after irrigation water can be distributed to each farm plot, the target paddy yield and production in the command area of Wat Chre sub-project are made as shown below. ***(2.3.6)***

**Modified Cropping Area and Predicted Crop Production in Wat Chre Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 50 | 3.0 | 150 |
| | Pumping | Direct sowing | 30 | 3.0 | 90 |
| | Sub-total | | 80 | | 240 |
| Wet | Gravity | Transplanting | 620 | 3.3 | 2,046 |
| | Pumping | Transplanting | 400 | 3.3 | 1,320 |
| | Sub-total | | 1,020 | | 3,366 |
| Total | | | 1,100 | | 3,606 |

Prepared by JICA SAPROF Study Team

44. Facilities to be rehabilitated or reconstructed under the Project are as follows: ***(2.3.6)***

**List of Facilities under the Project (Wat Chre Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,020 |
| | (Pump irrigation area included above) | 400 |
| 2. | Annual irrigation area (ha) | 1,100 |
| | - Early wet season paddy (ha) | 80 |
| | - Medium wet season paddy (ha) | 1,020 |

| No. | Description | Quantity |
|---|---|---|
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |
| | - Name of headworks | Wat Chre Headworks (Reconstruction) |
| | - Intake water level (EL. m) | 13.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 1.39 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 4.7 |
| | - Turnout (nos.) | 9 |
| 5. | Nos. of secondary/ sub-secondary canals | 6 |
| | - Total length (km) | 14.7 |
| | - Turnout (nos.) | 22 |
| 6. | Number of Tertiary Blocks (No.) | 27 |
| | Total length of tertiary canals (km) | 27.0 |
| 7. | Main drains | - Boeung Khnar R.,<br>- Ta Paong stream |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 5 |
| | - Total length of secondary drains (km) | 11.5 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

**Headworks and Major Facilities**

| Items | Description |
|---|---|
| Wat Chre Diversion Weir<br>♦ Design Flood Discharge: Q=65$m^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 13.6m<br>♦ with Fish Ladder: B:2.0m x H:3.1m x L:31m | ♦ Floating type weir with gates<br>♦ Width x height x length: B:20m x H:10.0m x L:35m<br>♦ Flood Gate: Fixed wheel gate (B:12.5m x H:3.4mx 1 no.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m x H:3.4m x 1 nos.) |
| Wat Chre Intake<br>♦ Design Discharge: Q=1.39$m^3$/s | ♦ Width x height x length: B:1.0m x H:2.4m x L:6m<br>♦ Slide Gate: B:1.0m x H:1.0m x 1 no. |

Prepared by JICA SAPROF Study Team

*Lum Hach Sub-Project*

45. In the Lum Hach sub-project area, irrigated rice cultivation can be carried out in around 40% of the command area for the early wet season and the whole area for the wet season. Aiming to enable all beneficiaries to fairly avail of double cropping opportunities, a five-year crop rotation system is to be introduced, comprising of the three-year single cropping of the wet season rice and two-year double cropping of the early wet season rice and the wet season rice. Early ripening rice varieties will be used for the early wet season cropping, while medium and medium late varieties are to be grown for the wet season cropping. Transplanting method is to be practiced for each cropping season. Assuming that beneficiary-farmers will put improved pre- and post-harvest technologies of rice cultivation into practice for the three-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Lum Hach sub-project are made as tabulated below. ***(2.3.7)***

**Modified Cropping Area and Predicted Crop Production in Lum Hach Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Transplanting | 1,090 | 3.0 | 3,270 |
| | Pumping | Transplanting | 180 | 3.0 | 540 |
| | Sub-total | | 1,270 | | 3,810 |
| Wet | Gravity | Transplanting | 2,660 | 3.3 | 8,778 |
| | Pumping | Transplanting | 440 | 3.3 | 1,452 |
| | Sub-total | | 3,100 | | 10,230 |
| Total | | | 4,370 | | 14,040 |

Prepared by JICA SAPROF Study Team

46. Facilities to be rehabilitated or reconstructed under the Project are as follows: ***(2.3.7)***

**List of Facilities under the Project (Lum Hach Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 3,100 |
| | (Pump irrigation area included above) | 440 |
| 2. | Annual irrigation area (ha) | 4,370 |
| | - Early wet season paddy (ha) | 1,270 |
| | - Medium wet season paddy (ha) | 3,100 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Boribo River |
| | - Name of headworks | Lum Hach Headwork (new construction) |
| | - Intake water level (EL. m) | 36.00 - 38.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 6.60 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 16.4 |
| | - Turnout (nos.) | 26 |
| 5. | Nos. of secondary/ sub-secondary canals | 11 |
| | - Total length (km) | 42.4 |
| | - Turnout (nos.) | 55 |
| 6. | Number of Tertiary Blocks (No.) | 69 |
| | Total length of tertiary canals (km) | 69.0 |
| 7. | Main drains | Boribo River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.83 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 9 |
| | - Total length of secondary drains (km) | 35.7 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

**Headworks and Major Facilities**

| Items | Description |
|---|---|
| Lum Huch Diversion Weir<br>♦ Design Flood Discharge: Q=430$m^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 38.0m<br>♦ Fish Ladder: B:2.0m x H:5.2m x L:52m | ♦ Floating type weir with gates<br>♦ width x height x length: B:60.5m x H:10.8m x L:31m<br>♦ Flood Gate: Fixed wheel gate (B:15 m x H:4.0m x 3 nos.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m xH:4m x 2 nos.) |
| Lum Hach Intake<br>♦ Design Discharge: Q=6.60$m^3$/s | ♦ width x height x length: B:7.1m x H:3.8m x L:9.5m<br>♦ Slide Gate: B:1.5m xH:1.5m x 3nos. |
| O Roluss Intake<br>♦ Design Discharge: Q=5.70$m^3$/s | ♦ width x height x length: B:5.7m x H:4.8m x L:15m<br>♦ Slide Gate: B:2.0m x H:1.5mx 2nos. |
| Lum Hach Approach Canal<br>♦ Design Discharge: Q=6.60$m^3$/s | ♦ width x height x length: B:3m x H:2.0m x L:750 m |

Prepared by JICA SAPROF Study Team

### *Ancillary Activities to Enhance Project Effect*

47. The outline of software component under the Project is as follows: ***(2.4.1)***

**FWUC Establishment and Strengthening**

| Item | Description |
|---|---|
| Objective | To materialize sustainable organizational set-up for irrigation water management and facilities' O&M |
| Strategy | ♦ Establishment of FWUC based on new layout of each sub-project<br>♦ Enhancement of FWUC's water management capability<br>♦ Strengthening of FWUCs capability in O&M of irrigation and drainage facilities<br>♦ Strengthening of organizational management capacity<br>♦ Establishment of water fee collection system |
| Activity | ♦ Support to establishment of FWUC<br>♦ Implementation of training programs in coordination with relevant organizations |
| Work Quantity | ♦ Number of FWUCs, FWUGs, Sub-FWUGs and WUGs to be established:<br>♦ Six FWUCs. 52 FWUGs, 287 sub-FWUGs and 2,552 WUGs<br>♦ Six times of walk-through survey to determine the tertiary alignment<br>♦ Three times of awareness program on FWUC's functions and responsibilities<br>♦ Three times of training programs on organizational management, water management and facilities' O&M<br>♦ Three times of training of trainers to train Sub-FWUGs' and WUGs' members<br>♦ Three times of follow-up workshops on sustainable irrigation system usage<br>♦ Six sets of manuals on irrigation water management and O&M activities<br>♦ Six sets of manuals on training of Sub-FWUGs' and WUGs' members |

Prepared by JICA SAPROF Study Team

**Agriculture Support Activities**

| Item | Description |
|---|---|
| Objective | To increase and stabilize rice farming in the sub-project areas |
| Strategy | ♦ Capacity development of both agricultural staff and farmers<br>♦ Training of trainers<br>♦ Commune-based agricultural extension<br>♦ Improvement of pre-harvest and post-harvest technologies<br>♦ Introduction of quality seed |
| Activity | ♦ Government Agricultural Staff Strengthening Program<br>♦ Training of Trainers Program for Capacity Development of Group Leaders acting as Agricultural Extension Agent<br>♦ Commune-based Agricultural Extension Agent Development Program<br>♦ Soil Fertility Diagnosis Program<br>♦ Pre-harvest Technology Group Training<br>♦ Post-harvest Technology Group Training Program on Farmers Field School Basis<br>♦ Quality Rice Seed Production and Distribution Program<br>♦ High Value Added Rice Production Promotion Program |
| Work Quantity | ♦ Three times of government agricultural staff strengthening program<br>♦ Six times of training of trainers program<br>♦ Six times of training programs for each program identified by needs analysis<br>♦ Commune-based agricultural extension manual<br>♦ Materials for training programs |

Prepared by JICA SAPROF Study Team

48. The outline of project supporting programs under the Project are as follows: ***(2.4.2)***

**Meteo-hydrological Observation Strengthening**

| Item | Description |
|---|---|
| Objective | ♦ To collect basic agro meteo-hydrological data, and<br>♦ To increase technical capability of MOWRAM and PDOWRAM in meteo-hydrological observation, data processing and analysis |
| Strategy | ♦ Enhancement of technical capability of relevant staff through on-the-job training |
| Activity | ♦ Preparation of manual for meteo-hydrological observation<br>♦ Training on meteo-hydrological data collection, processing and analysis<br>♦ Installation of equipment for meteo-hydrological observation in the selected |

| Item | Description |
|---|---|
| | points in the river basins (additional 12 nos. of equipment: 20 % increase in number from present conditions) |
| Work Quantity | ♦ Four sets of manual on meteo-hydrological observation<br>♦ Four times of workshop on introduction of manuals<br>♦ On-the-job training<br>♦ Follow-up workshop on sustainable water resources development<br>♦ Installation of equipment for meteo-hydrological observation at 12 points (20% increase in number from present conditions) |

Prepared by JICA SAPROF Study Team

**Capacity Development of MOWRAM Staff**

| Item | Description |
|---|---|
| Objective | ♦ To increase technical capability of MOWRAM staff in construction supervision |
| Strategy | ♦ Preparation of practical manual for construction supervision based on hardware component<br>♦ Dissemination workshops and training programs |
| Activity | ♦ Preparation of construction supervision manuals<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals<br>♦ Upgrade of the skills of MOWRAM staff for technical support to PDOWRAM staff in construction supervision |
| Work Quantity | ♦ Construction supervision manual<br>♦ Construction supervision manual for field use<br>♦ Eight times of dissemination and training workshops (two for MOWRAM, six for PDOWRAM) |

Prepared by JICA SAPROF Study Team

**Capacity Development of PDOWRAM Staff**

| Item | Description |
|---|---|
| Objective | ♦ To increase technical capability of PDOWRAM staff in construction supervision |
| Strategy | ♦ Preparation of practical manual for field use for construction supervision based on hardware component<br>♦ Dissemination workshops and training programs |
| Activity | ♦ Preparation of construction supervision manuals<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals<br>♦ Upgrade of the skills of PDOWRAM staff in construction supervision supported by MOWRAM |
| Work Quantity | ♦ As mentioned above |

Prepared by JICA SAPROF Study Team

49. The outline of the project formulation study for other potential areas is as follows: ***(2.4.2)***

**Project Formulation Study for Other Potential Areas**

| Item | Description |
|---|---|
| Objective | ♦ To prepare irrigation development plan for other potential areas |
| Strategy | ♦ Preparation of development plan for potential project using lessons learned as well as data to be obtained from the implementation of the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project |
| Activity | ♦ Screening of potential projects<br>♦ Selection of priority projects to be developed<br>♦ Assessment of available water resources through meteo-hydrological analysis<br>♦ Inventory survey of facilities<br>♦ Preparation of agriculture development plan<br>♦ Preparation of irrigation and drainage plan<br>♦ Cost estimates<br>♦ Preparation of implementation schedule |
| Work Quantity | ♦ Preparation of feasibility level development plan for second priority sub-projects (eight sub-projects) in the Basin-Wide Basic Irrigation and Drainage Master Plan Study totaling 24,050 ha. |

Prepared by JICA SAPROF Study Team

***Technical Assistance***

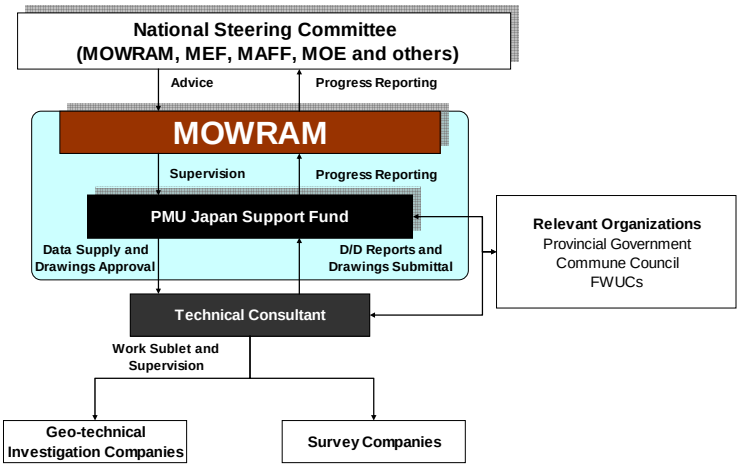
50. The purpose of technical assistance (T/A) is to advise and support the Project Management Unit (PMU) Japan Support Fund, an overall project management organization, in detailed design, construction supervision, software component and project supporting programs so as to accomplish the project objective and target. The technical consultant consists of a team of international and local consultants with different expertise to be attached to PMU Japan Support Fund. Approximate man-months necessary for the project consists of: 148 M/Ms for international consultants and 451 M/Ms for local consultants. ***(2.5.)***

## III. PROJECT IMPLEMENTATION AND O&M

***Project Implementation Plan***

51. The PMU Japan Support Fund will take responsibility for all project implementation and management activities by Japan's Official Development Assistance (ODA). Under PMU Japan Support Fund, five units are established to be in charge of each project activity through coordination with relevant technical departments at the national level. As for agriculture support activities, staffs will be dispatched from MAFF under the control of PMU Japan Support Fund to take charge of this component. At the provincial level, a Project Implementation Unit (PIU) will be established in each PDOWRAM to supervise activities of the project. In addition, particularly at the field level, agriculture support and FWUC strengthening activities will be jointly carried out by PDOWRAM, the Commune Councils (CCs.), and other relevant organizations. MOWRAM needs to assign professional engineers to the PMU Japan Support Fund to be supported by relevant technical departments at the central level. In addition, engineers need to be allocated to PIU at the provincial level from MOWRAM ***(3.1.1, 3.1.2)***

52. On the basis of above-mentioned conditions, the implementing system during D/D and C/S in the Project is as illustrated in the figures. ***(3.1.3)***

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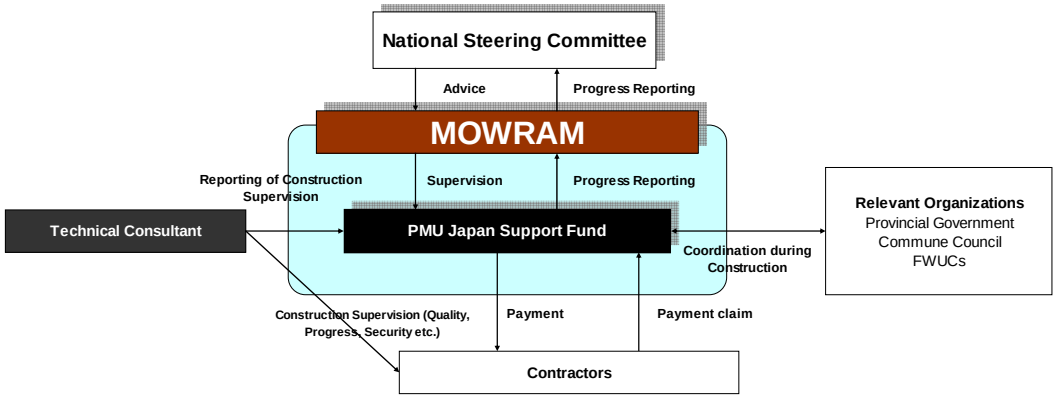
**Project Implementing System During Detailed Design**

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**Project Implementing System During Construction**

53. Under the technical cooperation, JICA has been assisting the Technical Service Centre (TSC) of Irrigation and Meteorology to enhance capability of the staff of both MOWRAM and PDOWRAM. Subsequently, the Improvement of Agricultural River Basin Management and Development Project (TSC-3) has commenced from September 2009, with its base in TSC and pilot areas in three provinces, namely Battambang, Pursat and Kampong Chhnang. Part of the work under the project is expected to be assisted by TSC-3, particularly activities with cross-cutting and broader objectives such as two capacity development programs. These are not the activities necessarily concentrated on the six sub-project areas but are related with the overall institutional strengthening which is one of the important missions of the TSC. ***(3.1.3)***

54. The procurement plan for each component of the Project is tabulated as follows: ***(3.1.4)***

**Method of Implementation for Each Component**

| Component | Activities | Method |
|---|---|---|
| Hardware Component: | Detailed Design | Implemented by the technical consultant selected though short-list method |
| Rehabilitation of Irrigation and Drainage Facilities | Rehabilitation and Reconstruction Works<br>♦ Irrigation Facilities<br>♦ Drainage Facilities<br>♦ Inspection Road | International Competitive Bidding (ICB) for Main and Secondary Systems<br>Local Competitive Bidding (LCB) for Tertiary Systems,<br>Works are supervised by the technical consultant |
| Software Component | FWUC Establishment and Strengthening | Implemented by MOWRAM/ PDOWRAM/ PDA and the technical consultant |
| | Agriculture Support Services | |
| Project Supporting Programs | Meteo-hydrological Observation Strengthening | Implemented by MOWRAM/ PDOWRAM and the technical consultant |
| | Capacity Development of MOWRAM | TSC in collaboration with the technical consultant |
| | Capacity Development of PDOWRAM | |
| Project Formulation Study | Feasibility study level planning for other potential areas | Implemented within the consulting services through coordination with construction supervision |

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55. The Project will be implemented for six years from 2010 to 2016. Two software components, the FWUC establishment and strengthening (3.5 years) and Agriculture Support Services (3 years), will be carried out for each sub-project in parallel with the construction works. Three project supporting programs: (i) Meteo-hydrological observation strengthening, (ii) Capacity development of MOWRAM staff and (iii) Capacity development of PDOWRAM staff, are to be implemented for three years, also concurrently with the hardware component. The project formulation study for other potential areas will be carried out in 2013 to prepare a feasibility study-level development plan for second priority projects in the Basin-wide Basic Irrigation and Drainage Master Plan Study by JICA based on lessons to be learnt from the project implementation. ***(3.1.5)***

***O&M Plan***

56. In accordance with regulations and guidelines related to O&M of irrigation and drainage facilities in Cambodia, the following issues need to be considered for the formulation of the O&M plan; (i) FWUCs need to be established at each irrigation system. (ii) Facilities are transferred to FWUCs depending upon the capability of the group based on the policy. Although the level of facilities are not clearly described in any document, the main and secondary facilities will be maintained by the government while tertiary facilities and below will generally be by FWUCs. (iii) The transfer of facilities will be made based on the consensus building and preparation of agreement document between MOWRAM and FWUC. (iv) Transfer of facilities from the government to FWUCs will be made gradually.

**O&M Responsibility Proposed for Irrigation and Drainage Facilities**

| Level / Activities | Headworks | Main Canal | Secondary canals | Tertiary canals |
|---|---|---|---|---|
| Preparation of annual O&M plan | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | PDOWRAM | FWUC |
| Preparation of cropping schedule | - | - | FWUC / FWUG | FUWG |
| Operation of facilities | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | PDOWRAM | FWUC |
| Maintenance work | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | FWUC | FWUC |

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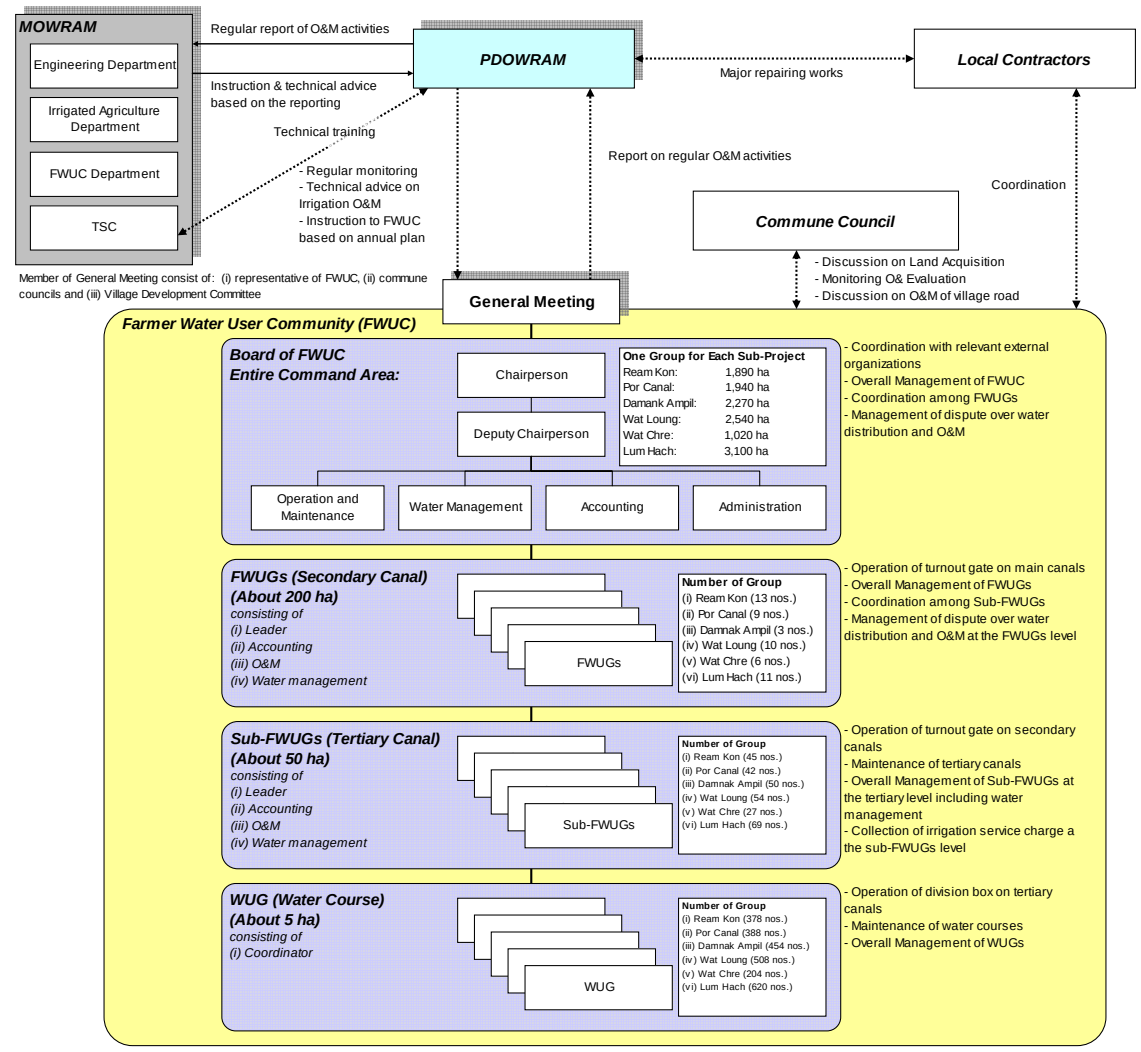


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**Proposed Organizational Set-up for O&M of Irrigation and Drainage Facilities**

Irrigation service fee (ISF) will cover all the O&M costs to be borne by FWUCs. ISF is tentatively set to be U$ 4.0/ha/cropping season for gravity irrigation and U$1.0/ha/cropping season for pump irrigation to cover necessary annual O&M cost to be borne by FWUCs as estimated above. During the project, the rate of ISF needs to be determined through consensus among members of FWUCs. ***(3.2)***

## IV. PROJECT COST ESTIMATE

### *Project Cost Estimate*

57. The initial investment cost for the Project is estimated at about US$ 49.1 million consisting of JPY 2.8 billion for the foreign currency (FC) portion and Riels. 83.8 billion for the local currency (LC) portion as shown in the following table. ***(4.2.1)***

**Initial Investment Cost for the Project**

| No. | Item | Total (US$ 1,000) | FC (JPY million) | LC (Riels. million) |
|---|---|---|---|---|
| 1. | Construction Cost | 31,693 | 1,921 | 48,722 |
| 2. | Procurement Cost | 464 | 35 | 428 |
| 3. | Consulting Services Cost | 5,485 | 304 | 9,621 |
| 4. | Soft Component Activities | 2,227 | 119 | 4,074 |
| 5. | Land Acquisition Cost | 665 | 0 | 2,736 |
| 6. | Project Administration Cost | 1,107 | 0 | 4,554 |
| 7. | Tax & Duty | 1,684 | 0 | 6,928 |
| 8. | Price Escalation | 3,546 | 267 | 3,243 |
| 9. | Physical Contingencies | 2,202 | 133 | 3,441 |
| 10. | Interest during Construction | 18 | 1 | 25 |
| | **Total** | **49,091** | **2,780** | **83,772** |
| Cost of Primary Benefit Area (12,760ha) | | | US$ 3,850/ha | |
| Cost of Primary and Secondary Benefit Area (25,610ha) | | | US$ 1,920/ha | |

Prepared by the JICA SAPROF Study Team

58. Annual operation and maintenance cost includes: (i) salaries and wages for staff personnel of FWUC consisting of board members of FWUC and Sub-FWUGs and (ii) direct cost for minimum office expenses and repair works. The annual operation and maintenance cost for the sub-projects is estimated at approximately US$10 per ha consisting of US$ 7 per ha by the government for main and secondary facilities, and US$ 3 per ha by FWUCs for tertiary facilities. Major repair cost, including replacement, will be executed every 10 years and the cost is assumed to be 5% of the construction costs, referring to similar types of the projects in Cambodia. The major repair cost for every 10 years is estimated at about US$ 1.8 million consisting of JPY 111 million for the FC portion and Riels 2.6 billion for the LC portion. ***(4.2.2)***

## V. PROJECT EVALUATION

### *Economic Evaluation*

59. The results of economic evaluation and sensitivity analysis are as follows: ***(5.2)***

**Results of Economic Analysis**

| NPV (Riel million) | B/C Ratio at 12% discount ratio | EIRR & Sensitivity Analysis (%) | | Cost | | |
|---|---|---|---|---|---|---|
| | | | | Normal | 10% up | 20% up |
| 99,536 | 1.10 | Benefit | Normal | 13.3 | 12.0 | 10.9 |
| | | | 10% down | 11.4 | 10.2 | 9.2 |
| | | | 20% down | 9.4 | 8.3 | 7.3 |

Prepared by JICA SAPROF Study Team

As seen above, it can be said that the proposed project is economically feasible under the conditions set up as described. ***(5.2)***

### *Financial Evaluation*

60. Financial evaluation of the proposed Project is undertaken in terms of financial viability

from the individual farmer's perspective, focusing on the beneficiary farmers' capacity to pay. Such payment is intended to partly shoulder the annual O&M cost from their increments of net farm income from irrigated rice cultivation. The average annual farmer's net income in the project area is estimated to increase by Riel 1,284,000/ha from Riel 785,000/ha at present to Riel 2,069,000/ha in the future. As the required annual O&M cost is estimated at US$ 10/ha or Riels 41,000/ha, an affordable portion of this cost can be covered with the increment of the net farm income. ***(5.3)***

***Indirect Benefit and Socio-Economic Impact***

61. In addition to the benefits derived from incremental increases in agricultural production, the Project will generate additional employment of around 82,000 person-days annually for the farming activities. It will be covered by the available family labor force of farm households. In addition, with increases in farmers' incomes, the farmers' ability to buy will rise in local markets. Particularly, businesses related to the agricultural service sector will be activated by improvement of farming conditions. This will impact positively on the general rural economy, stimulating increases in activity in other markets and indirectly increasing business opportunities for the local non-farming community. ***(5.4)***

**Operation Indicators (Tentative)**

| | Indicator | Unit | Without Project | With Project |
|---|---|---|---|---|
| 1 | Irrigated area | ha | 760 | 12,760 |
| 2 | Cultivated area of paddy | ha | 14,260 | 16,800 |
| 3 | Cropping intensity | % | 105 | 132 |
| 4 | Number of FWUGs | nos. | 0 | 52 |
| 5 | Collection ratio of water charge | % | 0 | 80 |

Prepared by JICA SAPROF Study Team

**Effect Indicators (Tentative)**

| | Indicator | Unit | Without Project | With Project |
|---|---|---|---|---|
| 1 | Paddy production | ton | 22,000 | 54,000 |
| 2 | Paddy yield | ton/ha | 1.5 | 3.2 |
| 3 | Annual income of farmer | Riel '000 | 785 | 2,069 |

Prepared by JICA SAPROF Study Team

62. Operation and effect indicators for the Project are proposed in the right table. ***(5.5.1, 5.5.2)***

## VI. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

***JBIC Guidelines for Confirmation of Environmental and Social Consideration (April 2002)***

63. Potential negative environmental impact anticipated on the basis of the JBIC checklist is summarized in the table as follows. Although it is not significant, four categories of the checklists are applicable as negative impacts by the Project. ***(6.3)***

**Potential Negative Environmental Impact Anticipated**

| Potential Impact | | Phase | | |
|---|---|---|---|---|
| Category | Item | Design | Construction | Operation |
| 1. Permits and Explanation | — | — | — | — |
| 2. Mitigation Measures | ♦ Water Quality<br>♦ Soil Contamination | — | — | ♦ Increase of agricultural input in the irrigation area |

| Potential Impact | | Phase | | |
|---|---|---|---|---|
| **Category** | **Item** | **Design** | **Construction** | **Operation** |
| 3. Natural Environment | ♦ Ecosystem | ― | ♦ Disturbance of fish migration by the headworks | ♦ Decrease in volume of flow in the downstream river |
| 4 Social Environment | ♦ Living and livelihood | ♦ Land acquisition by the construction of canals and drains | ― | ♦ Due to unequal water distribution |
| 5 Others | ♦ Impacts during Construction | ― | ♦ Degradation of sanitation condition and security by the inflow of workers<br>♦ Noise, vibrations, turbid water, dust, exhaust gases, and wastes caused by the construction works | ― |
| 6 Note | ― | ― | ― | ― |

Prepared by JICA SAPROF Study Team

64. On the basis of the negative impacts, seven mitigation measures are proposed for the Project: (i) Water pollution and soil contamination management, (ii) Construction of fish ladder, (iii) River maintenance flow control, (iv) Participatory land acquisition, (v) Improvement of irrigation water management and (vi) Environmental consideration in the preparation of the technical specifications for construction works. The adverse impacts identified above are not significant problems. ***(6.3.2)***

65. As for the consideration of socially vulnerable groups, it is proposed that the FWUC should have multiple functions to support community people. FWUC needs to be established and strengthened to carry out appropriate water management in the project. The organization's purpose is to effectively and sustainably manage and use the irrigation water. Moreover, the use of water should be equal for all the farmers without exception: women, old people, and those without land titles, in the sub-project areas. As the next phase of the organization, it is proposed to construct the system aiming to solve problems of rural economy, e.g. construction of the access nets to markets through the FWUC organization. If the system functions well, various people can use through the organization and have access to the market easily. Such activity may contribute to dissipate the problem of rural poverty. ***(6.6)***

## VII. CONCLUSIONS AND RECOMMENDATIONS

66. By combining hardware and software activities in the project, the area, 25,610 ha area, consisting of: primary benefit area (12,760 ha) and secondary benefit area (12,850 ha) will be benefited through (i) effective utilization of available resources through the rehabilitation of irrigation and drainage facilities and (ii) establishment of sustainable O&M system to increase agricultural productivity and to enhance living standards of farmers. The evaluation shows that the project is economically feasible and contributes to the enhancement of the "capacity to pay" of farmers. In addition, no significant adverse

environmental impact will be expected, if proposed mitigation measures are simultaneously carried out. In conclusion, the SAPROF Study Team recommends that the Project be carried out in the manner proposed in this SAPROF Study. ***(Chapter 7)***

67. The following issues need to be considered as risks for the smooth implementation of the project: (i) appropriate land acquisition procedure based on the regulation of the RGC through consensus building, which is most important in this process, (ii) establishment of coordinating mechanism among relevant organizations including local administration, (iii) arrangement of O&M budget necessary for the rehabilitated facilities by both government and FWUCs based on the analysis in the SAPROF Report and (iv) drastic price increase of construction works-related items. ***(Chapter 7)***

68. After the SAPROF Study, the following preparatory works and arrangement are recommended to be carried out by MOWRAM: (i) Discussion among relevant organizations consisting of MOWRAM, PDOWRAM of Battambang, Pursat and Kampong Chhnang, MEF, MAFF and MOE to commence the Project at the earliest possible stage, (ii) Arrangement for the establishment of the Steering Committee for the Project at the national level, (iii) Explanation of project contents to the members of the steering committee, (iv) Arrangement of provincial PIU and discussion with relevant local organizations and (v) arrangement necessary for land acquisition. ***(Chapter 7)***

# *PART II*
# *STUDY*

# PART-II STUDY

# CHAPTER 1 INTRODUCTION

## 1.1 Authority

This Final Report is prepared in accordance with the Minutes of Discussion on the JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project (hereinafter referred to as "SAPROF Study") between the Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Ministry of Water Resources and Meteorology (hereinafter referred to as "MOWRAM") on March 26th, 2009.

## 1.2 Background

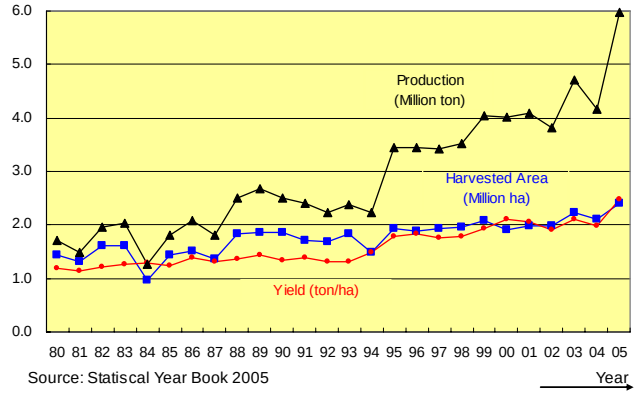
In the National Poverty Reduction Strategy (NPRS) and the National Strategic Development Plan (NSDP), the Royal Government of Cambodia (RGC) put higher priority on agriculture sector in order to alleviate poverty and to achieve economic growth in the country. Quantifiable development target shown in NSDP is tabulated on the right.

**Development Target in NSDP**

| Indicators | As of 2005 | 2010 (Target) |
|---|---|---|
| Paddy Planted Area (1,000 ha) | 2,374 | 2,500 |
| Yield (ton/ha) | 1.97 | 2.4 |
| Irrigation Area including Supplemental Irrigation (ha) | 588,687 | 650,000 |

Source: National Strategic Development Plan

Statistics on rice production of Cambodia is illustrated in the figure as follows. The country achieved food self-sufficiency in 1995. Unit yield and harvested area, however, remains sluggish growth, which needs to be improved. West Tonle Sap Region, the target area of the Study, is one of the important granary of the country, therefore, stabilization and increase of rice production in this area is of great importance to the country. Although this area have existing paddy field extending to 420,000 ha, irrigation rate is only less than 10 % so that agriculture production is in unstable conditions.




**Rice Production in Cambodia**

Corresponding to such situation, JICA together with MOWRAM carried out Basin-Wide Basic Irrigation and Drainage Master Plan Study from January 2007 to March 2009 to prepare irrigation and drainage development master plan and action plan toward year 2020 for four river basins: (i) Battambang, (ii) Moung Russei, (iii) Pursat and (iv) Boribo. In addition, six irrigation areas consisting of (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach, were selected as priority projects, for which Pre-F/S was carried out under the Study. Six irrigation

systems were packaged into one Project: **West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**.

### 1.3 Objective of the SAPROF Study

The Study aims to upgrade irrigation and drainage development plan prepared under the Basin-wide Basic Irrigation and Drainage Master Plan Study carried out among JICA and MOWRAM from January 2007 to March 2009 in order to contribute to stabilization and increase of the rice production in the Western Region of the Tonle Sap Lake.

### 1.4 Scope of the SAPROF Study

The scope of the SAPROF Study described in the Terms of Reference (TOR) prepared by JICA based on the Minutes of Discussion on the Preparatory Study is summarized as follows:

(1) TOR 1: Review and confirm the necessity and viability of the Project and formulate the Project Scope

- ♦ Review and confirmation of irrigation facilities to be rehabilitated
- ♦ Review of agriculture-related data and information
- ♦ Preparation of Technical Assistance Plan
- ♦ Confirmation of the importance and viability of the Project
- ♦ Formulation of Project Scope based on above-listed Study

(2) TOR 2: Examine the detail of the project component and the basic plan and design

- ♦ Study and review of design criteria for irrigation facilities
- ♦ Review of preliminary design prepared under Basin-Wide Basic Irrigation and Drainage Master Plan Study
- ♦ Study on Consulting Services necessary for the Project
- ♦ Study on procurement plan
- ♦ Preparation of annual implementation plan
- ♦ Review of unit construction cost
- ♦ Overall cost estimate
- ♦ Preparation of budget plan
- ♦ Confirmation on implementation organization
- ♦ Study on O&M plan

(3) TOR 3: The environmental and social consideration

- ♦ Preparation of environmental checklist based on relevant guidelines
- ♦ Social consideration

(4) TOR 4: Project evaluation and study of project monitoring system

- ♦ Preparation of operation and effect indicators (baseline, target, procedure etc.)
- ♦ Confirmation on intangible benefit from the Project
- ♦ Study on Economic Internal Rate of Return (EIRR) and financial analysis

## 1.5 Area of the SAPROF Study

Target area of the SAPROF Study is the six sub-projects: (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach extending to 12,760 ha as proposed in the previous Study.

## 1.6 Major Activities of the SAPROF Study

### 1.6.1 Team Members and Counterpart Personnel

Members of SAPROF Study Team and counterpart personnel assigned from MOWRAM are as follows:

**SAPROF Team Members and Counterpart Personnel**

| SAPROF Team Member | Position | Counterpart Personnel |
|---|---|---|
| 1. TOYA Yusaku | Team Leader | Dr. Teng Tara |
| 2. MIZUMA Shoji | Irrigation & Drainage Facilities | Mr. Sarun Sambath<br>Mr. Dom Ream Sey |
| 3. OTSUKA Shigeya | Irrigation & Drainage Plan and O&M | Mr. Khet Piseth |
| 4. MATSUMOTO Yutaka | Agriculture | Mr. Meas Savoeum |
| 5. KAWAI Takanori | Project Evaluation | Mr. Chea Vannarith |
| 6. MASAKI Junko | Environmental & Social Consideration | Mr. Chea Sophal |
| 7. TAMURA Keiji | Cost Estimate<br>(Assigned for home office work in Japan) | - |

Prepared by JICA SAPROF Study Team

### 1.6.2 Schedule

The schedule of the SAPROF Study is as follows:

**Schedule of the SAPROF Study**

| Step | Period | Major Output |
|---|---|---|
| 1. Preparatory Works in Japan | July, 2009 | Inception Report |
| 2. The First Field Work | August to September, 2009 | Findings based on the field survey |
| 3. The First Home Office Work | September to October, 2009 | Draft Final Report |
| 4. The Second Field Work | October to November, 2009 | Submittal and explanation of Draft Final Report |
| 5. The Second Home Office Work | November, 2009 | Final Report |

Prepared by JICA SAPROF Study Team

# CHAPTER 2 BACKGROUND

## 2.1 National, Agricultural and Irrigation Policies

### 2.1.1 National Poverty Reduction Strategy (2003 – 2005)

The National Poverty Reduction Strategy 2003-2005 (NPRS) was elaborated by the RGC in December 2002, aiming at reducing poverty and inequality, and improving the quality of life of the rapidly increasing poor in the country. The NPRS was formulated in the participatory process through frequent national workshops among relevant organizations. The NPRS proposes the eight priority actions for poverty reduction consisting of:

i) maintaining macroeconomic stability,
ii) improving rural livelihoods,
iii) expanding job opportunities,
iv) improving capabilities,
v) strengthening institutions and improving governance,
vi) reducing vulnerability and strengthening social inclusions,
vii) promoting gender equity, and
viii) priority focus on population.

The RGC has launched the revenue mobilization to achieve the targeted increase in revenue ratio from 9 % of GDP in 1998 to 14% by 2005 in order to achieve smooth implementation of these priority actions. The RGC established the poverty monitoring and analysis institutional framework early in 2002. The selected indicators for monitoring and evaluating the NPRS are: (i) resources from the RGC sources and donors, (ii) delivery capacity of institutions, (iii) timeframe of the NPRS, (iv) measurable and monitorable characteristics, (v) poverty-sensitivity of the indicators, (vi) baseline information, and (vii) capacity of the line agencies in collecting, maintaining and analyzing relevant information.

The NPRS was launched in March 2003. The Annual Progress Report prepared in August 2004 stated that the activities executed by the RGC were:

i) preparation of costed and prioritized programs in the annual budget,
ii) strengthening of budget management,
iii) governance improvement and corruption reduction,
iv) building of national capacity for poverty monitoring and evaluation of key programs and policies, and
v) focus on strategies of elaborating and implementing pro-poor rural and infrastructure development.

In the Report, the growth of agricultural sector is still given a high priority as an effective measure to alleviate the poverty in Cambodia.

### 2.1.2 National Strategy Development Plan (2006-2010)

The National Strategy Development Plan 2006-2010 was approved by the Council of Minister on 27 January 2006 and officially launched by Prime Minister of the RGC on 15 August 2006. It describes the *Rectangular Strategy for growth, employment, equity and efficiency* (RS), which provides the framework for Cambodia's socio-economic development. The Rectangular Strategy has four pillars for its implementation and four strategic growth rectangles. Each strategic growth rectangle has four sides:

i) Rectangle 1: Enhancement of Agriculture Sector,
ii) Rectangle 2: Further Rehabilitation and Construction of Physical Infrastructure,
iii) Rectangle 3: Private Sector Development and Employment Generation, and
iv) Rectangle 4: Capacity Building and Human Resource Development.

Each Rectangle covers the following strategic themes:

**Strategic Themes in Rectangular Strategy under NSDP**

| Rectangle | Strategic Themes |
|---|---|
| Rectangle 1: | (1) Improved productivity and diversification of agriculture |
| | (2) Land reform and clearing of mines |
| | (3) Fisheries reform |
| | (4) Forestry reform |
| Rectangle 2: | (1) Further restoration and construction transport infrastructure |
| | (2) Management of water resources and irrigation |
| | (3) Development of energy and power grids |
| | (4) Development of information and communication technology |
| Rectangle 3: | (1) Strengthened private sector and attraction of investments |
| | (2) Promotion of SMEs |
| | (3) Creation of jobs and ensuring improved working conditions |
| | (4) Establishment of social safety nets for civil servants, employees and workers |
| Rectangle 4: | (1) Enhanced quality of education |
| | (2) Improvement of health services |
| | (3) Fostering gender equity |
| | (4) Implementation of population policy |

Source: Address by Samdech HUN SEN Prime Minister of the Royal Government of Cambodia on Rectangular Strategy for Growth, Employment, Equity and Efficiency

Prioritizing on alleviating poverty and enhancing economic growth, the NSDP 2006-2010 places particular emphasis on *Enhancement of the agricultural sector* i.e. Rectangle 1. It states that "the priority goals in this sector are enhancement of food security, productivity and diversification, and market access for agricultural products. It outlines priority strategies for 2006-2010, the first of which is to "speedily formulate and implement a comprehensive Agriculture and Water Resources Strategy".

Rectangle 2 i.e. Rehabilitation and construction of physical infrastructure includes "management of water resources and irrigation" as one of its four components. The priorities in this component are closely related to agricultural use of water, and therefore to the NSDP's goals for the agricultural sector. By following the same concept, the RGC announced the Rectangular Strategy Phase-II as the "*Socio-Economic Policy Agenda*" of the "*Political Platform of the Royal Government of the fourth legislature of the National Assembly*" in 2008.[1]

### 2.1.3 Agricultural Sector Strategic Development Plan (2006-2010)

MAFF elaborated the Agricultural Sector Development Plan 2006-2010 based on main national development policy such as Rectangular Strategy and National Poverty Reduction 2003-2005.

In the Agricultural Sector Development Plan 2006-2010, the main sectoral goal is defined as "to ensure food security, increase incomes, create employment and improve nutrition status for all people by improving the productivity and diversification and commercialization of agriculture with the

[1] Address by Samdech Akka Moha Sena Padei Techo Hun Sen, Prime Minister of the Kingdom of Cambodia on "Rectangular Strategy" for Growth, Employment, Equity and Efficiency Phase II at the First Cabinet Meeting of the Fourth Legislature of the National Assembly, Phnom Penh, 26 September 2008

environmentally sound protection and food safety." In order to achieve the sectoral goal above mentioned, MAFF set seven specific objectives:

i) Food security, productivity, diversification,
ii) Improve and strengthen agricultural research and extension systems,
iii) Market access for agricultural products,
iv) Institutional and legislative development framework,
v) Land reform (land tenure and land market development and Pro-poor land access),
vi) Fisheries reform, and
vii) Forestry reform (promotion of conservation and management of sustainable forests, ensure better management of natural protected areas

The total cost was estimated at about US$153 million to implement and achieve all national priority goals.

The food security, productivity and diversification are given top priority among seven objectives based on the national development policy. Twenty-two action programs are proposed to maintain the food security, productivity and diversification. Out of them major actions related to the Project are as follows:

*Improve water management and available water supply for crop and livestock production through expanding irrigation and agricultural water supply, prioritizing food-insecure communities by:*

i) Promote higher returns from irrigation and rain-fed agriculture, through improving farming practices, diversification of crops types and support to distribution and marketing
ii) Improve 100,000 ha irrigation systems in potential production areas of irrigated and rain-fed areas, and promoting the participatory water management,
iii) Establish preparedness for risk reduction and disaster management dimensions in their activities to improve agricultural and livestock production (risk reduction and management of drought and flood impacts on crops, risk management of livestock diseases outbreaks)

### 2.1.4 Strategy for Agriculture and Water and Water, Irrigation and Land Management Program

(1) Strategy for Agriculture and Water

Strategy for Agriculture and Water (SAW) was prepared within the framework of the NSDP 2006-2010, and defines the long term vision and over-arching goal for agriculture and water resources management during 2006-2010:

i) Long term vision

To ensure enough, safe and accessible food and water for all people, reduce poverty, and contribute to economic growth, while ensuring the sustainability of natural resources.

ii) Over-arching goal

To contribute poverty reduction, food and economic growth through enhancing agricultural productivity and diversification, and improving water resources development and management.

(2) Water, Irrigation and Land Management Program under the Technical Working Group on Agriculture and Water

The RGC established the Technical Working Group on Agriculture and Water (TWGAW) to meet one of the specific targets of NSDP 2006-2010. To achieve the over-arching goal, the TWGAW determined to implement the following five development programs during 2006-2010.

i) Institutional capacity building and management and support program for agriculture and water sector
ii) Food security support program
iii) Agriculture and agri-business (value-chain) support program
iv) Water, irrigation and land management program
v) Agricultural and water resources, education and extension program

Every development program has been conceptualized by MOWRAM and MAFF under support of External Development Partners (EDPs) concerned. The development program iv) Water Resources, Irrigation and Land Management Program is given the development goal by SAW as follows:

> *Sustainable and pro-poor management of water resources, water management facilities, water-related hazards, and land resources that is integrated, efficient, are carried out in a river basin context.*

From October 2006 the program design team for the Water Resources, Irrigation and Land Management Program was formed by international and national experts funded by JICA as a pilot phase, and prepared a draft program design document. In the draft program design document 9 indicative components were proposed as follows:

i) Integrated, river basin-based Water and Land Utilization Planning
ii) Agro-ecosystems-analysis-based irrigation system development (based on i))
iii) Improvement of climatologic information
iv) Study of water potential for agriculture
v) Irrigation system rehabilitation and development (based on i))
vi) Participatory irrigation management and development including water use efficiency
vii) Participatory on-farm water and agricultural management training and extension
viii) Land allocation and tenure program
ix) Flood and drought preparedness program (based on i))

The major components related to the SAPROF Study are: (i) Integrated, river basin-based Water and Land Utilization Planning, (ii) Improvement of climatologic information, (iii) Study of water potential for agriculture, (iv) Irrigation System Rehabilitation and Development, (v) Participatory Irrigation Management and Development, (vi) Participatory On-farm Water and Agricultural Management Training and Extension.

Based on the lessons learnt during the pilot phase, TWGAW continues the activity to elaborate "indicative actions" and estimates of the resources required, to ensure that it provides a sound and comprehensive basis for resources allocation by ministry officials in the RGC and EDPs. Through the exercise, draft final report published in January 2009 shows sector review and proposal of programs including fund requirement.[2]

[2] MAFF and MOWRAM (2009), Strategy for Agriculture and Water 2006-2010 Program 4: Water, Irrigation and Land Management, Sector Review and Proposal of Program prepared by the Program Design Team, reviewed by the Task Management Support Group

### 2.1.5 Action Plan on Water Resources and Meteorology Management and Development (2009-2013)

MOWRAM issued the Action Plan on Water Resources and Meteorology Management and Development based on the Rectangular Strategy Phase 2 (2009-2013). The plan has the purpose of elaborating actions to be taken in 2009-2013 in irrigation sector based on the review of the lessons learnt and achievement in the past 5 years (2004-2008) so as to contribute to the stabilization and increase of food production in the country. The Plan primarily indicates: (i) the achievement in implementing water resources and meteorology in 5 years (2004-2008), (ii) the strategy and the action plan on water resources and meteorology (2009-2013) and (iii) on-going and future priority projects list.

The achievement in the past 5 years is summarized from the view point of: (i) legal framework, (ii) rehabilitation of irrigation infrastructure, (iii) drought intervention, flood mitigation and management, (iv) hydrological and meteorological basic information preparation and (v) human resources development.

Based on the achievement, strategic plan elaborated by MOWRAM for 2009-2013 is to:

> *effectively manage and develop water resources with fairness, and sustainability to ensure the eco-system to reduce the dangers caused by natural disasters: flood, drought on daily living and public property*

In order to implement the Action Plan on water resources and meteorology development and management (2009-2013) proposed, budget to be required from the RGC and foreign donors estimated in the Action Plan are US$735 million consisting of: (i) government budget US$99 million and (ii) foreign aid and development partners US$636 million. Annual budget to be required is as shown in the following table.

**Budget to be required for Water Resources and Meteorology Development and Management (2009-2013)**

| Year | Government Budget (US$1,000) | Foreign Aids and Development Partners (US$1,000) | | Total (US$1,000) |
|---|---|---|---|---|
| | | Committed | Not Committed | |
| 2009 | 13,902 | 31,200 | 0 | 45,102 |
| 2010 | 23,942 | 38,700 | 86,885 | 149,527 |
| 2011 | 22,625 | 50,300 | 98,863 | 171,788 |
| 2012 | 17,980 | 46,500 | 114,496 | 178,976 |
| 2013 | 20,971 | 39,500 | 129,730 | 190,201 |

---

The Report shows ten components of proposed programs:

(i) Component 1: Improvement of Water Data Management
(ii) Component 2: Development of Integrated Water Management
(iii) Component 3: Development of National Land Resource Assessment
(iv) Component 4: Improvement of the Productivity of Lowland Rice Soils
(v) Component 5: Improvement of the Productivity of Upland Soils for Sustainable Management and Utilization
(vi) Component 6: Strengthening of Smallholder Land Tenure Security and Productivity
(vii) Component 7: Strengthening of the Management of State Land Resources
(viii) Component 8: Provision of Information for Monitoring the Implementation and Impact of Land Use and Land Tenure Policies
(ix) Component:9: Continuation of the Development of Irrigation and Water Management Infrastructures with a more Participatory Design and in a more Integrated Way
(x) Component 10: Improvement of the Maintenance of the Water Management Infrastructures through a Transfer to or a Shared Management with the FWUC

| Year | Government Budget (US$1,000) | Foreign Aids and Development Partners (US$1,000) | | Total (US$1,000) |
|---|---|---|---|---|
| | | Committed | Not Committed | |
| Total | 99,420 | 206,200 | 429,974 | 735,594 |

Source: MOWRAM (2009), Action Plan on Water Resources and Meteorology Management and Development to contribute to the implementation of the Royal Government of Cambodia, Rectangular Strategy Phase 2 (2009-2013)

### 2.1.6 Policy for Participatory Irrigation Management and Development (PIMD)

The RGC has been trying to make sure of what the government has to do, what beneficiary can do regarding irrigation system and water management in the country as a part of integrated water resources management. In this line, MOWRAM prepared and issued six Modules for Participatory Irrigation Management and Development (PIMD) in October 2003 as follows:

i) Module 1: Introduction to Participatory Irrigation Management and Development (PIMD)
ii) Module 2: Participatory Irrigation Management and Development; Policy, Legal and Institutional Framework
iii) Module 3: Planning and Implementing Participatory Irrigation Management and Development at the National Level
iv) Module 4: Implementation of Participatory Irrigation Management and Development at Provincial and Irrigation System Levels
v) Module 5: Establishing and Developing the Farmer Water Users Community
vi) Module 6: Monitoring and Evaluation System for PIMD

The modules states that the crucial issues for sustainability of operation and maintenance of irrigation system are: (i) to establish efficient, sustainable, reliable and environment friendly irrigation systems, (ii) to promote irrigated agriculture ensuring food security and growth of national economy, (iii) to increase gradually the role and responsibility of organized beneficial farmers in every stage of implementation program to reduce the government's responsibility in irrigation development, (iv) to enhance the capability of FWUC in managing and safeguarding the irrigation systems, (v) to promote awareness of the beneficial farmers in taking over the management responsibility of the government managed irrigation schemes and expedite the transfer process to FWUC, (vi) to encourage the donor agencies for increased funding in developing and managing the irrigation systems with active involvement of beneficial farmers, and (vii) to bring about uniformity in selection and implementation process of irrigation development and management among the government institutions and supporting national and international agencies involved in irrigation extension.

Major policy, guidelines and manuals related with water management, irrigation and agriculture are listed as follows and described in Table II2.1.1.[3]

Water Resources

- National Water Resources Policy for the Kingdom of Cambodia

Water Management

- Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems
- Policy for Sustainability of Operation and Maintenance Irrigation Systems

[3] Sub-decrees related with water right, including: (i) water licensing and (ii) FWUC, are under drafting by MOWRAM.

- Steps in the Formation of a Farmer Water Users Community
- Training Manual for Participatory Irrigation management and Development (PIMD)
- Sub-Decree on Farmer Water User Community

Agricultural Cooperative

- Royal Decree on the Establishment and Functioning of Agricultural Cooperative, Union of Agricultural Cooperative and Pre-Agricultural Cooperative
- Model Statute of Agricultural Cooperative

## 2.2 Food Balance and Food Security

Although rice production of Cambodia has been showing fluctuation, the country has achieved food-self-sufficiency in 1995. The production share of the West Tonle Sap Region[4] in the country's rice production is 17 % on average according to the rice production data from 2002 to 2005. By assuming that the current production contributions from the region to the country are to be maintained to catch up with population growth, the production volumes required in this the region in years of 2010, 2015 and 2020 are respectively estimated using different assumptions as follows:

**Results of Food Balance using Different Assumptions**

(Unit: ton)

| Assumptions/ | Paddy Requirements 1/ | | | Contribution 2/ | | | Balance 3/ | | |
|---|---|---|---|---|---|---|---|---|---|
| Consumption | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 |
| Assumption 1 (Seed and post harvest loss: 13 %, Conversion rate to milled rice: 64 %: the figure utilized for the Food Balance Sheet of 2001 afterward) | | | | | | | | | |
| 143 kg/person (MAFF) | 4,302 | 4,821 | 5,406 | 731 | 820 | 919 | 71 | -18 | -117 |
| 155 kg/person (FAO) | 4,449 | 4,985 | 5,591 | 756 | 847 | 950 | 46 | -45 | -148 |
| 167 kg/person (Vietnam) | 4,793 | 5,371 | 6,023 | 815 | 913 | 1,023 | -13 | -111 | -222 |
| Assumption 2 (Seed and post harvest loss: 17 %, Conversion rate to milled rice: 62 %: the figure utilized for MAFF Food Balance Sheet before 2000) | | | | | | | | | |
| 143 kg/person (MAFF) | 4,696 | 5,261 | 5,901 | 798 | 894 | 1,003 | 4 | -92 | -201 |
| 155 kg/person (FAO) | 4,814 | 5,394 | 6,049 | 818 | 917 | 1,028 | -16 | -115 | -226 |
| 167 kg/person (Vietnam) | 5,187 | 5,811 | 6,517 | 882 | 988 | 1,108 | -80 | -186 | -306 |

1/: Estimated national paddy requirements for self-sufficiency

2/: 17% of the national requirements; expected contribution of the West Tonle Sap river basins to national production

3/: Paddy production increases required from the present level (802,000 tons) in the West Tonle Sap region

Note: Population increase is based on Population Projection published by the Ministry of Planning.

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

The assumptions applied for the analysis are: (i) 143 kg/person by MAFF Food Balance Sheet, (ii) 155 kg/person by FAO and (iii) 167 kg/person, the figure of Vietnam as a reference. As shown in the table, even in the case of minimum level assumed by the MAFF Food Balance Sheet, the production increase required for the West Tonle Sap Region is 117,000 tons/year by 2020. Therefore, an increase in rice production in the West Tonle Sap Region is necessary as maintaining granary of the country in order to maintain country's food security.

[4] The West Tonle Sap Region covers: four river basins: (i) Battambang, (ii) Moung Russei, (iii) Pursat and (iv) Boribo administratively covering three provinces: (i) Battambang, (ii) Pursat and (iii) Kampong Chhnang.

## 2.3 Summary of Completed and On-going Projects

### 2.3.1 Grant Assistance and Technical Cooperation by the Government of Japan

(1) Kandal Stung Irrigation Development Project

| | |
|---|---|
| Target area: | Kandal Stung District of Kandal Province |

Although population density of the suburbs of Phnom Penh is one of the highest in the country, the area have are lower fertile land with low river discharge. Infrastructure development is not sufficiently carried out and the socio-economic condition remains underdeveloped. Within such situation, the Kandal Stung area in the Kandal Stung District of Kandal Province extending along the right bank of the Prek Thnot River is inherent in comparatively fertile land, therefore, it is expected to play a role as a food supply station to the capital city, Phnom Penh.

**Main Canal Rehabilitated (July 11th, 2007) (Kandal Stung Irrigation Development Project)**

The Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburbs of Phnom Penh was carried out from 1994 to 1995, out of which Kandal Stung area was put higher priority for irrigation development with the assistance of JICA. On this basis, Basic Design Study on the Project for the Rehabilitation of the Kandal Stung Irrigation System was carried out from 2002 to 2004. The major facilities constructed and/or rehabilitated under Japan's Grant Assistance are as follows:

- ♦ Construction of new headworks : 1 no.
- ♦ Rehabilitation of regulators and 7th January Dam : 2 nos.
- ♦ Demolish regulator : 1 no.
- ♦ Construction of new intake : 1 no.
- ♦ Rehabilitation of main canal and related structures : 5.3 km
- ♦ Rehabilitation of O&M road : 9.3 km

The command area under the Kandal Stung Headworks has been utilized as a pilot area for the Technical Service Centre Project under the technical cooperation by JICA.

(2) Technical Service Centre Project Phase-2

| | |
|---|---|
| Target area: | Technical Service Centre of MOWRAM at Phnom Penh<br>Three Model Sites at (i) Kandal Stung, (ii) Takeo and (iii) Pursat |

The purpose of the Project is: (i) to enhance technical capability of MOWRAM and PDOWRAM and (ii) to improve farmers' capability in survey, planning, design, construction and O&M of irrigation and drainage facilities particularly for the tertiary level at the three pilot sites. Major activities of the Project are primarily to support to the following subjects: (i) preparation of guidelines and manuals in irrigation plan and design, (ii) training farmers through facilitating construction of tertiary canals and O&M of facilities at the pilot sites and (iii) contribution to the increase of agricultural productivity at the pilot areas.

According to the assessment jointly by the JICA evaluation study team and the MOWRAM, the results are summarized from the view point of project's relevance, effectiveness, efficiency, impact and

sustainability as follows:

**Result of the Evaluation of TSC-2**

| No. | Indicator | Result |
|---|---|---|
| 1 | Relevance | ♦ The Project is consistent with the policies of Cambodian Government such as the Rectangular Strategy and the National Strategic Development Plan (2006-2010) stressing the need of irrigation development to enhance agricultural productivity.<br>♦ Consistency with the ODA policies of Japanese Government was confirmed as Japanese ODA policy put priority on sustainable economic growth and social security for the support to Cambodia, and agriculture and rural development as well as improvement of agriculture productivity are considered as vital cooperation strategy in the assistance program. |
| 2. | Effectiveness | ♦ Both achievement of the curriculum target and satisfaction are judged to be high.<br>♦ Improvement of technical capability of MOWRAM, PDOWRAM staffs as well as training management of TSC have been achieved through the Project. |
| 3. | Efficiency | ♦ Appropriateness of input from both Japanese and Cambodian side are judged sufficient in timing, duration and quantity. |
| 4. | Impact | ♦ Not only the enhancement of capability of MOWRAM and PDOWRAM staffs, positive impacts have been observed such as increase of cropping intensity at the pilot sites. |
| 5. | Sustainability | ♦ Sustainability aspect is judged to be fair in general.<br>♦ Allocation of budget toward TSC after the Project would be smaller so that organizational sustainability of TSC system would be jeopardized.<br>♦ Regular technical update and upgrade needs to be carried out through further assistance.<br>♦ Technical capability needs to be expanded from tertiary level facilities to river basin and main facilities. |

Prepared by JICA SAPROF Study Team based on the Evaluation Report of JICA (2008)

The TSC-2 was completed in July 2009. On the basis of promising output, TSC-3 has commenced from September 2009 focusing on: (i) strengthening of training program and (ii) formulation of training courses on agricultural river basin management including the operation of six pilot sites in Battambang, Pursat and Kampong Chhnang Provinces.

(3) Battambang Rural Area Nurture and Development Project

| | |
|---|---|
| Target area: | Four districts in Battambang Province |

JICA implemented the Battambang Agricultural Productivity Enhancement Project (BAPEP) to establish rice farming technology as well as strengthening of farmers groups through collaboration with PDA.

By effectively utilizing the experiences and lessons learnt from BAPEP, the Battambang Rural Area Nurture and Development (BRAND) Project selected areas of four communes in four districts in Battambang Province so as to aggrandize agricultural support services by Battambang PDA and DAFO extension officers. General information of the BRAND is as follows:

| Item | Description |
|---|---|
| Counterpart Organization | ♦ Provincial Department of Agriculture (PDA) Battambang<br>♦ General Directorate of Agriculture (GDA), MAFF<br>♦ Department of Agriculture Extension (DAE) |
| Period | November 2006 to Match 2010 (3.5 years) |
| Purpose | Enhancement of agricultural extension delivery in 4 target communes in Battambbang Province |
| Beneficiaries | 40,000 people in 23 villages |
| Major target crops | Rice, vegetables and oranges |

Source: BRAND (2009)

The major activities under the Project are as follows:

- Confirmation of agriculture development potential and farmers' need
- Preparation of manual and guidelines for extension activities
- Dissemination of technologies of rice farming including: (i) salt water selection, (ii) hot water seed disinfection, (iii) appropriate seed rate and fertilization, though 36 demonstration farms and extension
- Provision and dissemination of qualified seed
- Support diversification of rural activities including livestock and fishery
- Support farmers' marketing activities by enhancing value-chain of agricultural products
- Support of Commune Councils to coordinate between commune investment plan and agriculture support services

Not only disseminating farming technology through the operation of the pilot farms, the BRAND has been contributing to the coordination among agricultural support services by MAFF and commune investment plan for maximizing ripple effect. In addition, under the technical support of the BRAND, the Battambang Rice Promotion Committee (BRPC) was established and strengthened with the aim of the improvement of milled rice quality and the promotion of marketing by public and private sectors.[5]

Major achievements of the BRAND are: (i) establishment of effective and applicable technologies in farming, (ii) establishment of dissemination mechanism of such technologies in collaboration with communes, villages, PDA and MAFF, (iii) capacity development of PDA staff, and (iv) establishment of collaboration mechanism on promoting rice sector by PDA and Public and Private Sectors.

(4) Bassac Reservoir Rehabilitation Project (Non-project Grant Assistance)

| | |
|---|---|
| Target area: | Moung Russei River Basin in the Battambang Province |

Bassac reservoir was constructed in upstream of Moung Russey River in Moung Russey District in 1975-1979. The construction work of the reservoir and irrigation facilities were not completed, and abandoned up today. The Government of Japan decided to assist the rehabilitation work of the project by Non-project Grant Assistance based on the request from MOWRAM and PDOWRAM Battambang Province. The project scope contains as follows: (i) dyke rehabilitation; slope protection by stone pitching, laterite surfacing on top, (ii) spillway rehabilitation; reconstruction, (iii) intake structure for Stung Sa Canal; construct a new structure, (iv) canal rehabilitation; excavation and (v) access road; 10 km laterite pavement.

**Spillway Completed in 2009 (August 10th, 2009) (Bassac Reservoir Rehabilitation Project)**

[5] BRPC has been established in August 2008 under the declaration of the Battambang Provincial Government. Main purpose of the committee is to promote aromatic variety rice through introducing quality grading and certification system. The committee is chaired by Vice Governor of the Battambang Province. There are four sub-committees:

(i) Quality Standard Sub-Committee to manage quality grading system,
(ii) Certification Sub-Committee to manage certification system,
(iii) Logo and Sample Sub-Committee for logo and package of products, and
(iv) Monitoring Sub-Committee to manage monitoring system

The rehabilitation works was completed in June 2009. The reservoir is reported to have 32 million m3 of effective storage[6], and possible to irrigate 20,000 ha.

(5) Toul Kou Irrigation Project (Grant Assistance for Grass-root Project)

| | |
|---|---|
| Target area: | Kien Villages, Kos Chum Commune, Sompovmeas District, Pursat Province |

The project was originally constructed in 1976, and left severely deteriorated. In 2004, the dyke and intake structure were rehabilitated under Grant Assistance for Grass-roots project. The irrigation system, however, needs canals and related structures to deliver irrigation water to fields.

The Government of Japan decided to assist irrigation development as a Gross-roots Project. The project scope contains as follows: (i) construction of dyke of 1,274m, (ii) construction of canal of 3,109m, (iii) construction of related structures 18 nos. and (iv) laterite surface spreading in 2,505m.

The total cost is estimated at US$79,810. After the rehabilitation work, the wet season and dry season irrigation area are expected to increase remarkably.

### 2.3.2 Project by Other Donor Agencies

(1) Northwest Irrigation Sector Project (ADB)

| | |
|---|---|
| Target area: | Four Provinces: (i) Pursat province, (ii) Battambang province, (iii) Banteay Meanchey province and (iv) Siem Reap province |
| Period | From 2004 to 2010 (7 years) |
| Cost | US$30.9 million for 39 nos. of eligible subprojects extending to 46,490 ha |

The objective of the Project is to achieve better use of water resources and promotion of irrigated agriculture through: (i) a comprehensive policy and strategic framework to be applied in the development of water resources, (ii) a better understanding knowledge and application of the integrated water resources management approach in a river basin context, (iii) improve water resources management through rehabilitated/upgraded small to medium-scale irrigation schemes and other water control infrastructure, (iv) a strengthened capacity of communities and institutions in planning, implementing , managing and maintaining such infrastructure, and (v) improved agricultural support services to the beneficially water users.

Out of 39, 17 sub-projects are located in the provinces of the West Tonle Sap region, therefore, water allocation to those sub-projects need to be considered to determine available water resources to six sub-projects under the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project.

(2) Tonle Sap Lowland Stabilization Project

| | |
|---|---|
| Target area: | Six Provinces: (i) Pursat province, (ii) Battambang province, (iii) Banteay Meanchey province, (iv) Siem Reap province, (v) Kampong Chhnang and (vi) Kampong Thom |
| Period | 7 years (originally proposed from 2008 to 2014) |
| Cost | US$32 million, out of which US$27 million is grant |

The objective of the Project is to improve livelihoods of households inhabiting the lowland project area so that they will be less inclined to unsustainably extract the natural resources of the Core and Buffer Zones of the Tonle Sap Biosphere Reserve (TSBR), thereby reducing the pressure on the

[6] Project Proposal for Bassac Reservoir Rehabilitation Project in Battambang Province, MOWRAM, October 2005

natural resources vital to the integrity of the TSBR.

The objective of the project is to prepare a design of a bankable project for possible ADB financing taking into account: (i) sustainable livelihood activities, (ii) environmental considerations, (iii) consultations of the stakeholders concerned and (iv) packaging of suitable investments in subprojects. The project (Study) selected 31 communes in six Provinces in the Tonle Sap basin. The project proposed the following components:

- Support to rural infrastructure such as irrigation facility, rural roads, bridges, culverts,
- Increasing options in rural communities such as on-farm income generating options, improving off-farm income generation options, improving access to micro-credit,
- Skills and awareness raised such as training and capacity development, enhance skills of farmer beneficiaries for income generation, agriculture and off-farm vocations, awareness of gender equality and environmental issue in rural community, and
- Environmental and social safeguards

The project cost is at US$32 million including US$27 million grant.

**Selected Communes of Tonle Sap Lowland Stabilization Project (Related to the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project only)**

| Province | District | Commune | River basin |
|---|---|---|---|
| Pursat | Bakan | Boeng Khnar | Pursat |
| | Bakan | Rumlech | Pursat |
| | Bakan | Khnar Toteng | Pursat |
| | Kandieng | Srae Sdok | Pursat |
| | Kandieng | Anlong Vil | Pursat |
| | Krakor | Tnaot Chum | Boribo |
| | Krakor | Kbal Trach | Boribo |
| Kampong Chhnang | Boribo | Khor Rang | Boribo |
| | Boribo | Melum | Boribo |
| | Boribo | Kampong Preah Koki | Boribo |
| | Kampong Tralach | Saeb | Boribo |

*1 Selected target communes of TSLSP (30 November 2006)
*2 Selected core communes of TSLSP (22 January 2007
Source: Draft Final Report TA No. 4756-CAM Tonle Sap Lowland Stabilization Project

(3) Multi-purpose Water Resources Development in Krang Ponley River Basin (KOICA)

| | |
|---|---|
| Target area: | Southern part of Boribo River Basin administratively covering two provinces: (i) Kampong Speu province and (ii) Kampong Chhnang province |
| Period | 2004 to 2011 for 8 years |
| Cost | US$33.5 million (Proposed construction cost for 16,982 ha) and US$3.74 million to be borne from RGC's Budget |

The project site is in Krang Ponley River sub-basin located in the southern part of Boribo River Basin. The project aims at to secure stability of irrigation water supply and provide rural water supply and electricity so that agricultural productivity is stabilized and increased. The main water sources of the project are Krang Ponley River and Prek Thnot River.

- Irrigation area: 16,982 ha (16,982 ha in wet season + 3220 ha in dry season)
- Cropping pattern: 16,982 ha in wet season paddy, 833 ha in dry season paddy, 2,387 ha upland crops in wet and dry seasons.

The project was planned to be implemented in approximately four years including detailed design,

bidding, construction supervision. The project cost was estimated at US$33.5 million including contingency (10%). The cost for improvement of secondary and tertiary irrigation canals, however, was not included in the above cost since the separate project is planned to be implemented by the RGC amounting to US$3,742,000. The feasibility study (F/S) revealed that the project was economically feasible at 8.6% of EIRR. The construction works commenced from the middle of 2009.

(4) Master Plan of Water Resources Development in Cambodia (KOICA)

| | |
|---|---|
| Target area: | Entire country |
| Period | April 2006 to November 2008 (Study period) |
| Cost | US$ 1,701 million (Proposed investment plan from 2009 to 2018)<br>US$189 million for multipurpose dam in the Sangkae River selected as priority projects |

The purpose of the Study was to establish medium and long term master plan and an action plan for water resources development in Cambodia including investment plan to respective river basin in order to efficiently utilize and manage water resources. The Study also covered feasibility study on the priority projects of water resources development selected in the master plan. On the basis of preliminary consumption projection for various sectors and resource assessment, investment plan was formulated for 42 river basins as a guideline. In addition, following recommendations were made: (i) Comprehensive water management scheme, (ii) Measures to the urbanization problems, (iii) Securing stability of water use, (iv) Safe water supply, (v) Ground water utilization, (vi) Comprehensive plan on the river environment and (vii) Investigation and R&D of water resources. In the master plan, the development of Battambang Multipurpose dam in the Sangkae River was selected as priority project for F/S.

**Main Features of Dam Proposed under the Study**

| | **Item** | **Features** |
|---|---|---|
| 1. | Water Source | |
| | River | Sangkae River |
| | Catchment area | 1,860 $km^2$ |
| | Annual mean runoff | 1,224 x $10^6$ $m^3$ |
| 2. | Dam and Reservoir | |
| | Location | Upstream of Sangkae River |
| | Height | 49.5 m |
| | Length | 3,970 m |
| | Total Storage | 897.2 x $10^6$ $m^3$ |
| 3. | Function | |
| | Water supply | 854.5 x $10^6$ $m^3$/year |
| | Flood control | 39.2 x $10^6$ $m^3$ |
| | Power generation | 61.5 GWh |

Source: KOICA and K-Water (2008), Master Plan of Water Resources Development in Cambodia

Although the propose dam is not directly related with six sub-projects under the SAPROF Study, potential areas for dam development would be similarly expected in the Moung Russei, Pursat and Boribo River Basins in the future.

(5) Water Resources Management Sector Project (ADB)

| | |
|---|---|
| Target area: | Four river basins: (i) Stung Sreng, (ii) Stung Staung, (iii) Stung Chikreng and Stung Sen administratively located in three provinces:<br>(i) Siem Reap province, (ii) Kampong Thom province and (iii) Banteay Meanchey province |
| Period | From the end of 2009 for 4.5 years (Proposed Plan) |
| Cost | US$44.9 million (Proposed cost for 27 sub-projects extending 21,880 ha) |

The overall objective of the Project is to reduce poverty and to ensure food security in mainly along the western coast of Tonle Sap Lake. The activities under the Project consist of following components.

i) ***Development of irrigation infrastructure***: rehabilitation of small to medium scale irrigation schemes approximately covering 20,000 ha of rice filed areas,
ii) ***Irrigated agriculture and livelihood support***: encouragement of high value non-rice crops, livestock husbandry and fish culture,
iii) ***Establishment and development of FWUC***: support to establish and/or develop an FWUC in each sub-project area by capacity building programs, and
iv) ***Capacity building for efficient project management***: capacity building of relevant institutions to expedite project implementation consisting of MOWRAM, PDOWRAM and PDAFF

As of the August 2009, negotiations between MOWRAM and donor agencies have been concluded and the Project will soon commence. As evident in proposed component of the Project, integral approach by combining facilities' rehabilitation and institutional development is essential in vitalizing irrigation sector.

(6) Feasibility Study on Stung Pursat Dam No. 3 and No. 5 Development Project

| | |
|---|---|
| Target area: | The Upstream of Pursat River Basin in the Pursat Province |
| Period | 34 months (Proposed construction period) |
| Cost | US$74 million (Proposed cost) |

With the assistance of China, feasibility study on dam development was completed in July 2009. The proposed dam site is located in the upstream of the Pursat River Basin. Two dams with the purpose of irrigation are proposed in the Study, main features of which are as follows:

**Salient features of Proposed Project**

| Description | Unit | No.3 Dam | No.5 Dam |
|---|---|---|---|
| Irrigation Area | ha | 2,800 | 3,400 |
| Catchment Area | $Km^2$ | 93.8 | 652 |
| ***Dimension of Dam*** | | | |
| Dam Type | Type | Concrete Gravity Dam | Concrete Gravity Dam |
| Normal Storage Capacity | $m^3$ | 24.5 million | 25.5 million |
| Flood Water Level | El (m) | 83.9 | 56.9 |
| Height | m | 41 | 35 |
| Crest Length | m | 480 | 370 |

Source: GDFC (2009), Feasibility Study on Stung Pursat Dam No. 3 & No. 5 Development Project

Proposed construction period is 34 months and the total investment cost estimated is US$ 74 million. EIRR expected from the Project is estimated to be 10.5 %.

### 2.3.3 Project by the Government of Cambodia

(1) Damnak Ampil Weir Construction Project

| | |
|---|---|
| Target area: | Pursat River in the Pursat Province |

Damnak Ampil weir and intake were constructed on the Pursat River in 2006 to replace an unfunctioning old weir which was constructed during Pol Pot regime. Overall objectives of the project is to support and contribute to the regional agricultural production needs by increasing crop production and to alleviated poverty in the rural area and to reduce economic gap between rural and urban area through enhancement of irrigated agricultural development. The beneficiary area is planed to be 27,467ha, 39,299 population in 12 communes in 3 districts. The Project cost was estimated at US$3.9 million approximately.

The project work comprised of the following component and completed in January 2006.

- Reconstruction of diversion weir across the river
  - Total length: 130m
  - Slide gate: W× H× no. of set=1.9m×3.50m×4sets
  - Nerpic type automatic gate: W× H× no. of set=10.25m×4.06m×7sets
  - Concrete pile foundation (W× D× L× nos. =0.30m×0.30m×6.0m×120nos.)
  - High water level=EL. 17.00m
  - Low water level=EL. 13.50m
- Construction of regulator (2 structures, its function is to take water from Pursat River to main canal; so it should be called as “Intake”)
  - Slide gate: W× H× no. of set=1.95m×2.5m×3sets per one regulator
  - Water level: EL. 17.00m
  - Bottom level: EL. 15.00m
- Rehabilitation of main canal
  - Total length of rehabilitation=7,316m
  - Bottom width=7.0m
  - Total depth=3.0m (a 1.0m wide berm is provided at 2.0m height from bottom)
  - Type of canal=trapezoidal cross section earth canal (inside slope=1:1.5),
  - Top width of embankment=4.0m for right and left side each
  - Width of laterite pavement=3.0m for right and left side each
- Construction of box culverts (10 structures)
  - Box culvert: W× H=1.50m×1.50m
  - Slide gate: W× H× no. of set=1.95m×3.50m×1set per one box culvert
- Construction of operation and maintenance office 1 structure
  - Floor 40m2

**Damnak Ampil Main Canal Completed in 2006 (February 2nd, 2008) (Damnak Ampil Weir Construction Project)**

(2) Char Rek Weir Construction Project

| | |
|---|---|
| Target area: | Pursat River in the Pursat Province |

Construction of the Char Rek weir on the Pursat River was completed in 2008 by MOWRAM force account using RGC budget. The weir is located about 50km downstream from the Damnak Ampil headworks. Irrigation areas under the Char Rek is assumed to be about 7,000 ha, and mostly located inside of transition zone of the Tonle Sap Lake.

**Cha Rec Headworks Completed in 2008 (August 11th, 2009) (Char Rek Weir Construction Project)**

(3) Thlea Maom Irrigation Rehabilitation Project (Government of Cambodia and JICA)

| | |
|---|---|
| Target area: | Tributaries of the Boribo River in the Pursat Province |

Thlea Maom Irrigation Rehabilitation Project is located in Boeung Kantuot Commune, Krakor District, Pursat Provinve in the Thlea Maom River basin, one of the tributaries of the Boribo River. The irrigation system was originally constructed in 1978, but deteriorated severely.

The PDOWRAM has strong intention to rehabilitate the system to irrigate about 1,700 ha. The design of rehabilitation work has been carried out in Technical Service Center Phase-II under JICA technical cooperation as a model pilot project for on-the-job training. The project scope consists of: (i) repairing barrage, (ii) rehabilitation of main canal 6.6km, (iii) rehabilitation of secondary canal 15.6km, (iv) rehabilitation of tertiary canal with the distance of 40km and (v) construction of canal related structures.

The project will be implemented in 3 phases, and the total cost is estimated at about US$ 1.1 million. The construction work will be executed by force account by MOWRAM/PDOWRAM. The budget will be expected to be financed by RGC.

# CHAPTER 3 SUMMARY OF THE PROJECT PROPOSED IN THE PREVIOUS STUDY

## 3.1 Background

### 3.1.1 General

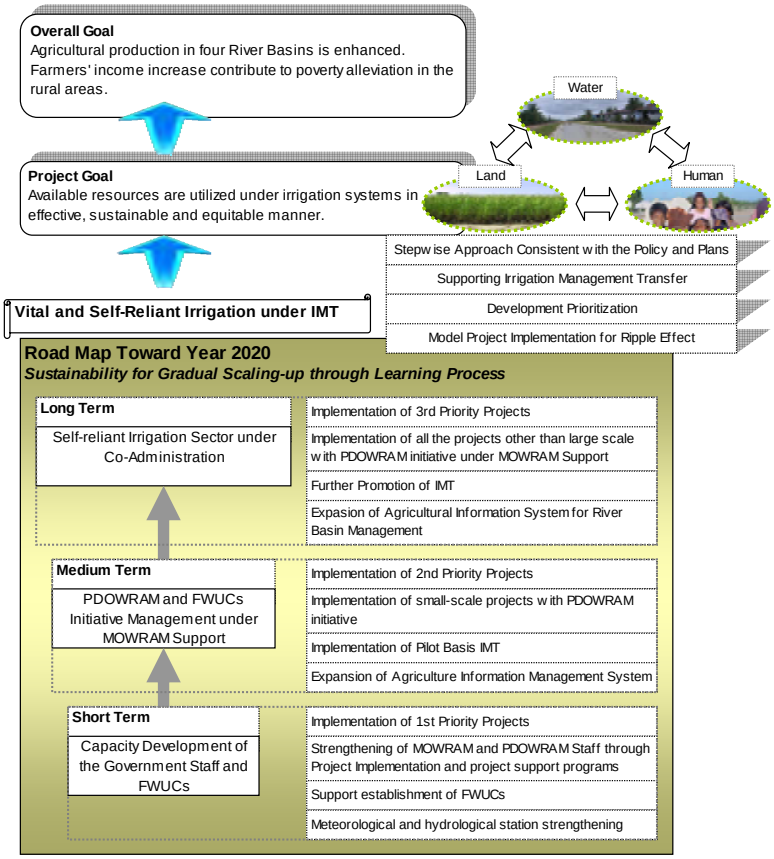
Prior to the SAPROF study, JICA together with MOWRAM carried out Basin-Wide Basic Irrigation and Drainage Master Plan Study from January 2007 to March 2009 to formulate irrigation and drainage development master plan and action plan toward year 2020 for four river basins: (i) Battambang, (ii) Moung Russei, (iii) Pursat and (iv) Boribo. In addition, Pre-feasibility Study (Pre-F/S) was carried out for priority projects selected in the Master Plan, which are the basis of SAPROF Study of West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project.

### 3.1.2 Master Plan and the Road Map 2020

In the previous Study, irrigation and drainage development master plan for four river basins were prepared through: (i) field survey in socio-economic conditions, agriculture, irrigation and drainage, environment and institutional aspect, (ii) development potential assessment, (iii) problem analysis, (iv) public consultation by way of socio-economic survey and the series of workshops. In the master plan, 21 numbers of irrigation projects were formulated in the four river basins.

Proposed 21 irrigation projects were ranked and prioritized using comprehensive sets of criteria: (i) resource factor, (ii) economic factor, (iii) social factor, (iv) environmental factor, (v) ease of implementation and (vi) maturity factor.

On the basis of prioritization result, the Road map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020 (The Road Map 2020) was elaborated for three terms consisting of: (i) the short term (2008-2010), (ii) the medium term (2011-2015) and (iii) the long term (2016-2020) with the thematic target, summary of which are as illustrated on the right figure. The point stressed in the Road Map 2020 was "Learning Process" proposing the stepwise approach with gradual expansion in irrigation development and management. Periodic revision and update was also




Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

**Illustrative Summary of the Road Map 2020**

stressed based on the new data, lessons to be gained from project implementation for further implementation.

### 3.1.3 Pre-Feasibility Study

In the Master Plan, six sub-projects consisting of (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach, were selected as priority projects, for which Pre-F/S was carried out.

The selected sub-projects were studied from the view point of agriculture, irrigation supporting services etc. to prepare improvement plans. Initial environmental examination (IEE) level study was also carried out to consider both social and natural environmental aspects in the project formulation. Six sub-projects were packaged into one Project: **West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**, descriptions of which are in the next section.

## 3.2 Project Component

### 3.2.1 Summary of the Project

On the basis of Pre-F/S for selected priority areas, the Project plan were proposed as summarized in the following table.

**West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project Proposed in the Basin-Wide Basic Irrigation and Drainage Master Plan**

| | Contents |
|---|---|
| Purpose | The Project aims to increase agriculture production and to thereby alleviate poverty by promotion of irrigation rehabilitation as stressed in National Poverty Reduction Strategy and Third National Strategic Development Plan. |
| Target | (1) Effective utilization of available resources in the Project area<br>(2) Contribution to national food security<br>(3) Vitalization of local economy<br>(4) Poverty alleviation of the country |
| Area | Six sub-projects located along the western coast of the Tonle Sap Lake<br>(1) Moung Russei River Basin: (i) Ream Kon Sub-Project and (ii) Por Canal Sub-Project (Battambang Province)<br>(2) Pursat River Basin: (i) Damnak Ampil Sub-Project, (ii) Wat Loung Sub-Project and (iii) Wat Chre Sub-Project (Pursat Province)<br>(3) Boribo River Basin: Lum Hach Sub-Project (Kampong Chhnang Province) |
| Component | (1) Hard Component: Rehabilitation of Irrigation and Drainage Facilities covering 12,760 ha<br>(2) Soft Component: (i) FWUC Establishment and Strengthening and (ii) Agriculture Extension Activities<br>(3) Project Supporting Programs: (i) Meteo-hydrological Observation Strengthening Program, (ii) Capacity Development Support Program for MOWRAM and (iii) Capacity Development Support Program for PDOWRAM<br>(4) Project Formulation Study for Other Potential Areas<br>(5) Consulting Services: (i) Detail Design, (ii) Assistance to Tender, (iii) Construction Supervision, (iv) Support to Environmental Monitoring, (v) Support to O&M etc. |
| Period | 9 years in total (Hard Component: 5 years, Soft Component: 6 years) |
| Cost | US$ 98 million in total<br>(1) Hard Component: US$ 90 million,<br>(2) Soft Component: US$ 8 million |

| | Contents |
|---|---|
| Project Evaluation | Economic Internal Rate of Return (EIRR): 12.8 %<br>B/C Ratio 1.62 |
| Executing Agency | Ministry of Water Resources and Meteorology (MOWRAM) |

Prepared by JICA SAPROF Study Team

Since harmonization of hardware (rehabilitation and development of facilities) and software (capacity building and institutional support) has been recognized as one of the most important keys for the success in irrigation projects, both hardware and software component were integrally proposed for the Project's activities in the previous Study.

### 3.2.2 Rehabilitation of Irrigation and Drainage Facilities

Rehabilitation plan of irrigation and drainage facilities for six sub-projects were prepared on the basis of following concepts:

i) clear demarcation of the command area and water distribution using rehabilitated facilities,
ii) suitable development scale based on the available resources,
iii) priority given to existing paddy field, and existing irrigation and drainage facilities,
iv) construction of additional facilities as appropriate,
v) appropriate drainage and flood protection measures considering allowable flooding depth and inundation period; floods from outside and habitual inundated area due to the Tonle Sap Lake and
vi) cost –effectiveness in the plan.

The rehabilitation and development plan of irrigation and drainage facilities for six sub-projects are tabulated as follows:

**Summary of Irrigation and Drainage Plan Prepared in the Previous Study**

| No. | Description | Name of sub-project | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | |
| 1. | Sub-project area (ha) | 1,890 | 1,940 | 2,270 | 2,540 | 1,020 | 3,100 | 12,760 |
| | (Pump irrigation area included above) | (280) | 0 | (500) | (800) | (400) | (410) | (2,390) |
| 2. | Annual irrigation area (ha) | 2,413 | 2,494 | 2,364 | 2,645 | 1,062 | 4,700 | 15,678 |
| | ♦ Early wet season paddy (ha) | 1,180 | 1,220 | 94 | 105 | 42 | 1,300 | 3,941 |
| | ♦ Medium wet season paddy (ha) | 1,180 | 1,220 | 2,270 | 2,540 | 1,020 | 3,100 | 11,330 |
| | ♦ Dry season paddy (ha) | 53 | 54 | 0 | 0 | 0 | 300 | 407 |
| 3. | Major water source | Moung Russei River | | Pursat River | | | Boribo River | - |
| | ♦ Headworks | Moung Russei (Reconstru-ction) | | Damnak Ampil (Existing) | | Wat Chre (Reconstru-ction) | Lum Hach (Reconstru-ction) | - |
| | ♦ Intake water level (EL. m) | 15.50 | 15.00 | 17.00 | 17.00 | 13.00 | 38.00 - 36.00 | - |
| | ♦ Diversion water requirement at intake ($m^3$/sec) | 2.66 | 2.74 | 7.93 | 3.45 | 1.39 | 6.60 | - |
| 4. | Main canals (nos.) | 2 | 2 | 1 | 1 | 1 | 1 | 8 |
| | ♦ Total length (km) | 18.4 | 12.7 | 7.5 | 20.3 | 4.7 | 16.4 | 80 |
| 5. | Nos. of secondary | 16 | 12 | 3 | 10 | 6 | 11 | 58 |

| No. | Description | Name of sub-project | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | |
| | canals | | | | | | | |
| | ♦ Total length (km) | 12.9 | 15.8 | 17.6 | 31.1 | 14.7 | 42.4 | 135 |
| 6. | Number of Tertiary Blocks (No.) | 47 | 42 | 50 | 54 | 27 | 67 | 287 |
| | Total length of tertiary canals (km) | 57 | 55 | 85 | 81 | 27 | 67 | 372 |
| 7. | Main drains | - Moung Russei, - Ou Anlong Rolus | - Moung Russei, - MD-1 | Ou Bakan/ Boeung Khnar River | Boeung Khnar R. | - Boeung Khnar R., - Ta Paong stream | Boribo River | - |
| | ♦ Total length (km) | 7.2 | 9.3 | - | - | - | - | 17 |
| | ♦ Drainage water requirement from paddy field (lit/sec/ha) | 7.17 | 7.17 | 6.32 | 6.32 | 6.32 | 6.83 | - |
| | ♦ Drainage water requirement from other land (lit/sec/ha) | 0.025~ 0.019 | 0.025~ 0.019 | 0.025~ 0.018 | 0.025~ 0.018 | 0.025~ 0.018 | 0.025~ 0.019 | - |
| 8. | Secondary drains (nos.) | 9 | 10 | 4 | 8 | 7 | 11 | 49 |
| | ♦ Total length of secondary drains (km) | 25.1 | 14.8 | 28.2 | 37.7 | 12.6 | 53.9 | 172 |
| 9. | Collector drains (nos.) | 3 | 2 | 0 | 0 | 0 | 0 | 5 |
| | ♦ Total length of collector drain (New, km) | 19.4 | 10.0 | 0 | 0 | 0 | 0 | 29 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

The irrigation and drainage facilities' rehabilitation plan covered from: (i) headworks improvement and reconstruction, (ii) main and secondary canals and drains to (iii) on-farm development including tertiary canals and their appurtenant structures.

### 3.2.3 Soft Component

Soft component proposed in the previous Study consists of two major activities: (i) FWUC establishment and strengthening and (ii) agricultural extension activities, both of which are planned to be executed at each sub-project area.

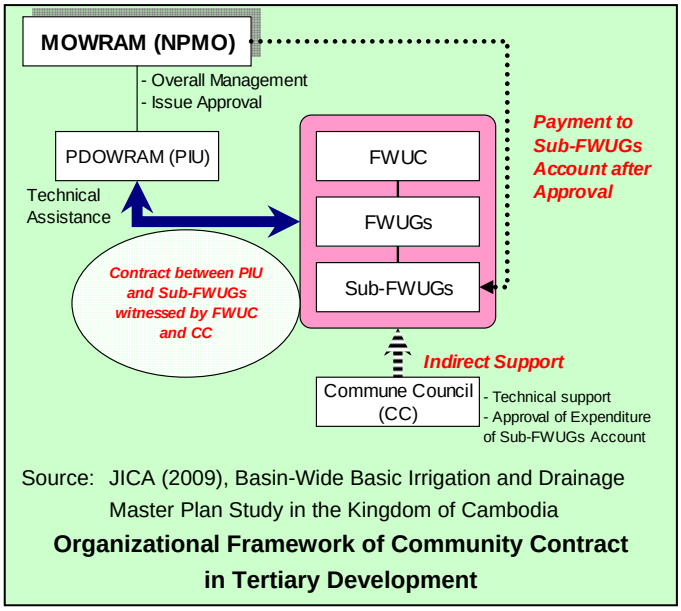
(1) FWUC Establishment and Strengthening

In order to materialize Project effect as planned, FWUC establishment and strengthening activities were proposed so that the proper water management and O&M of rehabilitated facilities are to be accomplished. General steps proposed are as follows:

i) set-up the structure and responsibilities,
ii) organizational formation consisting of FWUC, FWUCs and WUGs,
iii) capacity development through training for water management and O&M as well as participatory tertiary development through community contract and
iv) support of gradual transfer of facilities to FWUCs.

In particular, proposed procedure on participatory tertiary development is depicted in the following figure:

i) establishment of FWUC at each sub-project,
ii) preparation of tertiary development plan and selection of sub-FWUGs,
iii) joint-walk-through, design and cost estimate,
iv) contract between PIU and sub-FWUGs,
v) construction of tertiary canals by FWUGs, and
vi) inspection of the work completion.




Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

**Organizational Framework of Community Contract in Tertiary Development**

Although the process will require coordination among relevant organizations including commune councils, through this approach involving broader points from planning, O&M, organizational management to accounting management, capability of FWUCs are expected to be enhanced.

(2) Agricultural Extension Activities

The target on agricultural extension activities proposed in the previous Study are mainly focused on productivity improvement and production increase of rice. The strategies proposed are listed as follows:

i) introduction of irrigated farming and increase of annual cropping intensity,
ii) introduction of improved farming practices on the basis of current planting method utilized by farmers in sub-project areas supported by the strengthening of agricultural extension services,
iii) introduction of upland crops and/or vegetables production under irrigated condition in the early wet and dry season utilizing available water resources, and
iv) strengthening of agricultural extension services.

By employing strategies above, activities for agricultural extension proposed in the previous Study are: (i) field extension programs, (ii) farmer/farmer group training programs, (iii) mass guidance and/or workshop and (iv) extension staff empowerment. Support fund for extension staff and provision of transportation means were also proposed as part of extension activities.

### 3.2.4 Project Supporting Programs

The project supporting programs proposed in the previous Study cover cross-cutting issues for enhancement of the basis, especially institutional aspect, to accelerate project implementation. Necessity, objective and major activities for the three programs proposed are summarized in the following table:

**Proposed Project Support Programs**

| No. | Program Name | Necessity | Objective | Activities |
|---|---|---|---|---|
| 1 | Meteo-hydrological Observation strengthening Program | Meteo-hydrological data is an essential data for irrigation development as well as for future integrated river basin management. However it is not sufficiently collected at present. | The program aims to enhance the technical ability of MOWRAM and PDOWRAM staffs in meteo-hydrological observation, data processing and analysis | • Preparation of training program<br>• TOT in TSC<br>• Equipment supply<br>• Workshop<br>• Data publication |
| 2 | Capacity Development Program for MOWRAM | At present, the MOWRAM manual only focuses on planning and hydraulic design and, therefore, it needs to be developed further together with capacity development of staffs so as to enable them to carry out proposed sub-projects under M/P. | The target of the program is to enhance technical ability of MOWRAM staff in planning, design, construction management and O&M at the national level. | • Promotion of irrigation development in technically-appropriate manner<br>• Promotion of co-administration system in irrigation |
| 3 | Capacity Development Program for PDOWRAM | The program will be necessary in order to accelerate PIMD policy with the support of MOWRAM under Government's decentralized implementation mechanisms. | It is to strengthen technical capability of PDOWRAM staff in O&M of irrigation facilities and river basin control at the provincial level. | • Province-initiative irrigation development and management<br>• Facilitation of FWUCs Strengthening through Community-Contract Approach in Tertiary Development |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

### 3.2.5 Other Activities under the Project

(1) Project Formulation Study

In the Master Plan, 21 numbers of irrigation development projects were proposed, six of which have been selected as priority project as mentioned above. Project formulation study to prepare feasibility study level development plan was proposed to be implemented during **West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project**. Lessons to be learnt from the implementation of "Phase-I" of the Project will be utilized to effectively prepare the plan of "Phase-II" of the Project.

(2) Consulting Services

Main implementing organization for the Project is the National Project Management Office (NPMO) according to the regulation by MOWRAM. In order to smoothly implement the Project, technical consultant was proposed to be employed to support NPMO. The scope of the consulting services for the Project proposed were primarily:

i) Overall assistance for the Project management,
ii) Pre-construction arrangement such as studies, design, design review and modification of sub-projects,
iii) Supervision of construction works by the contracts,
iv) Arrangement and guidance of execution of O&M system improvement,
v) Arrangement and guidance of agricultural extension activities,
vi) Review of existing environmental study and support to environmental monitoring, and
vii) Socio-economic baseline surveys of the sub-projects.

## 3.3 Project Cost

### 3.3.1 Basic Conditions

The basic conditions applied for the cost estimate in the previous Study are listed as follows:

- Estimate refers to the prices as of September 2008
- Exchange rate: US$ 1 = 4,107 Riel = Japanese Yen 107.99
- Unit prices of labor, construction materials, engineering works etc.: collected from MOWRAM and market
- Construction is undertaken on the contract basis, and VAT is excluded from construction cost.
- Price escalation: 5.0 % annum based on the average annual change ratio of consumer price in Cambodia from year 2003 to 2008
- Construction consists of (i) foreign currency portion (FC) and (ii) local currency portion (LC), ratio of which is based on similar types of the projects in Cambodia

### 3.3.2 Initial Investment Cost

The initial investment cost for the Project is as summarized in the following table. The initial investment cost was estimated to be US$97.95 million in total.

**Initial Investment Costs for the Project**

| No. | Item | Amount (US$ 1,000) | Remarks |
|---|---|---|---|
| 1. | Construction Cost | 48,764 | See Sub-Section 9.2.2 for detail |
| 2. | Project Supporting Programs Cost | 2,438 | 5 % of Item 1 |
| 3. | Physical Contingencies | 5,120 | 10 % of Items (1+2) |
| 4. | Sub-Total | 56,322 | Items ( 1+2+3) |
| 5. | Consulting Services Cost | 14,332 | |
| 6. | Tax & Duty | 7,065 | 10 % of Item (4+5) |
| 7. | Land Acquisition Cost | 841 | For 391.9 ha for main, secondary and drains |
| 8. | Project Administration Cost | 5,632 | 10 % of Item 4 |
| 9. | Price Escalation | 13,762 | 5 %/annum of Item 4 |
| 10. | Grand Total | 97,954 | Items 4+5+6+7+8+9 |

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

### 3.4 Result of Environmental Assessment and Environmental Management Plan

IEE level environmental assessment was carried out in the previous Study from the view point of social environment, natural environment and pollution. Based on the assessment, although it would not be so significant, adverse environmental impact pointed out were as shown in the right table. In addition, following mitigation measures were proposed corresponding to the impacts anticipated:

**Adverse Environmental Impact Pointed Out in the Previous Study**

| Aspect | Point |
|---|---|
| Social Environment | ♦ Land acquisition for the construction of irrigation facilities<br>♦ Local conflict over interest<br>♦ Water use during construction<br>♦ Risk against infectious diseases |
| Natural Environment | ♦ Disturbance of fish sprawling<br>♦ Flora, fauna and biodiversity |
| Pollution | ♦ Air pollution<br>♦ Water pollution<br>♦ Soil contamination<br>♦ Waste from construction works<br>♦ Noise and vibration by the operation of construction machinery<br>♦ Accident by the operation of construction machinery |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

***Preparation***

i) Participatory land acquisition planning for main and secondary facilities,
ii) Participatory land acquisition planning for tertiary facilities,

***Construction***

i) Education program for construction labour,
ii) Construction of fish ladder,
iii) Environmental consideration in technical specification for construction works,

***Operation and maintenance***

Two mitigation measures under FWUC establishment and strengthening activities consisting of:

i) System O&M and water management and improvement
ii) Appropriate application of agricultural input

The result of initial environmental impact assessment shows that no significant impacts are predicted because all the sub-project areas will not include large scale expansion and/or new development. Therefore, it was concluded in the previous Study that no full scale environmental impact assessment (EIA) is considered necessary if mitigation measures listed above are concurrently carried out.

# CHAPTER 4 PROJECT SCOPE

## 4.1 Necessity and Justification

### 4.1.1 National and Sectoral Development Policy of Cambodia

It is beyond question that water is the key limiting factor for agriculture and food production in Cambodia. Thus, the supply, quality and efficient use of water dominates agricultural production, and irrigation infrastructure is critical in that process as stressed in the national and sectoral development policy of Cambodia. As described in Chapter 2, in order to supplement the NPRS to pave the way to the poverty reduction and economic growth of the country, the National Strategic Development Plan (NSDP 2006-2010) describes rectangular strategies. Out of four strategies, in the Rectangular 1: Enhancement of Agriculture Sector, increase of paddy planted area from 2.37 million ha in 2005 to 2.5 million ha in 2010 is set as one of the quantitative development targets. Improvement of yield from 1.97 ton/ha in 2005 to 2.4 ton/ha is also elaborated. Through the review of activities so far, "Rectangular Strategy" Phase II were disclosed in 2008, which continuously support agriculture sector as one of the most important mission of the country.

Although detailed provincial level policy is not available, importance of agriculture sector including irrigation development in Battambang, Pursat and Kampong Chhnang provinces is emphasized in the provincial annual report and the relevant documents. In the decentralization development programs such as SEILA and PSDD,[1] irrigated agriculture development is one of the most important activities to meet political target as well as community needs. Therefore, the Project supporting irrigation sector by integrating hardware and software component significantly contribute to the achievement of the target set in NSDP.

### 4.1.2 Economic Assistance Policy of Japanese Government and JICA

International organizations and donor countries have been supporting developing countries with the aim of achieving the Millennium Development Goal (MDGs) formulated in 1990s. According to the MDGs, the Government of Cambodia also established the National Poverty Reduction Strategy (2003-2005) (NPRS) focusing on eight thematic priority actions for poverty reduction, which all the donor societies are pursuing.

In line with this framework, as the country assistance policy to Cambodia, Japanese Government particularly addresses: (i) realization of sustainable economic growth and safe society, (ii) assistance to socially vulnerable groups, (iii) global issue, (iv) alleviation of economic gap with other ASEAN countries. Based on the policy, the Government has been assisting Cambodia in: (i) social and economic infrastructure development, (ii) health and medical care, (iii) agriculture and rural development, (iv) human resource development and so forth through various assistance schemes such as grant assistance and technical assistance.

JICA addresses driving vision, "*Inclusive and Dynamic Development*" with the four missions: (i) addressing global agenda, including climate change, water, food, energy, infectious diseases and financing, (ii) reducing poverty through equitable growth, (iii) improving governance and (iv)

[1] PSDD stands for Project to Support Democratic Development through Decentralization and Deconcentration supported by UNDP commenced from 2007 after SEILA program. The project is based on decentralized implementing mechanism through Provinces and Communes initiative.

achieving human security. Among others, is one of the most important agenda for many developing countries including Cambodia, in particular, JICA put emphasis on agricultural development as one of the important sectors in development assistance for poverty alleviation. Since the poverty rate in the rural area of Cambodia is significantly high, the proposed Project based on hardware and software component-integrated approach consisting of: (i) rehabilitation of irrigation and drainage facilities for the enhancement of agriculture productivity supported by, (ii) FWUC establishment and strengthening for sustainable O&M adequately conform to the policy.

### 4.1.3 Necessity and Justification of the Project

Rice is a staple food in Cambodia, therefore, attaining and maintaining self-sufficiency of rice is a priority theme. Three provinces, as an important granary, where six sub-projects are located have been contributing to 17 % of overall national production of rice at present, and it is of great importance to increase productivity of rice in this region so to catch up population increase of the country. [2]

The existing irrigation and drainage facilities in the six sub-projects are generally deteriorated and construction of secondary and tertiary level facilities are not in progress. It is of critical need to rehabilitate and/or develop irrigation facilities to enhance agricultural productivity in these areas.

All the six sub-projects have potential to be model irrigation systems in each river basin in the future. In the Moung Russei River Basin, construction of the Bassac Reservoir has been completed in 2009 and the Government is making great effort in developing irrigation systems located in the downstream of the reservoir for effective utilization of water resources. In this situation, the Ream Kon and the Por Canal sub-projects are recognized as having large potentials for agricultural production within the basin. Along the Pursat River, there are only two headworks already constructed, out of which Damnak Ampil Headworks constructed in 2006 is expected to contribute to the increase of agriculture production in and around the basin. Including three proposed sub-projects: (i) Damnak Ampil, (ii) Wat Loung and (iii) Wat Chre, there are six irrigation systems commanded by the Damnak Ampil Headworks. Development and sustainable O&M of these three sub-projects can be a prototype for effective utilization of water resources of the Pursat River. Along the Boribo River where Lum Hach sub-project is located, irrigation development comparatively lag behind. Therefore, small-scale development is predominant and agriculture productivity remains relatively lower. As one of the largest irrigation systems, the development of the Lum Hach sub-project will be of importance for the Boribo River Basin development.

By reviewing above-mentioned situation that the sub-projects are embracing, the Project will contribute to the enhancement of agriculture production in the sub-projects as well as each River Basin leading to food security as well as poverty alleviation of the country.

## 4.2 Summary of Examination of the Project Scope

### 4.2.1 Basic Concept

As summarized in the Chapter 3, the development plan proposed in the previous Study consists of both hardware and software components supported by project supporting programs, project formulation study and consulting services. Success of irrigation development primarily depends upon the

[2] Figures obtained from MAFF, Food Balance Sheet, the average between 2002 to 2005

availability of three essential resources: water, land and human resources so that comprehensive approach is required. In order to materialize project target as planned using rehabilitated irrigation and drainage facilities, agricultural support services is essential to improve farming technology. And to ensure sustainability of the Project effect, farmers' groups needs to be established so as to improve irrigation system performance in terms of water distribution and reduced life cycle cost by appropriately operating and maintaining irrigation and drainage facilities. Nevertheless, it remains clear that no part of an irrigation and drainage infrastructure can be expected to perform its intended functions for more than a very few reasons without effective organizational set-up.

Based on the discussion above, it is of necessity to harmonize: (i) rehabilitation of irrigation and drainage facilities and (ii) support programs to maximize and sustain effect of the Project as proposed in the previous Study.

The purpose of the Project is to establish equitable and timely irrigation water supply system by rehabilitating irrigation and drainage facilities to contribute to the stabilization of agricultural production of the sub-projects' command areas and to the alleviation of poverty in the target rural areas. On this basis, the components of the Project previously proposed are justified consisting of:

i) Hardware component: Rehabilitation of irrigation and drainage facilities,
ii) Software component: FWUC establishment and strengthening, and agriculture extension activities,
iii) Project supporting programs: Meteo-hydrologcal observation strengthening program, capacity development support program for MOWRAM and capacity development support program for PDOWRAM
iv) Project formulation study for other potential areas, and
v) Consulting services

Through site investigation, analysis and discussion with relevant organizations, the technical judgements by the SAPROF Study Team toward each component are summarized in the following sections.

### 4.2.2 Agricultural Development Plan

The agricultural development plan made in the JICA M/P and Pre-F/S has been examined from the viewpoint of soil suitability for growing field crops/vegetables as well as availability of local markets for forwarding them. Furthermore, the availability of discharge of the respective rivers for the dry season has been reconfirmed. Considering these examination results, the former agricultural development plan has been modified with a particular attention to the necessity of stabilizing irrigation water supply to the wet season rice cultivation.

The modified crop production plan is shown below.

**Modified Crop Production Plan**

| Sub-project | Physical Area (ha) | Pre-F/S | | | | | | SAPROF | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Irrigation Status | Early | | Wet | Dry | | Irrigation Method | Early Wet | Wet |
| | | | Rice (ha) | V'ble (ha) | Rice (ha) | Rice (ha) | V'ble (ha) | | Rice (ha) | Rice (ha) |
| Ream Kon | 1,890 | Irrigated | 1,080 | 0 | 1,180 | 0 | 0 | Gravity | 960 | 1,610 |
| | | | | | | | | Pump | 170 | 280 |
| | | Rain-fed | 0 | 0 | 710 | 0 | 0 | Rain-fed | 0 | 0 |
| Por Canal | 1,940 | Irrigated | 1,120 | 190 | 1,220 | 0 | 0 | Gravity | 1,200 | 1,940 |
| | | Rain-fed | 0 | 0 | 720 | 0 | 0 | Rain-fed | 0 | 0 |
| Damnak Ampil | 2,270 | Irrigated | 0 | 340 | 2,270 | 0 | 0 | Gravity | 130 | 1,770 |
| | | | | | | | | Pump | 40 | 500 |
| Wat Loung | 2,540 | Irrigated | 0 | 380 | 2,540 | 0 | 0 | Gravity | 130 | 1,740 |
| | | | | | | | | Pump | 60 | 800 |
| Wat Chre | 1,020 | Irrigated | 150 | 150 | 1,020 | 0 | 0 | Gravity | 50 | 620 |
| | | | | | | | | Pump | 30 | 400 |
| Lum Hach | 3,100 | Irrigated | 1,200 | 210 | 3,100 | 100 | 410 | Gravity | 1,090 | 2,660 |
| | | | | | | | | Pump | 180 | 440 |
| Total | 12,760 | | 3,550 | 1,270 | 12,760 | 100 | 410 | | 4,040 | 12,760 |

Prepared by JICA SAPROF Study Team

### 4.2.3 Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

Scope of the rehabilitation of irrigation and drainage facilities are determined based on the following concept.

i) Suitable development scale is determined based on the meteo-hydrological analysis carried out in the previous studies and the development progress of other irrigation systems in the river basin.
ii) Facilities already rehabilitated by other development schemes after the previous Study will be excluded from the Project.
iii) Priority is given to the facilities with higher rehabilitation effect. Facilities with lower and/or unclear rehabilitation efficiency are excluded from the Project.
iv) Cost-effectiveness and feasible investment scale for the development is considered.
v) Facilities with easier operation and maintenance are recommended to upgrade sustainability of the Project.

Technical judgment and evaluation of the plans proposed in the previous Study for each sub-project is delineated in Table II 4.2.1 to Table II 4.2.6 and summarized as follows:

**Ream Kon Sub-Project**

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Ream Kon Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 1,890 ha consisting of:<br>(i) Gravity Irrigation 1,610 ha and (ii) Pump Irrigation 280 ha | (i) Construction of the Bassac Reservoir has been completed by MOWRAM in 2009 as assumed in the previous Study. And no significant changes were observed for water use in the Basin. Total command area, therefore, can be as same as the previous Study.<br>(ii) 280 ha located on southern edge of the command area is high in elevation, which is impossible to be irrigated by gravity as planned in the previous Study. To minimize and optimize project cost, the original plan is feasible in the condition that the area will be irrigated using portable pumps by farmers. |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | 1 no.<br>Replacement of headworks | (i) Concrete structures of the headworks with gates are highly deteriorated, therefore, it is judged necessary to construct new headworks to be located approximately 60m upstream from the existing one.<br>(ii) Existing headworks will not be demolished during the construction of the new headworks, since it will serve as a temporary access road for the works. |
| 2) Intake Structure | 1 no.<br>Reconstruction | (i) Concrete structure of the existing intake located 1 km upstream of the headworks is already deteriorated and no gate is installed.<br>(ii) Due to higher elevation, the area located along the beginning section of the existing main canal cannot be irrigated by gravity. To minimize conflict over water use, the existing intake will be cancelled, and a new intake will be to be constructed near proposed the headworks site. |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | 18.4 km<br>2 nos. consisting of main canal-1 and main canal-2 | (i) In general, the canal section needs to be rehabilitated and expanded together with the provision of turnouts and other related structures to distribute water effectively.<br>(ii) Two main canals were proposed in the previous study. By reviewing topographic survey, it is found out that the Main Canal-2 is possible to command all the area. Therefore, only the Main Canal-2, is proposed as a main canal in new layout of the sub-project. |
| 2) Rehabilitation of Secondary Canal | 12.9 km<br>16 nos. | (i) Irrigation water does not reach to secondary canals, as most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 57.0 km<br>47 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water field level, and each of the tertiary canals will command approximately 50 ha according to the guideline of MOWRAM. |
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Moung Russei and<br>Ou Anlong Rolus River to be utilized for main drain | (i) Existing streams are planned to be utilized for main drains. This is judged effective for minimizing construction cost. |
| 2) Construction of Collector Drain | 19.4 km<br>3 nos. | (i) All the collector drains proposed in the previous Study need to be constructed and/or rehabilitated to protect command areas from water of northern and southern areas.<br>(ii) CD-2 proposed for temporary diversion channel for the construction of headworks, is planned to be equipped with emergency gates and drainage gates at the upstream and the downstream so to release excess water to the downstream and also to protect back water from the downstream. However, its effectiveness is judged unclear, and therefore, it is cancelled to minimize the Project cost. |
| **3.2 Secondary Drain** | | |
| 1) Construction | 25.1 km | (i) No secondary drains have been developed in the command area. |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| of Secondary Drain | | Since the development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project.<br>(ii) Drains proposed in the downstream of the command area, SD-1, SD-2, SD-3, SD-4 and SD-5 are not necessary for two reasons: (a) they run in the outside of command area so that land acquisition would be difficult and (b) the area is below El. 11.00, which will be affected by the water from Tonle Sap Lake. |

Prepared by JICA SAPROF Study Team

## Por Canal Sub-Project

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Por Canal Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 1,940 ha by Gravity Irrigation | (i) Construction of the Bassac Reservoir have been completed by MOWRAM in 2009 as planned in the previous Study. And no significant changes were observed for water use in the Basin. Total command area, therefore, can be as same as the previous Study.<br>(ii) Secondary canal S1-1 has been rehabilitated with the support of ECOSORN covering 288 ha. Due to low water level of the canal, however, water cannot be delivered to the field by gravity. The canal needs rectification works. Therefore, the Project will maintain total command area as planned, including ECOSORN's rehabilitated area. |
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | - | - |
| 2) Intake Structure | 1 no.<br>Reconstruction | (i) Concrete structure of the existing intake is already deteriorated and no gate is installed.<br>(ii) Based on the situation mentioned above, the intake structure needs to be replaced by new one with gates. |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | 12.7 km<br>2 nos. | (i) To ensure flow capacity, canal section needs to be rehabilitated and expanded together with turnouts and other related structures.<br>(ii) Two main canals were proposed in the previous Study. Since the Main canal 1-2 is running higher part of the command area, however, only the Main Canal 1-2 is proposed as a main canal in the new layout of the sub-project to minimize construction cost. |
| 2) Rehabilitation of Secondary Canal | 15.8 km<br>12 nos. | (i) Irrigation water does not reach to the secondary canals, because most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures.<br>(ii) Check structures need to be provided to raise water level for gravity irrigation. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 55.0 km<br>42 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Moung Russei River and MD-1 | (i) Existing streams are planned to be utilized for main drains. This is judged effective for minimizing construction costs. |
| 2) Construction of Collector Drain | 10.0 km<br>2 nos. | (i) Two collector drains in the previous Study were planned to run along the main canal-2 in parallel with the National Road No.5. They were originally proposed to catch excess water from the eastern side of the National Road so to protect main canal. However, its effectiveness is considered questionable, and it would be technically reasonable to cancel CD-1 and CD-2 to minimize construction costs. |
| **3.2 Secondary Drain** | | |
| 1) Construction of Secondary Drain | 14.8 km<br>10 nos. | (i) No secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project. |

Prepared by JICA SAPROF Study Team

## Damnak Ampil Sub-Project

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Damnak Ampil Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 2,270 ha consisting of gravisity irrigation (1,770 ha) and pump irrigation (500 ha) | (i) Command areas of the Damnak Ampil Headworks are determined by considering other irrigation systems under the Pursat River Basin since there are no significant changes in the conditions in water distribution after the previous Study, therefore, target area of the Project is judged suitable to adopt same command area as proposed in the previous Study.<br>(ii) Among three secondary canals proposed in the previous Study, S-2 was already rehabilitated in 2008, but no tertiary canals were provided. Therefore, the Project area will remain unchanged, including S-2 command area. |
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | - | - |
| 2) Intake Structure | - | - |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | - | (i) MOWRAM is planning to extend main canal to connect with the Svay Don Keo River to distribute water to irrigation systems under the Svay Don Keo River. |
| 2) Rehabilitation of Secondary Canal | 17.6 km<br>3 nos. | (i) At present, irrigation water does not reach to the secondary canals as most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures.<br>(ii) Out of three secondary canals proposed to be rehabilitated in the previous Study, S-2 has been already rehabilitated. Therefore, |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| | | rehabilitation of secondary canal, S-2, will be excluded from the Project component. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 85.0 km<br>50 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. |
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Ou Bakan and Boeung Khnar River | (i) Existing streams are planned to be utilized for main drains, this is judged effective for minimizing construction costs. |
| 2) Construction of Collector Drain | - | - |
| **3.2 Secondary Drain** | | |
| 1) Construction of Secondary Drain | 28.2 km<br>4 nos. | (i) No secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project. |

Prepared by JICA SAPROF Study Team

## Wat Loung Sub-Project

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Wat Loung Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 2,540 ha consisting of 1,740 ha by gravity and 500 ha pump | (i) Water for the sub-project is delivered from the Pursat River through headrace to be constructed under the Project. As explained in the Damnak Ampil sub-project, no significant difference in water availability from the previous Study and, therefore, command area of the Wat Loung sub-project is 2,540 ha as same as previous proposal. |
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | - | - |
| 2) Intake Structure | - | - |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | 20.3 km | (i) Currently, the main canal is significantly deteriorated and no water flows except flood water from the Pursat River in the rainy season. In order to ensure smooth water delivery, the canal section needs to be rehabilitated together with provision of turnouts and other related structures.<br>(ii) No major revisions are required on the proposal in the previous Study. |
| 2) Rehabilitation of Secondary | 31.1 km | (i) Only secondary canal S-8 is existing, but the canal sections are seriously deteriorated and collapsed. Priority needs to be given to |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| Canal | 10 nos. | rehabilitation of the canal and related structures. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 81.0 km<br>54 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. |
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Boeung Khnar River | (i) Existing streams are planned to be utilized for main drains. This is judged effective for minimizing construction costs.<br>(ii) Capacity of the Boeung Khnar River is sufficient to drain water from the command area and, therefore, no river dredging work is required under the Project. |
| 2) Construction of Collector Drain | - | - |
| **3.2 Secondary Drain** | | |
| 1) Construction of Secondary Drain | 37.7 km<br>8 nos. | (i) No secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project. |

Prepared by JICA SAPROF Study Team

## Wat Chre Sub-Project

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Wat Chre Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 1,020 ha consisting of:<br>(i) Gravity Irrigation 620 ha and (ii) Pump Irrigation 400 ha | (i) Water is delivered from the Pursat River through a main canal of the Wat Loung sub-project to be rehabilitated under the Project. Because of no significant difference in water utilization in the River from the previous Study, the command area of the Wat Chre sub-project is determined to be 1,020 ha as same as the previous proposal.<br>(ii) 400 ha out of the command area is high in elevation, which are impossible to be irrigated by gravity as planned in the previous Study. In order to minimize and optimize project costs, this area will be irrigated using portable pumps by farmers. |
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | 1 no.<br>Reconstruction of headworks | (i) No structure exists at present. In order to divert water from the Boueng Khnar River to the Wat Loung main canal, it is necessary to construct headworks on the Boueng Khnar River.<br>(ii) It is recommended to construct temporary diversion channel on the left bank for the construction works. |
| 2) Intake Structure | 1 no.<br>Reconstruction | (i) No structure exists at present. Together with the headworks, a new intake structure needs to be constructed. Location is proposed to be |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| | | within 100 m from the headworks to ease gate operation. |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | 4.7 km<br>1 no. | (i) Most of the main canal is highly deteriorated. At present, since no water is provided to the canal from the source River, all the canal sections need to be rehabilitated and reconstructed in order to ensure flow capacity.<br>(ii) The main canal was proposed to be utilized for temporary diversion for the construction of headworks with the capacity of 3.0 m3/sec. To minimize the Project cost, it is not recommendable to construct with large capacity for temporary diversion. A temporary diversion will be constructed on the left bank during the construction. |
| 2) Rehabilitation of Secondary Canal | 14.7 km<br>6 nos. | (i) Irrigation water does not reach to the secondary canals, as most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 27.0 km<br>27 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. |
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Boeung Khnar River and Ta Paong Stream | (i) Existing streams are planned to be utilized for main drains. This is judged effective for minimizing construction costs. |
| 2) Construction of Collector Drain | - | - |
| **3.2 Secondary Drain** | | |
| 1) Construction of Secondary Drain | 14.8 km (7 nos.) | (i) No secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project. |

Prepared by JICA SAPROF Study Team

## Lum Hach Sub-Project

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Lum Hach Sub-Project)**

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **1. Sub-project area** | | |
| 1) Total Command Area | 3,100 ha consisting of:<br>(i) Gravity Irrigation 2,690 ha and (ii) Pump Irrigation 410 ha | (i) The Boribo River diverges into two at the Bomnak water level station, namely one is the Boribo River to the Kampong Chhnang province and the other is the Thlea Maan River to the Pursat province. In the previous Study, 50 % of the river runoff is assumed to flow into the Boribo River by diversion at the Bomnak water level station. Since there is no large scale development at the Bomnak, the assumption utilized in the previous Study can be applied for the SAPROF Study. |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| **2. Rehabilitation of Irrigation Facilities** | | |
| **2.1 Headworks** | | |
| 1) Headworks | 1 no.<br>Reconstruction of headworks | (i) No structure is existing at present. In order to divert water from the Boribo River to the command area of the Lum Hach sub-project, the highest priority is given to the construction of headworks under the Project.<br>(ii) The main canal were planned to be utilized for temporary diversion during the construction of the headworks in the previous study. However, it is found appropriate to use the old Boribo stream as diversion through O-Roluss pond to minimize the construction costs. |
| 2) Intake Structure | 1 no.<br>Reconstruction | (i) No structure is existing at present. Together with the headworks, a new intake structure needs to be constructed. Location is proposed to be within 100 m from the headworks to ease gate operation.<br>(ii) The water is also diverted to the O-Roluss Irrigation System (3,400 ha) at the proposed headworks. Intake and spillway has been already provided at the O Roluss Pond. In addition, an intake structure is proposed to be constructed at the headworks site as proposed in the previous Study. |
| **2.2 Main and Secondary Canals** | | |
| 1) Rehabilitation of Main Canals | 16.4 km (1 no.) | (i) Overall, canal sections are highly deteriorated, requiring the rehabilitation. In general, the upstream portion has large capacity enough for the design discharge while the downstream portion needs expansion.<br>(ii) In order to reduce construction cost, the old Boribo water course is proposed to be utilized for the temporary diversion for the headworks construction. |
| 2) Rehabilitation of Secondary Canal | 42.4 km<br>11 nos. | (i) Irrigation water does not reach to the secondary canals, as most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. |
| **2.3 Tertiary Canals** | | |
| 1) Construction of Tertiary Canals | 67.0 km<br>67 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. |
| **3. Drainage** | | |
| **3.1 Main Drains and Collector Drains** | | |
| 1) Rehabilitation of Main Drain | Boribo River | (i) Existing streams are planned to be utilized for main drains. This is judged effective for minimizing construction cost. |
| 2) Construction of Collector Drain | - | - |
| **3.2 Secondary Drain** | | |
| 1) Construction of Secondary Drain | 53.9 km (11 nos.) | (i) No secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drains under the Project.<br>(ii) A drainage gate was proposed at the confluence of Boribo River and SD-3, but, its effectiveness is unclear. According to the interview at the field, no serious flooding during the rainy season was reported and, therefore, it is excluded from the Project component. |

| Works | Plan Proposed in the Previous Study | Technical Judgment |
|---|---|---|
| | | (iii) The road development is carried out by the Ministry of Public Works and Transport in the command area, running from the entrance at the National Road No. 5 to the Main Canal with 18 km. Side drains of the road have been already constructed together. Therefore, all or part of following drains are excluded from the project components: SD-2, SD-3, SD-4, SD-6 and SD-10. |

Prepared by JICA SAPROF Study Team

### 4.2.4 Software Component: FWUC Establishment and Strengthening and Agriculture Support Services

On the basis of the importance of integration of hardware and software component in the irrigation and drainage development, software component under the Project need to contribute to: (i) the realization of sustainable irrigation and drainage O&M and (ii) the enhancement of agricultural production by using rehabilitated facilities. Therefore, two components: (i) FWUC Establishment and Strengthening and (ii) Agriculture Extension Activities are included in the Project.

(1) FWUC Establishment and Strengthening

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (FWUC Establishment and Strengthening)**

| Plan Proposed in the Previous Study | Technical Judgment |
|---|---|
| Capacity development through training program and community-contract approach in tertiary development | (i) Training programs proposed in the previous Study was generally based on policy framework of PIMD and IMT, programs of which includes from awareness to practical field skills. Therefore, the necessity and the plans are generally justified.<br>(ii) As part of FWUC strengthening activities, tertiary development through community-contract was proposed in the previous study. It would be one of the effective methodologies, but, it also have difficulties in actual implementation as summarized as follows:<br>♦ Coordination of relevant agencies is required including commune councils, village development committees and so forth. Substantial organizational activities are not observed in all the sub-project areas, therefore, such coordination with group initiative would take time and cannot be accommodated within the timeframe of the Project.<br>♦ According to the regulation of MOWRAM, tertiary canals are the properties of farmers which are to be constructed by themselves. Therefore, no payment is generally made for their construction. If the Project applies community-contract approach, it would create the sense of unfairness among different irrigation schemes.<br>(iii) Therefore, it is recommended that the tertiary canals be constructed as one of the hardware components of the Project. Since tertiary level facilities are the properties of farmers, no compensation for lands will be made in accordance with the regulation. In order to alleviate social impact, tertiary alignment needs to be determined from both technical judgment and walk-through surveys among engineers and farmers. |

Prepared by JICA SAPROF Study Team

(2) Agriculture Support Services

The agricultural extension activities are generally justified as Project component. The activities focus on increasing paddy production under irrigated condition.

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Agriculture Support Services)**

| Plan Proposed in the Previous Study | Technical Judgment |
|---|---|
| (i) Field Extension Programs<br>(i) Farmer/Farmer Group Training Programs<br>(ii) Mass Guidance/ Workshop<br>(iv) Support Fund for Village Agriculture Extension & Field Staff<br>(v) Staff empowerment<br>(vi) Provision of Transportation Means | (i) Reconsidering soil characteristics, water resource availability and marketable situation of field crops/vegetables, priority is given over irrigated rice cultivation. In this relation, the former crop production plan is slightly modified as describe above.<br>(ii) The soft component, therefore, will be proposed focusing on increase and stabilization of the wet season paddy productivity in the sub-project areas. |

Prepared by JICA SAPROF Study Team

### 4.2.5 Project Supporting Programs

(1) Meteo-hydrological Observation Strengthening Program

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Meteo-hydrological Observation Strengthening Program)**

| Plan Proposed in the Previous Study | Technical Judgment |
|---|---|
| - Capacity development of MOWRAM and PDOWRAM staff through training, and<br>- Installation of additional equipment for meteo-hydrological observation | (i) Existing observation system is insufficient in number and functions to cover all the river basin of the Project area.<br>(ii) As suggested by the Technical Working Group (TWG) on Program 4, Agriculture and Water, the density of stations operational is very low 1 for 2,181 $km^2$ and the three River Basins where six sub-projects are located are not left out from this trend. In the Report, it is recommended that station needs to be established for every 600 $km^2$.<br>(iii) Basic irrigation information is greatly important to utilize water resources in sustainable manner, to develop river basin with the concept of integrated water resource management (IWRM) as stressed in MOWRAM strategy and to forecast flood and drought. |

Prepared by JICA SAPROF Study Team

(2) Capacity Development of MOWRAM Staff

Similarly, capacity development of PDOWRAM staff required is as follows to support province-initiative irrigation development and management and to promote PIMD at the provincial level:

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Capacity Development of MOWRAM Staffs)**

| Plan Proposed in the Previous Study | Technical Judgment |
|---|---|
| - Preparation of detailed design manual<br>- Dissemination workshop<br>- Periodical revision and update based on field application | (i) According to PIMD and IMT policy based on decentralization, capacity development of PDOWRAM staffs is of critical importance. Development of well-considered technical tools with those dissemination will be necessary. Therefore, the program is judged necessary.<br>(ii) The previous proposal focused on capacity development with the aim of promotion of community-contract approach in tertiary development. As elaborated in FWUC establishment and strengthening, however, community-contract approach will not be recommended as the Project component. Therefore, the aim of this program would rather focus on capacity development of staff for construction supervision based on hardware component of the Project. Activities include: (i) preparation of construction supervision manual and (ii) dissemination workshop etc. |

Prepared by JICA SAPROF Study Team

(3) Capacity Development of PDOWRAM Staffs

Similarly, capacity development of PDOWRAM staffs to be required is as follows to support province-initiative irrigation development and management and to promote PIMD at the provincial level:

**Technical Judgment of SAPROF Study Team Toward Development Plan of the Project Proposed in the Previous Study (Capacity Development of PDOWRAM Staffs)**

| Plan Proposed in the Previous Study | Technical Judgment |
|---|---|
| *Province-Initiative Irrigation and Development and Management*<br>♦ O&M manual preparation for field-use<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals<br>*Facilitation of FWUCs Strengthening through Community-Contract Approach in Tertiary Development*<br>♦ Training programs such as (i) facilitation, (ii) training management, (iii) awareness of participatory community development approach, (iv) transfer of O&M responsibility to FWUC etc. | (i) According to PIMD and IMT policy based on decentralization, capacity development of PDOWRAM staffs is of critical importance. Development of well-considered technical tools with those dissemination will be necessary. Therefore, the program is judged to be included in the scope of the Project.<br>(ii) The previous proposal focused on capacity development with the aim of promotion of community-contract approach in tertiary development. As elaborated in FWUC establishment and strengthening, however, community-contract approach will not be recommended as Project component. Therefore, the aim of this program would rather focus on capacity development of staff for construction supervision based on hardware component of the Project. Activities include: (i) preparation of construction supervision manual and (ii) dissemination workshop etc. |

Prepared by JICA SAPROF Study Team

### 4.2.6 Others: Project Formulation Study for Other Potential Areas

Since food security is the mandate of the Government, irrigation and drainage development at the potential areas is of critical importance, which can be effectively carried out using experiences obtained from the development activities. The project formulation study for other potential areas is to formulate future irrigation and drainage development projects in other potential areas using lessons to be learnt from the Project implementation. It is judged reasonable to be included as one of the Project component.

### 4.2.7 Project Scope

On the basis of technical evaluation on the plan prepared in the previous study, the Project scope proposed is summarized as follows.

- Hardware Component: Rehabilitation of Irrigation and Drainage Facilities
- Software Component: FWUC Establishment and Strengthening and Agriculture Extension Activities
- Project Supporting Programs, and
- Project Formulation study for Other Potential Areas

(1) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

**Summary of Irrigation and Drainage Plan**

| No. | Description | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|---|
| 1. | Sub-project area (ha) | 1,890 | 1,940 | 2,270 | 2,540 | 1,020 | 3,100 | 12,760 |
| | (Pump irrigation area included above) | 280 | 0 | 500 | 800 | 400 | 440 | 2,420 |
| 2. | Annual irrigation area (ha) | 3,020 | 3,140 | 2,440 | 2,730 | 1,100 | 4,370 | 16,800 |
| | - Early wet season paddy (ha) | 1,130 | 1,200 | 170 | 190 | 80 | 1,270 | 4,040 |
| | - Medium wet season paddy (ha) | 1,890 | 1,940 | 2,270 | 2,540 | 1,020 | 3,100 | 12,760 |
| | - Dry season paddy (ha) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. | Major water source | Moung Russei River | | Pursat River | | | Boribo River | |
| | - Name of headworks | Moung Russei Headworks | | Damnak Ampil Headworks | | Wat Chre Headworks | Lum Hach Headworks | |
| | - Intake water level (EL. m) | 15.50 | 15.00 | 17.00 | 17.00 | 13.00 | 36.00 - 38.00 | |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.66 | 2.74 | 7.93 | 3.45 | 1.39 | 6.60 | |
| 4. | Main canals (nos.) | 1 | 1 | 1 | 1 | 1 | 1 | 5 |
| | - Total length (km) | 9.9 | 6.8 | - | 20.3 | 4.7 | 16.4 | 58.1 |
| 5. | Nos. of secondary/ sub-secondary canals | 11 | 9 | 2 | 10 | 6 | 11 | 52 |
| | - Total length (km) | 18.3 | 19.1 | 12.6 | 31.1 | 14.7 | 42.4 | 138.2 |
| 6. | Number of Tertiary Blocks (No.) | 45 | 42 | 50 | 54 | 27 | 69 | 287 |
| | Total length of tertiary canals (km) | 54 | 55 | 85 | 81 | 27 | 69 | 371.0 |
| 7. | Main drains | - Moung Russei, - Ou Anlong Rolus | - Moung Russei, - MD-1 | Ou Bakan/ Boeung Khnar River | Boeung Khnar River | - Boeung Khnar River, - Ta Paong stream | Boribo River | |
| | - Total length (km) | 7.2 | 5.6 | - | - | - | - | 12.8 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 | 7.17 | 6.32 | 6.32 | 6.32 | 6.83 | |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 | 19~25 | 18~25 | 18~25 | 18~25 | 19~25 | |
| 8. | Secondary drains (nos.) | 7 | 10 | 3 | 8 | 5 | 9 | 42 |
| | - Total length of seconday drains (km) | 13.4 | 14.8 | 21.8 | 37.7 | 11.5 | 35.7 | 134.9 |
| 9. | Collector drains (nos.) | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| | - Total length of collector drain (New, km) | 21.8 | 0.0 | 0 | 0 | 0 | 0 | 21.8 |

Prepared by JICA SAPROF Study Team

(2) Software Component: FWUC Establishment and Strengthening and Agriculture Extension Activities

**Scope of FWUC Establishment and Strengthening**

| Soft Component | Purpose | Content |
|---|---|---|
| FWUC Establishment and Strengthening | To materialize sustainable organizational set-up for irrigation water management and facilities' O&M | ♦ Establishment of FWUC based on new layout of each sub-project<br>♦ Enhancement of FWUC's water management capability<br>♦ Strengthening of FWUCs capability in O&M of irrigation and drainage facilities<br>♦ Strengthening of organizational management capacity<br>♦ Establishment of water fee collection system |

| Soft Component | Purpose | Content |
|---|---|---|
| | | ♦ Implementation of training programs with the coordination of relevant organizations |

Prepared by JICA SAPROF Study Team

**Scope of Agriculture Support Services**

| Soft Component | Purpose | Content |
|---|---|---|
| Agriculture Support Services | To increase and stabilize the wet season paddy productivity in the sub-project areas | ♦ Government agricultural staff empowerment program<br>♦ Training of trainers program for capacity development of group leaders acting as agricultural extension agent<br>♦ Commune-base agricultural extension agent development program<br>♦ Soil fertility diagnosis program<br>♦ Pre-harvest technology group training program on farmers field school basis<br>♦ Post-harvest technology group training program on farmers field school basis<br>♦ Quality rice seed production and distribution program<br>♦ High value added rice production promotion program |

Prepared by JICA SAPROF Study Team

## (3) Project Supporting Programs

**Scope of Meteo-hydrological Observation Strengthening Program**

| Project Supporting Program | Purpose | Content |
|---|---|---|
| Meteo-hydrological Observation Strengthening Program | To collect basic agro meteo-hydrological data, and<br>To increase technical capability of MOWRAM and PDOWRAM in meteo-hydrological observation, data processing and analysis | ♦ Instillation of equipment of meteo-hydrological observation in the selected points in the river basins<br>♦ Training of meteo-hydrological data collection, processing and analysis |

Prepared by JICA SAPROF Study Team

**Scope of Capacity Development of MOWRAM Staffs**

| Project Supporting Program | Purpose | Content |
|---|---|---|
| Capacity Development of MOWRAM Staffs | To increase technical capability of MOWRAM staffs in Construction Supervision | ♦ Preparation of construction supervision manuals<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals |

Prepared by JICA SAPROF Study Team

**Scope of Capacity Development of PDOWRAM Staffs**

| Project Supporting Program | Purpose | Content |
|---|---|---|
| Capacity Development of PDOWRAM Staffs | To increase technical capability of PDOWRAM staffs in construction supervision at the provincial level | ♦ Preparation of construction supervision manuals for field-use<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals |

Prepared by JICA SAPROF Study Team

(4) Project Formulation study for Other Potential Areas

**Scope of Project Formulation Study for Other Potential Areas**

| Project Supporting Program | Purpose | Content |
|---|---|---|
| Scope of Project Formulation Study for Other Potential Areas | To prepare irrigation development plan for other potential areas | ♦ Screening of potential project<br>♦ Selection of priority project to be developed<br>♦ Assessment of available water resources through meteo-hydrological analysis<br>♦ Inventory survey of facilities<br>♦ Preparation of agriculture development plan<br>♦ Preparation of irrigation and drainage plan<br>♦ Cost estimate<br>♦ Preparation of implementation schedule |

Prepared by JICA SAPROF Study Team

# *PART II STUDY*

# *TABLE*

## Table II 2.1.1 Irrigation and Agriculture-Related Law and Regulation (1/2)

| Title | Issued in | Provisions |
|---|---|---|
| Water Resources Policy | | |
| National Water Resources Policy for the Kingdom of Cambodia | 2004 | ◆ It is a basic policy for using water resources in Cambodia. It is aim to ensure the effective, sustainable, wise and equitable use of water resources.<br>◆ The policy refers to all over the aspect for water use and consists of 4 chapters, i) Introduction, ii) Vision for water in Cambodia, iii) Fundamental principles, iv) The national water resources policy, v) Implementation of the national water resources policy, vi) Conclusion. |
| Water management | | |
| Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems | 1999 | ◆ MOWRAM defines the role of FWUC in the policy for Sustainability of Operation and Maintenance Irrigation Systems. Circular No.1 defines organizational flame of FWUC and is attached The Statute of The FWUC. The statute defines the objectives, criteria, organization, finance management, rules and punishment of FWUC, and enhances the establishment of FWUC. |
| Policy for Sustainability of Operation and Maintenance Irrigation Systems | 2000 | ◆ It defines the ways of operation and maintenance of irrigation system. In this policy, the management responsibility and water allocation transfer to FWUC. The functions and roles of FWUC, the system of irrigation service fee (ISF) and supporting system for maintenance activity of FWUC, Monitoring and Evaluation system are mentioned.<br>◆ It consists of 5 chapters, i) Introduction, ii) Operation and Maintenance Irrigation System, iii) Environment, iv) Human Resource Development, v) Miscellaneous. |
| Steps in the Formation of a Farmer Water Users Community | 2000 | ◆ FWUC has the responsibility for operation and maintenance of irrigation system. MOWRAM enhance to establish FWUC and shows steps in the formation of FWUC in this document. FWUC finally will be registered by MOWRAM. |
| Training Manual for Participatory Irrigation Management and Development (PIMD) | 2003 | ◆ The manual was prepared with the aim of promoting Participatory Irrigation Management and Development (PIMD) based on decentralization and Irrigation Management Transfer policy of the Government. The manual consists of 7 modules as follows:<br>◆ Module 1: General concept of PIMD and lesson and learnt of PIMD around the world.<br>◆ Module 2: Policy, legal and institutional framework of PIMD.<br>◆ Module 3: Planning and implementing PIMD at the national level.<br>◆ Module 4: Implementation of PIMD at provincial and irrigation system level.<br>◆ Module 5: Functions of FWUC support team in order to establish FWUC and develop their capacity.<br>◆ Module 6: Monitoring and evaluation system to support implementation and further development of PIMD. |

## Table II 2.1.1 Irrigation and Agriculture-Related Law and Regulation (2/2)

| Title | Issued in | Provisions |
|---|---|---|
| | | ◆ Module 7: Technical guide for irrigation water management targeted FWUC leaders and members. |
| Sub-Decree on Farmer Water User Community | Draft | ◆ The objective of this Sub-decree is to effectively and sustainable manage and use the irrigation systems. This sub-decree consists of 12 chapters and is to define the basic principles and process, function and supporting system etc.<br>◆ The sub-decree also fosters farmers participation in the operation and maintenance of irrigation system through FWUC based on PIMD and TIS. |
| Agricultural Cooperative | | |
| Royal Decree on the Establishment and Functioning of Agricultural Cooperative, Union of Agricultural Cooperative and Pre-Agricultural Cooperative | 2001 | ◆ The three communities are established in order to improve living standard of farmer. The sphere of these covers the agricultural sector as a whole, including the supply of material and all kinds of services at the disposal of farming production.<br>◆ This decree defines the establishment and functioning of three communities which covers the agricultural sector as a whole, including the supply of material and all kinds of services at the disposal of farming production.<br>◆ Under this decree, the agricultural cooperative is to define a private legal entity with full legal competence, self-financing and self-control.<br>◆ It has the multi functions related to the agriculture sector. All persons who have their business in agriculture or services can join the agricultural cooperative. |
| Model Statute of Agricultural Cooperatives | 2003 | ◆ In order to promote the establishment of Agricultural Cooperative, Model Statute was prepared by MAFF. It consists of 12 chapters referred to (i) administration, (ii) finance management, (iii) organization structure, (iv) management procedure and (v) dissolution procedure. |

Prepared by JICA SAPROF Study Team based on each policy papers and guidelines

**Table II 4.2.1 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Ream Kon Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|
| **Works** | **Quantity** | **Unit** | **Content** | | |
| **1. Sub-Project Area** | | | | | |
| 1) Total Command Area | 1,890 | ha | Gravity Irrigation Area: 1,610 ha<br>Pump Irrigation Area: 280 ha | (i) Construction of the Bassac Reservoir located about 30 km upstream of the Ream Kon sub-project, one of the main water source of Moung Russei River Basin, have been completed by MOWRAM in 2009 through the Grant Aid for Grassroots Human Security of Japan Embassy of Cambodia as planned in the previous Study. And no significant change were observed for water use in the Basin. Total command area, therefore, can be as same as the previous Study.<br>(ii) According to the review of topographic survey result, 280 ha located on southern edge of the command area is high in elevation which is impossible to be irrigated by gravity as planned in the previous Study. Raising water level in the main canal only to irrigate this higher area is not economically feasible. In order to minimize and optimize project cost, the original plan is feasible in the condition that the area will be irrigated using portable pumps by farmers. | Command area is proposed as same as the previous Study. |
| **2. Rehabilitation of Irrigation Facilities** | | | | | |
| **2.1 Headworks** | | | | | |
| 1) Headworks | 1 | no. | Replacement of headworks and its appurtenant structures<br>- Design discharge: Q=180 $m^3/s$ (T=100 years)<br>- Design flood water flood level: El. 17.2 m | (i) Concrete structure of the headworks are highly deteriorated, therefore, it is judged to be necessary to construct new headworks to be located approximately 60m upstream from existing one.<br>(ii) Scouring sluice gates and flood gates have been already removed and/or severely deteriorated. Therefore, they need to be replaced by new one.<br>(iii) Existing headworks will not be demolished during the construction of new headworks for the temporary access road for the works.<br>(iv) It is appropriate that existing creek, CD-2 will be utilized for temporary diversion for the construction works.<br>(v) Plan and design of the headworks need to be upgraded from the previous Study based on geotechnical investigation and topographic survey. | It is necessary to be replaced by new one as proposed in the previous Study. |
| 2) Intake Structure | 1 | no. | Reconstruction of intake structure<br>- Design discharge: Q=2.66 $m^3/s$ | (i) Concrete structure of the existing intake is already deteriorated and no gate is installed.<br>(ii) Since headworks has no function to regulate water level, water cannot be introduced to the command area through the intake. | As proposed in the previous Study, it is necessary to be replaced by new one with the gate. |

**Table II 4.2.1 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Ream Kon Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|
| Works | Quantity | Unit | Content | | |
| | | | - Intake water level: El. 15.50 m | (iii) Due to higher elevation, beginning section of existing main canal with the length of 925 m cannot irrigate paddy field along the canal by gravity. In actuality, this part has not been irrigated since the irrigation system was established. In order to minimize conflict over water use, existing intake located approximately 1 km upstream of existing headworks will be cancelled while new intake need to be constructed near proposed headworks site. | |
| **2.2 Main and Secondary Canals** | | | | | |
| 1) Rehabilitation of Main Canals | 18.4 | km | 2 nos. consisting of main canal-1 and main canal-2<br>- Capacity: Q=0.08 - 2.66 $m^3/s$ | (i) In order to ensure flow capacity, canal section needs to be rehabilitated and expanded together with the provision of turnout and other related structures to distribute water effectively. | Only one route of main canal is proposed as mentioned left. |
| | | | | (ii) Two main canals were proposed in the previous Study consisting of main canal-1 irrigating lower part and main canal-2 commanding higher part. By reviewing topographic survey, it is found out that the Main canal-2 is possible to command both higher and lower part. Therefore, only main canal-2 alignment is proposed for main canal in new layout of the sub-project to minimize construction cost. | |
| 2) Rehabilitation of Secondary Canal | 12.9 | km | 16 nos. | (i) At present, irrigation water does not reach to the secondary canals, therefore, most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. | Necessity of the secondary canals are justified. However, the plan needs to be revised corresponding to the revision of main canal plan. |
| | | | | (ii) As main canal rehabilitation plan is required to be revised, secondary canals plan also have to be concurrently revised. | |
| **2.3 Tertiary Canals** | | | | | |
| 1) Construction of Tertiary Canals | 57.0 | km | 47 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at the field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. | Construction of tertiary canals are included in the Project as mentioned left. |
| | | | | (ii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented. | |
| | | | | (iii) Community-contract approach was proposed in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | |

**Table II 4.2.1 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Ream Kon Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|
| Works | Quantity | Unit | Content | | |
| **3. Drainage** | | | | | |
| **3.1 Main Drains and Collector Drains** | | | | | |
| 1) Rehabilitation of Main Drain | 7.2 | km | Moung Russei and Ou Anlong Rolus River to be utilized for main drain | (i) Existing streams are planned to be utilized for main drains that are judged effective for minimizing construction cost. | The plan is as proposed in the previous Study. |
| | | | | (ii) All the main drains proposed in the previous Study needs to be constructed and/or rehabilitated to protect command area from water of northern and southern areas. | Drainage gate for CD-2 proposed in the previous Study is cancelled. |
| 2) Construction of Collector Drain | 19.4 | km | 3 nos. of collector drains consisting of CD-1, CD-2 and CD-3 | (i) Capacity of both Moung Russei and Ou Anlong Rolus River is sufficient to drain water from command area, therefore, no river dredging work is required under the Project. | |
| | | | | (ii) Among others, CD-2 proposed for temporary diversion channel for the construction of headworks, are planned to be equipped with emergency gate and drainage gate at the upstream and the downstream so to release excess water to the downstream and also to protect back water from the downstream. However, its effectiveness is necessarily unclear, therefore, it is cancelled to minimize Project cost. | |
| **3.2 Secondary Drain** | | | | | |
| 1) Construction of Secondary Drain | 25.1 | km | 9 nos. and drainage gate at the confluence of CD-2 and Moung Russei River | (i) At present, no secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project. | (i) Secondary drains are recommended to be constructed, however, downstream halves of SD-1 to SD-5 will be cancelled as mentioned left. |
| | | | | (ii) However, drainage proposed in the downstream of the command area, SD-1, SD-2, SD-3, SD-4 and SD-5 are not recommendable due to following two reasons: (a) they run in the outside of command area so that land acquisition would be difficult and (b) the area is under El. 11.00 to be affected by the water from Tonle Sap Lake, therefore, drainages do not perform their functions. | (ii) Drainage gate will be cancelled. |
| | | | | (iii) By changing main canal layout as explained above, secondary drain layout also need to be changed. In particular, the number of drainage culvert can be reduced so that the construction cost for the secondary canals are economized. | |

Prepared by JICA SAPROF Study Team

**Table II 4.2.2 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Por Canal Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| **1. Sub-Project Area** | | | | | | |
| 1) | Total Command Area | 1,940 | ha | Gravity Irrigation Area: 1,940 ha | (i) Construction of the Bassac Reservoir located about 30 km upstream of the Ream Kon sub-project, one of the main water source of Moung Russei River Basin, have been completed by MOWRAM in 2009 through Grant Aid for Grassroots Human Security of Japan Embassy of Cambodia as planned in the previous Study. And no significant change were observed for water use in the Basin. Total command area, therefore, can be as same as the previous Study. | Command area is proposed as same as the previous Study |
| | | | | | (ii) In the command area, secondary canal S1-1 has been already rehabilitated with the financial support of ECOSORN by EU covering 288 ha. Since current water level is lower, irrigation water cannot be delivered to the field in this rehabilitated area by gravity, which needs rectification works. Therefore, the Project will continuously maintain total command area cover as planned including ECOSORN rehabilitated-area to materialize gravity irrigation in the entire command area. | |
| **2. Rehabilitation of Irrigation Facilities** | | | | | | |
| **2.1** | **Headworks** | | | | | |
| 1) | Headworks | - | no. | - | (i) Headworks to divert the Moung Russei River water to the Por Canal sub-project will be covered by the Ream Kon sub-project as planned in the previous Study. | - |
| 2) | Intake Structure | 1 | no. | Reconstruction of intake structure<br>- Design discharge: Q=2.74 m3/s<br>- Intake water level: El. 15.00 m | (ii) Concrete structure of the intake is existing, however, it has been seriously deteriorated and no gate has been installed. | As proposed in the previous Study, it is necessary to be replaced by new one with the gate |
| | | | | | (iii) Based on the situation mentioned above, the intake structure with the gate needs to be replaced by new one. | |
| **2.2** | **Main and Secondary Canals** | | | | | |
| 1) | Rehabilitation of Main Canals | 12.7 | km | 2 nos. consisting of main canal 1-1 and main canal 1-2 | (i) In order to ensure flow capacity, canal section needs to be rehabilitated and expanded together with turnout and other related structures. | Only one route of main canal, 1-2, is proposed as mentioned left |

**Table II 4.2.2 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Por Canal Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | - Capacity: Q=0.21 - 2.74 $m^3/s$ | (ii) Two main canals were proposed in the previous Study consisting of main canal 1-1 irrigating western part and main canal 1-2 for eastern part. Since the Main canal 1-2 is running higher part of the command area, only main canal 1-2 alignment is proposed as main canal in new layout of the sub-project to minimize construction cost. | |
| 2) | Rehabilitation of Secondary Canal | 15.8 | km | 12 nos. | (i) At present, irrigation water does not reach to the secondary canals, therefore, most of the canals are seriously deteriorated and collapsed or even no canals. Priority needs to be given to the rehabilitation and construction of those canals equipped with turnout and other related structures. | Necessity of the secondary canals are justified, however, the plan needs to be revised corresponding to the revision of main canal development plan. In addition, rectification works for ECOSORN-rehabilitated canals will be covered by the Project. |
| | | | | | (ii) In general proposed alignment of secondary canals in the previous Study is acceptable. As main canal rehabilitation plan is required to be revised mentioned above, secondary canals plan also have to be concurrently revised. | |
| | | | | | (iii) S1-1 has been rehabilitated by ECOSORN in 2009, however, no check structures were constructed and paddy field cannot be irrigated by gravity. The project will end in 2010 and no further investment will be made for the Por Canal sub-project. In order to utilized this rehabilitated canals effectively, check structures are proposed to be constructed under the Project to effectively utilize this rehabilitated canals. | |
| **2.3** | **Tertiary Canals** | | | | | |
| 1) | Construction of Tertiary Canals | 55.0 | km | 42 tertiary blocks | (i) As same as the Ream Kon sub-project, currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at the field level, each of which will command approximately 50 ha according to the guideline of MOWRAM. | Construction of tertiary canals are included in the hardware component under the Project as mentioned left. |

**Table II 4.2.2 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Por Canal Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | | (ii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented. | |
| | | | | | (iii) Community-contract approach was proposed in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | |
| **3. Drainage** | | | | | | |
| **3.1 Main Drains and Collector Drains** | | | | | | |
| 1) | Rehabilitation of Main Drain | 9.3 | km | Moung Russei River and MD-1 | (i) In addition to MD-1 to be running on the northern edge of the command area, existing streams, the Moung Russei River, is planned to be utilized for main drains that are judged effective for minimizing construction cost. | The plan is as proposed in the previous Study. |
| | | | | | (ii) Capacity of both Moung Russei and Ou Anlong Rolus River is sufficient to drain water from command area, therefore, no river dredging work is required under the Project. | |
| 2) | Construction of Collector Drain | 10.0 | km | 2 nos. of collector drains consisting of CD-1 and CD-2 | (i) Two collector drains in the previous Study were planned to run along the main canal-2 in parallel with the National Road No.5. They were originally proposed to catch excess water from the eastern side of the National Road so to protect main canal, however, its effectiveness is questionable. It would be technically reasonable to cancel CD-1 and CD-2 so as to minimize construction cost. | CD-1 and CD-2 proposed in the previous Study are cancelled. |
| **3.2 Secondary Drain** | | | | | | |
| 1) | Construction of Secondary Drain | 14.8 | km | 10 nos. | (i) At present, no secondary drains have been developed in the command area. Since development plan of the Project is based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project to distribute irrigation water effectively. | Secondary drains are recommended to be constructed under the Project. |
| | | | | | (ii) Irrigation canal layout needs to be revised as mentioned above, arrangement of secondary level drains also will be revised. | |

Prepared by JICA SAPROF Study Team

**Table II 4.2.3 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Damnak Ampil Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| **1. Sub-Project Area** | | | | | | |
| 1) | Total Command Area | 2,270 | ha | Gravity Irrigation Area: 1,770 ha<br>Pump Irrigation Area: 500 ha | (i) Command area of the Damnak Ampil Headworks are determined by considering other irrigation systems under the Pursat River Basin including the Chr Rek system, headworks of which was completed in 2008 by MOWRAM. There are no significant change in the condition in water distribution in the River basin since the previous Study was completed in March 2009, therefore, target area of the Project is judged suitable to adopt same command area as proposed in the previous Study.<br>(ii) According to the review of topographic survey result and the aerial photograph, 500 ha out of entire command area is higher that are impossible to be irrigated by gravity as planned in the previous Study. Raising water level in the main canal only to irrigate this higher area is not economically feasible. In order to minimize and optimize project cost, such areas will be irrigated using portable pumps by farmers.<br>(iii) Among three secondary canals proposed in the previous Study, S-2 has been already rehabilitated with the assistance of DANIDA in 2008, under which tertiary canals are not constructed. Therefore, the Project area will include S-2 command area. | Command area is proposed as same as the previous Study |
| **2. Rehabilitation of Irrigation Facilities** | | | | | | |
| **2.1** | **Headworks** | | | | | |
| 1) | Headworks | 1 | no. | (i) Improvement of automatic gate installed on the Damnak Ampil Headworks<br>(ii) Construction of fish ladder | (i) Automatic gate installed on the Damnak Ampil Headworks by MOWRAM in 2006 currently does not function well. In order to improve function of the gate, in the previous Study, full electrification was proposed. With the aim of minimization of the Project cost, it is of necessity to propose simple and reasonable improvement plan.<br>(ii) Fish ladder was proposed in the previous Study to conserve fish resources in the Pursat River. Therefore, plan and design is made in the SAPROF Study based on topographic survey.<br>(iii) Scouring part at the downstream of the headworks is planned to be rehabilitated by MOWRAM, of which the Project will not cover. | Simple and reasonable gate improvement plan need to be proposed. |

**Table II 4.2.3 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Damnak Ampil Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| 2) | Intake Structure | - | no. | - Intake water level: El. 17.00 m | (i) Intake was constructed in 2006 and still in good condition. No rehabilitation is required. | - |
| **2.2** | **Main and Secondary Canals** | | | | | |
| 1) | Rehabilitation of Main Canals | - | km | - | (i) Since the main canal was rehabilitated by MOWRAM and still in better conditions, the Project does not include any construction and/or rehabilitation works for the main canal as having been planned in the previous Study<br><br>***Note: MOWRAM is planning to extend main canals to connect with Svay Don Keo River to irrigate irrigation systems under the Svay Don Keo River.*** | - |
| 2) | Rehabilitation of Secondary Canal | 17.6 | km | 3 nos. | (i) At present, irrigation water does not reach to the secondary canals, therefore, most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures.<br>(ii) Out of three secondary canals proposed to be rehabilitated in the previous Study, S-2 have been already rehabilitated with the assistance of DANIDA in 2008. Therefore, rehabilitation of secondary canal, S-2, will be excluded from the Project component. | Necessity of the secondary canals are justified. Based on the current progress, secondary canal rehabilitation will include two canals: S-1 and S-3. |
| **2.3** | **Tertiary Canals** | | | | | |
| 1) | Construction of Tertiary Canals | 85.0 | km | 50 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at the field level, each of which will command approximately 50 ha according to the guideline of MOWRAM.<br>(ii) As mentioned above, S-2 have been rehabilitated by DANIDA, under which no tertiary canals are constructed. Tertiary canals with those related structures under the command area of S-2 will be proposed to be constructed under the Project.<br>(iii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented. | Construction of tertiary canals are included in the Project as mentioned left. |

**Table II 4.2.3 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Damnak Ampil Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| | | | | | (iv) Community-contract approach was proposed in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | |
| **3. Drainage** | | | | | | |
| **3.1** | **Main Drains and Collector Drains** | | | | | |
| 1) | Rehabilitation of Main Drain | - | km | Ou Bakan and Boeung Khnar River | (i) Existing streams consisting of Ou Bakan and Boeung Khnar are planned to be utilized for main drains that are judged effective for minimizing construction cost.<br>(ii) Capacity of both Moung Russei and Ou Anlong Rolus River is sufficient to drain water from command area, therefore, no river dredging work is required under the Project. | The plan is as proposed in the previous Study. |
| 2) | Construction of Collector Drain | - | km | - | - | - |
| **3.2** | **Secondary Drain** | | | | | |
| 1) | Construction of Secondary Drain | 28.2 | km | 4 nos. | (i) At present, no secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project.<br>(ii) The proposed alignment of drainage in the previous Study is technically feasible. | Secondary drains are recommended to be constructed as proposed in the previous Study. |

Prepared by JICA SAPROF Study Team

**Table II 4.2.4 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Loung Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| **1. Sub-Project Area** | | | | | | |
| 1) | Total Command Area | 2,540 | ha | Gravity Irrigation Area: 1,740 ha<br>Pump Irrigation Area: 500 ha | (i) Water for the Wat Loung sub-project is delivered from the Pursat River through headrace to be constructed under the Project. As explained in the Damnak Ampil sub-project, no significant difference in water availability from the previous Study, therefore, command area of the Wat Loung sub-project is 2,540 ha as same as previous proposal.<br>(ii) According to the preliminary review of the aerial photograph of the sub-project area, 500 ha out of the command area is higher that are impossible to be irrigated by gravity as planned in the previous Study. Raising water level in the main canal only to irrigate this higher area is not economically feasible. In order to minimize and optimize project cost, this area will be irrigated using portable pumps by farmers. | Command area is proposed as same as the previous Study |
| **2. Rehabilitation of Irrigation Facilities** | | | | | | |
| **2.1** | **Headworks** | | | | | |
| 1) | Headworks | - | no. | - | (i) Although headworks were previously planned in 1970s to 1980s, it is not recommended to construct new one instead irrigation water is diverted from existing Damnak Ampil Headworks on the Pursat River to optimize the Project cost as planned in the previous Study. | - |
| 2) | Intake Structure | - | no. | - Intake water level: El. 17.00 m at Damnak Ampil Headworks | - | - |
| **2.2** | **Main and Secondary Canals** | | | | | |
| 1) | Rehabilitation of Main Canals | 20.3 | km | 1 no.<br>- Capacity: Q=1.39 - 3.33 $m^3/s$ | (i) Currently, main canal is significantly deteriorated and no water flows unless flooding from the Pursat River in the rainy season. In order to ensure smooth water delivery, canal section needs to be rehabilitated together with turnout and other related structures. | As mentioned left, no major revision is necessary. |

**Table II 4.2.4 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Loung Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | | (ii) Since the alignment of main canal is existing, no major revision is required from the proposal in the previous Study. | |
| 2) | Rehabilitation of Secondary Canal | 31.1 | km | 10 nos. | (i) At present, irrigation water does not reach to the secondary canals, therefore, most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. | Necessity of the secondary canals are confirmed. It is essential to rehabilitate secondary canals under the Project. |
| | | | | | (ii) At present, only secondary canal S-8 is existing although the canal sections are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures. | |
| **2.3** | **Tertiary Canals** | | | | | |
| 1) | Construction of Tertiary Canals | 81.0 | km | 54 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at the field level, each of which will command approximately 50 ha according to the guideline of MOWRAM.. | Construction of tertiary canals are included in the hardware component under the Project as mentioned left. |
| | | | | | (ii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented. | |
| | | | | | (iii) Community-contract approach was proposed in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | |
| **3. Drainage** | | | | | | |
| **3.1** | **Main Drains and Collector Drains** | | | | | |
| 1) | Rehabilitation of Main Drain | - | km | Boeung Khnar River | (i) Existing streams are planned to be utilized for main drains that are judged effective for minimizing construction cost. | The plan is as proposed in the previous Study. |

**Table II 4.2.4 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Loung Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | | (ii) Capacity of Boeung Khnar River is sufficient to drain water from the command area of Wat Loung, therefore, no river dredging works are required under the Project. | |
| 2) | Construction of Collector Drain | - | km | - | - | - |
| **3.2** | **Secondary Drain** | | | | | |
| 1) | Construction of Secondary Drain | 37.7 | km | 8 nos. | (i) At present, no secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project. | Secondary drains are recommended to be constructed under the Project. |

Prepared by JICA SAPROF Study Team

**Table II 4.2.5 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Chre Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| **1. Sub-Project Area** | | | | | | |
| 1) | Total Command Area | 1,020 | ha | Gravity Irrigation Area: 620 ha<br>Pump Irrigation Area: 400 ha | (i) Water is delivered from the Pursat River through the main canal of Wat Loung sub-project to be rehabilitated under the Project. As explained in the Damnak Ampil sub-project, no significant difference in water utilization in the River Basin from the previous Study, therefore, command area of the Wat Chre sub-project is determined to be 1,020 ha as same as previous proposal. | Command area is proposed as same as the previous Study |
| | | | | | (ii) According to the preliminary review of aerial photograph, 400 ha out of the command area is higher that are impossible to be irrigated by gravity as planned in the previous Study. Raising water level in the main canal only to irrigate this higher area is not economically feasible. In order to minimize and optimize project cost, this area will be irrigated using portable pumps by farmers. | |
| **2. Rehabilitation of Irrigation Facilities** | | | | | | |
| **2.1** | **Headworks** | | | | | |
| 1) | Headworks | 1 | no. | Reconstruction of headworks and its appurtenant structures<br><br>- Design flood discharge: Q=65 $m^3$/sec (T=100 years)<br>- Design flood water level: 13.6 m | (i) No structure is existing at present. In order to divert water from Boueng Khnar River to be delivered through Wat Loung main canal, it is justifiable to construct headworks on the Boueng Khnar River. | It is necessary to reconstruct new one as proposed in the previous Study |
| | | | | | (ii) The proposed location is generally same as the site proposed in the previous Study where the River flow is stable and no land acquisition is required for the construction. | |
| | | | | | (iii) Temporary diversion during the construction period was proposed utilizing main canal to be constructed with large section, which will require comparatively large earth work volume. It is recommended to construct temporary diversion channel on the left bank of the River for the construction of the headworks. | |
| | | | | | (iv) Plan and design of the headworks need to be upgraded from the previous Study based on geotechnical investigation and topographic survey. | |

**Table II 4.2.5 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Chre Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| 2) | Intake Structure | 1 | no. | Reconstruction of intake structure<br>- Design discharge: Q=1.39 $m^3/s$<br>- Intake water level: El. 13.00 m | (i) No structure is existing at present. Together with the headworks, new intake structure needs to be constructed. Location is proposed to be within 100 m from the headworks to ease gate operation. | As proposed in the previous Study, it is necessary to construct new one. |
| **2.2** | **Main and Secondary Canals** | | | | | |
| 1) | Rehabilitation of Main Canals | 4.7 | km | 1 no.<br>- Capacity: Q=0.31 - 1.39 m3/s | (i) Most of the main canal is highly deteriorated. At present, since no water is provided to the canal from the source River, all the section needs to be rehabilitated and reconstructed in order to ensure flow capacity.<br>(ii) It was proposed that the main canal be utilized for temporary diversion for the construction of headworks with the capacity of 3.0 m3/sec in the previous Study. In order to minimize the Project cost, it is not recommendable to construct large capacity of main canal for temporary diversion. Instead, temporary diversion will be constructed on the left bank of the River during the construction while main canal capacity need only 1.39 m3/sec, peak design discharge to reduce earth work volume.<br>(iii) At the end of the confluence of the main canal and Boueng Khnar River, it was proposed to install gate so as to keep water in the main canal by utilizing main canal as storage. However, the water is ensured by the construction of irrigation facilities and the necessity of this gate is not justifiable. This proposed gate is, therefore, cancelled. | Design discharge of the main canal is set to be 1.39 $m^3$. Temporary diversion will be constructed on the left bank that is separate from the main canal. |
| 2) | Rehabilitation of Secondary Canal | 14.7 | km | 6 nos. | (i) At present, irrigation water does not reach to the secondary canals, therefore, most of the canals are seriously deteriorated and collapsed. Priority needs to be given to the rehabilitation of those canals and related structures.<br>(ii) Proposed plan in the previous Study is technically feasible. | Necessity of the secondary canals are justified and the proposed plan in the previous Study is acceptable as mentioned on the left. |

**Table II 4.2.5 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Wat Chre Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| **2.3** | **Tertiary Canals** | | | | | |
| 1) | Construction of Tertiary Canals | 27.0 | km | 27 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute water at the field level, each of which will command approximately 50 ha according to the guideline of MOWRAM.<br>(ii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented.<br>(iii) Community-contract approach was proposed in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | Construction of tertiary canals are included in the Project as mentioned left. |
| **3. Drainage** | | | | | | |
| **3.1** | **Main Drains and Collector Drains** | | | | | |
| 1) | Rehabilitation of Main Drain | - | km | - Boeung Khnar River<br>- Ta Paong Stream | (i) Existing streams are planned to be utilized for main drains that are judged effective for minimizing construction cost.<br>(ii) Capacity of both Boeung Khnar River and Ta Paong Stream is sufficient to drain water from command area, therefore, no river dredging work is required under the Project. | The plan is as proposed in the previous Study. |
| 2) | Construction of Collector Drain | - | km | - | - | - |
| **3.2** | **Secondary Drain** | | | | | |
| 1) | Construction of Secondary Drain | 14.8 | km | 7 nos. | (i) At present, no secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project. | Secondary drains are recommended to be constructed under the Project. |

Prepared by JICA SAPROF Study Team

**Table II 4.2.6 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Lum Hach Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| | Works | Quantity | Unit | Content | | |
| **1. Sub-Project Area** | | | | | | |
| 1) | Total Command Area | 3,100 | ha | Gravity Irrigation Area: 2,690 ha<br>Pump Irrigation Area: 410 ha | (i) Boribo River, the main source of the Lum Hach sub-project, diverge into two at the Bomnak water level station, one is the Boribo River to the Kampong Chhnang province and the other is the Thlea Maan River to the Pursat province. In the previous Study, 50 % of the river runoff is assumed to flow into the Boribo River by diversion at the Bomnak water level station. Since there is no large scale development at the Bomnak, the assumption utilized in the previous Study can be continuously applied for the SAPROF Study. Therefore, target area of the sub-project is as same as the previous Study.<br>(ii) According to the review of the topographic survey result, 410 ha located on the southern edge of the command area is higher that are impossible to be irrigated by gravity as planned in the previous Study. Raising water level in the main canal only to irrigate this higher area is not economically feasible. In order to minimize and optimize the Project cost, this area will be irrigated using portable pumps by farmers. | Command area is proposed as same as the previous Study |
| **2. Rehabilitation of Irrigation Facilities** | | | | | | |
| **2.1** | **Headworks** | | | | | |
| 1) | Headworks | 1 | no. | Reconstruction of headworks and its appurtenant structures<br>- Design flood discharge: Q=430 m3/sec (T=100 years)<br>- Design flood water level: 38.0 m | (i) No structure is existing at present. In order to divert water from the Boribo River to the command area of the Lum Hach sub-project, the highest priority is given to the construction of headworks under the Project.<br>(ii) Main canal were planned to be utilized for temporary diversion during the construction of the headworks, however, it would be appropriate to use old Boribo stream as diversion through O-Roluss pond to minimize the construction cost.<br>(iii) Plan and design of the headworks need to be upgraded from the previous Study based on geotechnical investigation and topographic survey. | New headworks construction is proposed as planned in the previous Study. |
| 2) | Intake Structure | 2 | no. | Reconstruction of intake structure for: (i) Lum Hach sub-project and (ii) O-Roluss Irrigation System | (i) No structure is existing at present. Together with the headworks, new intake structure needs to be constructed. Location is proposed to be within 100 m from the headworks to ease operation of water management. | As proposed in the previous Study, it is necessary to be constructed. |

**Table II 4.2.6 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Lum Hach Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | - Design discharge: Q=6.60 $m^3/s$ (Lum Hach) and Q=5.70 $m^3/s$ (O-Roluss)<br>- Intake water level: El. 38.00 - 36.00 m | (ii) The water is also diverted to O-Roluss Irrigation System (3,400 ha) constructed by MOWRAM in 2007 from the proposed Lum Hach headworks. Intake and spillway has already been provided at the O Roluss Pond located approximately 3.6 km downstream on old Boribo water course. In addition to those structures, intake structure is proposed to be constructed at the headworks site as planned in the previous Study. | |
| **2.2 Main and Secondary Canals** | | | | | | |
| 1) | Rehabilitation of Main Canals | 16.4 | km | 1 no.<br>- Capacity: Q=0.83 - 6.60 m3/s | (i) Overall, canal sections are highly deteriorated so that the rehabilitation is required. In general, the upstream portion has large enough for the design discharge while the downstream portion needs expansion.<br>(ii) In the previous Study, approach canal proposed in the most upper stream were proposed to be utilized for temporary diversion for the headworks construction. In order to reduce construction cost, old Boribo water course is proposed to be utilized for the temporary diversion so that the earth work for approach canal can be reduced. | Proposed main canal is appropriate, however, capacity of most upstream part can be reduced by changing the methodology of construction for the headworks. |
| 2) | Rehabilitation of Secondary Canal | 42.4 | km | 11 nos. | (i) At present, irrigation water does flow only when it heavily rains, therefore, almost no water does reach to secondary levels and no secondary canals have been constructed. Therefore, priority needs to be given to the construction of those canals and related structures.<br>(ii) By reviewing topographic survey and aerial photographs, alignment proposed in the previous Study is technically feasible in general. | Necessity of the secondary canals are justified and plans proposed in the previous Study is feasible as mentioned left. |
| **2.3 Tertiary Canals** | | | | | | |
| 1) | Construction of Tertiary Canals | 67.0 | km | 67 tertiary blocks | (i) Currently, no tertiary canals have been developed in the command area. Tertiary canals are surely required to distribute at the water field level, each of which will command approximately 50 ha according to the guideline of MOWRAM.. | Construction of tertiary canals are included in the hardware component under the Project as mentioned left. |

**Table II 4.2.6 Technical Judgment by JICA SAPROF Study Team Toward Development Plan Proposed in the Previous Study (Lum Hach Sub-Project)**

| Proposed Plan Prepared in the Previous Study | | | | | Findings of SAPROF Study based on Field Survey | Judgment and Any Revisions from the Previous Study |
|---|---|---|---|---|---|---|
| Works | | Quantity | Unit | Content | | |
| | | | | | (ii) Since no compensation for land acquisition is made for the construction of tertiary canals according to the regulation of the Government, consensus building among farmers are of importance when the Project is implemented. | |
| | | | | | (iii) Community-contract approach was proposed to construct tertiary level facilities in the previous Study as an effective tools for capacity development of FWUC. However, it requires complicated organizational arrangement. Therefore, tertiary development will be covered by civil works. | |
| **3. Drainage** | | | | | | |
| **3.1 Main Drains and Collector Drains** | | | | | | |
| 1) | Rehabilitation of Main Drain | - | km | Boribo River is utilized as main drain. | (i) Boribo River is planned to be utilized for main drains that are judged effective for minimizing construction cost. | The plan is as proposed in the previous Study. |
| | | | | | (ii) No dredging works are required for Boribo River to be utilized as main drain. | |
| 2) | Construction of Collector Drain | - | km | - | (i) No collector drains are required as judged in the previous Study. | - |
| **3.2 Secondary Drain** | | | | | | |
| 1) | Construction of Secondary Drain | 53.9 | km | 11 nos. and the drainage gate at the confluence of SD-3 and Boribo River | (i) At present, no secondary drains have been developed in the command area. Since development plan is prepared based on independent setting of irrigation and drainage canals at the secondary level, it is judged necessary to construct secondary level drainage under the Project. | Secondary drains are recommended to be constructed, some of which proposed in the previous Study, however, will be excluded from the Project |
| | | | | | (ii) Drainage gate was proposed at the confluence of Boribo River and SD-3, however, its effectiveness is unclear. According to the interview at the field, no serious flooding during the rainy season was reported. Therefore, it is excluded from the Project component. | |
| | | | | | (iii) The road development is being carried out by the Ministry of Public Works and Transport in the command area, connecting from the entrance at the National Road No. 5 to the Main Canal, approximately 18 km. Side drains have been already constructed together (with the width of 2m to more than 7m), therefore, all or part of following drains does not have to be constructed: SD-2, SD-3, SD-4, SD-6 and SD-10. | |

Prepared by JICA SAPROF Study Team

## Table II 4.2.7 Summary of Irrigation and Drainage Plan of Six Sub-projects

| No. | Description | Name of sub-project | | | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ream Kon | | Por Canal | | Damnak Ampil | | Wat Loung | | Wat Chre | | Lum Hach | | | |
| | | Pre F/S | SAPROF | Pre F/S | SAPROF | Pre F/S | SAPROF | Pre F/S | SAPROF | Pre F/S | SAPROF | Pre F/S | SAPROF | Pre F/S | SAPROF |
| 1. | Sub-project area (ha) | 1,890 | 1,890 | 1,940 | 1,940 | 2,270 | 2,270 | 2,540 | 2,540 | 1,020 | 1,020 | 3,100 | 3,100 | 12,760 | 12,760 |
| | (Pump irrigation area included above) | (280) | (280) | 0 | 0 | (500) | (500) | (800) | (800) | (400) | (400) | (410) | (440) | (2,390) | (2,420) |
| 2. | Annual irrigation area (ha) | 2,413 | 3,020 | 2,494 | 3,140 | 2,364 | 2,440 | 2,645 | 2,730 | 1,062 | 1,100 | 4,700 | 4,370 | 15,678 | 16,800 |
| | - Early wet season paddy (ha) | 1,180 | 1,130 | 1,220 | 1,200 | 94 | 170 | 105 | 190 | 42 | 80 | 1,300 | 1,270 | 3,941 | 4,040 |
| | - Medium wet season paddy (ha) | 1,180 | 1,890 | 1,220 | 1,940 | 2,270 | 2,270 | 2,540 | 2,540 | 1,020 | 1,020 | 3,100 | 3,100 | 11,330 | 12,760 |
| | - Dry season paddy (ha) | 53 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 300 | 0 | 407 | 0 |
| 3. | Major water source | Moung Russei River | | | | Pursat River | | | | | | Boribo River | | - | - |
| | - Name of headworks | Moung Russei (Reconstruction) | | | | Damnak Ampil (Existing) | | | | Wat Chre (Reconstruc.) | | Lum Hach (Reconstruc.) | | - | - |
| | - Intake water level (EL. m) | 15.50 | 15.50 | 15.00 | 15.00 | 17.00 | 17.00 | 17.00 | 17.00 | 13.00 | 13.00 | 36.00 - 38.00 | 36.00 - 38.00 | | |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.66 | 2.66 | 2.74 | 2.74 | 7.93 | 7.93 | 3.45 | 3.45 | 1.39 | 1.39 | 6.60 | 6.60 | - | - |
| 4. | Main canals (nos.) | 2 | 1 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 5 |
| | - Total length (km) | 18.4 | 9.9 | 12.7 | 6.8 | 7.5 | - | 20.3 | 20.3 | 4.7 | 4.7 | 16.4 | 16.4 | 80.0 | 58.1 |
| 5. | Nos. of secondary/ sub-secondary canals | 16 | 13 | 12 | 9 | 3 | 3 | 10 | 10 | 6 | 6 | 11 | 11 | 58 | 52 |
| | - Total length (km) | 12.9 | 18.3 | 15.8 | 19.1 | 17.6 | 12.6 | 31.1 | 31.1 | 14.7 | 14.7 | 42.4 | 42.4 | 134.5 | 138.2 |
| 6. | Number of Tertiary Blocks (No.) | 47 | 45 | 42 | 42 | 50 | 50 | 54 | 54 | 27 | 27 | 67 | 69 | 287 | 287 |
| | Total length of tertiary canals (km) | 57.0 | 54.0 | 55.0 | 55.0 | 85.0 | 85.0 | 81.0 | 81.0 | 27.0 | 27.0 | 67.0 | 69.0 | 372.0 | 371.0 |
| 7. | Main drains | - Moung Russei, - Ou Anlong Rolus | - Moung Russei, - Ou Anlong Rolus | - Moung Russei, - MD-1 | - Moung Russei, - MD-1 | Ou Bakan/Boeung Khnar River | Ou Bakan/Boeung Khnar River | Boeung Khnar R. | Boeung Khnar R. | - Boeung Khnar R., - Ta Paong stream | - Boeung Khnar R., - Ta Paong stream | Boribo River | Boribo River | | |
| | - Total length (km) | 7.2 | 7.2 | 9.3 | 5.6 | - | - | - | - | - | - | - | - | 16.5 | 12.8 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 | 7.17 | 7.17 | 7.17 | 6.32 | 6.32 | 6.32 | 6.32 | 6.32 | 6.32 | 6.83 | 6.83 | | |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 | 19~25 | 19~25 | 19~25 | 18~25 | 18~25 | 18~25 | 18~25 | 18~25 | 18~25 | 19~25 | 19~25 | | |
| 8. | Secondary drains (nos.) | 9 | 7 | 10 | 10 | 4 | 3 | 8 | 8 | 7 | 5 | 11 | 9 | 49 | 42 |
| | - Total length of secondary drains (km) | 25.1 | 13.4 | 14.8 | 14.8 | 28.2 | 21.8 | 37.7 | 37.7 | 14.8 | 11.5 | 53.9 | 35.7 | 174.5 | 134.9 |
| 9. | Collector drains (nos.) | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 |
| | - Total length of collector drain (New, km) | 19.4 | 21.8 | 10.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.4 | 21.8 |

Prepared by JICA SAPROF Study Team

# *PART III*
# *IMPLEMENTATION PROGRAM*

# PART-III IMPLEMENTATION PROGRAM

# CHAPTER 1 PROJECT AREA

## 1.1 Project Area

The six Sub-projects are respectively located in Pursat, Moung Russei and Boribo River Basins. All the sub-project areas are in the western Tonle Sap Lake along the National Road No.5. The locations and the administrations of the sub-projects are shown in the following table:

**Location and Administration of Sub-project Areas**

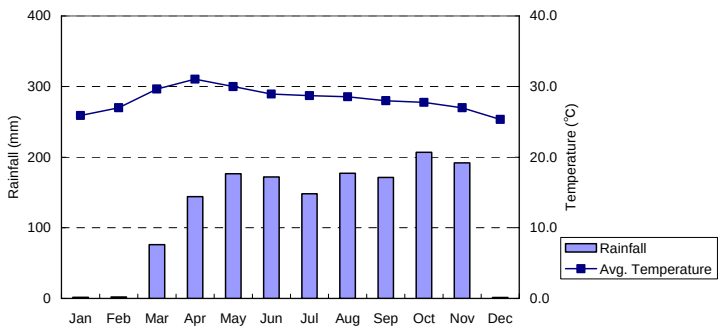
| No. | Sub Project | River Basin | Province | Commune | No. of Villages | Population |
|---|---|---|---|---|---|---|
| 1 | Ream Kon | Moung Russei | Battam-bang | Kear, Chrey, Prey Svay | 6 | 4,667 |
| 2 | Por Canal | | | Chrey, Kear, Ta Loas, Kor Koah | 13 | 4,739 |
| 3 | Damnak Ampil | Pursat | Pursat | Lorlok Sar, Snam Preah, Trapeang Chong, Phteah Rung, Bak Chenhchien | 6 | 10,401 |
| 4 | Wat Loung | | | Lorlok Sar, Trapeang Chong, Snam Preah, Khnar Totueng, Boueng Khnar | 5 | 9,232 |
| 5 | Wat Chre | | | Boueng Khnar, Me Tuek | 4 | 3,797 |
| 6 | Lum Hach | Boribo | Kampong Chhnang | Krang Skear, Anchanh Rung, Prasneb, Phsar | 6 | 9,624 |
| | Total | | | | 40 | 42,460 |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia (SEILA Database 2005)

## 1.2 Natural Conditions

### 1.2.1 Moung Russei River Basin

The Mourg Russei river basin where the Ream Kon and the Por Canal sub-projects are situated is depicted in Figure III 1.2.1. The Bassac Reservoir located approximately 30 km upstream of the Ream Kon and the Por Canal sub-projects was constructed in 2009 with the Grant Assisstance for Grassroots Human Security of the government of Japan at Cambodia, as one of the main source structures in the Moung Russei River. The catchment area for the two sub-projects is 785 km$^2$ in total consisting of: (i) Bassac Reservoir area (598 km$^2$) and (ii) the residual area between the Bassac Reservoir and the National Road No.5 (187 km$^2$). In the residual area, the Prek Chik irrigation system is located.




Prepared by JICA SAPROF Study Team based on Department of Meteorology, MOWRAM (Battambang Station)

**Monthly Rainfall and Temperature of the Moung Russei River Basin**

(1) Agro-meteorological Conditions

Rainfall and temperature of the Moung Russei River Basin is illustrated above. Average annual rainfall is 1,387 mm. More than 90 % of the rainfall is concentrated from March to November. Annual mean temperature is 28.1 degrees Celsius in which highest month is April (30.2 degrees Celsius) and the lowest month is December (24.0 degrees Celsius).

(2) Hydrological Conditions

Five-day Discharge

Annual average discharge from 2001 to 2005 for five-day discharges for five years is 3.23 $m^3$/sec or 102 MCM/year at the Basak Reservoir and 1.00 $m^3$/sec or 32 MCM/year at residual area between the Basak Reservoir and the National Road No. 5, details of which are shown in Table III 1.2.1.

Flood Discharge

Probable flood discharge at the Moung Russei station is estimated as summarized in the following Table.

**Peak Flood Discharge at the Moung Russei Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 100 | 110 | 120 | 130 | 160 | 190 |

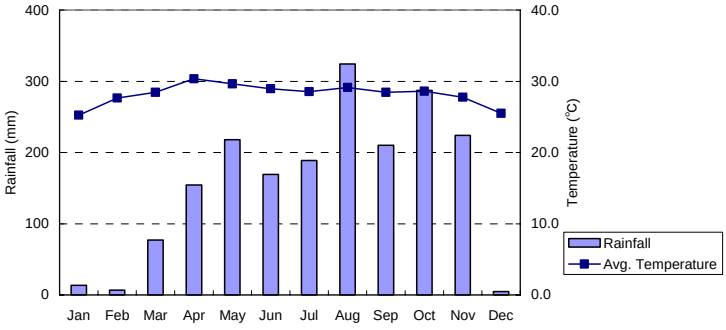
Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

### 1.2.2 Pursat River Basin

Pursat river basin where three sub-projects in the Pursat Province, the Damnak Ampil and the Wat Loung and the Wat Chre sub-projects are located is shown in Figure III 1.2.2. Catchment area of the Pursat River at existing headworks is 4,480 $km^3$.

(1) Agro-meteorological Conditions

Rainfall and temperature of the Pursat River Basin is shown in the right graph. Average annual rainfall is 1,624 mm. As similar to the Moung Russei River Basin, more than 90 % of the rainfall is concentrated from March to November. Annual mean temperature is 28.0 degrees Celsius in which highest month is April (29.9 degrees Celsius) and the lowest month is January (25.4 degrees Celsius).




Prepared by JICA SAPROF Study Team based on Department of Meteorology, MOWRAM (Pursat Station)

**Monthly Rainfall and Temperature of the Pursat River Basin**

(2) Hydrological Conditions

Five-day Discharge

Annual average discharge from 2001 to 2005 for five-day discharges for five years is 76.4 $m^3$/sec or 2,426 MCM/year at existing headworks, details of which are shown in Table III 1.2.2.

Flood Discharge

Probable flood discharge at the Bac Trakoun station, nearest station from the Damnak Ampil

Headworks is estimated as summarized in the following Table.

**Peak Flood Discharge at the Bac Trakoun Station located near the Damnak Ampil Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 710 | 970 | 1,130 | 1,270 | 1,440 | 1,560 |

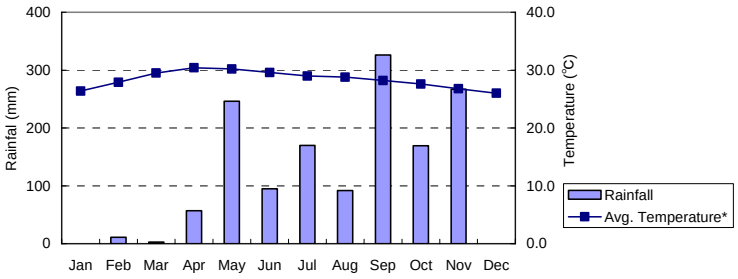
Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

### 1.2.3 Boribo River Basin

Boribo river basin where the Lum Hach sub-project is located is shown in Figure III 1.2.3. Catchment area of the Boribo River at proposed headworks site is 735 $km^3$, out of which 384 $km^3$ is that of the Bomnak River Basin. Location of proposed headworks is approximately 15 km downstream of the Bomnak water level station where a reservoir was previously constructed in the Pol Pot regime.

(1) Agro-meteorological Conditions

Rainfall and temperature of the Boribo River Basin is shown in the right graph. Average annual rainfall is 1,615 mm. As similarly shown in the Moung Russei and the Pursat River Basins, more than 90 % of the rainfall is concentrated from March to November. However, the rainfall from June to August shows distinctively smaller. Annual mean temperature is 28.4 degrees Celsius in which highest month is April (30.4 degrees Celsius) and the lowest month is December (26.4 degrees Celsius).




Prepared by JICA SAPROF Study Team based on Department of Meteorology, MOWRAM (Kampong Chhnang Station)

**Monthly Rainfall and Temperature of the Boribo River Basin**

(2) Hydrological Conditions

Five-day Discharge

Water of the Boribo River is divided into two directions at the Bomnak water level station: (i) to the Thlea Maam irrigation system in the Pursat Province and (ii) to the Kampong Chhnang Province side including Lum Hach sub-project as depicted in the right figure. Annual average discharge from 1998 to 2007 for five-day discharges for five years on the assumption that the 50 % of the water is allocated to the Pursat Province and the remaining is to the Kampong Chhnang Province is 15.4 $m^3$/sec or 487 MCM/year at proposed headworks, details of which are shown in Table III 1.2.3.


Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Location of Bomnak Diversion**

Flood Discharge

Probable flood discharge at the proposed headworks

site is estimated as summarized in the following Table.

**Peak Flood Discharge at the Proposed Headworks**

| | 2 years | 5 years | 10 years | 20 years | 50 years | 100 years |
|---|---|---|---|---|---|---|
| **Qpeak ($m^3$/sec)** | 220 | 270 | 290 | 320 | 380 | 430 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

## 1.3 Socio-Economic Conditions

### 1.3.1 Ethnicity

The community, in common with the religion in general, is Khmer and Buddhist, with no presence of ethnic minorities or immigrants of other nationalities in all the sub-project areas.

### 1.3.2 Poverty

As elaborated in the National Poverty Reduction Strategy (NPRS) 2003-2005, eradication of poverty and inequality is of critical importance in Government's policy. According to the definition by "A Poverty Profile of Cambodia 2004", poverty in Cambodia is estimated based on: (i) food poverty line and (ii) non-food allowance. Former is estimated to be Riel 1,684 (US$ 0.42) per day while latter is Riel 440 (US$ 0.10) per day, therefore, the total poverty line is Riel 2,124 (US$0.53) per day in average 2004 Phnom Penh prices.

**Provincial level poverty headcount ratio**

| Province | Poverty head count index (%) |
|---|---|
| Phonm Penh | 4.60 |
| Battambang | 33.69 |
| Kompong Chhnang/ Pursat | 39.57 |
| Cambodia | 35.13 |

Extracted from Ministry of Planning (2006), A poverty profile of Cambodia 2004

Provincial poverty headcount ratio is summarized in the right table showing that two provinces, Kampong Chhnang and Pursat indicate higher poverty ratio than the national average. On the other hand, Battambang province shows slightly better than the country's average.

Comparison of poverty situation between urban and rural areas are summarize on the right table. The figure indicates that the country's poverty is rooted largely in rural areas where people primarily depend upon agricultural sector that is currently lower productivity due to insufficient irrigation facilities. Although a share of agriculture sector in GDP is in declining trend in country's economy, more than 70 % of the people are living in rural areas to support food security of the country.

**Poverty headcount ratio, urban and rural areas**

| Region | Head Count Index (%) | | % of all Poor (%) | |
|---|---|---|---|---|
| | 1993/94 | 2004 | 1993/94 | 2004 |
| Poverty Line | | | | |
| Phom Penh | 11.39 | 4.6 | 3.1 | 2.3 |
| Other urban areas | 36.62 | 20.54 | 10.3 | 9.4 |
| Rural areas | 43.12 | 33.66 | 86.5 | 88.3 |
| Cambodia | 39.00 | 27.97 | 100.0 | 100.0 |
| Food poverty line | | | | |
| Phom Penh | 6.19 | 2.55 | 3.3 | 2.5 |
| Other urban areas | 19.63 | 12.5 | 10.8 | 11.3 |
| Rural areas | 21.95 | 16.66 | 85.9 | 86.2 |
| Cambodia | 20.00 | 14.18 | 100.0 | 100.0 |

Extracted from Ministry of Planning (2006), A poverty profile of Cambodia 2004

There are no authorized statistical figures for commune and village level in the sub-project areas. Socio-economic survey carried out in the previous Study, however, shows that "Poor" and "Destitute"

occupies more than provincial average. This would be due to low income from agriculture caused by insufficient irrigation facilities, poor marketing conditions, insufficient support and so forth.

**Summary of Poverty Ranking carried out in the Previous Study**

| Sub-Project | Percentage of People in Poor Status (Categorized into "Destitute" and "Poor" | Income source | Asset (Land: ha) |
|---|---|---|---|
| Ream Kon | 61 % | Labor and/or Land Owner Farmers | 0 – 1.0 |
| Por Canal | 62 % | | 0 – 1.5 |
| Damnak Ampil | 55 % | | 0 – 1.0 |
| Wat Loung | 71 % | | 0 – 1.0 |
| Wat Chre | 71 % | | 0 – 0.5 |
| Lum Hach | 59% | | 0 – 1.5 |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

### 1.3.3 Gender Issue

In Cambodia, there are generally some gender issues pointed out such as: (i) unbalance in work load due to women's overload particularly in housekeeping, (ii) income gap between men and women resulted from differences of opportunity in economic activities, (iii) difference in participating social activities and so forth. According to the socio-economic survey carried out in the previous Study, activities of men and women are comparatively differentiated. Women generally engage in: (i) housekeeping, (ii) farming, (iii) care of children while men are in charge of other economic activities including manual labor for construction works. Both of them take charge of farm management. It was observed that women's participation to the workshop in the previous studies were comparatively active. And no significant gender problems were essentially addressed by the community members. Survey result showed that both men and women have equal accessibility and control to properties such as water source, land, livestock, and water source in all the sub-project areas.

## 1.4 Agriculture

(1) Soils and Land Suitability

Soils in the respective sub-project areas were classified in the JICA M/P and Pre-F/S Study based on the reconnaissance level soil survey and then the FAO/UNESCO classification system as shown below.

**Soil Classification of Sub-project Areas**

| Soil Sub-unit / Sub-project | Ream Kon | Por Canal | Dm. Ampil | Wat Loung | Wat Chre | Lum Hach |
|---|---|---|---|---|---|---|
| | Distribution of Soil Sub-unit (%) | | | | | |
| Gleyic Luvisol | 100 | 100 | | | | |
| Gleyic Acrisol/ Plinthic Acrisol | | | 100 | 100 | 100 | |
| Gleyic Acrisol | | | | | | 56 |
| Plinthic Acrisol | | | | | | 38 |
| Dystric Fluvisol | | | | | | 6 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

As for land suitability classification, the area where Gleyic Luvisol and Dystric Fluvisol are distributed is moderately suitable for rice cultivation and marginally suitable for field crop cultivation. Other soil sub-units are marginally suitable for growth of the both rice and field crops. Therefore, the whole of Ream Kon and Por Canal Sub-project areas and a part of Lum Hach Sub-project are moderately suitable for growing rice, while Damnak Ampil, Wat Loung, Wat Chre and majority of

Lum Hach Sub-project areas are marginally suitable for rice cultivation.

(2) Present Land Use

The present land use condition in command areas of six sub-projects is featured by extensive distribution of paddy field. Due to prolonged malfunction of the existing irrigation systems in all sub-project areas, major parts of paddy field is used under rain-fed condition, and limited number of farmers are using portable pumps for getting water from puddles for supplemental irrigation purposes. In general, farmers grow vegetables and other field crops in their home yards in residential place within villages. The current land use is summarized below.

**Present Land Use Condition of Sub-project Areas**

| Land Use Category / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|
| Supplementally irrigated paddy field | 50 | 100 | 500 | 130 | 60 | 200 | 1,040 |
| Rain-fed paddy field | 1,970 | 1,970 | 1,930 | 2,590 | 1,030 | 3,120 | 12,610 |
| Paddy field total | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| Right-of-ways | 150 | 160 | 180 | 200 | 80 | 250 | 1,020 |
| Command area total | 2,170 | 2,230 | 2,610 | 2,920 | 1,170 | 3,570 | 14,670 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

(3) Agro-demography and Land Holding

Agro-demographic and land holding features of major communes where the respective sub-projects are located were estimated in the JICA M/P and Pre-F/S Study by referring to the Commune Survey on Crops & Livestock, 2003, MAFF and SEILA Commune Data Base, 2005. The summary is as shown below, and among others the average holding size of paddy field ranges from 1.2 ha in Damnak Ampil Sub-project area to 2.4 ha in Por Canal Sub-project area.

**Agro-demographic and Land Holding Features in Major Communes related to Sub-project Areas**

| Agro-demography & Land Holding Size / Sub-project | | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach |
|---|---|---|---|---|---|---|---|
| Number of major Communes | | 3 | 3 | 2 | 3 | 3 | 2 |
| Share of farm households | Range | 67-98% | 67-95% | 88-90% | 88-94% | 89-95% | 95-100% |
| in total households | Average | 82% | 77% | 89% | 90% | 93% | 98% |
| Share of non-farm households | Range | 2-33% | 5-33% | 10-12% | 6-12% | 5-11% | 0-5% |
| in total households | Average | 18% | 23% | 11% | 10% | 7% | 3% |
| Share of farm households raising | Range | 76-99% | 68-97% | 100% | 100% | 91-100% | 100% |
| wet season rice in farm household | Average | 91% | 81% | 100% | 100% | 97% | 100% |
| Average family size | Range | 4.9-5.4 | 5.0-5.4 | 5.1-5.5 | 5.1-5.5 | 5.2-5.7 | 4.4-4.5 |
| | Average | 5.1 | 5.2 | 5.3 | 5.2 | 5.4 | 4.5 |
| Share of landless households | Range | 2-33% | 5-33% | 10-12% | 6-12% | 5-11% | 0-5% |
| in total households | Average | 18% | 23% | 11% | 10% | 7% | 3% |
| Share of households with land | Range | 4-38% | 2-34% | 0-15% | 0-15% | 0-5% | 0% |
| holding size of less than 0.1 ha | Average | 27% | 16% | 8% | 6% | 2% | 0% |
| Share of households with land | Range | 33-80% | 33-90% | 12-18% | 12-20% | 8-29% | 0-3% |
| holding size of more than 3.0 ha | Average | 55% | 61% | 15% | 16% | 18% | 2% |
| Average holding size of paddy field (ha) | | 2.2 | 2.1 | 1.2 | 1.4 | 1.6 | 1.4 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

(4) Crop Production

A single cropping of rice under rain-fed condition for the wet season prevails in the whole sub-project areas. Other crops like watermelon, cucumber, gourd and pumpkin are grown by a few farmers in their home yards either early wet season or dry season, which are consumed in their homes. As shown below, therefore, the cropping intensity on paddy field averages 104% and ranges between 100% and 120%.

**Cropping Pattern and Cropping Intensity in Sub-project Areas**

| Cropping Pattern / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach | Total |
|---|---|---|---|---|---|---|---|
| Total paddy field (ha) | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| Early wet season | 200 | 410 | 0 | 0 | 0 | 0 | 610 |
| *- Pumping irrigated rice (ha)* | *200* | *410* | *0* | *0* | *0* | *0* | *610* |
| Wet season | 2,020 | 2,070 | 2,430 | 2,720 | 1,090 | 3,320 | 13,650 |
| *- Supplemental irrigated rice (ha)* | *50* | *100* | *0* | *0* | *0* | 0 | *150* |
| *- Rain-fed rice (ha)* | *1,970* | *1,970* | *2,430* | *2,720* | *1,090* | *3,320* | *13,500* |
| Annual cropped area (ha) | 2,220 | 2,480 | 2,430 | 2,720 | 1,090 | 3,320 | 14,260 |
| Cropping intensity (%) | 110 | 120 | 100 | 100 | 100 | 100 | 104 |

Source: JICA Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, 2009

(5) Farming Practices and Farm Mechanization

Major varieties of rice grown in the respective sub-project areas are as follows:

- For the early wet season IR 66, Sen Pidao, and Rumpe, all of which are early ripening varieties;
- For the wet season, Sen Pidao as early ripening variety, Phka Khney, Phka Rumdoul, Phka Runchang, Phka Mulis, Phka Sla Phka Samley, Somali, Rian Chey, Sen Chey, and Srov Sor as medium ripening varieties as well as CAR 4, CAR 6, CAR 7, Komping Puoy, Neang Mine, Neang Khon, Neang Pong, Neang Sor, and Kang Threung as late ripening varieties; and
- For the dry season, IR 66, and Sen Pidao as early ripening varieties.

Land preparation and planting methods practiced in the wet season are as follow:

- In Ream Kon Sub-project area, hand tractors are used by 65% of farmers and draft animals by 35% for land preparation, while direct sowing with seeding rate of 120~150 kg/ha is applied by 60% of farmers and transplanting by 40%;
- In Por Canal Sub-project area, hand tractors are used by 62% of farmers and draft animals by 38% for land preparation, while direct sowing and transplanting is applied by 50% each;
- In Damnak Ampil Sub-project area, hand tractors are used by 20% of farmers and draft animals by 80% for land preparation, while transplanting is applied by 92% of farmers and direct sowing by 8%;
- In Wat Loung Sub-project area, hand tractors are used by 20% of farmers and draft animals by 80% for land preparation, while transplanting is applied by 92% of farmers and direct sowing by 8%;
- In Wat Chre Sub-project area, hand tractors are used by 40% of farmers and draft animals

by 60% for land preparation, while transplanting is applied by 90% of farmers and direct sowing by 10%; and

- In Lum Hach Sub-project area, hand tractors are used by 30% of farmers and draft animals by 70% for land preparation, while transplanting is applied by 95% of farmers and direct sowing by 5%.

(6) Paddy Yield and Production

In the JICA M/P and Pre-F/S Study, paddy yield and production in the respective sub-project areas were estimated on the basis of data of PDA/DOA, SEILA Data Base, JICA Socio-economic Survey and Inventory Survey, and interviews. The results have been updated by referring to the latest statistic data. Paddy yield in each sub-project for 2008 is estimated as shown below.

**Paddy Yield in Sub-project Areas**

| Paddy Yield (ton/ha) / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach |
|---|---|---|---|---|---|---|
| Early wet season | | | | | | |
| - Pumping irrigated paddy | 2.8 | 2.8 | - | - | - | - |
| Wet season | | | | | | |
| - Supplemental irrigated paddy | 2.1 | 2.1 | - | - | - | - |
| - Rain-fed paddy | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.2 |

Prepared by JICA SAPROF Team

Paddy production in each sub-project area is estimated on the basis of the above cropping pattern and paddy yield as shown below. Paddy production in the project area under the normal climate condition during the dry season is around 22,000 tons.

**Paddy Production in Sub-project Areas**

| Paddy Production (ton) / Sub-project | Ream Kon | Por Canal | Damnak Ampil | Wat Loung | Wat Chre | Lum Hach |
|---|---|---|---|---|---|---|
| Early wet season | | | | | | |
| - Pumping irrigated paddy | 560 | 1,148 | - | - | - | - |
| Wet season | | | | | | |
| - Supplemental irrigated paddy | 105 | 210 | - | - | - | - |
| - Rain-fed paddy | 2,955 | 3,152 | 3,888 | 4,352 | 1,744 | 3,968 |
| Total | 3,620 | 4,510 | 3,888 | 4,352 | 1,744 | 3,968 |

Prepared by JICA SAPROF Team

(7) Post-harvest Facilities

Farmers cut rice stalks with sickles and then thresh paddy by hiring an engine thresher. In Lum Hach Sub-project area, however, they manually thresh paddy by using a pedal thresher. Generally, most farmers dry harvested paddy only which is kept for their family foods as well as self-stocked seeds for the next crop season. Those who need cash at the harvesting time usually sell their paddy to either collectors/middlemen or rice mills without any drying works immediately after they finish threshing of paddy.

At present, there exist 37 commercial mills and 824 cottage industry-type custom mills in and around the project area as shown below. The average milling capacity is estimated at 0.2~0.3 ton/hr for a custom mill and 1.1 ton/hr for a commercial mill. As the former has an estimated maximum processing capacity of 3 ton/day and the latter is 12 ton/day, a total of 115,000-ton paddy can be said to be

processed annually.

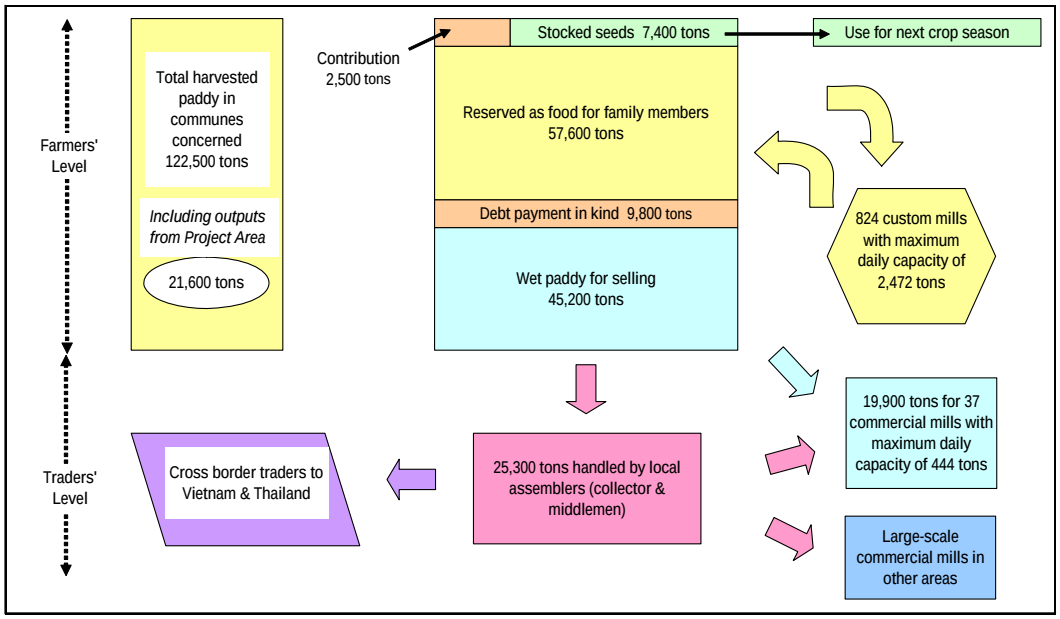
**Large and Small Rice Mills operated in Communes around Sub-project Areas**

| Province | District | Sub-project | Commune | Commercial Mill | Custom Mill |
|---|---|---|---|---|---|
| Battambang | Moung Russei | Ream Kon & Por Canal | Kear | 6 | 4 |
| | | | Chrey | 4 | 0 |
| | | | Prey Svay | 5 | 0 |
| | | | Ta Loas | 2 | 2 |
| | | | Kor Koah | 1 | 1 |
| Pursat | Bakan | Wat Loung & Damnak Ampil | Trapeang Chong | 4 | 112 |
| | | | Smam Preah | 3 | 135 |
| | | | Khnar Totueng | 2 | 27 |
| | | Wat Chre | Boeng Khnar | 5 | 58 |
| | | | Me Tuek | 1 | 100 |
| | | | Ou Ta Paong | 4 | 89 |
| Kampong Chhnang | Boribo | Lum Hach | Anhchanh Rung | 0 | 93 |
| | | | Pech Changvar | 0 | 34 |
| | | | Popel | 0 | 53 |
| | | | Phsar | 0 | 54 |
| | Tuek Phos | | Krang Skear | 0 | 62 |

Prepared by JICA SAPROF Team

(8) Marketing

Aiming at clarification of the actual situation concerning farmers' utilization of paddy after harvesting works, an additional face-to-face interview survey to 303 respondent farmers was carried out in each sub-project area at this time. Based on the outputs of this survey coupled with various information obtained through hearings from officials concerned and rice mill owners, the following flow chart is made, indicating the current utilization of harvested paddy by around 33,500 farmers in 17 communes concerned with the respective sub-projects.




Prepared by JICA SAPROF Team

**Current Utilization of Harvested Paddy in Communes Concerned**

Focal points on market channels are as follows:

- Farmers usually depend on 824 custom mills to polish rice for their daily use. At present, these custom mills can meet farmers' requirements by only 24-day full operation of their milling equipment. From the said survey, farmers' needs to reserve additional paddy for home consumption purpose are predicted at 20,100 tons. It can be considered, therefore, that farmers will not be confronted with shortage of daily milling services;
- Available processing capacity of 37 commercial mills in the 17 communes concerned is sufficient to handle the current share of forwarded paddy from farmers. The main reason is that these commercial mills have less operation funds to buy more quantity of paddy from farmers, not insufficient processing capacity which can process the existing share by 45-day full operation; and
- In order to strengthen the rural economy through the vitalization of rice mill industry in and around the project area, therefore, it is indispensable for encouraging the existing commercial mills by means of offering low-interest credit services to cover their increasing operational fund requirements.

(9) Agricultural Supporting Services

Current agricultural support activities operated in the respective sub-project areas are as follows:

- Economic & Social Relaunch of Northwest Provinces (ECOSORN) has supplied quality rice seeds in communes related to Ream Kon Sub-project and implemented quality rice seed supply and irrigation canal & road rehabilitation works in Por Canal Sub-project area; and
- National Coordination Committee for Decentralization (NCCD) provides road construction and animal vaccination services in communes related to all sub-project areas.

Farm input supplies in three provinces are mostly carried out by dealers and large scale rice millers.

Major formal rural credit operators in three districts include ACLEDA Bank, PRASAC MFI, Hartha Kaksekar Ltd., Credit MFI and Cambodia Entrepreneur Building Ltd. The terms and conditions for farm credit are as follows:

- ACLEDA offers 6-month credit of less then 500,000 Riels and 12-month credit of more than 500,000 Riels both with interest rate of 3.0% per month having such conditions as provision of collateral and approval of commune council; and
- PRASAC MFI offers 4~12-month credits with interest rate of 3.0% per month having such conditions as provision of collateral and approval of commune council.

The formation of agricultural cooperatives has been promoting by MAFF/PDA in the country. Up to date, four cooperatives with 170 members in total were established in Moung Russei District of Battambang Province and two cooperatives with 861 members in Bakan Distric were established. However, the status of each cooperative is still developing resulting in that no cooperative carry out procurement, shipment and selling activities.

## 1.5 Irrigation and Drainage

(1) Ream Kon Sub-Project

The Ream Kon irrigation system originally was developed in 1978 during the Pol Pot regime. The headworks constructed on the Moung Russei River for the irrigation of both Ream Kon and Por Canal command areas was already deteriorated due to frequent flood. In addition, canal networks were also significantly damaged and no functioning at present. Current conditions of the facilities are summarized as follows:

**Conditions of Irrigation and Drainage Facilities at Ream Kon Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 4,700 ha | The figure is based on JICA inventory (2006)[1] including flood plain of Tonle Sap Lake. |
| | ♦ Existing | 190 ha | Only located in the upstream of command area by using pumps |
| 2. | Headworks | | |
| | Type | Weir with gates | No gates are functioned. In addition, concrete structure is highly deteriorated |
| | Width | 19.2 m | |
| | Height | 5.5 m | |
| 3. | Intake | 1 no. | No gates are existing. In addition, concrete is highly deteriorated. |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 12.0 km | The existing canals are highly deteriorated. And the water level is too low to carry water gravity irrigation. |
| | ♦ Secondary | 26.0 km | Only part of the secondary canals have been developed, however, no water flow for a long period of time due to deterioration of main facilities. |
| | ♦ Tertiary | No | No tertiary canals have been constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | No | |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Road crossing culvert (secondary) | 1 no. | Concrete structure is severely deteriorated and needed to be replaced. |
| | ♦ Check (main) | 1 no. | Concrete structure is severely deteriorated and needed to be replaced. |
| | ♦ Bridge (secondary) | 1 no. | Concrete structure is severely deteriorated and needed to be replaced. |
| 6. | Inspection road | 26.0 km | It is in bad conditions so that the accessibility within the command area is poor. |
| 7. | Others | | |
| | Dyke | 2.4 km | The dyke was originally constructed to surround upstream areas to store water in the wet season, however, it is no function at present. |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

[1] Inventory survey of irrigation and drainage systems carried out by JICA Cambodia Office in 2006

(2) Por Canal Sub-Project

The Por Canal system was constructed in 1978 during the Pol Pot regime, the area of which are commanded by the Ream Kon Headworks. Because the Ream Kon Headworks is not functioning at present, only part of the area is irrigated by gravity. In 2007, the main canals were rehabilitated by MAFF under the Project ECOSORN[2] financially supported by EU. The conditions of irrigation and drainage facilities under the Por Canal system are summarized as follows:

**Conditions of Irrigation and Drainage Facilities at Por Canal Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 2,500 ha | The figure is based on JICA inventory (2006) including flood plain of Tonle Sap Lake. |
| | ♦ Existing | 400 ha | Only located in the upstream of command area by using pumps |
| 2. | Headworks | | |
| | Type | Weir with gates | The headworks is shared with Ream Kon sub-project. No gates are functioning. In addition, concrete structure is highly deteriorated. |
| | Width | 19.2 m | |
| | Height | 5.5 m | |
| 3. | Intake | 1 no. | No gates exist. Further, concrete structure is highly deteriorated and to be replaced. |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 9.5 km | The main canals consist of: (i) main canal-1 (4.8 km) and (ii) main canal-2 (4.7 km) These canals were recently rehabilitated by ECOSORN in 2007 and 2008 respectively. Therefore, they are now in moderate conditions. |
| | ♦ Secondary | 11.0 km | Only part of the secondary canals have been developed including ECOSORN-rehabilitated canal (2.2 km). No water flows for a long period due to deterioration of major facilities. |
| | ♦ Tertiary | No | No tertiary canals have been constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | No | |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Diversion (main) | | One diversion structure was constructed by ECOSORN. It is in good condition. |
| | ♦ Road crossing culvert (secondary) | 7 no. | The bottoms are too high. Concrete structure is severely deteriorated and needed to be replaced. |
| | ♦ Check (main) | 1 no. | No gate is equipped. Concrete structure is severely deteriorated and needed to be replaced. |
| | ♦ Bridge (main) | 1 no. | Concrete structure is in fair condition. |
| 6. | Inspection road | 2.2 km | Road along the ECOSORN-rehabilitated canal is in better conditions while others are none or bad conditions. |
| 7. | Others | | |
| | Dyke | No | - |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

[2] Economic and Social Relaunch of Northwest Provinces in Cambodia

(3) Damnak Ampil Sub-Project

The system was originally constructed in 1976 in the Pol Pot regime. The headworks and canal systems were seriously damaged by floods in 1979. New headworks was constructed in 2006 and the upstream portion of the main canal (7.3 km out of 23 km) together with checks and off-take structures was rehabilitated by MOWRAM so as to irrigate the command area of 2,270 ha in total.

One secondary canal was already rehabilitated with the assistance of DANIDA in 2008, but no structures were equipped. MOWRAM is planning to extend main canals down to the crossing point with the Svay Don Keo River to supply several irrigation systems located along the Svay Done Keo River with the Pursat River water. Conditions of irrigation and drainage facilities under the Damnak Ampil sub-project are summarized in the following table.

**Conditions of Irrigation and Drainage Facilities at Damnak Ampil Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 12,440 ha | The figure is based on JICA inventory (2006). |
| | ♦ Existing | 400 ha | Only located in the upstream of command area by using pumps |
| 2. | Headworks | | |
| | Type | Weir with gates | The headworks was constructed in 2006 by MOWRAM with automatic gates, however, gates are not functioning smoothly and need to be improved. In addition, no fish ladder is provided which hinder fish migration. |
| | Width | 144 m | |
| | Height | 5.5 m | |
| 3. | Intake | 1 no. | It is rehabilitated in 2006 by MOWRAM. Design intake water level is 17.00 m |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 30.0 km | Upstream portion of the canal (7.3 km) was rehabilitated by MOWRAM. Design flow capacity is 8.0 $m^3$/sec. |
| | ♦ Secondary | 150.0 km | Secondary canal No. 2 (5.0 km) was rehabilitated with the assistance of DANIDA. |
| | ♦ Tertiary | No | No tertiary canals have been constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | No | |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Off-take (main) | 9 nos. | They were rehabilitated by MOWRAM and in good conditions. |
| | ♦ Check (main) | 1 no. | It was rehabilitated by MOWRAM and in good conditions. |
| | ♦ Spillway (main) | 1 no. | It was rehabilitated by MOWRAM and in good conditions. |
| | ♦ Bridge (main) | 3 nos. | Concrete structure is in fair condition. |
| 6. | Inspection road | 7.3 km | Road along the main canal is rehabilitated by MOWRAM and in better conditions while others are none or bad conditions. |
| 7. | Others | | |
| | Dyke | No | - |

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<u>Automatic gate equipped at the headworks</u>

♦ The automatic gates are provided on the headworks. The gats fall down smoothly when the water level is more than El. 16.85 m, however, they hardly rise up even if the water level get to be

designated lowest level, El. 13.70m. Therefore, designed water level at Damnak Ampil sub-project, El. 17.00 m, is not ensured.

(4) Wat Loung Sub-Project

The sub-project is located at the right bank of the Ou Bakan and Boeng Khnar River. The irrigation system was originally developed in 1977 in the Pol Pot regime. The system was damaged in 1979 by a flood and no functioning until now. At present, only ruins of headworks are observed on the Pursat River, approximately 3.5 km downstream of the Damnak Ampil headworks. Therefore, no water is introduced from the Pursat River at present. Conditions of irrigation and drainage facilities are summarized in the following table.

**Conditions of Irrigation and Drainage Facilities at Wat Loung Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 7,400 ha | Based on JICA inventory (2006). |
| | ♦ Existing | 120 ha | Located in the upstream of command area (by using pumps). |
| 2. | Headworks | | |
| | Type | Not clear | The headworks was constructed in 1977, however, it was already flushed away. |
| | Width | 120 m | |
| | Height | 5.0 m | |
| 3. | Intake | 1 no. | No intake structure remains at present. |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 17.0 km | Earthen type of canal, running from the Pursat River to northwestward and finally joining with Boeung Khnar River. However, its section is seriously damaged. |
| | ♦ Secondary | 3.0 km | Only one secondary canal is existing, however, its condition is poor. |
| | ♦ Tertiary | No | No tertiary canals were constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | No | |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Check (main and secondary) | 2 nos. | They are in poor conditions and need to be replaced. |
| | ♦ Bridge (main and secondary) | 2 nos. | They are in fair conditions. |
| 6. | Inspection road | - | No roads were developed, therefore, accessibility condition within the command area is poor. |
| 7. | Others | | |
| | Dyke | No | - |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

(5) Wat Chre Sub-Project

The Wat Chre sub-project was constructed along the Boeung Khnar River in 1977, however, it was damaged in 1979 and 1980 due to series of floods. The headworks was already flushed away and the canal network is seriously deteriorated at present. No water is provided to the command area from the water source. The system consists of: (i) the right bank of the Boeng Khnar River (1,020 ha) and (ii) the left bank of the River (480 ha). Conditions of irrigation and drainage facilities of the Wat Chre sub-

project are summarized in the following table.

**Conditions of Irrigation and Drainage Facilities at Wat Chre Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 1,500 ha | Based on JICA inventory (2006). |
| | ♦ Existing | 1,020 ha | Located at the right bank of the Boeung Khnar River. |
| 2. | Headworks | | |
| | Type | Not clear | The headworks was constructed in 1977, however, it has been already flushed away. |
| | Width | 60 m | |
| | Height | 2.7 m | |
| 3. | Intake | 1 no. | No intake structure remains at present since it was already flshed away. |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 3.5 km | Earthen type of canal, which is seriously deteriorated. |
| | ♦ Secondary | 8.7 km | Earthen type of canal, which is seriously deteriorated. |
| | ♦ Tertiary | No | No tertiary canals were constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | No | |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Off-takes (main) | 2 nos. | They are in poor conditions and need to be replaced. |
| | ♦ Spillway (main) | 1 no. | It is in poor conditions and needs to be replaced. |
| | ♦ Bridge (main) | 1 no. | It is in poor conditions and needs to be replaced. |
| 6. | Inspection road | - | No roads were developed, therefore, accessibility condition within the command area is poor. |
| 7. | Others | | |
| | Dyke | No | - |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

### (6) Lum Hach Sub-Project

The Lum Hach irrigation system was completed in 1977 to utilize the Boribo River water for irrigation purpose. The system was damaged in 1981 and 1982, therefore, only some 300 ha are provided with water using pumps. There are two main irrigation systems along the Boribo River: (i) Lum Hach system located on the right bank of the River and (ii) O Roluss system on the left bank of the River. Main canal of the O Roluss system was rehabilitated by MOWRAM in 2007. However, since the catchment of existing O Roluss pond is too small being only 12.8 $km^2$, the proposed Lum Hach headworks is expected to provide water to both the Lum Hach and the O Roluss systems.

The road between the National Road No. 5 and the main canal is under rehabilitation by the Ministry of Public Works and Transport (MPWT) which is expected to contribute to the improvement of accessibility within the command area of the sub-project. Conditions of irrigation and drainage facilities are summarized in the following table.

**Conditions of Irrigation and Drainage Facilities at Lum Hach Sub-Project**

| No. | Item | Quantity | Conditions |
|---|---|---|---|
| 1. | Irrigation area | | |
| | ♦ Potential | 3,100 ha | Based on JICA inventory (2006). |
| | ♦ Existing | 300 ha | Only limited areas are irrigated using pumps. |
| 2. | Headworks | | |
| | Type | Not clear | The headworks was constructed in 1977, however, it was already flushed away. |
| | Width | - | Dimension of the original structures are not clear. |
| | Height | - | |
| 3. | Intake | - | Dimension of the original structures are not clear. |
| 4. | Irrigation and Drainage System | | |
| | (1) Canal | | |
| | ♦ Main | 3.6 km | Earthen type of canal, which is seriously deteriorated. |
| | ♦ Secondary | 9.1 km | Earthen type of canal, which is seriously deteriorated. |
| | ♦ Tertiary | No | No tertiary canals were constructed. |
| | (2) Drain | | |
| | ♦ Main | No | No drainage system was developed in the command area. |
| | ♦ Secondary | 12. 0 km | It is along the main road connecting between the National Road No. 5 and the main canal. |
| | ♦ Tertiary | No | |
| | ♦ Collector | No | |
| 5. | Canal-related Structures | | |
| | ♦ Off-takes (secondary) | 1 no. | It is in poor conditions and needs to be replaced. |
| | ♦ Check (cross regulator at main) | 1 no. | It is in poor conditions and needs to be replaced. |
| | ♦ Spillway (main) | 1 no. | It is in poor conditions and needs to be replaced. |
| | ♦ Bridge (secondary) | 2 nos. | They are in fair conditions. |
| | ♦ Culvert (secondary) | 6 nos. | They are in fair conditions. |
| 6. | Inspection road | 12.7 km | Road connecting from the National Road No. 5 and the main canal was rehabilitated by MOPWT, however, no roads are provided along the secondary canals. |
| 7. | Others | | |
| | Dyke | No | - |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

(7) Operation and Maintenance, and Farmer Water User Community

Since the irrigation facilities are deteriorated at most of the systems, water is not stably supplied to the command areas under the sub-projects. Instead, farmers are primarily dependent on rainfall and flood water particularly in the dry season.

At present no O&M activities have been executed by PDOWRAM since all the areas need full-scale irrigation system rehabilitation. At the Damnak Ampil sub-project, FWUC was established, however, no registered FWUCs and/or FWUGs are observed in other five sub-projects.

## 1.6 Institutions

There are two organizations relevant to the Project implementation and O&M: (i) Ministry of Water Resources and Meteorology (MOWRAM) and (ii) Ministry of Agriculture, Forestry and Fisheries (MAFF).

### 1.6.1 Ministry of Water Resources and Meteorology

(1) Organizational Structure

MOWRAM was originally established in 1999 under the Sub-decree 58 with the mission of developing and managing water resources of the country. The organizational structure of MOWRAM as of August 2009 is illustrated in Figure III 1.6.1. Function of departments under MOWRAM is summarized in Table III 1.6.1. MOWRAM consists of seven technical departments, three administrative departments and technical service center for irrigation and meteorology (TSC). There are five categories in staff qualification: (i) engineer, (ii) technician, (iii) vocational, (iv) qualified and (v) non-qualified and the total number of staff is approximately 700 at the central level and 740 at the provincial level.

**Categories of Staff Qualification of MOWRAM**

| Category | Engineer | Technician | Vocational | Qualified | Non-qualified | Total |
|---|---|---|---|---|---|---|
| Central | 271 | 184 | 28 | 12 | 210 | 705 |
| Province | 80 | 138 | 78 | 26 | 422 | 744 |

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia

Among others, more than 50 % of the staff is assigned to the Irrigated Agriculture Department and the Engineering Department.

(2) National Project Management Office

The National Project Management Office (NPMO) was established in 2006 to coordinate, manage and implement all the water resources development and management projects in the country.[3] Under the NPMO, there are five units, and their task demarcations are summarized as follows:

**Task Demarcation among Units under the NPMO**

| Unit | Task |
|---|---|
| Southeast Project Management Unit (SEPMU) | ♦ In charge of loan and grant assistance projects supported by donor agencies<br>♦ Area: Kampot, Kandal, Krong Kep, Kampong Cham, Kra Tie, Mondulkiri, Phnom Penh Capital, Prey Veng, Rattanakiri, Stueng Treng, Svay Rieng and Takeo |
| Northwest Project Management Unit (NWPMU) | ♦ Loan and grant assistance projects by donor agencies such as the Northwest Irrigation Sector Project (ADB)<br>♦ Area: Bantey Meanchey, Battambang, Koh Kong, Kampong Chhnang, Kampong Som city, Kampong Speu, Kampong. Thom, Pailin, Preah Vihear, Pursat, Siem Reap, Udor Meanchey |
| Project Management Unit for the Government Budget | ♦ In charge of Government fund projects for the entire country |
| Project Management Unit for the World Bank | ♦ In charge of Projects supported by the World Bank |
| Project Management Unit for Japan Support Fund | ♦ In charge of Projects financially supported by the Japanese Government (established in October 2008)[4] |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

[3] MOWRAM (2006), Terms of Reference for Project Management Office (PMO) of MOWRAM

[4] MOWRAM (2008), Decision on the Establishment of Working Team for Implementing the Irrigation System Rehabilitation Project under Utilization of Japan's Budget in Ministry of Water Resources and Meteorology issued on October 23rd, 2008

(3) Budget of MOWRAM

The Annual budgets of MOWRAM are tabulated in Table III 1.6.2 and summarized as follows:

**Annual Budget of MOWRAM (Approved Budget) (Unit: million Riel)**

| Year | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| Budget | 11,336<br>(US$ 2.89 million) | 12,517<br>(US$3.19 million) | 13,210<br>(US$3.37 million) | 16,881<br>(US$4.24 million) |

Source: MOWRAM

(4) Provincial Department of Water Resources and Meteorology (PDOWRAM)

There is the Provincial Department Office of Water Resources and Meteorology (PDOWRAM) in each province under the supervision of MOWRAM. PDOWRAM consist of: technical offices such as (i) water resources management and conservation, (ii) irrigated agriculture, (iii) water supply & sanitation and (vi) hydrology and administrative office. In addition, each PDOWRAM subordinates district offices (183 district offices in total). Number of staff of PDOWRAM related with the Project is tabulated as follows:

**Number of staff in PDOWRAM Offices (Unit: person)**

| Battambang | Pursat | Kampong Chhnang |
|---|---|---|
| 88 | 29 | 35 |

Source: MOWRAM

(5) Budget of PDOWRAM

The annual budgets of the PDOWRAM of Battambang, Pursat and Kampong Chhnang are tabulated as follows:

**Annual Budget of PDOWRAM Offices (Unit: million Riel)**

| Year | Battambang | Pursat | Kampong Chhnang |
|---|---|---|---|
| 2005 | 317<br>(US$81 thousand) | 131<br>(US$ 33 thousand) | 138<br>(US$ 35 thousand) |
| 2006 | 487<br>(US$124 thousand) | 297<br>(US$76 thousand) | 219<br>(US$ 55 thousand) |
| 2007 | 725<br>(US$184 thousand) | 308<br>(US$79 thousand) | 230<br>(US$59 thousand) |

Source: MOWRAM

### 1.6.2 Ministry of Agriculture, Forestry and Fisheries

(1) Central

The organizational structure of the Ministry of Agriculture, Forestry and Fisheries (MAFF) is illustrated in Figure III 1.6.2. MAFF is in charge of providing technical and administrative services in agriculture sector contributing to ensuring food security, increased agricultural output and add value on a sustainable and cost effective basis to agricultural, fishery and forestry based sectors in the country. According to the mission statement, functions of MAFF are listed as follows:

- Organize and operate the development policies in agriculture sector which aimed at the improvement of the living standards of the population;
- Participate in the establishment of pricing policies and search out the markets for agricultural products;
- Direct and establish the agriculture sector development plans;
- Coordinate, monitoring and evaluate the implementation of policies and activities for development of agriculture;
- Monitor and manage natural resources of agriculture sector and facilitate activities of exploitation on these resources to meet domestic demands with respect to the stability of ecology system;
- Enact legislation and regulations on the management, maintain and protect the natural resources of agriculture sector and monitor on implementation;

- ♦ Evaluate and develop human resources for participation in the development of agriculture with promoting the technical skills and knowledge and make an effective use of these human resources;
- ♦ Necessarily support and advise to the farmers on technologies to improve production and increase productivity;
- ♦ Set up principles and monitor on implementation to enhance and improve the process of concerned professional organizations, associations involved in agriculture sector;
- ♦ Conduct research, study and extension on agricultural technology, science and economics for all sub-sectors;
- ♦ Advise on agricultural land development, soil quality improvement and appropriate utilization of land, seeds, breeds, fertilizer, chemicals to the conditions of geographic manner and regional climate and this leads to ensure the increasing high yield and maintain the balancing of natural environment;
- ♦ Coordinate and cooperate with internal and external organizations, non-governmental organizations for the development of agriculture sector;
- ♦ Participate in enhancing and acceleration of investment, export of food and agricultural products;
- ♦ Participate and implement the activities related to Mekong Basin in accordance with the rule and functions of the Ministry;
- ♦ Participate in the establishment of pricing policies and search out the markets for agricultural products;
- ♦ Collect revenue to the national budget or collaborate with the Ministry of Economy and Finance for revenue collection; and
- ♦ Implement other activities to be given by the Royal Government

Source: MAFF

Among the departments under MAFF, the Department of Agriculture Extension is in charge of supervising agricultural support services particularly in the dissemination of farming technology at the field level through extension workers.

(2) Provincial Department of Agriculture

At the provincial level, provincial Department of Agriculture (PDA) is organized under the supervision of MAFF.[5] PDA generally has several technical offices such as: (i) agricultural extension, (ii) veterinary & animal production, (iii) agricultural machinery, (iv) agricultural legislation, (v) agro-industry and (vi) agronomy & land improvement and administrative offices with some District Agriculture Offices (DAO). The total numbers of staff under each PDA including District Offices are approximately 100 to 300. The number of staff in PDA of Battambang, Pursat and Kampong Chhnang Province is as follows:

**Number of Staff in PDA**

| | **Battambang** | **Pursat** | **Kampong Chhnang** |
|---|---|---|---|
| Skilled | 280 | 52 | 54 |
| Non-skilled | 84 | 65 | 69 |
| Total | 364 | 117 | 123 |

Source: MAFF

Extension workers are allocated at the district level in the DAO directly supervised by deputy director of PDA in charge. At present, agricultural support services are carried out through DAO, major activity of which is demonstration of improved rice farming practice. In addition, agricultural extension is implemented with collaboration of NGOs such as World Vision, CEDAC and New Human.

[5] The organizational structures of PDA at Battambang, Pursat and Kampong Chhnang are shown in Appendix-A1.

# CHAPTER 2 THE PROJECT

## 2.1 Scope and Objective of the Project

### 2.1.1 Scope of the Project

The target area of the Project covers six irrigation systems (hereinafter called sub-projects) located in the western region of the Tonle Sap Lake. The Project scope is summarized in the following table:

**Scope of the Project**

| Area | | | | Scope of the Project |
|---|---|---|---|---|
| **No.** | **Sub Project** | **River Basin** | **Province** | |
| 1 | Ream Kon | Moung Russei | Battambang | Toward: Six Sub-Project Areas<br>*Hardware Component:*<br>(i) Rehabilitation of Irrigation and Drainage Facilities<br>*Software Component:*<br>(i) FWUC Establishment and Strengthening<br>(ii) Agriculture Support Services<br>Toward: Six Sub-Project Areas and River Basins-related<br>*Project Supporting Program:*<br>(i) Meteo-hydrological Observation Strengthening Program<br>*Project Formulation Study for Other Potential Areas*<br>Toward: Entire Countries including Six Sub-Project related Provinces<br>*Project Supporting Program:*<br>(ii) Capacity Development of MOWRAM Staffs<br>(iii) Capacity Development of PDOWRAM Staffs |
| 2 | Por Canal | | | |
| 3 | Damnak Ampil | Pursat | Pursat | |
| 4 | Wat Loung | | | |
| 5 | Wat Chre | | | |
| 6 | Lum Hach | Boribo | Kampong Chhnang | |

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### 2.1.2 Overall Goal of the Project

Overall goal of the Project is: (i) to increase agricultural productivity in the western region of the Tonle Sap Lake and (ii) to alleviate rural poverty through the increase of farmers' income.

### 2.1.3 Objective of the Project

In order to accomplish above-mentioned overall goals, the objectives of the Project are established as follows:

- ♦ Effective utilization of available resources in the Project area through the rehabilitation of irrigation and drainage facilities
- ♦ Establishment of sustainable O&M system to increase agricultural productivity in the sub-project areas and to enhance living standard of beneficiaries

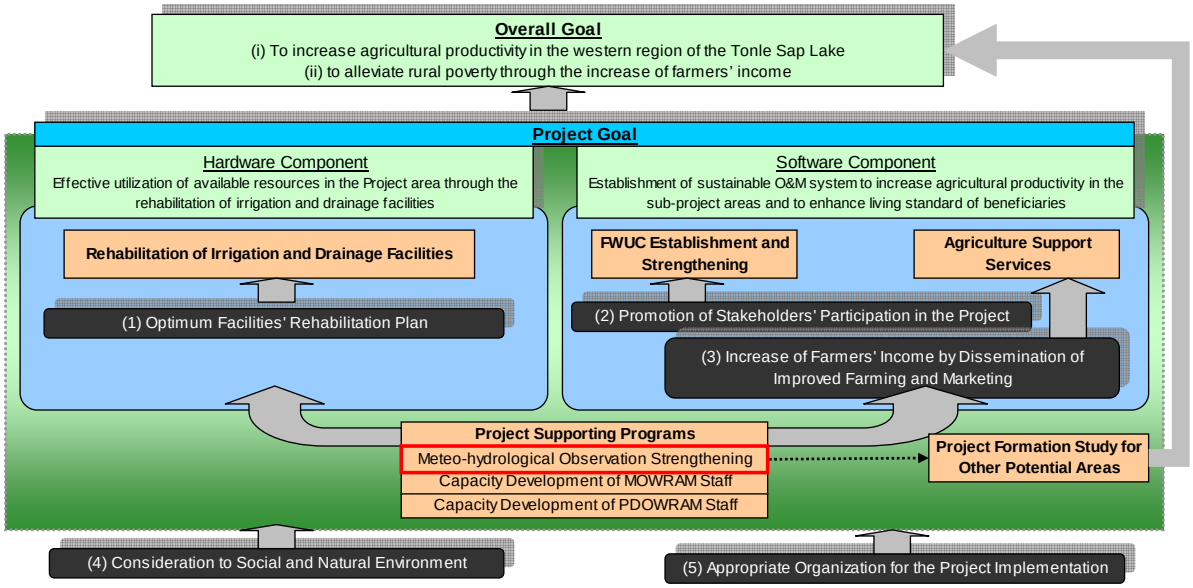
### 2.1.4 Expected Output and Outcome from the Project

Expected output and outcome from the Project are listed as follows:

- ♦ Materialization of equitable and efficient irrigation water distribution using rehabilitated irrigation and drainage facilities
- ♦ Increase of irrigated areas and cropping intensity under the six sub-projects
- ♦ Establishment of collection system of water charge among farmers' group
- ♦ Increase of agricultural productivity contributing to the alleviation of rural poverty
- ♦ Vitalization of rural economy

## 2.2 Approach and Strategy of the Project

Effective utilization of three essential resources: (i) water, (ii) land and (iii) human is critically important to succeed in irrigation and drainage development project, which needs to be supported by the combination of hardware and software component in the development activities. The approach and strategy of the Project is illustrated as follows:

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**Approach and Strategy of the Project**

(1) Optimum Facilities' Rehabilitation Plan

In order to effectively utilize water and land resources inherent, it is of great importance to stably allocate irrigation water and increase agriculture production by the rehabilitation of irrigation and drainage facilities. The following points are considered in the preparation of irrigation facilities' rehabilitation plan.

- Available water resources: Optimum irrigation area and scale is determined based on water resource availability for each sub-project including the progress of similar projects located in the same river basins.
- Measures to flood protection: Since the target sub-projects are located in flat western Tonle Sap areas, flood damage cannot be overlooked in and surrounding areas. The drainage and flood protection plan is made: (i) to drain excess water in the command area taking allowable depth and inundation into consideration, (ii) to protect command areas from floods by the construction of collector drains and (iii) to exclude areas affected by habitual inundation by the Tonle Sap Lake.
- Rehabilitation and construction of additional facilities: The existing irrigation and drainage facilities are not sufficient in number and/or seriously deteriorated to hamper irrigation water use in the command area under the sub-projects. Rehabilitation and additional construction plan for facilities will be prepared so as to improve water distribution.
- Construction of tertiary facilities: For the smooth water distribution, tertiary facilities development is essential. In the Design Manual for Small and Medium Scale Irrigation System

Planning prepared by MOWRAM (2004), a command area under a tertiary canal is 50 ha, therefore, the development plan generally follow this criteria. Appropriate tertiary development plan is prepared by considering the criteria of MOWRAM and the results of similar projects.

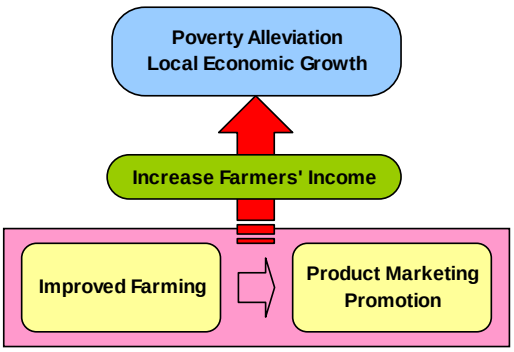
- Consideration to dispersive soil: In the preparation of the construction plan for the proposed facilities, attention is also given to dispersive soil widely observed in Cambodia, having unstable characteristics for embankment works. Suitable borrow materials will be utilized for the construction works.

(2) Promotion of Stakeholders' Participation in the Project

On the basis of the Policy on Participatory Irrigation Management and Development (PIMD), since 2000 MOWRAM has been promoting co-administration in irrigation system among the Government and FWUCs. In 2000, "Circular No. 1 on the Implementation Policy for Sustainable Irrigation Systems" and "Policy for Sustainability of Operation and Maintenance Irrigation Systems" were promulgated, and importance of FWUC is put greater emphasis in irrigation development and management. Additionally, series of Modules on PIMD were developed to support this policy framework at the field level. In the Project, FWUC establishment and strengthening will be implemented at each sub-project, the plan of which is based on the policy and lessons learnt in similar projects so as to prepare the plan for participation mechanism of FWUC for the enhancement of sustainability of the Project.

(3) Increase of farmers' income by dissemination of improved farming and marketing

Cambodia has achieved food self-sufficiency in 1995. However, due to higher population increase rate, 1.7 % annually, it is remarkably important to continue agriculture development to ensure food supply in the country. Low agricultural productivity was pointed out as one of the great constraints in the sub-project areas. Agricultural support services are, therefore, carried out at each sub-project area to maximize effect of rehabilitated facilities.




(4) Consideration to social and natural environment

The Project consists of: (i) hardware component, i.e. rehabilitation of irrigation and drainage facilities and (ii) software component, i.e. FWUC capacity development and agriculture support. All the six sub-projects will not need new large scale land consolidation, therefore, the Project will not give significant negative environmental impact in and around the command areas.

The Sub-Decree on Environmental Impact Assessment Process explains that irrigation development with more than 5,000 ha is required to carry out EIA or IEIA for approval from the Ministry of Environment (MOE) prior to the implementation. Six sub-projects are respectively less than 5,000 ha, therefore, IEIA and/or EIA is not required from regulatory view point. Social and natural environmental aspect related with each sub-project is carefully reviewed to prepare eco-friendly development plan.

(5) Appropriate Organization for the Project Implementation

Project Management Unit Japan Support Fund (PMU Japan Support Fund) was established in 2008 within MOWRAM, taking responsibility on all the project implementation and management by Japanese ODA Grant and Loan. The proposed Project is planned to be managed by PMU Japan Support Fund through coordination with relevant technical departments at the national level. At the provincial level, Project Implementation Unit (PIU) will be established in each PDOWRAM to supervise activities of the Project. In addition at the field level, particularly agriculture support and FWUC strengthening activities will be jointly carried out by PDOWRAM, Commune Councils (CCs.) and others. Overall management is made by MOWRAM headoffice with the coordination of relevant organizations so as to smoothly and effectively carry out the Project.

## 2.3 Project Component

### 2.3.1 Summary of the Project Component

The Project consists of: (i) hardware component, (ii) software component, (iii) project supporting programs, and (iv) project formulation study for other potential areas, each of which includes following activities:

(1) Hardware Component

- Rehabilitation and reconstruction of irrigation facilities
- Rehabilitation and reconstruction of drainage facilities
- Rehabilitation and reconstruction of inspection roads

(2) Software Component

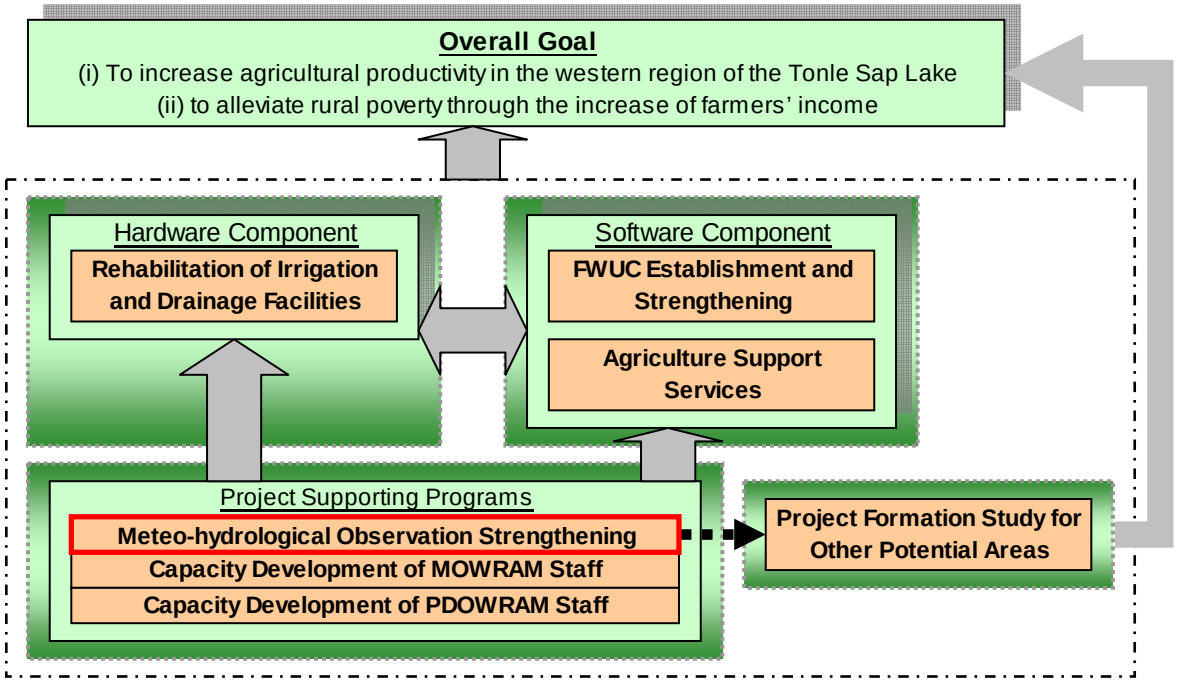
- FWUC Establishment and Strengthening
- Agriculture Support Activities

(3) Project Supporting Activities

- Meteo-hydrological Observation Strengthening
- Capacity Development Program for MOWRAM Staffs
- Capacity Development Program for PDOWRAM Staffs

(4) Project Formulation Study for Other Potential Areas

Linkages and outlines of those activities are summarized as follows:

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**Linkage of Components under the Project**

**Outline of the Activities under the Project**

| No. | Component | Activities | Purpose | Stakeholders |
|---|---|---|---|---|
| 1. | Hardware Component | Rehabilitation and reconstruction of irrigation facilities | ♦ Recover the function of irrigation facilities<br>♦ Effective distribution of irrigation water | Contractors, Community people (FWUC), Consultant, MOWRAM and PDOWRAM |
| | | Rehabilitation and reconstruction of drainage facilities | ♦ Improvement of drainage conditions within the command area<br>♦ Protection of command area from external run-off | Contractors, Community people (FWUC), Consultant, MOWRAM and PDOWRAM |
| | | Rehabilitation and reconstruction of inspection roads | ♦ Improvement of accessibility within the command area | Contractors, Community people (FWUC), Consultant, MOWRAM and PDOWRAM |
| | | Target development area under the hardware component is summarized in the table below. | | |
| 2. | Software Component | FWUC Establishment and Strengthening | ♦ Organizational set-up of appropriate and sustainable O&M of irrigation facilities | Community people (FWUC), Consultant, MOWRAM and PDOWRAM |
| | | Agricultural Support Services | ♦ Dissemination of improved farming technology in the command area of sub-projects | Community people (FWUC), Commune Councils, Consultant, MOWRAM and PDOWRAM |
| 3. | Project Supporting Programs | Meteo-hydrological Observation Strengthening | ♦ Collection of basic meteo-hydrological data to prepare irrigation schedule as well as further development plan in the river basins | Consultant, MOWRAM and PDOWRAM |
| | | Capacity Development | ♦ Improvement of technical | Consultant, MOWRAM, |

| No. | Component | Activities | Purpose | Stakeholders |
|---|---|---|---|---|
| | | for MOWRAM Staffs | capability of MOWRAM Staffs in construction supervision of irrigation and drainage facilities | PDOWRAM and TSC |
| | | Capacity Development for MOWRAM Staffs | ♦ Improvement of technical capability of PDOWRAM Staffs in construction supervision of irrigation and drainage facilities | Consultant, MOWRAM, PDOWRAM, and TSC |
| 4. | Project Formulation Study | Preparation of feasibility study level development plan for other potential areas | ♦ Increase of agricultural productivity in the western region of the Tonle Sap Lake and alleviation of rural poverty through the increase of farmers' income by continuing the Road Map 2020 prepared in the Basin-wide Basic Irrigation and Drainage Master Plan Study | Consultant, MOWRAM and PDOWRAM |

Prepared by JICA SAPROF Study Team

The target area for the Project consists of primary benefit area and secondary benefit area, the total of which under the hardware component is tabulated as follows:

**Target Development Area under the Hardware Component**

| No. | Sub-Project | Primary Benefit Area (ha) | Secondary Benefit Area (ha)[1] | Total (ha) |
|---|---|---|---|---|
| | | The area that the main, secondary and tertiary irrigation facilities are rehabilitated or constructed under the Project | The area to be supplied with irrigation water from the water source through the rehabilitated main facilities under the Project | |
| 1 | Ream Kon Sub-Project | 1,890 | 90 | 1,980 |
| 2 | Por Canal Sub-Project | 1,940 | 430 | 2,370 |
| 3 | Damnak Ampil Sub-Project | 2,270 | 8,930 | 11,200 |
| 4 | Wat Loung Sub-Project | 2,540 | 0 | 2,540 |
| 5 | Wat Chre Sub-Project | 1,020 | 0 | 1,020 |
| 6 | Lum Hach Sub-Project | 3,100 | 3,400 | 6,500 |
| | Grand Total | 12,760 | 12,850 | 25,610 |

Prepared by JICA SAPROF Study Team

The Project primarily aims to increase and stabilize rice production in the wet season. Crop production plan under the six sub-projects are summarized in the following table.

[1] Out of secondary benefit areas, following development plans are under implementation by MOWRAM based on expanding policy of irrigation development.

(i) Damnak Ampil Sub-Project: Extension of Damnak Ampil main canal to Svay Don Keo River

(ii) Lum Hach Sub-Project: Development of O Roluss system (main canal already completed)

**Summary of Crop Production Plan under the Six Sub-Projects**

| Sub-project | Irrigation Method | Irrigation Area (ha) | Cropping Season | |
|---|---|---|---|---|
| | | | Early Wet (ha) | Wet (ha) |
| Ream Kon | Gravity | 1,610 | 960 | 1,610 |
| | Pump | 280 | 170 | 280 |
| | Rain-fed | - | 0 | 0 |
| Por Canal | Gravity | 1,940 | 1,200 | 1,940 |
| | Rain-fed | - | 0 | 0 |
| Damnak Ampil | Gravity | 1,770 | 130 | 1,770 |
| | Pump | 500 | 40 | 500 |
| Wat Loung | Gravity | 1,740 | 130 | 1,740 |
| | Pump | 800 | 60 | 800 |
| Wat Chre | Gravity | 620 | 50 | 620 |
| | Pump | 400 | 30 | 400 |
| Lum Hach | Gravity | 2,660 | 1,090 | 2,660 |
| | Pump | 440 | 180 | 440 |
| Total | | 12,760 | 4,040 | 12,760 |

Prepared by JICA SAPROF Study Team

### 2.3.2 Preparatory Works

(1) Preparation of Topographic Maps

In the initial stage of the Project, topographic maps were prepared covering command areas of the six sub-projects. Orthophoto with the scale of 1:10,000 was already prepared during the Basin-wide Basic Irrigation and Drainage Master Plan Study under JICA, and results of topographic surveys will be overlaid on this photograph. The works will be sublet to survey companies in Cambodia. The works necessary for the preparation of topographic maps are listed as follows:

- Preparation of work schedule, general and technical specification and contract document for topographic maps
- Supervision of ground control survey
- Data processing
- Preparation of working report

(2) Establishment of Project Office, and Procurement of Vehicles and Office Equipment

The Project office for MOWRAM staffs and the Consultant is established, location of which is within the space of MOWRAM headoffice or nearby. Equipment necessary for the Project will be also procured such as computer, photocopy machine, stationery etc.

In addition, the following vehicles will be procured for the implementation of the Project.

- 4 Wheel-Drive Station Wagon: 4 nos.
- 4 Wheel-Drive Pick-up Truck: 6 nos.
- Motor Cycle: 24 nos.

During the Project implementation, vehicles for MOWRAM will be managed by the Project Management Unit (PMU) Japan Support Fund while vehicles for the Consultant will be maintained by the Consultant. All the vehicles will be transferred to MOWRAM and PDOWRAM.

(3) Budgetary Arrangement by MOWRAM

Different from ordinary budgetary arrangement, after the Loan Agreement (L/A) is effective, special account will be open for the Project. Then, MOWRAM will prepare annual financial expenditure plan based on the estimate of the cost necessary for the Project in detail and request it to Ministry of Economy and Finance (MEF).[2]

### 2.3.3 Ream Kon Sub-Project

(1) Sub-Project Command Area

The command area is determined based on the availability of water resources in the Moung Russei River Basin and the allocation of water to other irrigation systems. According to the water balance study including the Bassac Reservoir newly constructed under the grant aid by the Government of Japan, the development areas in the Basin amounts to 9,200 ha, out of which 3,900 ha can be developed in the Ream Kon and the Por Canal Sub-Projects. The area with the elevation of less than 11.00 m is affected by floods from the Tonle Sap Lake in the wet season, therefore, the command area of the Ream Kon Sub-Project is delineated to be 1,890 ha based on the topographic conditions.

In addition, water will be provided to the right bank of new main canal, the most upstream from existing intake extending approximately 90 ha as a secondary benefit area.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- Irrigation area consists of: (i) gravity irrigation area (1,610 ha) and (ii) pump irrigation area (280 ha). Ground height of southern edge area extending 280 ha is higher than water level in the canal. Raising water level in the main canal only to irrigate this higher area is not economically feasible. Therefore, pump irrigation will be applied for this area. In the pump irrigation area, farmers need to rent pumps from communes or other sources.

*Headworks*

- New headworks (the Moung Russei headworks) will be constructed so that mal functioned existing headworks will be replaced due to the following reasons: (i) existing structures including concrete and gates are highly deteriorated, (ii) since the gate sill elevation is too high and spacing of the gates and piers are comparatively narrow, the release of flooding is jeopardized. The location of proposed headworks is approximately 60 m upstream of existing one. On the other hand, existing headworks will be utilized for the bridge for community people just only by removing the pier.
- Weir type is determined as floating type because the foundation ground is not suitable for the spread foundation according to the result of geotechnical investigation.
- The existing intake structure is situated about 1 km upstream of the headworks. In order to ease gate operation, a new intake structure will be relocated near the headworks.

[2] As shown in Part-III of Chapter, the cost to be covered by the RGC for the Project is: (i) land acquisition, (ii) project administration and (iii) tax & duty amounting to US$3.5 million.

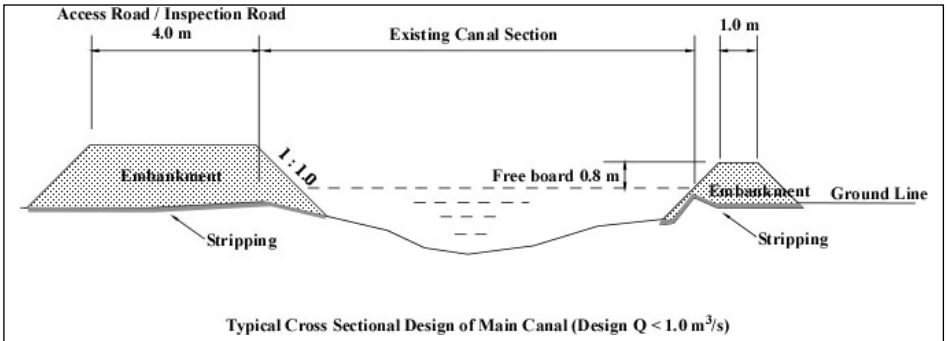
- Fixed wheel type gate is selected for flood gate and slide gate is selected for high reliability as well easy operation.

*Irrigation and Drainage Canal Network*

- At present, there are two main canals, out of which the existing canal running on the southern edge of the command area will be utilized for new main canal to cover whole command area.
- Tertiary canals are constructed, each with a command area of generally 50 ha or less based on MOWRAM guideline.[3]
- Main and secondary level drains will be constructed to establish independent setting on irrigation and drainage. In addition, natural stream will be utilized for main drain to minimize project cost.
- Drainage connecting between secondary drains with natural streams with the elevation of less than 11.00 m are not constructed since the areas of less than 11.00 m are affected by the floods from the Tonle Sap Lake in the wet season.
- Collector drains will be constructed so that drainage water of external areas will be drained directly to natural rivers.
- Typical rehabilitation and improvement works for an existing canal section is illustrated as follows.

*Inspection Road*

- Along the main canals, inspection roads with the width of 4.0 m will be provided to improve transportation within the command area of the Ream Kon sub-project.




Typical Cross Sectional Design of Main Canal (Design Q < 1.0 $m^3/s$)

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study

Unit Irrigation Water Requirement

The irrigation water requirement is estimated based on the proposed cropping pattern. The basic conditions applied are as follows:

- Meteorological data; average of mean monthly data at Battambang and Pursat stations
- Percolation rate 3.5 mm/day based on the observed data
- Rainfall data; Daily rainfall data at Moung Russei, Svay Don Keo, and Talo stations
- Effective rainfall; (i) less than 5mm/day: ineffective rainfall, (ii) 5mm to 80mm/day: Rx80%, (iii) more than 80mm: 80x80%=64mm
- Ratio of transplanting and direct sowing area; 50% and 50%, respectively

[3] MOWRAM (2004), Design Manual for Small and Medium Scale Irrigation System Planning

- Irrigation efficiency in the tertiary unit= 85 %
- Irrigation efficiency in the secondary and main canals= 88 %, respectively
- Overall efficiency= 85 × 88 × 88 % = 66 %

The 5-day water requirement is calculated based on the proposed cropping pattern. The peak diversion water requirement is estimated at 1.41 lit/sec/ha for early wet season paddy in April based on the overall irrigation efficiency of 66%.

Drainage Requirement

*From paddy field*

The unit drainage requirement, q (lit/sec/ha), from paddy field for the Ream Kon Sub-project is calculated at 7.17 lit/sec/ha, based on the annual maximum rainfall in 3 consecutive days at one in 5 years return period.

$$q = 0.186 \times 10{,}000 \div (3 \times 86400) \times 1000 = 7.17$$

where, 0.186 is a probable 3 consecutive days rainfall at Moung Russei station

*Drainage water requirement from other type of land*

The sub-project area consists of paddy fields and other types of lands located adjacent to the paddy field assumed to be 15% of the paddy fields, which do not have storage function. Therefore, runoff characteristics are different from that of paddy field. The unit drainage water requirement for those lands is calculated by the rational formula based on the annual maximum daily rainfall at one in 5 years return period (122 mm/day). The unit drainage water requirement for the other types of lands with the area of less than 100 ha and more than 100 ha are as follows:

Qpeak = 0.25m3/sec/ha from the area less than 100 ha

Qpeak = 0.19m3/sec/ha from the area more than 100 ha

Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Ream Kon Sub-Project are respectively shown in Figure III 2.3.1 and Figure III 2.3.2.

Design Conditions of Moung Russei Headworks

Design conditions of Moung Russei Headworks are summarized as follows:

**Summary of Design Condition for Moung Russei Headworks**

| Design Parameter | Condition | Remarks |
|---|---|---|
| Design Flood Discharge $Q_F$: | 180 $m^3$/sec | Close to T=100 year return period |
| Design Flood Water Level $WL_F1$: | WL. 17.2m | At Weir site |
| Design Flood Water Level $WL_F2$: | WL. 17.82m | At National Road No.5 (180 $m^3$/s) |
| Design River Bank Elevation | EL. 18.00m | Between/ Weir site and National Road No.5 |
| Design Irrigation Water Level WL1: | WL. 15.50m | Top of Gate. Allowable overflow h=0.20m |
| Design River bed Elevation (Upstream): | EL. 11.70m | |
| Design River bed Elevation (Downstream): | EL. 11.70m | |
| Design Gate Sill Elevation: | EL. 11.70m | |
| Intake discharge to Ream Kon Sub-project: | 2.66 $m^3$/sec | Peak discharge |

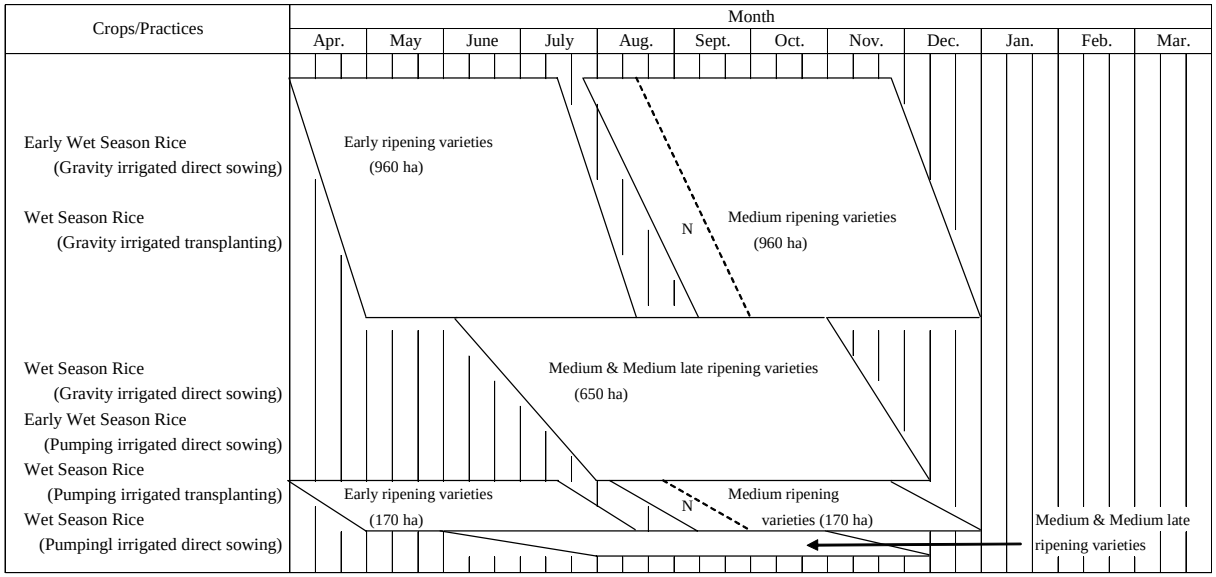
| Design Parameter | Condition | Remarks |
|---|---|---|
| Intake discharge to Por Canal Sub-project: | 2.74 $m^3$/sec | Peak discharge |
| Discharge of fish ladder: | ≧0.79 $m^3$/sec | River maintenance flow[4] for 785$km^2$ |

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study

(3) Crop Production Plan

Although there is a considerably large potential to grow rice under irrigated condition for the dry season in the Ream Kon Sub-project area, it is a prerequisite for the exploitation of such potential to develop water resources in the upstream of the Moung Russei River by constructing a regulating reservoir. In line with the project concept, however, the proposed crop production plan is to be drawn up focusing on promotion of double cropping of shorter maturity rice varieties during the wet season by fully utilizing natural flow of the water source river.

Under either gravity or pumping irrigated condition, rice is to be grown in every tertiary block on the 3-year rotation system basis. As illustrated below, double cropping of rice with early ripening varieties for the early wet season and medium ripening varieties for the wet season will be continuously done for two years followed by one year single cropping of rice with medium or medium late ripening varieties for the wet season.




Prepared by JICA SAPROF Study Team

**Modified Cropping Pattern Proposed for Ream Kon Sub-project**

In the double cropping area, transplanting method will be practiced for the wet season, while direct sowing method will be carried out for the early wet season. In the single cropping area, the both methods are to be practiced.

[4] There is no regulation on river maintenance flow in Cambodia, therefore, 0.1 $m^3$/sec/100 $km^2$ is applied for river maintenance flow based on Japanese guideline (Dam *BINRAN* or *HATSUDEN* Guideline). River maintenance flow for three source rivers utilized for the Project are as follows:

**River Maintenance Flow**

| basin | Catchment Area ($km^2$) | River Maintenance Flow ($m^3$/sec) |
|---|---|---|
| Moung Russei river | 785 | 0.79 |
| Pursat river | 4,480 | 4.48 |
| Boribo river | 735 | 0.74 |

Prepared by JICA SAPROF Study Team

Supposing that improved pre- and post-harvest technologies of irrigated rice cultivation including proper use of irrigation water at the on-farm level are put into practice for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Ream Kon Sub-project are set up as shown below.

**Modified Cropping Area and Predicted Crop Production in Ream Kon Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 960 | 3.0 | 2,880 |
| | Pumping | Direct sowing | 170 | 3.0 | 510 |
| | Sub-total | | 1,130 | | 3,390 |
| Wet | Gravity | Transplanting | 960 | 3.3 | 3,168 |
| | Gravity | Direct sowing | 650 | 3.3 | 2,145 |
| | Pumping | Transplanting | 170 | 3.3 | 561 |
| | Pumping | Direct sowing | 110 | 3.3 | 363 |
| | Sub-total | | 1,890 | | 6,237 |
| Total | | | 3,020 | | 9,627 |

Prepared by JICA SAPROF Study Team

As discussed in Section 1.4 (8) of Part III, nearly 60% of the current forwarded paddy is handled by local assemblers. They act as agents to resell mostly collected paddy to cross border traders who bring out paddy to the neighboring countries. On the other hand, local commercial rice mills are forced to operate their systems at very low rate due to insufficient funds to purchase paddy forwarded from farmers, even though they have enough processing capacity to meet farmers' demand. In order to materialize the effect of paddy production increase for generating rural economy, it is eagerly hoped to offer a low-interest rural credit menu to local commercial mill owners aiming to enable them to secure their operation funds enough to collect paddy forwarded from farmers as much as possible.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

On the basis of the basic concept on irrigation and drainage development, facilities to be rehabilitated and/or reconstructed under the Project are tabulated as follows:

**List of Facilities under the Project (Ream Kon Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,890 |
| | (Pump irrigation area included above) | (280) |
| 2. | Annual irrigation area (ha) | 3,020 |
| | - Early wet season paddy (ha) | 1,130 |
| | - Medium wet season paddy (ha) | 1,890 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Moung Russei River |
| | - Name of headworks | Moung Russei Headworks (New) shared with Por Canal Sub-Project, dimensions of which are summarized afterward |
| | - Intake water level (EL. m) | 15.50 |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.66 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 9.9 |
| | - Turnout (nos.) | 14 |
| 5. | Nos. of secondary/ sub-secondary canals | 11 |
| | - Total length (km) | 18.3 |

| No. | Description | Quantity |
|---|---|---|
| | - Turnout (nos.) | 43 |
| 6. | Number of Tertiary Blocks (No.) | 45 |
| | Total length of tertiary canals (km) | 54.0 |
| 7. | Main drains | - Moung Russei,<br>- Ou Anlong Rolus |
| | - Total length (km) | 7.2 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 7 |
| | - Total length of secondary drains (km) | 13.4 |
| 9. | Collector drains (nos.) | 3 |
| | - Total length of collector drain (New, km) | 21.8 |

Prepared by JICA SAPROF Study Team

**Moung Russei Headworks and Major Facilities**

| Items | Description |
|---|---|
| Moung Russei Diversion Weir<br>♦ Design Flood Discharge: Q=180m$^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 17.2m<br>♦ with Fish Ladder: B:2.0m x H:3.5m x L:35m (Half Cone Type) | ♦ Floating type weir with gates<br>♦ width x height x length (B:33.5m x H:10.7m x L:37.0m)<br>♦ Flood Gate: Fixed wheel gate (B:11.5m x H:3.8m x 2 nos.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m x H:3.8m x 1 no.) |
| Ream Kon Intake<br>♦ Design Discharge: Q=2.66m$^3$/s | ♦ -width x height x length: B3.5m x H:3.5m x L:7m<br>♦ -Slide Gate: B:1.0m x H:1.2m x 2nos. |

Prepared by JICA SAPROF Study Team

The typical dimension of the Moung Russei River based on design flood discharge of 180 m$^3$/sec is shown as follows:

**Typical Dimension of River Section of the Moung Russei Diversion Weir**

| River Section type | Design Discharge (m$^3$/sec) | River bed width (m) | Bed slope | Inner side slope | Water depth (m) | Free board (m) |
|---|---|---|---|---|---|---|
| Earth, Trapezoidal cross section | 180 | 16.0 | 1/900 | 1:2.0 | 5.4 | 0.6 |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

♦ Stable and equitable water distribution will be materialized so that agricultural production is stabilized for primary benefit area (1,890 ha) and secondary benefit area (90 ha).

*Drainage Facilities*

♦ Drainage condition will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

♦ Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.

- O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

### 2.3.4 Por Canal Sub-Project

(1) Sub-Project Command Area

As described in the section of the Ream Kon Sub-Project, the total irrigated development area of the Ream Kon and the Por Canal amounts to 3,900 ha based on water availability within the River Basin. By reviewing the topographic conditions of the Por Canal area, the target area is determined to be 1,940 ha.

In addition, as a secondary benefit area, irrigation water will be provided to: (i) the area between proposed new main canal and the National Road No. 5 (200 ha) and (ii) ECOSORN-rehabilitated area located in the downstream of the Moung Russei River (236 ha), amounting to 436 ha.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- All the command area (1,940 ha) will be irrigated by gravity.

*Headworks*

- New headworks, the Moung Russei headworks will be constructed and both the Ream Kon Sub-Project and the Por Canal Sub-Project will be supplied with irrigation water from this headworks. In addition, existing deteriorated intake structure will be replaced by new one.

*Irrigation and Drainage Canal Network*

- At present, there are two main canals, of which a canal running on the western edge of the command area along the National Road No.5 will be utilized for a new main canal to cover the whole command area according to the topographic conditions.
- Tertiary canals are constructed with the command area of generally 50 ha based on MOWRAM guideline.
- Main and secondary drainage canals will be constructed to establish independent setting on irrigation and drainage. In addition, natural streams will be utilized as main drains.
- Secondary canal, S-1, located at the most upstream, and its tertiary level facilities commanding 288 ha have been rehabilitated by ECOSORN financially supported by EU. However, canal water levels are considered too low to irrigate by gravity. Check structures will be provided under the Project to regulate the canal water levels.

*Inspection Road*

- Along the main canal, an inspection road with the width of 4.0 m is provided to improve transportation within the command area as introduced in the section of the Ream Kon Sub-Project.

Unit Irrigation Water Requirement

The basic conditions applied to calculate unit irrigation water requirement is as described in the

section of Ream Kon Sub-Project. The 5-day water requirement is calculated in accordance with proposed cropping pattern. The peak diversion water requirement is estimated at 1.41 lit/sec/ha for early wet season paddy in April based on the overall irrigation efficiency of 66%.

Drainage Water Requirement

As explained in the section of the Ream Kon Sub-Project, drainage water requirement is as follows:

*From paddy field*

q = 0.186×10,000÷(3×86400)×1000=7.17

where, 0.186 is a probable 3 consecutive days rainfall at Moung Russei station

*Drainage water requirement from other type of land*

Qpeak = 0.25m3/sec/ha from the area less than 100 ha

Qpeak = 0.19m3/sec/ha from the area more than 100 ha

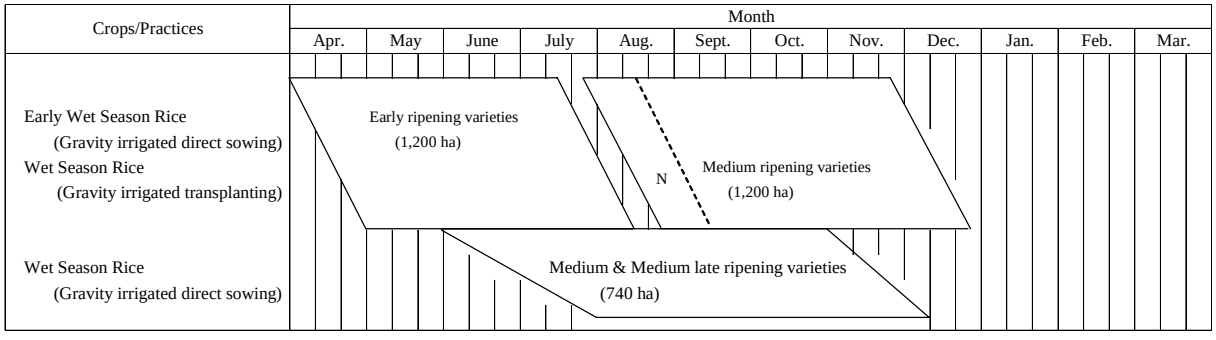
Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Por Canal Sub-Project are shown in Figure III 2.3.3 and Figure III 2.3.4 respectively.

(3) Crop Production Plan

Following the project concept, the proposed crop production plan is to be prepared focusing on the promotion of double cropping of shorter maturity rice varieties throughout the wet season by fully utilizing natural flow of the Moung Russei River.

As double cropping of rice can be done under gravity irrigation system in about two-third of the irrigation command area, the 3-year rotation system is to be practice in the whole area of Por Canal Sub-project. For securing irrigation water supply to paddy plots where the double cropping of rice is done, early ripening varieties are to be grown for the early wet season followed by growing of medium ripening varieties. In the single cropping area, medium and medium late ripening varieties are to be selected. The modified cropping pattern is shown below.




Prepared by JICA SAPROF Study Team

**Modified Cropping Pattern Proposed for Por Canal Sub-project**

Direct sowing method will be applied to the double cropping area for the early wet season and the single cropping area for the wet season. Transplanting method is to be practiced in the double cropping area for the wet season.

Assuming that improved pre- and post-harvest technologies of rice cultivation are to be put into

practices among beneficial farmers for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Por Canal Sub-project are made as shown below.

**Modified Cropping Area and Predicted Crop Production in Por Canal Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 1,200 | 3.0 | 3,600 |
| | Sub-total | | 1,200 | | 3,600 |
| Wet | Gravity | Transplanting | 1,200 | 3.3 | 3,960 |
| | Gravity | Direct sowing | 740 | 3.3 | 2,442 |
| | Sub-total | | 1,940 | | 6,402 |
| Total | | | 3,140 | | 10,002 |

Prepared by JICA SAPROF Study Team

Although farmers will utilize some part of increased paddy production for reserving more stocked seeds and food for their family members, the future market situation will be the same as in the Ream Kon Sub-project area.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

Based on the irrigation and drainage development concept mentioned above, facilities to be rehabilitated and/or reconstructed under the Project are tabulated as follows:

**List of Facilities under the Project (Por Canal Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,940 |
| | (Pump irrigation area included above) | 0 |
| 2. | Annual irrigation area (ha) | 3,140 |
| | - Early wet season paddy (ha) | 1,200 |
| | - Medium wet season paddy (ha) | 1,940 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Moung Russei River |
| | - Name of headworks | Moung Russei Headworks (New) shared with Ream Kon Sub-Project |
| | - Intake water level (EL. m) | 15.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 2.74 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 6.8 |
| | - Turnout (nos.) | 8 |
| 5. | Nos. of secondary/ sub-secondary canals | 9 |
| | - Total length (km) | 19.1 |
| | - Turnout (nos.) | 44 |
| 6. | Number of Tertiary Blocks (No.) | 42 |
| | Total length of tertiary canals (km) | 55.0 |
| 7. | Main drains | - Moung Russei,<br>- MD-1 |
| | - Total length (km) | 5.6 |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 7.17 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 10 |
| | - Total length of secondary drains (km) | 14.8 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0.0 |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

- Stable and equitable water distribution will be materialized so that agricultural production is stabilized at: primary benefit area (1,940 ha) and secondary benefit area (436 ha).

*Drainage Facilities*

- Drainage condition will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

- Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.
- O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

### 2.3.5 Damnak Ampil Sub-Project

(1) Sub-Project Command Area

The result of water balance study of the Pursat River Basin shows that a total area of approximately 38,000 ha is able to be irrigated at 80% dependability. In the Damnak Ampil sub-project, existing upstream portion covering 2,270 ha will be the target of the Project due to the following technical evaluation.

- There are three secondary canals, of which the secondary canal No.2 has been rehabilitated with the assistance of DANIDA, but not functioning. Vitalization of the upstream portion of the Damnak Ampil irrigation system needs to be considered in the first step.
- A FWUC was established but not registered at PDOWRAM yet. Substantial activities are not observed until now.
- Farmers under the sub-project area do not have sufficient experiences and knowledge in irrigation management.

As a secondary benefit area, irrigation water will be provided to: (i) Damnak Ampil Extension Area (5,730 ha), (ii) Bakan & Krouchi Seuchi irrigation system (1,000 ha), (iii) Svay Daun Keo irrigation system (2,200 ha), amounting to 8,930 ha.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- Irrigation area consists of: (i) gravity irrigation area (1,770 ha) and (ii) pump irrigation area (500 ha). Ground height of some plots under the command area extending 500 ha is higher than water level in the canal. Raising water level in the main canal only to irrigate this higher area is not economically feasible, therefore, pump irrigation will be applied for this area. In the pump irrigation area, farmers need to rent pumps from communes or other sources.

*Headworks*

- The existing automatic gates do not function smoothly and need to be improved. In such situation, therefore, improvement works are required to ensure diversion of the Pursat River water smoothly. Possible countermeasures would be as follows: (i) Counterweights will be increased to raise the design water level for fall down from EL. 16.85 m to EL. 17.20 m. (ii) Manual or power hoist system will be provided to operate gates. Based on the comparative study, power hoisting system will be applied for the improvement works. Gate improvement works to be carried out under the Project will consist of: (i) installation of new hoisting system for assisting flood gate lifting, (ii) improvement of bushing of flood gate, and (iii) installation of new hoisting system for assisting scouring sluice gate lifting.
- At present, no fish ladder is provided at the existing Damnak Ampil Headworks. In order to maintain fish resources in the Pursat river by supporting fish sprawling, a new fish ladder will be installed on the right bank of the weir.

*Irrigation and Drainage Canal Network*

- The existing main canal with appurtenant structures consisting of checks and off-takes have been rehabilitated by MOWRAM in 2006. They are in better conditions, therefore, no rehabilitation is required under the Project.
- Out of three existing secondary canals, the secondary canal No.2, has been rehabilitated by the assistance of DANIDA although no new structures were provided. The Project covers rehabilitation of other two canals and construction of related structures for all three secondary canals.
- Tertiary canals are constructed with each command area of generally 50 ha or less to distribute water smoothly at the tertiary level based on MOWRAM guideline.
- Main and secondary level drains will be constructed to establish independent setting on irrigation and drainage. In addition, natural stream will be utilized for main drains to minimize project costs.

Unit Irrigation Water Requirement

The irrigation water requirement is estimated based on the proposed cropping pattern described above. The basic conditions applied are as follows:

- Meteorological data; average of mean monthly data at Pursat station
- Percolation rate 2.5 mm/day based on the field observation data
- Rainfall data; Daily rainfall data at Boeung Khnar, Pursat, Boeung Kantout stations
- Effective rainfall; (i) less than 5mm/day: ineffective rainfall, (ii) 5mm to 80mm/day: Rx80%, (iii) more than 80mm: 80x80%=64mm
- The transplanting method is practiced in the Sub-project area
- Irrigation efficiency in the tertiary unit= 85 %
- Irrigation efficiency in the secondary canal and main canal= 88 %, respectively
- Overall efficiency= 85 × 88 × 88 % = 65.8 % = 66 %

The 5-day water requirement is calculated in accordance with the proposed cropping pattern. The peak diversion water requirement in the Sub-project as a whole is figured out at 1.36 lit/sec/ha by wet season paddy in August taking into account the overall irrigation efficiency of 66%.

Drainage Water Requirement

*From paddy field*

The unit drainage water requirement from paddy field is calculated at 6.32 lit/sec/ha, based on the annual maximum rainfall in 3 consecutive days at one in 5 years return period.

*Drainage water requirement from other type of land*

The sub-project area consists of paddy field and other types of land located adjacent to the paddy field, and are assumed to be 15% of the paddy field, those of which do not have storage function as paddy field. Therefore, runoff characteristics are different from that of paddy field. The unit drainage water requirement for those lands is calculated by the rational formula based on the annual maximum one day rainfall at one in 5 years return period (110 mm/day). The unit drainage water requirement for the other types of land with the area of less than 100 ha and more than 100 ha are as follows:

Qpeak = 0.25m3/sec/ha from the area less than 100 ha

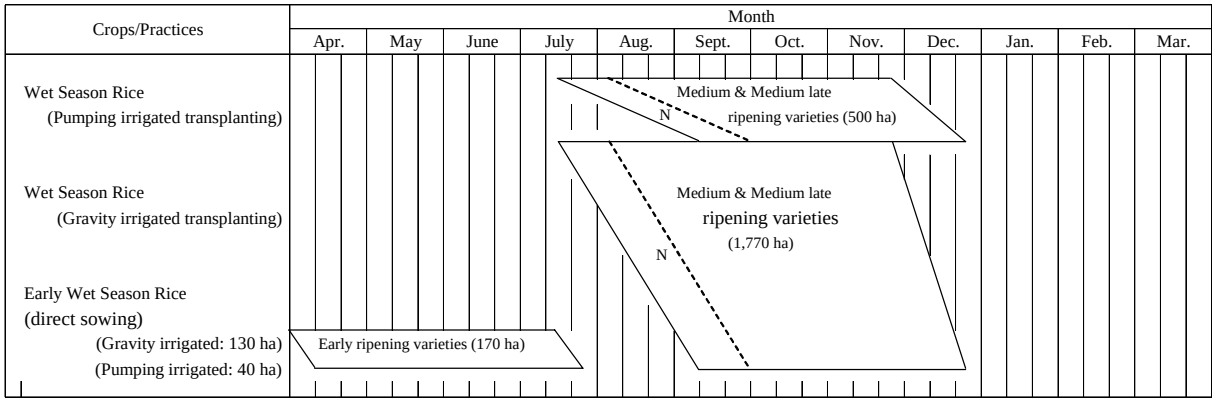
Qpeak = 0.18m3/sec/ha from the area more than 100 ha

Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Damnak Ampil Sub-Project are respectively shown in Figure III 2.3.5 and Figure III 2.3.6.

(3) Crop Production Plan

Duly considering the seasonal limitation of discharge of the Pursat River as the irrigation water source for the Damnak Ampil, Wat Loung and Wat Chre Sub-projects, the proposed crop production plan is to focus on single cropping of rice for the wet season in 93% of the irrigation command area. Thus, double cropping area covers only 7%. Early ripening varieties are to be selected for the early wet season, while medium and medium late varieties will be grown for the wet season, as shown below. To secure fair irrigation water use for the early wet season among beneficiaries, a long-term crop rotation system is to be introduced, by which farmers will be able to grow the early wet season rice every 14 years.




Prepared by JICA SAPROF Study Team

**Modified Cropping Pattern Proposed for Damnak Ampil Sub-project**

Direct sowing method will be practiced only in the double cropping area for the early wet season, while transplanting method is to be applied to the whole area for the wet season.

Under the limited water resource of the Pursat River, farming practices of irrigated rice cultivation needs to be more improved than other three sub-project areas in Batambang and Kampong Chhnang. Providing beneficiaries with intensive training programs in terms of pre- and post-harvest technologies for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Damnak Ampil Sub-project are made as shown below.

**Modified Cropping Area and Predicted Crop Production in Damnak Ampil Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 130 | 3.0 | 390 |
| | Pumping | Direct sowing | 40 | 3.0 | 120 |
| | Sub-total | | 170 | | 510 |
| Wet | Gravity | Transplanting | 1,770 | 3.3 | 5,841 |
| | Pumping | Transplanting | 500 | 3.3 | 1,650 |
| | Sub-project | | 2,270 | | 7,491 |
| Total | | | 2,440 | | 8,001 |

Prepared by JICA SAPROF Study Team

In the Damnak Ampil, Wat Loung and Wat Chre Sub-project areas, it is estimated that farmers will forward 44% of their harvested paddy to local markets. The existing 19 commercial mills available in Bakan District are facilitated with the sufficient capacity to process the whole forwarded paddy of 16,500 tons. Due to the limited operation funds of these mill owners, however, local assemblers will shoulder more than half of this quantity. As a result, a considerable portion of value added will be spilled out to other areas and abroad and less contribution to rural economy is usual. Such situation can be improved if rural credit services with easy accessibility are offered to the owners for enhancing their operation funds.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

On the basis of the basic concept on irrigation and drainage development, facilities to be rehabilitated and/or reconstructed under the Damnak Ampil Sub-Project are tabulated as follows:

**List of Facilities under the Project (Damnak Ampil Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 2,270 |
| | (Pump irrigation area included above) | (500) |
| 2. | Annual irrigation area (ha) | 2,440 |
| | - Early wet season paddy (ha) | 170 |
| | - Medium wet season paddy (ha) | 2,270 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |
| | - Name of headworks | Damnak Ampil Headworks (Existing) Gate Improvement works and fish ladder under the Project is summarized below. |
| | - Intake water level (EL. m) | 17.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 7.93 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | - |

| No. | Description | Quantity |
|---|---|---|
| | - Turnout (nos.) | 3 |
| 5. | Nos. of secondary/ sub-secondary canals | 3 |
| | - Total length (km) | 12.6 |
| | - Turnout (nos.) | 44 |
| 6. | Number of Tertiary Blocks (No.) | 50 |
| | Total length of tertiary canals (km) | 85.0 |
| 7. | Main drains | Ou Bakan/Boeung Khnar River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 3 |
| | - Total length of secondary drains (km) | 21.8 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

*Gate Improvement Works*

**Improvement Works for Damnak Ampil Weir Flood Gate System**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new hoist system (Replacement of present hoist) | 7 sets | ♦ 1 motor-2 drum winch type with clutch for counter weight<br>♦ Local control panels w/ cable network system, Hoist deck<br>♦ Generator 75 kVA<br>♦ Lightening rods with earthing network |
| Exchange of bushing (Replacement of present bushing) | 7 sets | Bushing with larger diameter and oil-less bearing for long durability because the existing bushes do not have enough strength for mechanical lifting proposed |

Prepared by JICA SAPROF Study Team

**Improvement Works for Damnak Ampil Weir Scouring Sluice Gate System**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new hoist system (Replacement of present hoist) | 4 sets | ♦ Rack type hoist with motor<br>♦ Local control panel |

Prepared by JICA SAPROF Study Team

*Fish Ladder*

**Dimension of Fish Ladder**

| Items | Contents | Remarks |
|---|---|---|
| Installation of new fish ladder | 1 no. | ♦ Discharge: 4.71 m3/sec (maintenance flow + D&I flow) + residual<br>♦ Width: B=5.0m (common for above types)<br>♦ Slope: I = 1/10 (commonly for above types)<br>♦ Height: H=4.5m (Gate height-inlet water depth)<br>♦ Inlet elevation:EL.16.50m(Water depth=0.5m)<br>♦ Outlet elevation:EL.12.00m(Existing River Bed)<br>♦ Length: L6=45 m (=4.5/(1/10) ) |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

♦ Gate improvement for the Damnak Ampil Headworks will ensure intake water level so that the river water will be diverted to irrigation systems commanded by the Headworks.

- Stable and equitable water distribution will be materialized by the rehabilitation of secondary and tertiary level facilities so that agricultural production is stabilized at primary benefit area (2,270 ha) and secondary benefit area (8,930 ha).

*Drainage Facilities*

- Drainage condition will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

- Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.
- O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

### 2.3.6 Wat Loung Sub-Project

(1) Sub-Project Command Area

As described in the section of the Damnak Ampil Sub-Project, the command areas of the sub-projects under the Pursat River Basin are determined based on the water balance study of the Basin. The command area of the Wat Loung Sub-Project is 2,540 ha by considering topographic conditions and water allocation to other irrigation systems.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- Irrigation area consists of: (i) gravity irrigation area (1,740 ha) and (ii) pump irrigation area (800 ha) since the ground height of upstream area along the main canal is higher than the canal water level. Raising water level in the main canal only to irrigate this higher area is not economically feasible, therefore, pump irrigation will be applied for this area. In the pump irrigation area, farmers need to rent pumps from communes or other sources.

*Irrigation and Drainage Canal Network*

- Water will be diverted from the Pursat River by the Damnak Ampil Headworks through a headrace connecting with the Wat Loung main canal.
- The existing Wat Loung main canal is seriously deteriorated. Therefore, its rehabilitation works will be included in the Project.
- Tertiary canals are constructed with the command area of generally 50 ha based on MOWRAM guideline.
- Main and secondary level drains will be constructed to establish independent setting on irrigation and drainage. In addition, natural streams will be utilized for main drains to minimize project costs.

*Inspection Road*

- Along the main canal, an inspection road with the width of 4.0 m is provided to improve transportation within the command area.

Unit Irrigation Water Requirement

The irrigation water requirement is estimated based on the proposed cropping pattern. The 5-day water requirement is calculated in accordance with the proposed cropping pattern. The peak diversion water requirement in the Sub-project as a whole is figured out at 1.36 lit/sec/ha by wet season paddy in August taking into account the overall irrigation efficiency of 66% as same as the Damnak Ampil Sub-Project.

Drainage Water Requirement

*From paddy field*

The unit drainage water requirement from paddy field is calculated at 6.32 lit/sec/ha, based on the annual maximum rainfall in 3 consecutive days at one in 5 years return period as same as Damnak Ampil Sub-Project.

*Drainage water requirement from other type of land*

As explained in the section of Damnak Ampil Sub-Project, drainage water requirement from other type of lands is as follows:

Qpeak = 0.25m3/sec/ha from the area less than 100 ha

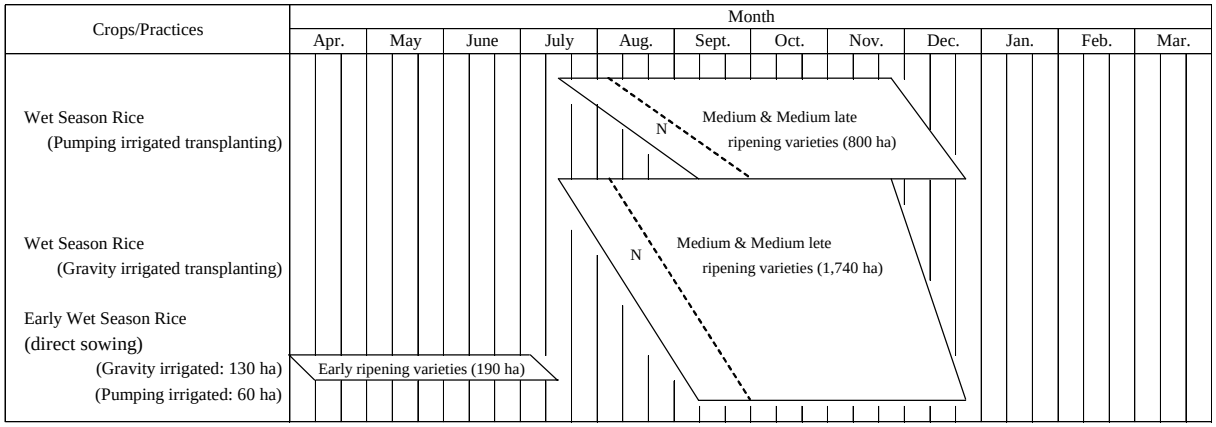
Qpeak = 0.18m3/sec/ha from the area more than 100 ha

Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Wat Loung Sub-Project are respectively shown in Figure III 2.3.7 and Figure III 2.3.8.

(3) Crop Production Plan

With the same concept on rice variety selection, practice of double cropping system during the wet season because of limited discharge available in the Pursat River and fair opportunity of irrigation water use adapted to the Damnak Ampil Sub-project, the modified cropping pattern of Wat Loung Sub-project is made as illustrated below.




Prepared by JICA SAPROF Study Team

**Revised Cropping Pattern Proposed for Wat Loung Sub-project**

Direct sowing and transplanting methods are to be practiced for early wet season cropping and wet season cropping, respectively.

Similar attention has to be paid to how to improve farming practices on irrigated rice cultivation in the Wat Loung Sub-project area. With implementation of agricultural supporting activities for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Wat Loung Sub-project are drawn up as shown below.

**Modified Cropping Area and Predicted Crop Production in Wat Loung Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 130 | 3.0 | 390 |
| | Pumping | Direct sowing | 60 | 3.0 | 180 |
| | Sub-project | | 190 | | 570 |
| Wet | Gravity | Transplanting | 1,740 | 3.3 | 5,742 |
| | Pumping | Transplanting | 800 | 3.3 | 2,640 |
| | Sub-project | | 2,540 | | 8,382 |
| Total | | | 2,730 | | 8,952 |

Prepared by JICA SAPROF Study Team

The future market situation of forwarded paddy from farmers in the Wat Loung Sub-project area is considered as same in the Damnak Ampil Sub-project area.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

On the basis of the basic concept on irrigation and drainage development, facilities to be rehabilitated and/or reconstructed under the Wat Loung Sub-Project are tabulated as follows:

**List of Facilities under the Project (Wat Loung Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 2,540 |
| | (Pump irrigation area included above) | (800) |
| 2. | Annual irrigation area (ha) | 2,730 |
| | - Early wet season paddy (ha) | 190 |
| | - Medium wet season paddy (ha) | 2,540 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |

| No. | Description | Quantity |
|---|---|---|
| | - Name of headworks | Damnak Ampil Headwork (Existing) |
| | - Intake water level (EL. m) | 17.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 3.45 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 20.3 |
| | - Turnout (nos.) | 12 |
| 5. | Nos. of secondary/ sub-secondary canals | 10 |
| | - Total length (km) | 31.1 |
| | - Turnout (nos.) | 52 |
| 6. | Number of Tertiary Blocks (No.) | 54 |
| | Total length of tertiary canals (km) | 81.0 |
| 7. | Main drains | Boeung Khnar River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 8 |
| | - Total length of secondary drains (km) | 37.7 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

- Stable and equitable water distribution will be materialized so that agricultural production for the target area of 2,540 ha is stabilized.
- Water will be smoothly allocated to the Wat Chre sub-project located in the downstream of Wat Loung sub-project by the rehabilitation of the main canal.

*Drainage Facilities*

- Drainage conditions will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

- Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.
- O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

### 2.3.7 Wat Chre Sub-Project

(1) Sub-Project Command Area

As described in the section of the Damnak Ampil Sub-Project, command areas of the sub-projects under the Pursat River Basin are determined based on the water balance study of the Basin. The command area of the Wat Loung Sub-Project is 1,020 ha by considering topographic conditions and water allocation to other irrigation systems.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- Irrigation area consists of: (i) gravity irrigation area (620 ha) and (ii) pump irrigation area (400 ha). Since the ground height of upstream area along the main canal is higher than water level in the canal, combination of gravity irrigation and pump irrigation is proposed as a basic concept of the plan. In the pump irrigation area, farmers need to rent pumps from communes or other sources.

*Headworks*

- Water will be diverted from the Pursat River by the Damnak Ampil Headworks through the Wat Loung main canal to the Boeung Khnar River. A new headworks will be constructed on the Boeung Knar to introduce delivered water to the command area of the Wat Chre Sub-Project.
- Weir type is determined as floating type because the foundation ground is not suitable for the spread foundation according to the result of geotechnical investigation.
- Fixed wheel type gate is selected for flood gate and slide gate is selected for high reliability as well easy operation.

*Irrigation and Drainage Canal Network*

- The proposed main canal consists of the two portions: (i) newly constructed portion (700 m), located the most upstream and (ii) rehabilitation portion using existing canal.
- Tertiary canals are constructed with the command area of generally 50 ha based on MOWRAM guideline.
- Secondary level drains will be constructed to establish independent setting on irrigation and drainage. In addition, secondary drains connect with the Boueng Khnar River.

*Inspection Road*

- Along the main canal, on inspection road with the width of 4.0 m is provided to improve transportation within the command area.

Unit Irrigation Water Requirement

As estimated for the Damnak Ampil Sub-Project, the irrigation water requirement is based on the proposed cropping pattern. The 5-day water requirement is calculated in accordance with the proposed cropping pattern. The peak diversion water requirement in the Sub-project as a whole is figured out at 1.36 lit/sec/ha by wet season paddy in August taking into account the overall irrigation efficiency of 66%.

Drainage Water Requirement

The unit drainage water requirement from paddy field is calculated at 6.32 lit/sec/ha, based on the annual maximum rainfall in 3 consecutive days at one in 5 years return period as same as the Damnak Ampil Sub-Project.

Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Wat Chre Sub-Project are respectively shown in Figure III 2.3.9 and Figure III 2.3.10.

Design Conditions of Wat Chre Headworks

Design conditions of the Wat Chre Headworks are summarized as follows:

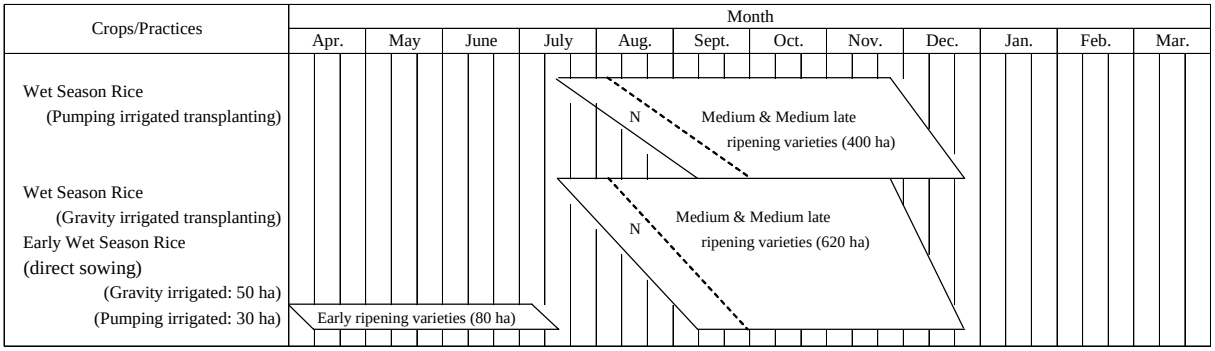
**Summary of Design Condition for Wat Chre Headworks**

| Design Parameter | Condition | Remarks |
|---|---|---|
| Design Flood Discharge $Q_F$: | 65 $m^3$/sec | T=100 year return period |
| Design Flood Water Level $WL_F1$: | WL. 13.6m | at Weir site |
| Design Flood Water Level $WL_F2$: | WL. 14.2m | at the Bridge on National Road No.5 |
| Design River Bank Elevation | EL. 14.30 - 15.00m | betw/ Weir site and National Road No.5 |
| Design Irrigation Water Level WL1: | WL. 13.00m | Top of Gate. Overflow depth=0.2m |
| Design River bed Elevation (Upstream): | EL. 9.60m | |
| Design River bed Elevation (Downstream): | EL. 9.60m | |
| Design Gate Sill Elevation: | EL. 9.60m | |
| Intake Discharge to Wat Chre Sub-project: | 1.39 $m^3$/sec | Peak discharge |
| Discharge of fish ladder | $\geq$0.18$m^3$/sec | River maintenance flow for180 $km^2$ |

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study

(3) Crop Production Plan

The modified cropping pattern of Wat Chre Sub-project as illustrated below is made based on the same concept on rice variety selection, practice of double cropping system during the wet season because of limited discharge available in the Pursat River and fair opportunity of irrigation water use adapted to the Damnak Ampil Sub-project.




Prepared by JICA SAPROF Study Team

**Revised Cropping Pattern Proposed for Wat Chre Sub-project**

Transplanting method is to be fully practiced for the wet season cropping, while direct sowing method is put into practice for the early wet season cropping.

With implementation of agricultural supporting activities to improve pre- and post-harvest practices for irrigated rice cultivation for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Wat Chre Sub-project are made as shown below.

**Modified Cropping Area and Predicted Crop Production in Wat Chre Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Direct sowing | 50 | 3.0 | 150 |
| | Pumping | Direct sowing | 30 | 3.0 | 90 |
| | Sub-total | | 80 | | 240 |
| Wet | Gravity | Transplanting | 620 | 3.3 | 2,046 |
| | Pumping | Transplanting | 400 | 3.3 | 1,320 |
| | Sub-project | | 1,020 | | 3,366 |
| Total | | | 1,100 | | 3,606 |

Prepared by JICA SAPROF Study Team

The future market situation of forwarded paddy from farmers in the Wat Chre Sub-project area will be same as the situation in the Damnak Ampil Sub-project area.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

On the basis of the basic concept on irrigation and drainage development, facilities to be rehabilitated and/or reconstructed under the Wat Chre Sub-Project are tabulated as follows:

**List of Facilities under the Project (Wat Chre Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 1,020 |
| | (Pump irrigation area included above) | 400 |
| 2. | Annual irrigation area (ha) | 1,100 |
| | - Early wet season paddy (ha) | 80 |
| | - Medium wet season paddy (ha) | 1,020 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Pursat River |
| | - Name of headworks | Wat Chre Headworks (Reconstruction) |
| | - Intake water level (EL. m) | 13.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 1.39 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 4.7 |
| | - Turnout (nos.) | 9 |
| 5. | Nos. of secondary/ sub-secondary canals | 6 |
| | - Total length (km) | 14.7 |
| | - Turnout (nos.) | 22 |
| 6. | Number of Tertiary Blocks (No.) | 27 |
| | Total length of tertiary canals (km) | 27.0 |
| 7. | Main drains | - Boeung Khnar R.,<br>- Ta Paong stream |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.32 |
| | - Drainage water requirement from other land (lit/sec/ha) | 18~25 |
| 8. | Secondary drains (nos.) | 5 |
| | - Total length of secondary drains (km) | 11.5 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

**Headworks and Major Facilities**

| Items | Description |
|---|---|
| Wat Chre Diversion Weir<br>♦ Design Flood Discharge: Q=65m$^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 13.6m<br>♦ with Fish Ladder: B:2.0m x H:3.1m x L:31m | ♦ Floating type weir with gates<br>♦ width x height x length: B:20m x H:10.0m x L:35m<br>♦ Flood Gate: Fixed wheel gate (B:12.5m x H:3.4mx 1 no.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m x H:3.4m x 1 nos.) |
| Wat Chre Intake<br>♦ Design Discharge: Q=1.39m$^3$/s | ♦ width x height x length: B:1.0m x H:2.4m x L:6m<br>♦ Slide Gate: B:1.0m x H:1.0m x 1 no. |

Prepared by JICA SAPROF Study Team

The typical dimension of the Boueng Khanr River based on design flood discharge of 65 m$^3$/sec is shown as follows:

**Typical Dimension of River Section of the Wat Chre Diversion Weir**

| River Section type | Design Discharge (m$^3$/sec) | River bed width (m) | Bed slope | Inner side slope | Water depth (m) | Free board (m) |
|---|---|---|---|---|---|---|
| Earth, Trapezoidal cross section | 65 | 15.0 | 1/3000 | 1:2.5 | 3.3 | 0.6 |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

♦ Stable and equitable water distribution will be materialized so that agricultural production is stabilized.

*Drainage Facilities*

♦ Drainage condition will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

♦ Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.

♦ O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

### 2.3.8 Lum Hach Sub-Project

(1) Sub-Project Command Area

The Lum Hach Sub-Project command area is determined based on the following conditions.

♦ The Boribo River is the main source of the Lum Hach Sub-Project. The river water is divided into two directions: (i) the Kampong Chhnang Province and (ii) the Thlea Maan River to the Pursat Province, at the Bomnak water level station located 20 km upstream of the proposed site of the Lum Hach headworks. As a water resource of the Lum Hach sub-project, 50 % of the water is planned to be delivered to the Kampong Chhnang side.

♦ As a secondary benefit area, water will be also distributed to the O Roluss irrigation system, the

existing main canals, intake and spillway of which were rehabilitated by MOWRAM in 2006 covering 3,400 ha, by utilizing the proposed Lum Hach Headworks.

On this basis, the command area of the Lum Hach Sub-Project is determined to be 3,100 ha of paddy fields taking into the topographic conditions and present land use.

(2) Irrigation and Drainage Plan

Basic Concept

*Irrigation Method*

- Irrigation area consists of: (i) gravity irrigation area (2,660 ha) and (ii) pump irrigation area (440 ha). Since the ground height of some of the portions are significantly higher than water level in the canal, the combination of gravity irrigation and pump irrigation is proposed as a basic concept of the plan. In the pump irrigation area, farmers need to rent pumps from communes or other sources.

*Headworks*

- A new headworks will be constructed at approximately 500 m upstream of the existing old structures. The water is provided to both: (i) Lum Hach Sub-Project (3,100 ha) and (ii) O Roluss irrigation system (3,400 ha). To do so, new intake structures will also be constructed for both irrigation systems.
- Fixed wheel type gates are selected for flood gates, and slide gates are selected for high reliability and easy operation as well.
- Weir type is determined as floating type because the foundation ground is not suitable for the spread foundation according to the result of geotechnical investigation.
- A fish ladder will be provided in order to conserve fish resources by supporting fish sprawling.

*Irrigation and Drainage Canal Network*

- The upstream reach of the January 7$^{th}$ canal and an existing secondary canal are rehabilitated to be utilized as the main canal for the sub-project. Since the most upstream of the January 7$^{th}$ canal has invert slope, approximately 800 m of an approach canal will be newly constructed from the intake.
- Tertiary canals are constructed with the command area of generally 50 ha based on MOWRAM guideline.
- Secondary level drains will be constructed to establish independent setting on irrigation and drainage. In addition, secondary drains including side drain of the road constructed by the Ministry of Public Works and Transport connect with the Boribo River to be utilized for main drain.

*Inspection Road*

- Along the main canal, an inspection road with the width of 4.0 m is provided to improve transportation within the command area.

Unit Irrigation Water Requirement

The irrigation water requirement is estimated based on the proposed cropping pattern. The basic

conditions applied are as follows:

- Meteorological data; average of mean monthly data at Pochentong International Airport in Phnom Penh
- Percolation rate 3.0 mm/day based on the observed data
- Rainfall data; Daily rainfall data at Boeung Kantout and Bamnak stations
- Effective rainfall; (i) less than 5mm/day: ineffective rainfall, (ii) 5mm to 80mm/day: Rx80%, (iii) more than 80mm: 80x80%=64mm
- Paddy is cultivated by transplanting method in all over Sub-project area
- Irrigation efficiency in the tertiary unit= 85 %
- Irrigation efficiency in the secondary canal and main canal= 88 %, respectively
- Overall efficiency= 85 × 88 × 88 % = 65.8 % = 66 %

The 5-day water requirement is calculated based on the proposed cropping pattern. The peak diversion water requirement in the Sub-project as a whole is figured out at 2.13 lit/sec/ha by wet season paddy in August taking into account the overall irrigation efficiency of 66%.

Drainage Water Requirement

The unit drainage water requirement of the Lum Hach Sub-Project, q (lit./sec/ha), from paddy field is calculated to be 6.83 lit/sec/ha based on the annual maximum rainfall in 3 consecutive days at one in 5 years return period.

$$q = 0.177 \times 10{,}000 \div (3 \times 86400) \times 1000 = 6.83$$

where, 0.177 is a probable 3 consecutive day-rainfall at Kampong Chhnang station

Irrigation and Drainage Diagram

Based on the proposed layout and unit requirement, irrigation and drainage diagram of the Lum Hach Sub-Project are respectively shown in Figure III 2.3.11 and Figure III 2.3.12.

Design Conditions of Lum Hach Headworks

Design conditions of the Lum Hach Headworks are summarized as follows:

**Summary of Design Condition for Lum Hach Headworks**

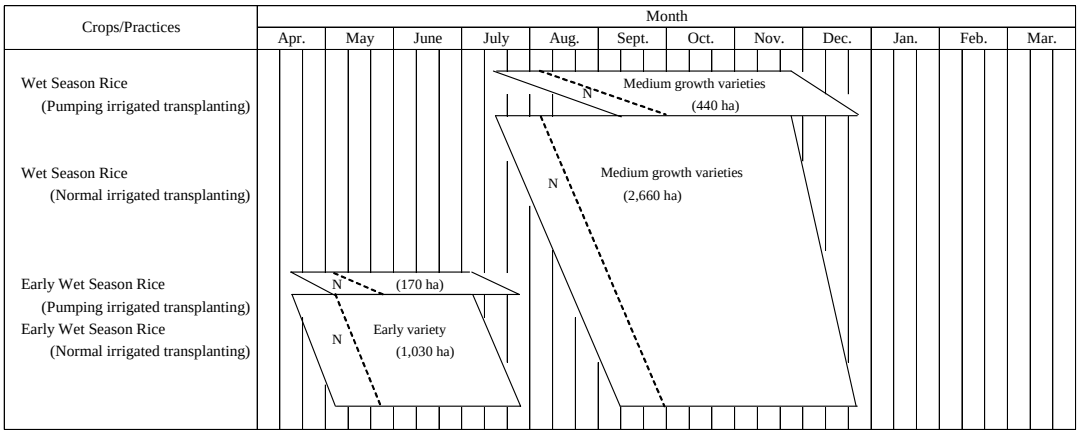
| Design Parameter | Condition | Remarks |
|---|---|---|
| Design Flood Discharge $Q_F$: | 430 $m^3$/sec | T=100 year return period |
| Design Flood Water Level $WL_F1$: | WL. 38.00m | at Weir site |
| Design River Bank Elevation | EL. 39.00m | |
| Design Irrigation Water Level WL1: | WL. 38.00m | Top of Gate. Overflow depth=0.2m |
| Design River bed Elevation (Upstream): | EL. 34.00m | |
| Design River bed Elevation (Downstream): | EL. 34.00m | |
| Design Gate Sill Elevation: | EL. 34.00m | |
| Intake discharge for Lum Hach Sub-project: | 6.60 $m^3$/sec | Maximum discharge |
| Intake discharge for O Roluss irrigation systems: | 5.70 $m^3$/sec | Maximum discharge |
| Discharge of fish ladder: | 0.88 $m^3$/sec | River maintenance flow 0.74 for 735 $km^2$, domestic & industrial use 0.14 |

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study

(3) Crop Production Plan

The Lum Hach Sub-project has a large potential of the dry season rice cultivation if it is possible for creating a year-round irrigation water resource in the upstream of the Boribo River. In line with the project concept, however, the proposed crop production plan focuses on promotion of double cropping of shorter maturity rice varieties during the wet season by fully utilizing natural flow of the water source river.

In the Lum Hach Sub-project area, irrigated rice cultivation can be carried out in around 40% of the command area for the early wet season and the whole area for the wet season. Aiming to enable all beneficiaries to enjoy double cropping opportunities fairly, 5-year crop rotation system is to be introduced, comprising 3-year single cropping of the wet season rice and 2-year double cropping of the early wet season rice and the wet season rice. Early ripening varieties will be used for the early wet season cropping, while medium and medium late varieties are to be grown for the wet season cropping as shown below.




Prepared by JICA SAPROF Study Team

**Revised Cropping Pattern Proposed for Lum Hach Sub-project**

Transplanting method is to be practiced for each cropping season.

Supposing that beneficial farmers will put improved pre- and post-harvest technologies of rice cultivation into practices for the 3-year period after irrigation water can be distributed to each farm plot as planned, the target paddy yield and production in the command area of Lum Hach Sub-project are made as tabulated below.

**Modified Cropping Area and Predicted Crop Production in Lum Hach Sub-project Area**

| Cropping Season | Irrigation Method | Planting Method | Planted Area (ha) | Paddy Yield (ton/ha) | Production (ton) |
|---|---|---|---|---|---|
| Early wet | Gravity | Transplanting | 1,090 | 3.0 | 3,270 |
| | Pumping | Transplanting g | 180 | 3.0 | 540 |
| | Sub-total | | 1,270 | | 3,810 |
| Wet | Gravity | Transplanting | 2,660 | 3.3 | 8,778 |
| | Pumping | Transplanting | 440 | 3.3 | 1,452 |
| | Sub-project | | 3,100 | | 10,230 |
| Total | | | 4,370 | | 14,040 |

Prepared by JICA SAPROF Study Team

The future market situation to handle paddy forwarded from farmers in five communes covering the Lum Hach Sub-project area is quite similar to other communes concerned with the five sub-projects. It is therefore envisaged that offering of useful financing menus is very attractive to local commercial

rice mill owners who intend to enhance their capacity to purchase paddy as much as possible from farmers in the Lum Hach Sub-project area.

(4) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

List of Irrigation and Drainage Facilities to be Rehabilitated or Reconstructed

On the basis of the basic concept on irrigation and drainage development, facilities to be rehabilitated and/or reconstructed under the Lum Hach Sub-Project are tabulated as follows:

**List of Facilities under the Project (Lum Hach Sub-Project)**

| No. | Description | Quantity |
|---|---|---|
| 1. | Sub-project area (ha) | 3,100 |
| | (Pump irrigation area included above) | 440 |
| 2. | Annual irrigation area (ha) | 4,370 |
| | - Early wet season paddy (ha) | 1,270 |
| | - Medium wet season paddy (ha) | 3,100 |
| | - Dry season paddy (ha) | 0 |
| 3. | Major water source | Boribo River |
| | - Name of headworks | Lum Hach Headwork (new construction) |
| | - Intake water level (EL. m) | 36.00 - 38.00 |
| | - Diversion water requirement at intake ($m^3$/sec) | 6.60 |
| 4. | Main canals (nos.) | 1 |
| | - Total length (km) | 16.4 |
| | - Turnout (nos.) | 26 |
| 5. | Nos. of secondary/ sub-secondary canals | 11 |
| | - Total length (km) | 42.4 |
| | - Turnout (nos.) | 55 |
| 6. | Number of Tertiary Blocks (No.) | 69 |
| | Total length of tertiary canals (km) | 69.0 |
| 7. | Main drains | Boribo River |
| | - Total length (km) | - |
| | - Drainage water requirement from paddy field (lit/sec/ha) | 6.83 |
| | - Drainage water requirement from other land (lit/sec/ha) | 19~25 |
| 8. | Secondary drains (nos.) | 9 |
| | - Total length of secondary drains (km) | 35.7 |
| 9. | Collector drains (nos.) | 0 |
| | - Total length of collector drain (New, km) | 0 |

Prepared by JICA SAPROF Study Team

**Headworks and Major Facilities**

| Items | Description |
|---|---|
| Lum Huch Diversion Weir<br>♦ Design Flood Discharge: Q=430$m^3$/s (T=100 years)<br>♦ Design Flood Water Level: WL. 38.0m<br>♦ Fish Ladder: B:2.0m x H:5.2m x L:52m | ♦ Floating type weir with gates<br>♦ width x height x length: B:60.5m x H:10.8m x L:31m<br>♦ Flood Gate: Fixed wheel gate (B:15 m x H:4.0m x 3 nos.)<br>♦ Scouring Sluice Gate: Slide gate (B:2m xH:4m x 2 nos.) |
| Lum Hach Intake<br>♦ Design Discharge: Q=6.60$m^3$/s | ♦ width x height x length: B:7.1m x H:3.8m x L:9.5m<br>♦ Slide Gate: B:1.5m xH:1.5m x 3nos. |
| O Roluss Intake<br>♦ Design Discharge: Q=5.70$m^3$/s | ♦ width x height x length: B:5.7m x H:4.8m x L:15m<br>♦ Slide Gate: B:2.0m x H:1.5mx 2nos. |
| Lum Hach Approach Canal<br>♦ Design Discharge: Q=6.60$m^3$/s | ♦ width x height x length: B:3m x H:2.0m x L:750 m |

Prepared by JICA SAPROF Study Team

The typical dimension of the Boribo River based on design flood discharge of 430 $m^3$/sec is shown as

follows:

**Typical Dimension of River Section of the Wat Chre Diversion Weir**

| River Section type | Design Discharge ($m^3$/sec) | River bed width (m) | Bed slope | Inner side slope | Water depth (m) | Free board (m) |
|---|---|---|---|---|---|---|
| Earth, Trapezoidal cross section | 430 | 25.0 | 1/250 | 1:1.0 (R)<br>1:0.4 (L) | 3.4 | 0.6 |

Prepared by JICA SAPROF Study Team

Expected Output

*Irrigation Facilities*

- Stable and equitable water distribution will be materialized so that agricultural production is stabilized at primary benefit area (3,100 ha) and secondary benefit area, O Roluss irrigation system (3,400 ha).

*Drainage Facilities*

- Drainage condition will be improved so that the agricultural productivity is enhanced.

*Inspection Road*

- Accessibility within the command area will be improved. It will ease introduction and promotion of agricultural input as well as marketing activities contributing to the increase of agricultural production and marketing.
- O&M activities will be easier so that continuous and appropriate O&M works will be carried out by both Government and FWUC.

## 2.4 Ancillary Activities to Enhance Project Effect

Based on the approach and strategy of the Project described in section 2.2, the following ancillary activities are proposed to enhance the Project effect.

Software Component:

- FWUC Establishment and Strengthening
- Agricultural Support Services

Project Supporting Programs:

- Meteo-hydrological Observation Strengthening
- Capacity Development for MOWRAM Staff
- Capacity Development for PDOWRAM Staff

Others

- Project Formulation Study for Other Potential Areas

The objective, strategy and activities are summarized as follows:

### 2.4.1 Software Component

(1) FWUC Establishment and Strengthening

| Item | Description |
|---|---|
| Objective | To materialize sustainable organizational set-up for irrigation water management and facilities' O&M |
| Strategy | ♦ Establishment of FWUC based on new layout of each sub-project<br>♦ Enhancement of FWUC's water management capability<br>♦ Strengthening of FWUCs capability in O&M of irrigation and drainage facilities<br>♦ Strengthening of organizational management capacity<br>♦ Establishment of water fee collection system |
| Activity | ♦ Support to establishment of FWUC<br>♦ Implementation of training programs with the coordination of relevant organizations |
| Work Quantity | ♦ Number of FWUCs, FWUGs, Sub-FWUGs and WUGs to be established:<br>♦ 6 FWUCs. 52 FWUGs, 287 sub-FWUGs and 2,552 WUGs<br>♦ 6 (six) times of walk-through survey to determine the tertiary alignment<br>♦ 3 (three) times of awareness program on FWUC's functions and responsibilities<br>♦ 3 (three) times of training programs on organizational management, water management and facilities' O&M<br>♦ 3 (three) times of training of trainers to train Sub-FWUGs' and WUGs' members<br>♦ 3 (three) times of follow-up workshops on sustainable irrigation system usage<br>♦ 6 sets of manuals on irrigation water management and O&M activities<br>♦ 6 sets of manuals on training of Sub-FWUGs' and WUGs' members |

Prepared by JICA SAPROF Study Team

(2) Agriculture Support Activities

| Item | Description |
|---|---|
| Objective | To increase and stabilize rice farming in the sub-project areas |
| Strategy | ♦ Capacity development of both Agricultural Staffs and Farmers<br>♦ Training of Trainers<br>♦ Commune-based Agricultural Extension<br>♦ Improvement of pre-harvest and post-harvest technology<br>♦ Introduction of Quality Seed |
| Activity | ♦ Government Agricultural Staff Empowerment Program<br>♦ Training of Trainers Program for Capacity Development of Group Leaders acting as Agricultural Extension Agent<br>♦ Commune-base Agricultural Extension Agent Development Program<br>♦ Soil Fertility Diagnosis Program<br>♦ Pre-harvest Technology Group Training<br>♦ Post-harvest Technology Group Training Program on Farmers Field School Basis<br>♦ Quality Rice Seed Production and Distribution Program<br>♦ High Value Added Rice Production Promotion Program |
| Work Quantity | ♦ 3 (three) times of government agricultural staff empowerment program<br>♦ 6 (six) times of training of trainers program<br>♦ 6 (six) times of training programs for each program identified by needs analysis<br>♦ Commune-base agricultural extension manual<br>♦ Materials for training programs |

Prepared by JICA SAPROF Study Team

### 2.4.2 Project Supporting Programs

(1) Meteo-hydrological Observation Strengthening

| Item | Description |
|---|---|
| Objective | ♦ To collect basic meteo-hydrological data, and<br>♦ To increase technical capability of MOWRAM and PDOWRAM in meteo-hydrological observation, data processing and analysis |
| Strategy | ♦ Enhancement of technical capability of relevant staff through On-the-Job Training |
| Activity | ♦ Preparation of manual for meteo-hydrological observation<br>♦ Training of meteo-hydrological data collection, processing and analysis<br>♦ Instillation of equipment of meteo-hydrological observation in the selected points in the river basins (additional 12 nos. of equipment: 20 % increase in number from present conditions) |
| Work Quantity | ♦ 4 (four) sets of manual on meteo-hydrological observation<br>♦ 4 (four) times of workshop on introduction of manuals<br>♦ On-the-Job Trainings<br>♦ Follow-up workshop on sustainable water resources development<br>♦ Installation of equipments for meteo-hydrological observation at 12 points (20% increase in number from present conditions) |

Prepared by JICA SAPROF Study Team

(2) Capacity Development of MOWRAM Staff

| Item | Description |
|---|---|
| Objective | ♦ To increase technical capability of MOWRAM staff in construction supervision |
| Strategy | ♦ Preparation of practical manual for construction supervision based on hardware component<br>♦ Dissemination workshops and training programs |
| Activity | ♦ Preparation of construction supervision manuals<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals<br>♦ Upgrade of the skills of MOWRAM staff in technical support to PDOWRAM staff in the construction supervision |
| Work Quantity | ♦ Construction supervision manual<br>♦ Construction supervision manual for field use<br>♦ 8 (eight) times of dissemination and training workshops (two for MOWRAM, six for PDOWRAM) |

Prepared by JICA SAPROF Study Team

(3) Capacity Development of PDOWRAM Staff

| Item | Description |
|---|---|
| Objective | ♦ To increase technical capability of PDOWRAM staff in construction supervision |
| Strategy | ♦ Preparation of practical manual for field-use for construction supervision based on hardware component<br>♦ Dissemination workshops and training programs |
| Activity | ♦ Preparation of construction supervision manuals<br>♦ Dissemination and training workshop<br>♦ Periodical revision of manuals<br>♦ Upgrade of the skills of PDOWRAM staff in construction supervision supported by MOWRAM |
| Work Quantity | ♦ As mentioned above |

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### 2.4.3 Others: Project Formulation Study for Other Potential Areas

| Item | Description |
|---|---|
| Objective | ♦ To prepare irrigation development plan for other potential areas |
| Strategy | ♦ Preparation of development plan for potential project using lessons to be learnt as well as data to be obtained from the Project (West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project) implementation |
| Activity | ♦ Screening of potential project<br>♦ Selection of priority project to be developed<br>♦ Assessment of available water resources through meteo-hydrological analysis<br>♦ Inventory survey of facilities<br>♦ Preparation of agriculture development plan<br>♦ Preparation of irrigation and drainage plan<br>♦ Cost estimate<br>♦ Project evaluation<br>♦ Preparation of implementation schedule |
| Work Quantity | ♦ Preparation of feasibility level development plan for second priority sub-projects (eight sub-projects) in the Basin-Wide Basic Irrigation and Drainage Master Plan Study as listed as follows:<br>(i) Damnak Ampil Extension Project 8,000 ha<br>(ii) Nikom/Dai Ta Chan Rehabilitation Project 600 ha<br>(iii) Beoun Preah Ponley Rehabilitation Project 8,500 ha<br>(iv) Bassac Reservoir Rehabilitation Project 3,500 ha<br>(v) Chan Keak Rehabilitation Project 110 ha<br>(vi) Chak Teum, Trapeang Khlong, Don Pov Rehabilitation Project 980 ha<br>(vii) Toul Champey Rehabilitation Project 360 ha<br>(viii) 7th January Canal Rehabilitation Project 2,000ha<br>Total 24,050 ha |

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## 2.5 Technical Assistance

### 2.5.1 Purpose

The purpose of technical assistance (T/A) is to advise and support the Project Management Unit (PMU) Japan Support Fund, an overall project management organization, in detail design, construction supervision, software component and project supporting programs so as to accomplish the Project objective and target.

### 2.5.2 Outline of Consulting Services

Outline of consulting services for the Project is as follows:

**Outline of Consulting Services**

| Part | Description | |
|---|---|---|
| Part-I | Review of previous plan and preparation of definitive development plan | |
| Part-II | II-1 Detail Design | Additional Survey |
| | | Detail Design |
| | | Tender Document |
| | | Software Component |
| | | Project Supporting Programs |
| | II-2 Construction Supervision | Task Concept Service |
| | | Assistant Concept Service |

| Part | Description | |
|---|---|---|
| | | Software Component |
| | | Project Supporting Programs |
| Part-III | Socio-economy/rural development baseline study | |
| Part-IV | Environmental Management and Monitoring | |
| Part-V | Project Formulation Study | |
| Part-VI | Preparation of Reports | |

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### 2.5.3 Scope of Consulting Services

Scope of consulting services during detail design (D/D) and construction supervision (C/S) are described as follows:

(1) During Detail Design

Task Concept

- To check and review existing plan based on Basin-Wide Basic Irrigation and Drainage Master Plan Study and the SAPROF Study,
- To check availability of irrigation water, flood discharge at weir sites, drainage conditions of sub-projects,
- To check and, if necessary, modify location, layout plan and design of large or important structures including rehabilitation works such as diversion weirs, intakes, main and secondary irrigation canals, and main drains,
- Geo-technical and soil mechanical investigations,
- Topographic surveys and mapping,
- Construction material surveys,
- Detailed design of irrigation and drainage facilities including preparation of detailed design drawings,
- Preparation of bill of quantities and cost estimate, and
- To revise cost estimate, and
- To prepare pre-qualification and tender documents based on the detailed design taking into account of procurement procedure of Cambodia
- Arrangement of establishment/strengthening of FWUCs and guidance to MOWRAM/PDOWRAM staff pertaining to O&M of sub-projects

(2) Construction Supervision

Task Concept

- Preparation of pre-qualification and tender evaluation report
- To prepare quality control manuals for earth works, concrete works, stone works and other important construction works and to apply such manuals for quality control in the field,
- To check and approve construction drawings and shop drawings to be prepared by the contractors,

- To check and approve the setting-out lines and levels, and control points established by the contractors,
- To supervise field tests, sampling and laboratory tests,
- To inspect construction methods, equipment use, workmanship at the sites, and to attend shop inspection and manufacturing test in accordance with the technical specifications,
- To issue site instructions or other instructions to the contractors, as the necessity arises, on the way of clarification of construction drawings and technical specifications, and the construction supervision,
- To attend regular meetings to check and confirm construction methods, work performance, work progress, status of equipment and materials, work schedule, and problems to be solved,
- To survey and measure the work output performed by the contractors,
- To check and certify the advance payments and progress payments claimed by the contractors for approval of the project managers of sub-projects,
- To keep proper records necessary for preparation of the project completion report,
- To perform the final inspections of the works together with the sub-project offices and recommend to issue the completion certificates,
- To prepare O&M manuals, and organization management of each sub project,

Assistant Concept

- To assist and advise PMU Japan Support Fund in pre-qualification of construction firms,
- To assist and advise PMU Japan Support Fund in tender evaluation,
- To assist and advise in modifying original tender designs, technical specifications and drawings, related calculation and cost estimate as the necessity arises in accordance with the actual site condition,
- To assist and advise in settlement of the contractor's claim and disputes on the basis of the analysis of the Consultant hereof in accordance with the civil work contract,

(3) Socio-economy/rural development baseline study

Assistant Concept

- To collect such data and information from National Institute of Statistics, Ministry of Planning and other agencies as national and provincial socio-economic data related to sub-projects,

(4) Software Component: FWUC Establishment and Strengthening and Agricultural Support Services

Task Concept

- To carry out sub-project specific FWUCs establishment and strengthening
- To provide feedback from reviews and assessments for progress reporting, and
- To prepare manuals, materials and guidelines

Assistant Concept

- To advise and assist in the overall implementation of the program

(5) Project Supporting Programs: Meteo-hydrological Observation Strengthening, Capacity Development for MOWRAM Staff and Capacity Development for PDOWRAM Staff

Task Concept

- To procure and install meteo-hydrological equipment
- To prepare manual for observation, data collection and processing
- To prepare manual for construction supervision

Assistant Concept

- To advise and assist in the overall implementation of the program
- To assist in the organization of in-class discussion & lectures, study tour, workshop

(6) Project Formulation Study for Other Potential Areas

Task Concept

- To formulate integrated implementation plans and action plans of the candidate sub-projects for thier realization

### 2.5.4 Necessary Input of Consulting Services

Technical consultant consists of a team of international and local consultants in different expertise to be attached to PMU Japan Support Fund. Approximate man-month necessary for the Project consist of: (i) International consultant (148 M/M) and (ii) Local Consultant (451 M/M) as tabulated as follows:

**Required Man-month for Consulting Services**

| No. | Item | International Consultant | Local Consultant |
|---|---|---|---|
| 1 | Hardware Component | | |
| 1-1 | ♦ Detail Design | 47 | 102 |
| 1-2 | ♦ Construction Supervision | 60 | 172 |
| | Sub-total of Hardware Component (=1) | 107 | 274 |
| 2 | Software Component | | |
| 2-1 | ♦ FWUC Establishment and Strengthening | 11 | 62 |
| 2-2 | ♦ Agriculture Support Services | 9 | 32 |
| | Sub-total of Software Component (=2) | 20 | 94 |
| 3 | Project Supporting Programs | | |
| 3-1 | ♦ Meteo-hydrological Observation Strengthening | 6 | 22 |
| 3-2 | ♦ Capacity Development for MOWRAM Staffs | 3 | 3 |
| 3-3 | ♦ Capacity Development for PDOWRAM Staffs | | |
| | Sub-total of Project Supporting Programs (=3) | 9 | 25 |
| 4 | Project Formulation Study (=4) | 12 | 58 |
| | Total (=1+2+3+4) | 148 | 451 |

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# CHAPTER 3 PROJECT IMPLEMENTATION AND O&M PLAN

## 3.1 Project Implementation Plan

### 3.1.1 Implementing Organization

The Project implementing organization is depicted in Figure III 3.1.1. The Project Management Unit (PMU) Japan Support Fund was established within MOWRAM in October 2008, taking responsibility on all the project implementation and management by Japan's ODA. Under PMU Japan Support Fund, five units are established to be in charge of each Project activities through coordination with relevant technical departments consisting of: (i) Engineering, (ii) Irrigated Agriculture, (iii) FWUC and (iv) TSC at the national level. As for agriculture support activities, staff will be dispatched from MAFF to be members for the Project under the control of PMU Japan Support Fund to take charge of this component.

At the provincial level, Provincial Project Implementation Unit (PIU) will be established in each PDOWRAM to supervise activities of the Project. In addition, at the field level, particularly agriculture support and FWUC strengthening activities will be jointly carried out by PDOWRAM, and Commune Councils (CCs.) and others. General tasks of those organizations are tabulated as follows:

**Job Description of Relevant Organizations for the Project**

| Organizations | Task |
|---|---|
| Steering Committee | ♦ Provision of the necessary political coordination and supports from the relevant Ministries to MOWRAM to carry out the Project in effective and efficient manner<br>♦ Assisting for the arrangement of necessary technical support and supplemental budget to be required for the Project<br>♦ Monitoring of Project progress and provision of advices when necessary |
| Project Management Unit (PMU) Japan Support Fund | ♦ Overall management of the Project<br>♦ Preparation of annual disbursement plan of the Project<br>♦ Coordination with relevant technical departments within MOWRAM<br>♦ Procurement of the technical consultant<br>♦ Procurement of contractors for hardware component<br>♦ Overall supervision and guidance to the technical consultant and the contractors to be engaged in the Project<br>♦ Supervision of land acquisition, necessary for the Project, by the Resettlement Unit<br>♦ Monitoring and evaluation as well as reporting of project progress to relevant Ministries and the Steering Committee |
| Ministry of Agriculture, Forestry and Fisheries | ♦ Dispatch of necessary staff to the PMU Japan Support Fund for the implementation of Agriculture Support Activities[1]<br>♦ Technical advice to PMU Japan Support Fund in Agriculture Support Activities |
| Provincial Project Implementation Unit | ♦ Supervision of construction works at the field level supported by MOWRAM<br>♦ Preparation of annual work plan in collaboration with PMU Japan Support Fund<br>♦ Coordination with relevant rural administration including provincial government and commune councils<br>♦ Provision of advice to the technical consultant including available data and information related with each sub-project |

[1] Dispatch of MAFF staff to MOWRAM for the implementation of agriculture support services has been similarly carried out in Northwest Irrigation Sector Project financially supported by ADB.

| Organizations | Task |
|---|---|
| | ♦ Provision of supervision and guidance to the local contractors<br>♦ Progress monitoring and evaluation of the Project and regular report to PMU Japan Support Fund<br>♦ Performing any other tasks necessary to support PMU Japan Support Fund |
| Commune Councils | ♦ Coordination with MOWRAM, PDOWRAM and farmers for the implementation of the Project at the commune level<br>♦ Support of FWUC establishment and strengthening<br>♦ Coordination with FWUC for irrigation system O&M<br>♦ Internal monitoring at the commune level |

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### 3.1.2 Staff Required for Design and Construction Works

In order to smoothly implement the Project, full-time professional staff will be assigned to PMU Japan Support Fund at the central level and PIUs at the provincial level supported by relevant technical departments. Necessary number of staff required for design and construction stage is shown in the following table.

**Staff Required for Design and Construction Works**

| Organizations | Position | Nos. |
|---|---|---|
| **Central Level** | | |
| PMU Japan Support Fund | Project Director | 1 |
| | Project Manager | 2 |
| | Administration & Finance | 5 |
| | Procurement | 4 |
| | FWUC | 4 |
| | Resettlement & Environment | 5 |
| | Technical | 6 |
| Sub-total (Central Level) (=1) | | 27 |
| **Provincial Level** | | |
| Project Implementation Unit (PIU) | | |
| ♦ Battambang Province | Technical | 5 |
| | Agriculture | 2 |
| Sub-Total of Battambang (=2) | | 7 |
| ♦ Pursat Province | Technical | 5 |
| | Agriculture | 2 |
| Sub-Total of Pursat (=3) | | 7 |
| ♦ Kampong Chhnang Province | Technical | 5 |
| | Agriculture | 2 |
| Sub-Total of Khanpong Chhnang (=4) | | 7 |
| Sub-total (Provincial Level) (=5=2+3+4) | | 21 |
| **Grand Total (=1+5)** | | **48** |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study

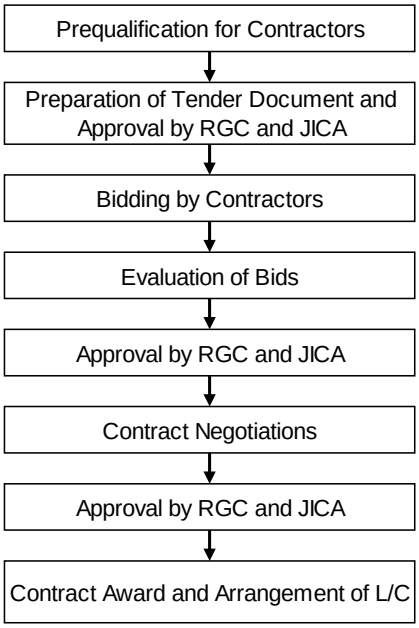
Staff to be allocated for the Project is “Engineering Level” in the staff qualification of MOWRAM. At the provincial level, number of staff are limited, therefore, technical staff(s) needs to be dispatched from the technical departments of MOWRAM to perform necessary tasks at the provincial level. As for agriculture support services at the provincial level, staff(s) will be dispatched from PDA as similarly carried out by the Northwest Irrigation Sector Project (ADB).

### 3.1.3 Decision and Instruction Flow

(1) Detail Design

To commence the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project in timely manner, it will be necessary to arrange and put into place well in advance to maintain higher level of success. Organization, decision and instruction flow for the Project implementation is based on the following conditions.

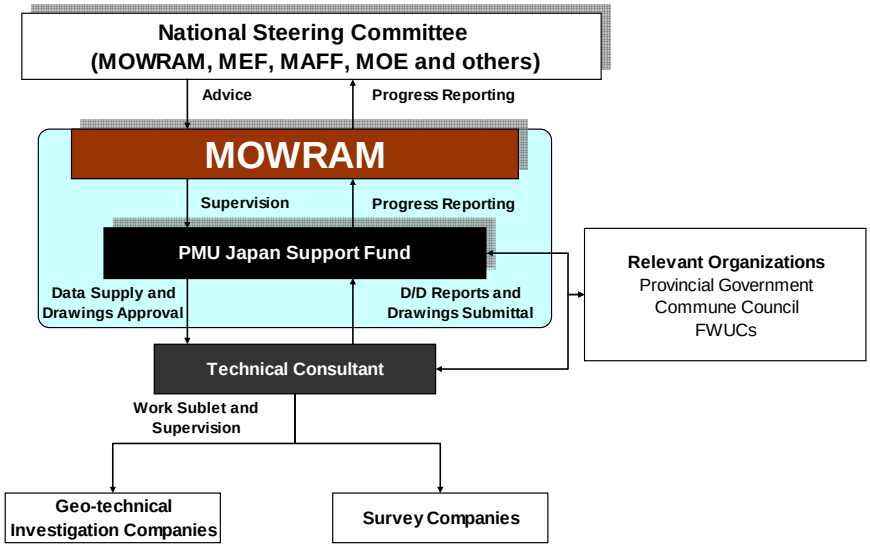
- ♦ PMU Japan Support Fund is the organization responsible for overall management of the Project. Rehabilitation of irrigation and drainage facilities are carried out under international competitive bidding (ICB) for main and secondary facilities, and local competitive bidding (LCB) for tertiary facilities, general flow of which are illustrated on the right and as explained afterward.
- ♦ Technical consultant provides services for detail design, tender document preparation, tender evaluation and construction supervision under the contract with MOWRAM.
- ♦ National Steering Committee will be established to coordinate among relevant Ministries at the national level. Prospective members will be: (i) MOWRAM (chair), (ii) MEF, (iii) MAFF, (iv) MOE and others so that all the parties involved will be well informed to facilitate close coordination.
- ♦ In order to smoothly implement construction works at the field level, regular meeting will be held among MOWRAM, PDOWRAM and relevant local administrations.
- ♦ Land acquisition necessary for the Project will be managed by the Resettlement Unit under NPMO, as a key organization in communicating matters on the land acquisition and compensation with the parties concerned including the Inter-Ministerial Resettlement Committee (IRC), PIU of three Provinces and the affected people.




Prepared by JICA SAPROF Study Team

**Procedure on ICB Method and Contract Award for Hardware Component**

On this basis, the right figure shows the



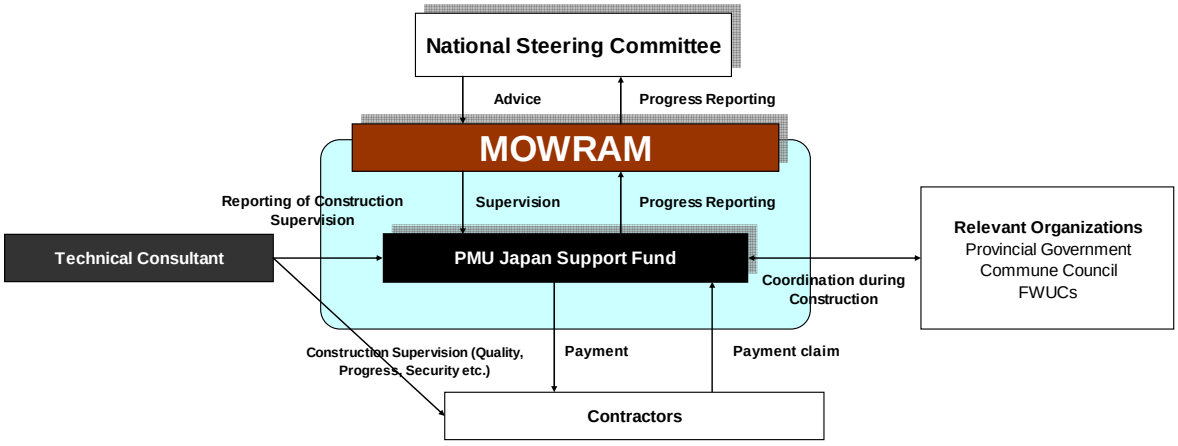

Prepared by JICA SAPROF Study Team

**Project Implementing System During Detail Design**

implementing system and role of each organization during detail design.

Technical consultant will make contract with MOWRAM, however, substantial work will be executed by PMU Japan Support Fund supported by relevant technical departments under MOWRAM. Technical consultant prepares design report, drawings, pre-qualification document, tender document and submit to PMU Japan Support Fund. PMU Japan Support Fund will check the document and issue approval. Technical survey such as topographic survey and geotechnical investigation will be sublet to local consultant, under the supervision of technical consultant. Necessary data during the design will be provided from PMU Japan Support Fund to the technical consultant.

On the other hand, the implementing system during construction supervision for irrigation and drainage facilities is illustrated as follows:

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**Project Implementing System During Construction**

The contractors make contract with MOWRAM, and the daily work will be supervised by PMU Japan Support Fund. The technical consultant is in charge of construction supervision under the instruction of PMU Japan Support Fund. Various problems to be raised during construction such as land acquisition for temporary works, stoppage of irrigation water etc. will be discussed with local administration through having regular meetings and committees among stakeholders.

(3) Soft Component and Project Supporting Programs

Such activities as soft component: (i) FWUC establishment and strengthening and (ii) Agriculture Support Activities will be carried out by the technical consultant through maintaining close coordination with PMU Japan Support Fund, MOWRAM and PDOWRAM. The organizational system is described as follows:

**Implementing System for Soft Component, Project Supporting Programs and Project Formulation Study for Other Potential Areas**

| Activities | Preparation of Work Plan | Approval of Work Plan | Technical Assistance | Main Target Group |
|---|---|---|---|---|
| **Soft Component** | | | | |
| FWUC Establishment and Strengthening | Technical Consultant | PMU Japan Support Fund | MOWRAM/PDOWRAM and the Consultant | FWUCs to be established |
| Agriculture Support Activities | Technical Consultant | PMU Japan Support Fund | MOWRAM/PDOWRAM / PDA and the Consultant | FWUCs to be established<br>Extension Workers under PDA and DAO |

| Activities | Preparation of Work Plan | Approval of Work Plan | Technical Assistance | Main Target Group |
|---|---|---|---|---|
| **Project Supporting Programs** | | | | |
| Meteo-hydrological Observation Strengthening | Technical Consultant | PMU Japan Support Fund | MOWRAM/PDOWRAM and the Consultant | - |
| Capacity Development of MOWRAM | Technical Consultant | PMU Japan Support Fund | Technical Service Centre of Irrigation System and Meteorology (TSC) and the Technical Consultant | MOWRAM technical staff |
| Capacity Development of PDOWRAM | Technical Consultant | PMU Japan Support Fund | Technical Service Centre of Irrigation System and Meteorology (TSC) and the Technical Consultant | PDOWRAM technical staff |
| **Project Formulation Study** | | | | |
| Project Formulation Study for Other Potential Areas | Technical Consultant | PMU Japan Support Fund | Technical Consultant | - |

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(4) Coordination with the Japanese Technical Cooperation

JICA has been providing various technical cooperation in irrigation and agriculture sector of Cambodia such as the dispatch of experts, acceptance of participants for training, study scheme including M/P and F/S, grant aid and so forth. Under the technical cooperation, JICA has been assisting the Technical Service Centre of Irrigation and Meteorology to enhance capability of the staff of both MOWRAM and PDOWRAM. In succession, "the Improvement of Agricultural River Basin Management and Development Project (TSC-3)" has commenced from September 2009 basing in TSC and pilot areas in three provinces: (i) Battambang, (ii) Pursat and (iii) Kampong Chhnang.

When looking at possible collaboration with the JICA's technical cooperation, the most productive combination is considered to be in the capacity development aspect of the Project. Part of the work would be, therefore, expected to be assisted by TSC-3 particularly activities with cross-cutting and broader objectives such as two capacity development programs since they are not the activities necessarily concentrated on six-sub-project areas but they are related with overall institutional strengthening which is one of the important missions of the TSC.

### 3.1.4 Procurement Plan

Procurement plan for each component of the Project is tabulated as follows:

**Method of Implementation for Each Component**

| Component | Activities | Method |
|---|---|---|
| Hardware Component: Rehabilitation of Irrigation and Drainage Facilities | Detail Design | Implemented by the technical consultant selected though short-list method |
| | Rehabilitation and Reconstruction Works<br>♦ Irrigation Facilities<br>♦ Drainage Facilities<br>♦ Inspection Road | International Competitive Bidding (ICB): Main and Secondary Systems<br>Local Competitive Bidding (LCB): Tertiary Systems,<br>the work of which are supervised by the technical consultant |
| Software Component | FWUC Establishment and Strengthening | Implemented by MOWRAM/PDOWRAM/PDA and the technical consultant |
| | Agriculture Support Services | |

| Component | Activities | Method |
|---|---|---|
| Project Supporting Programs | Meteo-hydrological Observation Strengthening | Implemented by MOWRAM/PDOWRAM and the technical consultant |
| | Capacity Development of MOWRAM | TSC in collaboration with the technical consultant |
| | Capacity Development of PDOWRAM | |
| Project Formulation Study | Feasibility study level planning for other potential areas | Implemented by the technical consultant through coordination with construction supervision |

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Among others, prospective packaging for the hardware component (rehabilitation of irrigation and drainage facilities) is tabulated as follows:

**Packaging for the Works of Hardware Component**

| Sub-Project | Province | Number of Package | | | |
|---|---|---|---|---|---|
| | | International Competitive Bidding (ICB) | | Local Competitive Bidding (LCB)[2] | |
| Ream Kon and Por Canal Sub-Projects | Battambang | 1 | ♦ Construction of Moung Russei Headworks,<br>♦ Construction of main and Secondary Systems of Ream Kon and Por Canal Sub-Projects | 3 | ♦ Construction of tertiary systems |
| Damnak Ampil, Wat Loung and Wat Chre Sub-Projects | Pursat | | ♦ Gate improvement of Damnak Ampil Headworks<br>♦ Construction of Wat Chre Headworks<br>♦ Construction of main and secondary systems of Damnak Ampil, Wat Loung and Wat Chre Sub-Projects | 5 | ♦ Construction of tertiary systems |
| Lum Hach Sub-Project | Kampong Chhnang | | ♦ Construction of Lum Hach Headworks<br>♦ Construction of main and secondary systems | 3 | ♦ Construction of tertiary systems |
| Total | | 1 | - | 11 | - |

Prepared by JICA SAPROF Study Team

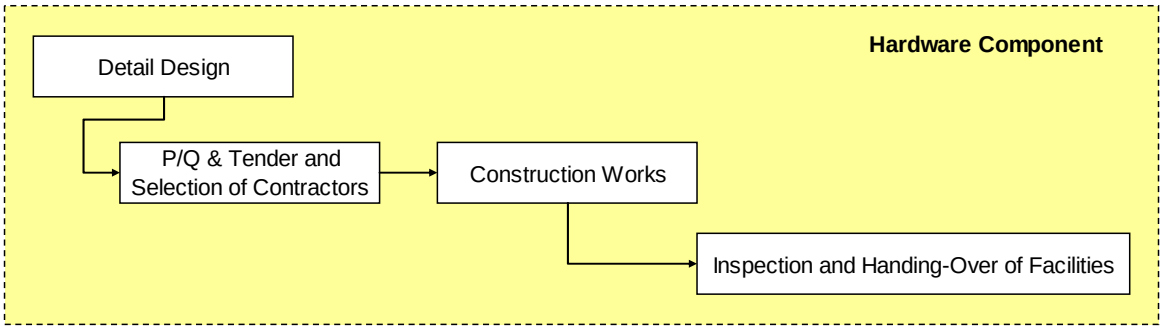
### 3.1.5 Implementation Schedule

The implementation schedule of the Project is shown in Figure 3.2.1. The Project will be implemented over 5 years from the commencement of detail design.

(1) Hardware Component: Rehabilitation of Irrigation and Drainage Facilities

General procure on hardware component is illustrated as follows.

[2] The RGC has issued Procurement Manual consisting of two volumes: (i) Volume-I, Policies and Procedures and (ii) Volume-II, Standard National Bidding Documents Procurement of Goods. Although clear regulation is not specified for irrigation development project in MOWRAM, the Department of Engineering under the MOWRAM apply that the work for LCB is generally less than the cost of US$ 1.0 million.

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**General Procedure on Hardware Component:**
**Rehabilitation of Irrigation and Drainage Facilities**

Detail Design

Detail design will commence from the end of 2010 over 1.5 years, major works of which are as follows:

- Topographic survey: longitudinal and cross sectional survey of canals and drains, and mapping
- Geotechnical investigation: Moung Russei, Wat Chre and Lum Hach Headworks sites and other major irrigation and drainage facilities such as fish ladder at Damnak Ampil Headworks
- Detail Design: Detail design of headworks, irrigation, drainage canals, related facilities and inspection roads including drawings and design report
- Tender-related works: Preparation of pre-qualification (P/Q) document and tender document

Pre-qualification and Tender

As described above, main and secondary facilities are based on ICB while tertiary facilities are carried out on LCB. In general, tender will be managed and evaluated by PMU Japan Support Fund and approved by the MEF through the Minister of MOWRAM. Prior to tendering, pre-qualification (P/Q) will be carried out to select qualified tenderer. The successful bidder will be selected based on the evaluation of proposal to be submitted by the bidders. Procurement will be made based on JICA procurement guideline.

Construction Works

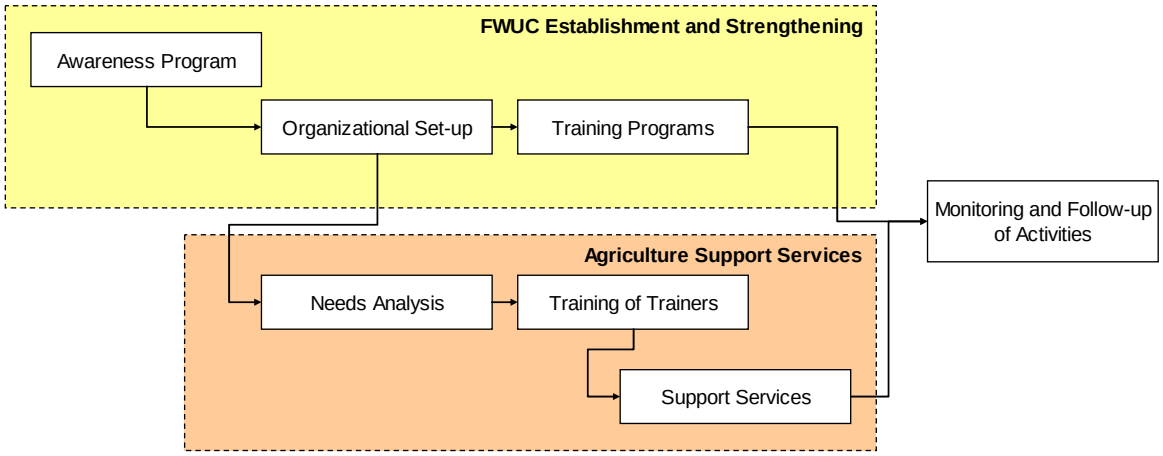
Construction works will be carried out from the end of 2011 to the beginning of 2015 over 3.5 years. Major works on the construction of headworks at Moug Russei, Wat Chre and Lum Hach will be carried out during dry season.

Handing-over of Facilities

The rehabilitated facilities will be transferred to MOWRAM after joint final inspection and issuance of approval.

(2) Software Component: FWUC Establishment and Strengthening and Agriculture Support Services

General procure on software component is illustrated as follows.

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**General Procedure on Software Component:**
**FWUC Establishment and Strengthening and Agriculture Support Services**

FWUC establishment and strengthening will be implemented over 3.5 years at each sub-project. The program will commence from awareness programs during detail design to technical training for water management and O&M of irrigation and drainage facilities. As a new FWUC to be established, activities in all ten steps as recommended by MOWRAM is generally followed with adequate time to be allocated.[3]

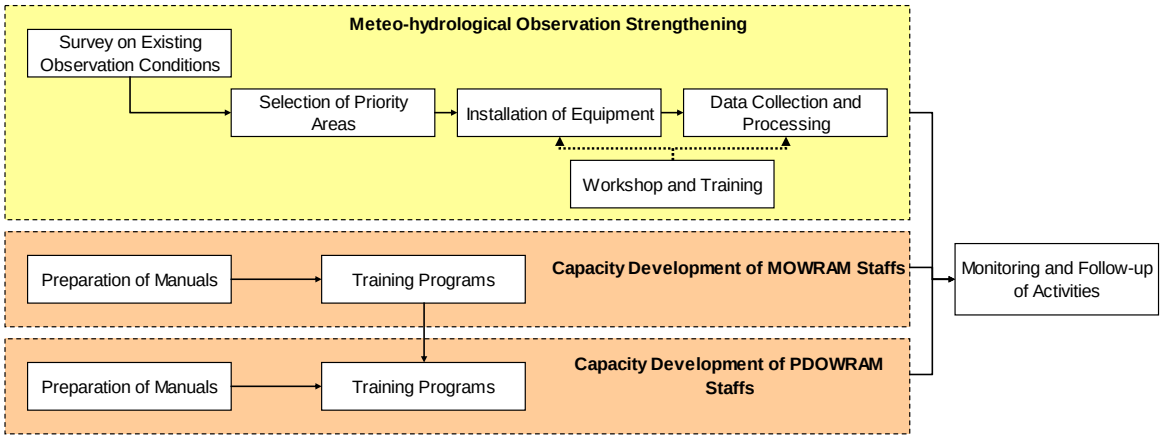
Agriculture support services will be started after organizational set-up will be made based on FWUC establishment and strengthening, approximately half years after FWUC establishment and strengthening activities. The Agriculture Support Services will be over 3 years for each sub-project area. The activities will be carried out by the Technical Consultant in collaboration with MOWRAM, PDOWRAM and PDA.

(3) Project Supporting Programs: Meteo-hydrological Observation Strengthening, Capacity Development for MOWRAM Staff and Capacity Development for PDOWRAM Staff

General procedure on project supporting programs is illustrated as follows.

[3] As a prototype, the steps recommended in "Training Manual for PIMD Module 5 on Establishing and Developing the Farmer Water Users Community" in MOWRAM are as follows:

| | |
|---|---|
| Step 1: | Initial Meeting to identify constraints and opportunities within communities |
| Step 2: | Identify irrigation area and potential members for FWUCs through Participatory Rural Appraisal (PRA) |
| Step 3: | Consensus building among FWUCs for activities plan |
| Step 4: | Preparation of FWUC statute and by-laws |
| Step 5: | Establishment of FWUCs and selection of leaders |
| Step 6: | Capacity building of FWUCs for preparation of irrigation service plan |
| Step 7: | Finalization of irrigation service plan |
| Step 8: | Preparation and adoption of management transfer agreement |
| Step 9: | Rehabilitation of systems through FWUCs participation |
| Step 10: | Provision of periodical support services to continue FWUC capacity building based on lessons learned from above activities |

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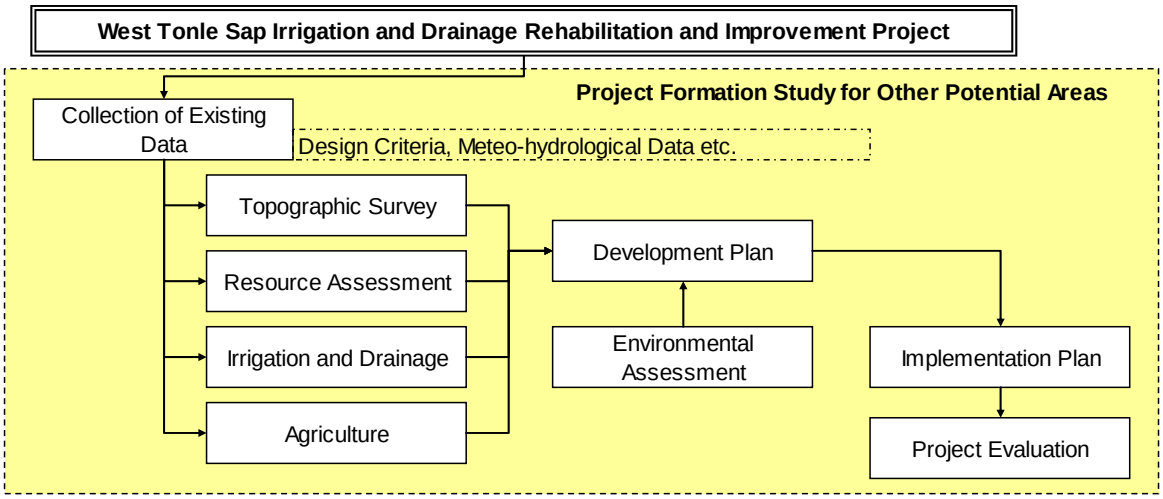
**General Procedure on Project Supporting Programs: Meteo-hydrological Observation Strengthening, Capacity Development of MOWRAM Staff and Capacity Development of PDOWRAM Staff**

The program will be carried out through existing organizational set-up within MOWRAM. In particular, out of three programs, the TSC will play an hub role for two programs: (i) Capacity Development for MOWRAM Staff and (ii) Capacity Development for PDOWRAM staff. Three project supporting programs will commence in parallel with detail design, each of which will be over 3 years.

(4) Project Formulation Study for Other Potential Areas

Through the coordination with the construction supervision team, general procedure on the project formulation study for other potential areas is illustrated as follows.

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**General Procedure on Project Formulation Study for Other Potential Areas**

Project formulation study for other potential areas will be carried out in 2013 over 1 year to prepare feasibility level plan for second priority project (8 numbers) during Basin-wide Basic Irrigation and Drainage Master Plan Study by JICA using lessons to be learnt and data to be collected in the Project.

## 3.2 O&M Plan

### 3.2.1 Relevant Regulations for O&M of Irrigation and Drainage Facilities

Regulations and guidelines in Cambodia related with operation and maintenance of irrigation and drainage facilities are summarized as follows:

**Regulations and Guidelines Related with O&M of Irrigation and Drainage Facilities**

| Title | Issue Year | Description |
|---|---|---|
| Circular No.1 on the Implementation Policy for Sustainable Irrigation Systems | 1999 | ♦ MOWRAM stipulated the role of FWUC in the policy for Sustainability of Operation and Maintenance Irrigation Systems.<br>♦ Circular No.1 defines organizational framework of FWUC attached with the Statute of the FWUC.<br>♦ The statute describes the objectives, criteria, organization, finance management, rules and punishment of FWUC.<br>♦ It also enhances the importance of the establishment of FWUC at each irrigation system. |
| Policy for Sustainability of Operation and Maintenance Irrigation Systems | 2000 | ♦ This policy shows the management responsibility, water distribution, the functions and roles of FWUC, system of irrigation service fee (ISF), transfer of facilities to FWUC, supporting system for maintenance activity of FWUC, and monitoring and evaluation of systems.<br>♦ It consists of 5 chapters: (i) introduction, (ii) operation and maintenance of irrigation system, (iii) environment, (iv) human resource development, and (v) miscellaneous. |
| Steps in the Formation of a Farmer Water Users Community | 2000 | ♦ FWUC has the responsibility for operation and maintenance of irrigation system.<br>♦ MOWRAM enhance to establish FWUC and shows steps in the formation of FWUC in this document.<br>♦ FWUC finally will be registered by MOWRAM. |
| Training Manual for Participatory Irrigation Management and Development (PIMD) | 2003 | ♦ The manual was prepared with the aim of promoting Participatory Irrigation Management and Development (PIMD) based on decentralization and Irrigation Management Transfer policy of the Government. The manual consists of 7 modules as follows:<br>✧ Module 1: General concept of PIMD and lesson and learnt of PIMD around the world.<br>✧ Module 2: Policy, legal and institutional framework of PIMD.<br>✧ Module 3: Planning and implementing PIMD at the national level.<br>✧ Module 4: Implementation of PIMD at provincial and irrigation system level.<br>✧ Module 5: Functions of FWUC support team in order to establish FWUC and develop their capacity.<br>✧ Module 6: Monitoring and evaluation system to support implementation and further development of PIMD.<br>✧ Module 7: Technical guide for irrigation water management targeted FWUC leaders and members. |
| Sub-Decree on Farmer Water User Community | Draft | ♦ The objective of this Sub-decree is to carry out effective and sustainable management and usage the irrigation systems. The sub-decree consists of 12 chapters defining the basic principles and process, function and supporting system etc.<br>♦ The sub-decree also fosters farmers' participation in the O&M of irrigation system through FWUC based on PIMD and IMT. |

Prepared by JICA SAPROF Study Team based on MOWRAM

In essence following issues need to be considered to prepare O&M plan.

- FWUCs need to be established at each irrigation system.
- Irrigation and drainage facilities are transferred to FWUCs depending upon the capability of the group based on PIMD and IMT policy. Although level of facilities are not clearly described in any documents, main and secondary facilities will be maintained by the Government while tertiary facilities and below will be by FWUCs in common.
- The transfer of facilities will be made based on the consensus building and preparation of agreement document between MOWRAM and FWUC.
- Transfer of facilities from the Government to FWUCs is made in gradual manner as referred to following table, the share of O&M cost mentioned in the Policy for Sustainability of Operation and Maintenance Irrigation System.

**Share of O&M Cost**

| Year after completion | Government | Beneficial Farmers |
|---|---|---|
| One | 80% | 20% |
| Second | 60% | 40% |
| Third | 40% | 60% |
| Fourth | 20% | 80% |
| After Fifth | 0% | 100% |

Prepared by JICA SAPROF Study Team based on the Policy for Sustainability of Operation and Maintenance Irrigation System, June 2000, MOWRAM

### 3.2.2 Staff Required for O&M Works

Necessary number of staff required for operation and maintenance of facilities is shown in the following table.

**Staff Required for O&M Works**

| Organizations | Position | Nos. |
|---|---|---|
| **Central Level** | | |
| PMU Japan Support Fund | Project Director | 1 |
| | Project Manager | 1 |
| Sub-total (Central Level) (=1) | | 2 |
| **Provincial Level** | | |
| Project Implementation Unit (PIU) | | |
| ♦ Battambang Province | Project Manager | 1 |
| | Irrigation/O&M | 1 |
| | Gate operator | 1 |
| Sub-Total of Battambang (=2) | | 3 |
| ♦ Pursat Province | Project Manager | 1 |
| | Irrigation/O&M | 2 |
| | Gate operator | 2 |
| Sub-Total of Pursat (=3) | | 5 |
| ♦ Kampong Chhnang Province | Project Manager | 1 |
| | Irrigation/O&M | 1 |
| | Gate operator | 1 |
| Sub-Total of Kampong Chhnang (=4) | | 3 |
| Sub-total (Provincial Level) (=5=2+3+4) | | 11 |
| **Grand Total (=1+5)** | | **13** |

Prepared by JICA SAPROF Study Team based on JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan

Study

### 3.2.3 O&M Responsibility

(1) Relevant Organizations and Responsibility of O&M

Responsibility of O&M after the Project is proposed as follows based on the abovementioned regulations and guidelines:

- At present, no substantial group activities are observed for O&M of irrigation facilities at all the sub-projects, transfer of all the facilities to FWUCs are not realistic. Demarcation of O&M responsibility among MOWRAM, PDOWRAM and FWUCs are proposed as follows:

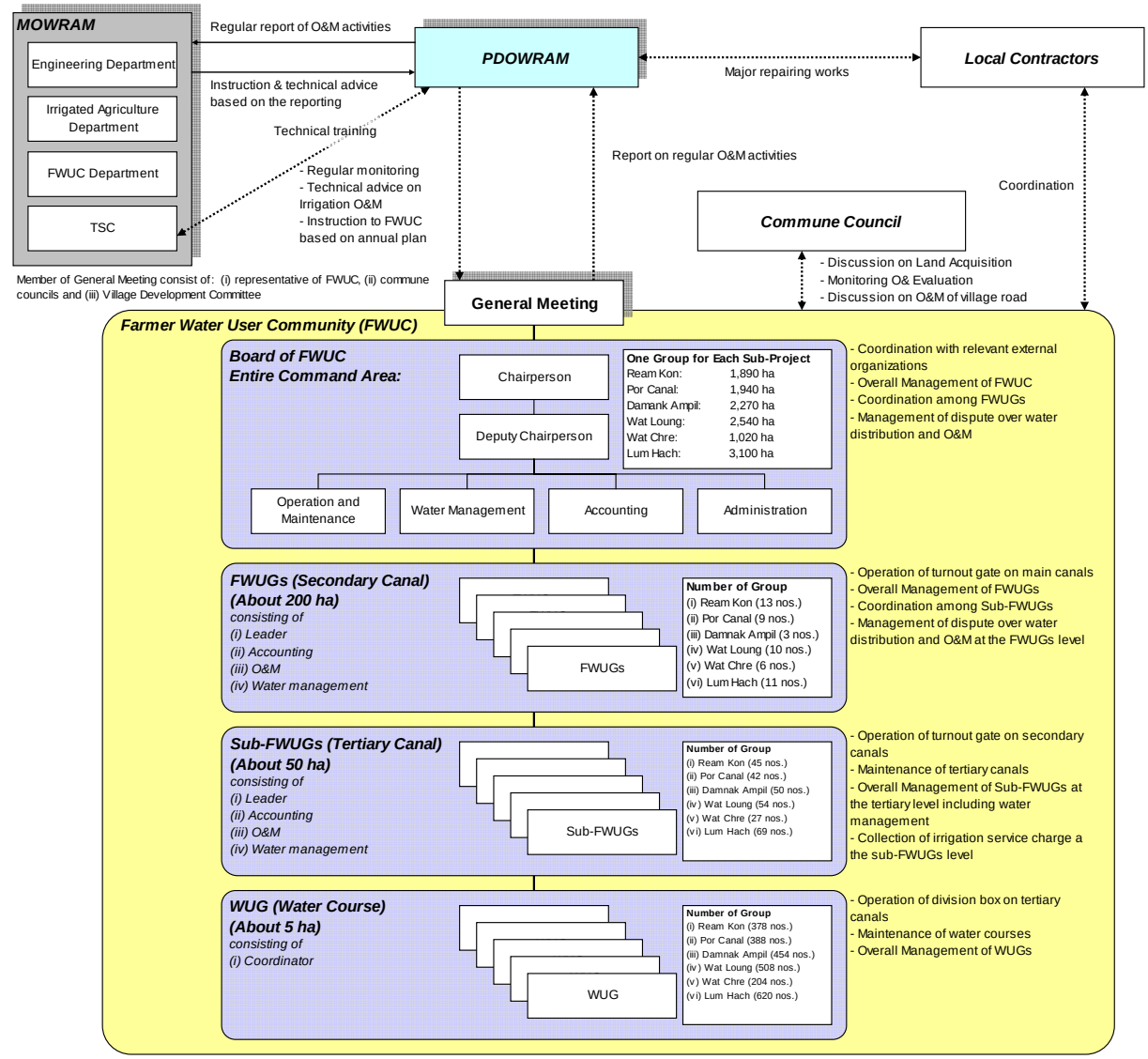
**O&M Responsibility Proposed for Irrigation and Drainage Facilities**

| Level / Activities | Headworks | Main Canal | Secondary canals | Tertiary canals |
|---|---|---|---|---|
| Preparation of annual O&M plan | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | PDOWRAM | FWUC |
| Preparation of cropping schedule | - | - | FWUC / FWUG | FUWG |
| Operation of facilities | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | PDOWRAM | FWUC |
| Maintenance work | MOWRAM / PDOWRAM | MOWRAM / PDOWRAM | FWUC | FWUC |

Prepared by JICA SAPROF Study Team

- Operation and Maintenance Manuals will be prepared by MOWRAM and PDOWRAM and be handed over to the respective parties responsible during transfer process. The manual will be regularly updated jointly by MOWRAM and PDOWRAM based on follow-up activities.

Proposed organizational set-up for O&M of irrigation and drainage facilities for each sub-project are illustrated as follows:




Prepared by JICA SAPROF Study Team

**Proposed Organizational Set-up for O&M of Irrigation and Drainage Facilities**

O&M responsibility of each organization is described as follows:

MOWRAM

The department closely relevant to O&M would be: (i) the Engineering Department, (ii) the Irrigated Agriculture Department, (iii) the FWUC Department and (iv) the Technical Service Centre of Irrigation and Meteorology.

- ♦ Instruction & technical advice based on the reporting from PDOWRAM
- ♦ Budgetary arrangement for O&M
- ♦ Provision of technical training to PDOWRAM staff and the members of FWUCs particularly by TSC
- ♦ Major repairing and replacement works

PDOWRAM

Sub-projects operation team within PDOWRAM would consist of: (i) the director of PDOWRAM, (ii) irrigation engineer/O&M and (iii) gate operators.

- Preparation of annual O&M plan including budgetary plan
- Regular monitoring of FWUCs activities at the field level
- Technical advice on irrigation and drainage O&M
- Instruction to FWUC based on annual plan
- Regular reporting of O&M activities to MOWRAM
- Request of budgetary plan to MOWRAM
- Meteo-hydrological observation: (i) rainfall, (ii) temperature, (iii) evaporation, (iv) humidity at the sub-project and river basin level and (v) river water level and run-off for the water source

FWUC

FWUC will consist of: (i) General Meeting, (ii) Board of FWUC, (ii) FWUGs, (iii) Sub-FWUCs and (iv) WUGs, each of which are established depending upon the level of facilities.

*General Meeting*

- Consisting of commune councils, and the representative of FWUC
- Coordination among local authorities and FWUC

*Board of FWUC*

- Coordination with relevant external organization such as provincial government and commune councils through general meeting
- Coordination among FWUGs
- Management of dispute over water distribution and O&M
- Overall financial management of the group

*FWUGs*

- Established for each secondary canal covering 200 ha averagely
- Operation of turnout gate for main canal
- Coordination among Sub-FWUGs including ISF collection

*Sub-FWUGs*

- Established for each tertiary canal covering 50 ha averagely
- Operation of turnout gate for secondary canal
- Coordination among WUGs
- Collection of irrigation service fee of Sub-FWUGs members

*WUGs*

- Established for each water course covering 5 ha averagely
- Operation of division box on water course

(2) O&M Cost

O&M cost for the sub-projects is estimated as follows consisting of (i) Salary and Wages for FWUCs and FWUGs, (ii) Direct cost including office expenses, labor for minor maintenance work and (iii) other expenses.

**Annual Operation and Maintenance Cost for the Sub-Projects**

| Item | Unit | Qty. | Government | | | FWUC | | |
|---|---|---|---|---|---|---|---|---|
| | | | Unit Rate (US$) | Amount (US$) | Amount (Riels.) | Unit Rate (US$) | Amount (US$) | Amount (Riels.) |
| 1. Salary and Wages | | | | | | | | |
| 1.1. FWUCs | | | | | | | | |
| 1) Chairperson | MM | 72 | 30 | 2,160 | 8,886,240 | | | |
| 2) Deputy chairperson | MM | 72 | 25 | 1,800 | 7,405,200 | | | |
| 3) Other staff | MM | 288 | 20 | 5,760 | 23,696,640 | | | |
| 1.2. FWUGs | | | | | | | | |
| 1) Leader | MM | 660 | 20 | 13,200 | 54,304,800 | | | |
| 2) Other staff | MM | 1,980 | 15 | 29,700 | 122,185,800 | | | |
| 2. Direct costs | | | | | | | | |
| 1.1. Office expenses | month | 732 | 10 | 7,320 | 30,114,480 | | | |
| 1.2. Labor for minor maintenance | MD | 39,260 | | | | 1 | 39,260 | 161,515,640 |
| 1.3. Other expenses (gate maintenance) | L.S. | 1 | 20,000 | 20,000 | 82,280,000 | | | |
| **Total** | | | | **79,940** | **328,873,160** | | **39,260** | **161,515,640** |
| | | | = | US$6.26 | | = | US$3.08 | |
| | | | **say** | **US$7.00 per ha** | | **say** | **US$3.00 per ha** | |

Prepared by JICA SAPROF Study Team

As shown above, total annual O&M cost is $10 /ha consisting of (i) $7/ha shouldered by the Government and (ii) $3/ha by the FWUC. As stipulated in the Policy for Sustainability of Operation and Maintenance Irrigation System, O&M of main and secondary canals will be transferred to FWUCs 5 years after the Project. Based on the gradual transfer policy, share of O&M during transfer period is tabulated as follows:

**Share of O&M Cost during Transfer Period**

| Year after completion | Government | | Beneficial Farmers | |
|---|---|---|---|---|
| | per ha | Amount | per ha | Amount |
| One | US$ 9.4 | US$ 119,944 | US$ 0.6 | US$7,656 |
| Second | US$ 8.8 | US$ 112,288 | US$ 1.2 | US$15,312 |
| Third | US$ 8.2 | US$ 104,632 | US$ 1.8 | US$22,968 |
| Fourth | US$ 7.6 | US$ 96,976 | US$ 2.4 | US$30,624 |
| After Fifth | US$ 7.0 | US$ 89,320 | US$ 3.0 | US$38,280 |

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(3) Irrigation Service Fee

Irrigation service fee (ISF) will cover all the O&M costs to be borne by FWUCs. ISF is tentatively set to be: (i) U$ 4.0/ha/cropping season for gravity irrigation and (ii) U$1.0/ha/cropping season for pump irrigation to cover necessary annual O&M cost as estimated above.[4] During the Project, the value of ISF needs to be determined through the consensus among members of FWUCs.

[4] According to the survey on the advanced FWUCs under the pilot project under the Comprehensive Agricultural Development of Prek Thnot River Basin (JICA), the ISF and collection ratio is shown as follows:

**Comparison of Relatively Advanced FWUCs in ISF**

| | Ou Treang FWUC | Sdau Kaong FWUC | Phoum Roung FWUC | Ou Veaeng FWUC |
|---|---|---|---|---|
| Value | Rainy season<br>(i) Gravity and pump: Riel 20,000 ($5)/ha<br>(ii) Pump: Riel 10,000 ($2.5) /ha<br>Dry season<br>(i) and (ii): Riel 40,000 ($10,0)/ha | 1st year: Riel 7,000 ($1.75)/ha<br>2nd year: Riel 8,000 ($2.0)/ha<br>3rd year: Riel 11,000 ($2.75)/ha | (i) Gravity: Riel 40,000 ($10)/ha<br>(ii) Pump: Riel 10,000 ($2.5)/ha | (i) Gravity: Riel 30,000 ($7.5)/ha<br>(ii) Gravity and pump: Riel 20,000 ($5)/ha<br>(iii) Pump Riel 10,000 ($2.5)/ha |
| Ratio of Collection | 80-85% | 99% | 35% | 10% |

Extracted from the pilot project under the Comprehensive Agricultural Development of Prek Thnot River Basin (2008), JICA

# CHAPTER 4 PROJECT COST ESTIMATE

## 4.1 Basic Conditions for Cost Estimate

The basic conditions and assumptions employed for the project cost estimate are as follows:

i) Cost estimate refers to the prices as of August 2009.
ii) Exchange rates applied are as of December 2008, and they are as follows:
1 US Dollar (US$) = 4,114 Riel
= 96.8 Yen
iii) Unit prices of labor, construction materials, engineering works, etc., were collected from MOWRAM and market.
iv) Project costs are divided into foreign currency portion (FC) and local currency portion (LC). Ratios of the FC and the LC are estimated for each content, referring to similar types of the projects in Cambodia.
v) Price escalation rates are assumed to be 2.6 %/annum for FC and 1.2 %/annum for LC.
vi) Physical contingency is 5.0%.
vii) Tax (VAT) is 10% according to the Government regulation.
viii) Project administration cost is 3.0% of construction cost.
ix) Interest during construction is 0.01% of accumulated loan portion.

## 4.2 Project Cost Estimate

### 4.2.1 Initial Investment Cost for the Project

The initial investment cost for the Project is estimated at US$ 49.1 million consisting of JPY 2.8 billion for FC portion and Riels. 84.0 billion for LC portion as shown in Appendix B3 and summarized in the following table:

**Initial Investment Cost for the Project**

| No. | Item | Total (US$ 1,000) | FC (JPY million) | LC (Riels. million) |
|---|---|---|---|---|
| 1. | Construction Cost | 31,693 | 1,921 | 48,722 |
| 2. | Procurement Cost | 464 | 35 | 428 |
| 3. | Consulting Services Cost | 5,485 | 304 | 9,621 |
| 4. | Soft Component Activities | 2,227 | 119 | 4,074 |
| 5. | Land Acquisition Cost | 665 | 0 | 2,736 |
| 6. | Project Administration Cost | 1,107 | 0 | 4,554 |
| 7. | Tax & Duty | 1,684 | 0 | 6,928 |
| 8. | Price Escalation | 3,546 | 267 | 3,243 |
| 9. | Physical Contingencies | 2,202 | 133 | 3,441 |
| 10. | Interest during Construction | 18 | 1 | 25 |
| | **Total** | **49,091** | **2,780** | **83,772** |
| Cost of Primary Benefit Area (12,760ha) | | | US$ 3,850/ha | |
| Cost of Primary and Secondary Benefit Area (25,610ha) | | | US$ 1,920/ha | |

Prepared by the JICA SAPROF Study Team

(1) Construction Cost

The construction cost includes direct construction costs and costs for general items, miscellaneous works and contractor's expenses and is estimated for the following components of each sub-project:

Item 1-1: Headworks and Major Related Structures

Diversion weir, intake structures and other important major structures.

Item 1-2: Main and Secondary Systems

Main and secondary irrigation and drainage canals and related structures.

Item 1-3: On-farm Development

Tertiary canal systems and related facilities.

The construction cost for each sub-project is estimated as shown in Appendix B3 and summarized in the following table:

**Construction Cost for the Sub-Projects**

| Name of Sub-project | Total (US$ 1,000) | FC (JPY 1,000) | LC (Riels. mill.) | Remarks |
|---|---|---|---|---|
| 1. Ream Kon Rehabilitation Sub-Project | 6,674 | 417,982 | 9,693 | 1,890 ha w/HW |
| 2. Por Canal Rehabilitation Sub-Project | 2,215 | 129,034 | 3,629 | 1,940 ha |
| 3. Damnak Ampil Rehabilitation Sub-Project | 4,008 | 190,309 | 8,401 | 2,270 ha w/HW |
| 4. Wat Loung Rehabilitation Sub-Project | 4,811 | 294,853 | 7,261 | 2,540 ha |
| 5. Wat Chre Rehabilitation Sub-Project | 3,276 | 193,310 | 5,262 | 1,020 ha w/HW |
| 6 Lum Hach Rehabilitation Sub-Project | 10,709 | 695,992 | 14,477 | 3,100 ha w/HW |
| Total | 31,693 | 1,921,480 | 48,722 | |

w/HW: Headworks will be re-built in the particular sub-projects.

Prepared by the JICA SAPROF Study Team

(2) Procurement Cost

Procurement cost includes: (i) procurement cost of vehicles, (ii) procurement cost of motorcycles and (iii) procurement cost of office equipment and furniture. The procurement cost is estimated as follows:

**Procurement Cost for the Project**

| Item | Total (US$ 1,000) | FC (JPY 1,000) | LC (Riels. mill.) | Remarks |
|---|---|---|---|---|
| 1. Procurement of Vehicles | 360 | 35,000 | 0 | 10 nos. |
| 2. Procurement of Motorcycles | 24 | 0 | 99 | 24 nos. |
| 3. Procurement of office equipment and Furniture | 80 | 0 | 329 | |
| Total | 464 | 35,000 | 428 | |

Prepared by the JICA SAPROF Study Team

(3) Consulting Services Cost

The consulting services cost consists of remuneration for necessary professional experts and direct costs such as office running cost, communication, survey and investigations, workshop costs, etc. The consulting services cost is estimated as shown in Appendix B3 and summarized in the following table:

**Consulting Services Cost for the Project**

| Component | Total (US$ 1,000) | FC (JPY 1,000) | LC (Riels. mill.) |
|---|---|---|---|
| 1. Detailed Design (D/D) | 2,464 | 133,430 | 4,460 |
| 2. Construction Supervision (C/S) | 3,021 | 170,850 | 5,161 |
| **Total** | **5,485** | **304,280** | **9,621** |

Prepared by the JICA SAPROF Study Team

(4) Soft Component Activities

The cost for soft component activities is estimated as shown in Appendix B3 and summarized in the following table:

**Soft Component Activities Cost for the Project**

| Component | Total (US$ 1,000) | FC (JPY 1,000) | LC (Riels. mill.) |
|---|---|---|---|
| 1. FWUC Establishment and Strengthening Program | 621 | 32,390 | 1,180 |
| 2. Agricultural Extension Activities | 443 | 26,460 | 692 |
| 3. Meteo-hydrological Observation Strengthening Program | 417 | 18,240 | 936 |
| 4. Capacity Development of MOWRAM and PDOWRAM staff | 113 | 8,670 | 92 |
| 5. Project Formulation Study | 633 | 33,570 | 1,174 |
| **Total** | **2,226** | **119,330** | **4,074** |

Prepared by the JICA SAPROF Study Team

(5) Land Acquisition Cost

Land acquisition cost for the Project is estimated based on the actual anticipated area for each sub-project (refer to Chapter 6 for details). The land acquisition cost for each sub-project is estimated as shown in the following table:

**Land Acquisition Cost for each Sub-Project**

| Component | Area (ha) | | | | Amount | |
|---|---|---|---|---|---|---|
| | Headworks | Canal system*) | Drain | Total | (US$ 1,000) | (Riels. mill.) |
| 1. Ream Kon Rehabilitation Sub-Project | 0.0 | 16.7 | 25.4 | 42.1 | 126 | |
| 2. Por Canal Rehabilitation Sub-Project | 0.0 | 11.8 | 12.2 | 24.0 | 72 | |
| 3. Damnak Ampil Rehabilitation Sub-Project | 0.0 | 3.8 | 10.9 | 14.7 | 44 | |
| 4. Wat Loung Rehabilitation Sub-Project | 0.0 | 29.8 | 22.6 | 52.4 | 157 | |
| 5. Wat Chre Rehabilitation Sub-Project | 0.0 | 10.2 | 6.9 | 17.1 | 51 | |
| 6 Lum Hach Rehabilitation Sub-Project | 85.8 | 36.1 | 21.4 | 143.3 | 215 | |
| Total | | | | 293.6 | 665 | 2,736 |

* Main and secondary systems only

Prepared by the JICA SAPROF Study Team

(6) Annual Disbursement Schedule

The annual disbursement schedule is prepared based on the project implementation schedule shown in Figure III 3.2.1. The annual disbursement schedule is shown in Appendix B3 and summarized in the following table:

**Annual Disbursement Schedule for the Project**

| Year | Total (US$ 1,000) | FC (JPY 1,000) | LC (Riels. mill.) |
|---|---|---|---|
| 2010 | 1,020 | 54,084 | 1,912 |
| 2011 | 2,913 | 157,128 | 5,285 |
| 2012 | 1,860 | 58,972 | 5,143 |
| 2013 | 27,755 | 1,588,025 | 46,688 |
| 2014 | 14,959 | 895,435 | 23,479 |
| 2015 | 372 | 15,481 | 870 |
| 2016 | 212 | 11,329 | 395 |
| Total | 49,091 | 2,780,454 | 83,772 |

Prepared by the JICA SAPROF Study Team

### 4.2.2 Operation and Maintenance Cost

(1) Annual Operation and Maintenance Cost

Annual operation and maintenance cost includes: (i) salary and wages for staff personnel of FWUC consisting of board members of FWUC and Sub-FWUGs and (ii) direct cost for minimum office expenses and repairing works. The annual operation and maintenance cost for the sub-projects is estimated as follows:

**Annual Operation and Maintenance Cost for the Sub-Projects**

| Item | Unit | Qty. | Unit Rate (US$) | Amount (US$) | Amount (Riels.) |
|---|---|---|---|---|---|
| 1. Salary and Wages | | | | | |
| 1.1. FWUCs | | | | | |
| 1) Chairperson | MM | 72 | 30 | 2,160 | 8,886,240 |
| 2) Deputy chairperson | MM | 72 | 25 | 1,800 | 7,405,200 |
| 3) Other staff | MM | 288 | 20 | 5,760 | 23,696,640 |
| 1.2. FWUGs | | | | | |
| 1) Leader | MM | 660 | 20 | 13,200 | 54,304,800 |
| 2) Other staff | MM | 1,980 | 15 | 29,700 | 122,185,800 |
| 2. Direct costs | | | | | |
| 1.1. Office expenses | month | 732 | 10 | 7,320 | 30,114,480 |
| 1.2. Labor for minor maintenance | MD | 39,260 | 1 | 39,260 | 161,515,640 |
| 1.3. Other expenses (gate maintenance) | L.S. | 1 | 20,000 | 20,000 | 82,280,000 |
| **Total** | | | | **119,200** | **490,388,800** |
| | | | = | US$9.34 | |
| | | | **say** | **US$10.00** | **per ha** |

Prepared by JICA SAPROF Study Team

(2) Major Repair Cost

Major repair including replacement will be executed every 10 years and the cost is assumed to be 5% of the construction costs, referring to similar types of the projects in Cambodia. The major repair cost for every 10 years is estimated at about US$ 1.8 million consisting of JPY 114 million for FC portion and Riels. 2.7 billion for LC portion.

# CHAPTER 5 PROJECT EVALUATION

## 5.1 Evaluation Conditions

Project benefits generated from the rehabilitation of the six sub-projects would come from the stabilization of irrigation water supply to the rice cultivation area for the wet season. In other words, the increase in the net production value (NPV) is equivalent to the project benefit. This is the increased net income to be borne by improving the function of irrigation system after completion of the proposed civil works in the respective sub-projects. The expected increase in paddy yield by stabilizing rice production resulting from the training and/or guidance on improved farming practices and proper irrigation water use should also be added to the project benefit.

Based on the drawn-up development plan and implementation schedule, the NPV, benefit-cost (B/C) ratio and economic internal rate of return (EIRR) of the proposed project are calculated by taking the following basic assumptions into account:

i) The evaluation period is 30 years from 2010;

ii) The financial project cost covers civil works, engineering services including support programs, and O&M and major repairing works, which is estimated based on the price level in September 2009 and exchange rate at USD 1.00 = Riel 4,114;

iii) The financial project cost is converted to the economic project cost by applying the standard conversion factor (SCF) of 1.0 to foreign currency portion of each cost item, 0.977 to the physical portion of civil works, engineering services and O&M estimated at local currency, and 0.75 to unskilled labor cost of the civil works;

iv) The project benefit is to borne after the completion of civil works and reach to the target yield in the fourth year; and

v) Discount rate is set as 12 % for calculation of B/C.

## 5.2 Economic Evaluation

Through re-examination of the original design capacity of irrigation facilities and available irrigation water resources, additional irrigation areas can be expected to come from the outside of command areas of Ream Kon, Por Canal, Damnak Ampil and Lum Hach Sub-projects. These areas have been quantified at 12,850 ha as the secondary benefit area in addition to 12,760 ha as the primary benefit area. From the engineering point of view, therefore, the initial investment costs of irrigation facilities commonly used for irrigation water intake purposes by the both benefit areas can be allocated according to the ratio of both command areas. Taking into account the above basic assumptions as well as the allocation concept of initial investment costs, the cash flow is projected for the respective sub-projects and then the entire proposed project as summarized below.

**Cash Flow of Economic Cost and Benefit**

Unit: Riel Million

| Item | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Economic investment cost | 2,041 | 9,121 | 3,453 | 80,168 | 42,024 | 1,073 | 592 | | |
| Economic annual O&M cost | 0 | 0 | 0 | 0 | 272 | 410 | 410 | 410 | 410 |
| Economic benefit | 0 | 0 | 0 | 0 | 6,083 | 16,063 | 18,978 | 21,893 | 22,840 |

Prepared by JICA SAPROF Study Team

Based on the cash flow, NPV, B/C ratio and EIRR are computed for the proposed project. Also sensitivity analyses are performed for such cases as cost 10% and 20% up, benefit 10% and 20% down, and combination of each case. The results of the economic evaluation as shown below reveals that the proposed project is economically sound as its EIRR is 13.3% exceeding the bankable decision-making standard.

**Results of Economic Analysis**

| NPV (Riel million) | B/C Ratio at 12% discount ratio | EIRR & Sensitivity Analysis (%) | | Cost | | |
|---|---|---|---|---|---|---|
| | | | | Normal | 10% up | 20% up |
| 99,536 | 1.10 | Benefit | Normal | 13.3 | 12.0 | 10.9 |
| | | | 10% down | 11.4 | 10.2 | 9.2 |
| | | | 20% down | 9.4 | 8.3 | 7.3 |

Prepared by JICA SAPROF Study Team

## 5.3 Financial Evaluation

Financial evaluation of the proposed project is undertaken in terms of financial viability from individual farmer's perspective, focusing on the beneficiary farmers' capacity to pay. Such pay is intended for shouldering partly annual O&M cost from their increments of net farm income from irrigated rice cultivation. The average annual farmer's net income in the project area is estimated to increase by Riel 1,284,000/ha from Riel 785,000/ha at present to Riel 2,069,000/ha in the future. As the annual O&M cost required is estimated at USD 10/ha or Riel 41,000/ha annually, an affordable portion of this cost can be covered with this increment of the net farm income.

## 5.4 Indirect Benefit and Socio-Economic Impact

In addition to the above mentioned direct benefits derived from incremental increase in paddy production, the following indirect benefits and socio-economic impacts can be expected from the implementation of the proposed Project.

(1) Increase in Employment Opportunity

The proposed Project will generate additional employment of around 82,000 person-days as extra requirement after meeting by available family labors to the maximum extent during the peak time of farm operation like transplanting and harvesting. Thus an increase in employment opportunities, especially for unskilled labors, can be expected during the construction period, because contractors will require un-skilled labors for construction from local residents. Some unskilled labors will also get technique and become to be semi-skilled labor through on-the-job training. This experience will provide them with new opportunities for post project employment.

(2) Socio-economic Impacts

When implemented, the proposed project would create various impacts not only affecting the direct beneficiaries but also the rural economy as a whole. The impacts on the direct beneficiaries attributable to an increase in their net household income are expected:

- To enable them to send their children to schools and access higher education;
- To enable their family members to buy other goods and services as well as luxuries which have positive effect to other cottage industries; and

- To secure sufficient rice supply for their family's consumption.

## 5.5 Operation and Effect Indicators

### 5.5.1 Operation Indicators

Operation indicators proposed for monitoring the sub-projects are listed as follows. The project benefit is to be borne from the next year after the completion of civil works and reach to the target yield in the fourth year.

**Operation Indicators**

| | Indicator | Unit | Without Project | With Project |
|---|---|---|---|---|
| 1 | Irrigated area | ha | 760 | 12,760 |
| 2 | Planted area of paddy | ha | 14,260 | 16,800 |
| 3 | Cropping intensity | % | 104 | 132 |
| 4 | Number of FWUGs | nos. | 0 | 52 |
| 5 | Collection ratio of water charge | % | 0 | 80 |

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### 5.5.2 Effect Indicators

Effect indicators proposed for monitoring the sub-projects are listed as follows. The project benefit is to be borne from the next year after the completion of civil works and reach to the target yield in the fourth year.

**Effect Indicators**

| | Indicator | Unit | Without Project | With Project |
|---|---|---|---|---|
| 1 | Paddy production | ton | 22,000 | 54,000 |
| 2 | Paddy yield | ton/ha | 1.5 | 3.2 |
| 3 | Annual net farm income | Riel/ha | 785,000 | 2,069,000 |

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### 5.5.3 Procedures for Monitoring Operation and Effect Indicators

The operation and effect indicators above mentioned will be collected by the project consultant. The consultant will carry out baseline survey and monitoring and evaluation activities (M&E). Based on the collected data, monthly, quarterly and annual report will be prepared by the project consultant. After finishing the Project, M&E activity will be handed over from the consultant to MOWRAM.

# CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

## 6.1 List of Law and Regulations

It is necessary to ascertain whether a project complies with environmental laws and standards of the host national and local governments concerned. The following table shows the list of main legislations relating to natural and social environment in Cambodia.

**List of Major Legislations for Environment**

| Content | Law/Regulation |
|---|---|
| Constitution | Article 59 of the National Constitution of the Kingdom of Cambodia (1993) |
| Basic Law | Law on Environmental Protection and Natural Resource Management (LEPNRM) |
| Environmental Management Institution | Sub-Decree on the Organization and Functions of the Ministry of Environment (1997) |
| Environmental Impact Assessment | Sub-Decree on Environmental Impact Assessment Process (1999) |
| | Declaration on Guidelines for Conducting Environmental Impact Assessment Report (2000) |
| | Guideline for Conducting Environmental Impact Assessment(EIA) Report (2000) |
| Protected Areas Management | Royal Decree on the Protection of Protected Areas (1993) |
| | Declaration No.1033 on Protected Areas (1994) |
| | Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve (2001) |
| | Protected Areas Law (2008) |
| Pollution Control | Sub-Decree on Water Pollution Control (1999) |
| | Sub-Decree on Solid Waste Management (1999) |
| | Sub-Decree on Air Pollution and Noise Disturbance (2000) |
| Resource Management | Land Law (2001) |
| | National Water Resources Policy for The Kingdom of Cambodia (2007) |
| | Sub-Decree on Addressing Socio-Economic Impacts caused by Development Projects (Draft) |
| | Sub-Decree on Farmer Water User Community (2008) |

Prepared by JICA SAPROF Study Team

## 6.2 JBIC Guidelines for Confirmation of Environmental and Social Consideration (April 2002)

### 6.2.1 General

Japan Bank for International Cooperation (hereinafter referred to as “JBIC”) has prepared “JBIC Guidelines for Confirmation of Environmental and Social Considerations” (hereinafter referred to as the “Guidelines”) which is applied to all projects subject to lending or other financial operations by JBIC. JBIC makes clear in its Guidelines the environmental and social considerations required for projects to receive their funding, and confirms those environmental and social considerations. This guideline is applicable to ODA loan projects of JICA after merger of JICA and JBIC in 2008.

In light of the Guidelines and taking into account the characteristics of the project and the particular circumstances of the country and its location, JICA confirms in its environmental reviews: (i) whether appropriate and sufficient consideration is given to environmental and social issues before the implementation of the project, (ii) whether appropriate environmental and social considerations can be expected after JICA makes decisions on the funding of the project in light of such factors as the state of preparation by the project proponent and host government, their experience, operational capacity, and the state of securing funds, as well as external factors of instability.

It is required for all loan projects of JICA to undertake efficient environmental reviews through the appropriate use of the environmental checklists for each category and the result of assessing the

Project according to the checklist is shown as follows.

### 6.2.2 Contents of the Environmental checklist for Irrigation Projects

The contents of the environmental checklist of irrigation projects are in the right table:

**Contents of the Environmental checklist for Irrigation Projects**

| Category | Environmental Item |
|---|---|
| 1. Permits and Explanation | (1) EIA and Environmental Permits<br>(2) Explanation to the Public |
| 2. Mitigation Measures | (1) Water Quality, (2)Soil Contamination<br>(2) Subsidence |
| 3. Natural Environment | (1) Protected Areas, (2)Ecosystem |
| 4. Social Environment | (1) Resettlement, (2)Living and Livehood,<br>(2) Heritage, (4)Landscape |
| 5. Others | (1) Impacts during Construction, (2)Monitoring |
| 6. Note | (1) Reference to checklist of Other Sectors<br>(2) Note on Using Environmental Checklist |

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## 6.3 Environmental and Social Impacts Anticipated

The result of comparing the checklist of irrigation project with the Project, potential negative environmental impact anticipated is summarized in the table as follows and details are shown afterward. Although it is not significant, four categories of the checklist are applicable as negative impacts by the Project.

**Potential Negative Environmental Impact Anticipated**

| Potential Impact | | Phase | | |
|---|---|---|---|---|
| Category | Item | Design | Construction | Operation |
| 1. Permits and Explanation | — | — | — | — |
| 2. Mitigation Measures | ♦ Water Quality<br>♦ Soil Contamination | — | — | ♦ By the increase of agricultural input in the irrigation area |
| 3. Natural Environment | ♦ Ecosystem | — | ♦ Disturbance of fish migration by the construction of headworks (Lum Hach and Ream Kon) | ♦ Decrease in amount of flowing in the downstream river by irrigation water |
| 4 Social Environment | ♦ Living and livelihood | ♦ Land acquisition by expansion of the main, secondary and Tertiary canal | — | ♦ Due to unequal allocation of irrigation water |
| 5 Others | ♦ Impacts during Construction | — | ♦ Degradation of sanitation condition and security due to inflow of construction workers<br>♦ Noise, vibrations, turbid water, dust, exhaust gases, and wastes caused by construction vehicle and heavy equipment | — |
| 6 Note | — | — | — | — |

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### 6.3.1 Permits and Explanation

"The Sub-Decree on Environmental Impact Assessment Process" explains that irrigation development with more than 5,000 ha is required to carry out EIA or IEIA for approval from the Ministry of Environment (MOE) prior the implementation. The Six sub-project areas are

**List of the Projects Require an IEIA or EIA (Agriculture)**

| No | Type and Activities of the Projects | Size/Capacity |
|---|---|---|
| 1 | Concession forest | ≧10,000ha |
| 2 | Logging | ≧500ha |
| 3 | Land covered by forest | ≧500ha |
| 4 | Agriculture and agro industrial land | ≧10,000ha |
| 5 | Flooded and coastal forests | All sizes |
| **6** | **Irrigation systems** | **≧5,000ha** |
| 7 | Drainage systems | ≧5,000ha |
| 8 | Fishing ports | All sizes |

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respectively less than 5,000 ha, therefore, IEIA and/or EIA is not required from regulatory view point.

Besides, an Initial Environment Examination (IEE) was carried out at the previous Study from the view point of: (i) social environment, (ii) natural environment and (iii) pollution. The IEE judged that the environmental impact by the Project is few for all the view points.

### 6.3.2 Mitigation Measures

(1) Water pollution and Soil Contamination (Operation)

*Water pollution and soil contamination management*

| Item | Description |
|---|---|
| Activity | Implementation of irrigated agriculture using rehabilitated and/or constructed irrigation and drainage facilities |
| Affected Area | In and around Projects area including downstream areas (All the six sub-projects) |
| Projected Impact | At the rehabilitation and/or new irrigation area, it is possible that usage of the fertilizer and pesticide will increase in the future by getting enough irrigation water. In such cases, water and soil will be contaminated affecting natural habitat, flora and fauna. |
| Management Measure | <u>To control the amount of fertilizer and pesticide through the training to farmers</u><br>Sustainable agriculture needs to control appropriate amounts of fertilizer and pesticide for the future, therefore, all farmers should learn the appropriate use of fertilizer and pesticide though the training. These training should be carried out through FWUCs under the lead of PDOWRAM.<br><u>To support check system among the FWUC members regarding farming management</u><br>Awareness among farmers in the short-term on the hazards of using toxic chemicals should be promoted, and community-based mutual checking system supported by extension agent should be established among FWUC members for proper chemical and fertilizer application based on WHO guideline.<br><u>To monitor water quality and soil condition</u><br>In the operation phase, it is necessary to monitor water quality and soil conditions in each sub-project areas. |
| Conclusion of Examination | Currently, water and soil contamination is not serious problem, because most of farmers use compost, not chemical fertilizer. But irrigation has potential negative impacts such as salinization of soils and water pollution. Careful attention should be paid regularly to these factors. |
| Stakeholder | ♦ MOWRAM<br>♦ PDOWREAM<br>♦ Commune Council<br>♦ Affected Farmers |

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### 6.3.3 Natural Environment

(1) Ecosystem (Construction)

*Construction of fish ladder*

| Item | Description |
|---|---|
| Activity | Construction and/or rehabilitation of headworks at Moung Russei, Pursat and Lum Hach Sub-Projects |
| Affected Area | Moung Russei river basin, Pursat river basin, Boribo river basin |
| Projected Impact | The Tonle Sap lake is the largest freshwater lake in Southeast Asia. The lake and wetland area around the lake forms rich ecosystem, in which many species of freshwater fishes live. In the rainy season, these species move to upper basins from the lake with flooding water, and in dry season, back to the lake. The construction of headworks would give negative impacts by preventing such fish sprawling. |
| Management Measure | <u>To construct Fish ladder in the new headworks (Ream Kon, Wat Chre and Lum Hach)</u><br>The Project plans to construct new headworks with fish ladder in three sub-projects, Ream Kon, Wat Chre and Lum Hach. The design of fish ladder is proposed to be half-cone type. Many kinds of fish live in the river and the lake and half-cone type is suitable for various type of species. |

| Item | Description |
|---|---|
| | To improve the existing headworks (Damnak Ampil)<br>Because there is no fish ladder with exist headworks of Damnak Ampil, the headworks prevents fish migration between Pursat River and the lake. It is desirable to improve to reducing the problem for natural environment impacts of irrigation project. |
| Conclusion of Examination | The rich ecosystem around Tonle Sap Lake plays very important role in Cambodia. Large amount of fishes are supplied to rural communities. Freshwater fisheries play an important role in rural people life for household consumption to supplement rice in the meals. To construct and/or improve headworks would give impact onto this ecosystem, however, to construct fish ladder minimize this impact. |
| Stakeholder | ♦ MOWRAM<br>♦ PDOWRAM<br>♦ Commune Council<br>♦ Local Authority<br>♦ Local Fisher |

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(2) Ecosystem (Operation)

*River maintenance flow control*

| Item | Description |
|---|---|
| Activity | Diversion of large amounts of irrigation water from rivers to rehabilitation and/or new irrigation area |
| Affected Area | In and around Projects area including downstream areas (All the Six Sub-projects) |
| Projected Impact | Regional water balance changes by irrigation development would have the possibility of influencing the ecosystem particularly in the downstream area. |
| Management Measure | To maintain the amount of irrigation water<br>The maintenance flow discharges of each river under the plan are shown in the right table. It is assumed that negative impact is not significant if the constant volume of water is neatly maintained. |
| Conclusion of Examination | Ecosystem consists of complex relationship of various organisms. Even if a limited area is affected, it may lead to significant environmental problems by spreading to other species and areas with progress time. It is necessary to control so as not to use water too much on the irrigation area to maintain the volume of water to the downstream. |
| Stakeholder | ♦ MOWRAM<br>♦ PDOWRAM<br>♦ MAFF<br>♦ PDA<br>♦ Community people including those downstream irrigation systems<br>♦ Local Authority |

**Design of Maintenance Flow**

| basin | River Maintenance Flow ($m^3$/sec) |
|---|---|
| Moung Russei river | 0.79 |
| Pursat river | 4.48 |
| Boribo river | 0.74 |

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### 6.3.4 Social Environment

(1) Living and Livelihood (Design)

*Participatory land acquisition*

| Item | Description |
|---|---|
| Activity | Expansion and/or new construction of facilities (Main, secondary and tertiary canals, drains) |
| Affected Area | Total 475.8 ha in the Project Area (All the Six sub-project area) as tabulated as follows: |

Unit :ha

| | Total | Main and Secondary | | | | Tertiary |
|---|---|---|---|---|---|---|
| | | Canal | | Drain | Sub-total | |
| | | Rehabilitation | New | | | |
| Ream Kon | 81.6 | 4.2 | 12.5 | 25.4 | 42.1 | 39.5 |
| Por Canal | 64.8 | 6.5 | 5.3 | 12.2 | 24.0 | 40.8 |

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>Damnak Ampil</td><td>62.4</td><td>3.8</td><td>0.0</td><td>10.9</td><td>14.7</td><td>47.7</td></tr>
<tr><td>Wat Loung</td><td>105.8</td><td>9.1</td><td>20.7</td><td>22.6</td><td>52.4</td><td>53.4</td></tr>
<tr><td>Wat Chre</td><td>38.6</td><td>3.4</td><td>6.8</td><td>6.9</td><td>17.1</td><td>21.5</td></tr>
<tr><td>Lum Hach</td><td>122.6</td><td>5.7</td><td>30.4</td><td>21.4</td><td>57.5</td><td>65.1</td></tr>
<tr><td>Total</td><td>475.8</td><td>32.7</td><td>75.7</td><td>99.4</td><td>207.8</td><td>268.0</td></tr>
</table>
Prepared by JICA SAPROF Study Team</td></tr>
<tr><td>Projected Impact</td><td>Land acquisition is an important and sensitive matter for irrigation project. The project needs land for the expansion and/or new construction of facilities. However, there will be no large resettlement and/or land compensation necessary for its implementation because the project mainly aims at rehabilitation of existing irrigation and drainage facilities.<br>Land acquisition for main and secondary level facilities are to be managed by the Government, while tertiary level are to be managed by the local community. Therefore, the Government must compensate required land (208 ha) for main and secondary canals and drains while required land (268 ha) for tertiary canals will not be compensated by the Government. It is necessary to discuss management of land acquisition among local community, including all of affected people. Careful attention should be paid to the discussion process because their living and relation among local community would be changed by the Project.</td></tr>
<tr><td>Management Measure</td><td><u>To design canals considering land acquisition</u><br>The canal alignment will generally follow existing bund wherever possible so as to minimize the area of land acquisition.<br>Paddy field price on field survey as of August 2009<br>Unit: US$/m$^2$
<table>
<tr><th>Item \ Place</th><th>Battambang</th><th>Pursat</th><th>Kampong Chhnang</th></tr>
<tr><td>Paddy Field</td><td>0.3～0.4$</td><td>0.4～0.5$</td><td>0.15～0.2$</td></tr>
</table>
Prepared by JICA SAPROF Study Team<br><u>To carry out appropriate land acquisition for main/secondary canals and drain</u><br>The Draft “Sub-Decree on Addressing Socio-Economic impacts caused by Development Projects (2007)” explains resettlement and land acquisition management. It is necessary to facilitate coordination among Inter-ministerial Resettlement Committee (IRC) and local-based authorities to properly carry out (i) asset valuation at replacement cost and resettlement cost estimation to be affected through the implementation and (ii) compensation measures. Compensation rate for land loss and value of land according to field interview with PDOWRAM in Aug 2009 is tabulated in the right.<br><u>To support local authorities and community for Land acquisition for tertiary canal</u><br>Currently, no tertiary level facilities have been developed in the project area. At tertiary level development is the responsibility of local authorities and communities technically supported by MOWRAM and PDOWRAM.</td></tr>
<tr><td>Conclusion of Examination</td><td>Land acquisition process is very sensitive matter, the process should be conducted very carefully from designing phase.</td></tr>
<tr><td>Stakeholder</td><td>♦ MOWRAM<br>♦ PDOWRAM<br>♦ Commune Council<br>♦ Representative of farmers<br>♦ All affected farmers<br>♦ FWUCs and FWUGs</td></tr>
</table>
Prepared by JICA SAPROF Study Team

## (2) Living and livelihood (Operation)

*Improvement of irrigation water management*

| Item | Description |
|---|---|
| Activity | Supply of irrigation water to rehabilitation and/or new irrigation area |
| Affected Area | In and around projects area (All the Six Sub-projects) |
| Projected Impact | At present, farmers in the Project area are largely dependent on rainfall and flood water especially in the wet season, however, it is not sufficient. Water supply is improved after the Project, however, another problem “Unequal water allocation” need to be considered.<br>Unequal water allocation would be anticipated if proper water management is not carried out in the |

| Item | Description |
|---|---|
| | Project command areas. This issue is related not only within the command area but also with other irrigation systems particularly located in the downstream of the Project. |
| Management Measure | To establish and strengthen FWUC for appropriate water management<br>At the sub-project areas, appropriate water management should be carried out for all farmers through the FWUC. In addition, staff of the FWUC needs to join training program such as: (i) Operation and management of irrigation system, and (ii) Proper water management at Tertiary level<br>To monitor appropriate water management by the Government<br>It is important to carry out water management by the sub-project area FWUC. However, the organization is not matured at the initial stage, and it is difficult for them to control stable water management. If the organization fails in water management, conflict about water will occur at the rural community. Therefore, the Government should monitor and conduct FWUC's activity to avoid such rural conflict. |
| Conclusion of Examination | Through combination of facilities' rehabilitation and institutional strengthening with appropriate monitoring mechanism, no significant impact will be anticipated. |
| Stakeholder | ♦ MOWRAM<br>♦ PDOWRAM<br>♦ Community people including those of downstream irrigation systems<br>♦ Local Authority |

Prepared by JICA SAPROF Study Team

### 6.3.5 Others

(1) Impacts during Construction (Construction Phase)

*Environmental consideration in technical specification for construction works*

| Item | Description |
|---|---|
| Activity | Construction and/or rehabilitation of canals, drains and those related facilities |
| Affected Area | In and around Projects area (All the Six Sub-projects) |
| Projected Impact | Inflow of construction workers<br>During construction phase, the construction workers inflow from out of the sub-project areas is expected. Anticipated negative impacts are: (i) Degradation of sanitation condition, (ii) Degradation of rural public security, (iii) local conflict among local people and construction workers from outside. The construction works are not large scale because the main substance is rehabilitation, however, as two sub-projects: (i) Lum Hach and (ii) Ream Kon have new construction of headworks. They should be especially considered for these impacts.<br>Noise, Vibrations, Turbid water, Dust, Exhaust gases, and Wastes caused by construction vehicle and heavy equipment<br>Transportation of construction vehicles and transportation/operation of heavy equipment, such as dump truck, excavator, bulldozer, roller for flat and watering lorry will cause some impacts as follows: (i) noise, (ii) vibrations, (iii) dust, (iv) exhaust gases (e.g. nitrogen dioxide ($NO_2$) and suspended particulate matter (SPM)) in and around sub-project area.<br>During construction of headworks, it is necessary to stop existing river flow and to drain turbid water by constructing temporary drain. In addition, during construction works, farmers would have limited irrigation water supply, instead, turbid water will would inflow in canals and drains.<br>The construction works would create many wastes such as solid waste, soil to be borne from construction works and waste from construction workers' living if appropriate management measures are not carried out. |
| Management Measure | To supply appropriate sanitary condition of construction workers<br>The Contractors must supply proper arrangement of accommodation, installation of toilets and proper water supply for construction workers.<br>To educate construction workers about environment impacts<br>All the construction workers must take the education program about environmental impacts by the construction.<br>To stipulate needs to environmental consideration on technical specification for the construction works<br>Technical specification for the construction to consider matters the bellows: i) water use for agriculture, ii) air pollution, iii) water pollution and treatment, vi) waste disposal, v) noise and vibration, vi) accidents |

| Item | Description |
|---|---|
| | needs to be clearly specified, to mitigate negative impact in and around the sub-project sites during construction period.<br>To limit construction time e.g. at daytime only<br>As a rule, construction time is to be limited only daytime (e.g. 8:00-17:00) to reduce the impacts of noise and vibration.<br>To explain purpose and period of construction for rural community<br>Most of rural people living in the sub-project areas would take some impacts by the construction works. It is necessary to persist in a prior explanation to understand the purpose and the period of this construction to the rural communities, not to give the excessive anxiety for the rural people.<br>To recycle of material from construction work<br>The materials from construction work are recycled, e.g. soil from construction use as the material of canals and drains as much as possible to reduce the amount of wastes. |
| Conclusion of Examination | Because most of the construction works are not large scale and construction phase is limited, the number of construction vehicles and heavy equipments for the construction will not be many. Therefore, the negative impacts will not be serious if proper managements and appropriate mitigation measures are carried out. |
| Stakeholder | ♦ MOWRAM<br>♦ PDOWRAM<br>♦ Contractors<br>♦ Construction Workers<br>♦ Around Community people<br>♦ Local Authority |

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### 6.3.6 Note

It is not necessary to refer to checklist of other sectors, because the main activities of the project is rehabilitation and improvement, and no new large scale development is included.

## 6.4 Environmental Management Plan

### 6.4.1 Participatory Process of Land Acquisition for Tertiary Canals and Drains

(1) Purpose

To support local community to execute appropriate land acquisition for tertiary level development

(2) Procedure

| |
|---|
| Step-1 Establishment of local-based organization for compensation<br>Locally-based compensation committee should be establish in charge of tertiary level land acquisition consisting PDOWRAM, PDA , FWUC and other organization to relate the land acquisition process. |
| Step-2 Design of compensation step<br>Among committee members, compensation step is discussed and designed talking land tenure and local economic conditions into consideration. |
| Step-3 Joint walk-through to determine the alignment of canal and road network<br>Joint walk –through is carried out involving PDOWRAM, representatives from village and farmers to design canals and road network, view of which needs both social and technical consideration. |
| Step-4 Identification of affected people and contact socio-economic survey<br>Trough joint walk-through survey, affected areas and affected people are confirmed. At this step, socio-economic survey would collect information of land acquisition for affected people. |
| Step-5 Workshop organization<br>At this step, Workshop is organized for local community people. In the Workshop, the draft plan of tertiary canal and related facilities would be disclosed to get feed-back from stakeholders. |
| Step-6 Finalization of compensation plan |

| |
|---|
| Land acquisition compensation as well as tertiary development plan are finalized on the basic of stakeholder's opinion in the workshop. |
| Step-7 Implementation of tertiary development<br>Based on the implementation plan agreed in the preceding steps, tertiary development is carried out. |
| Step-8 Monitoring and follow-up<br>Compensation committee is responsible for monitoring during the implementation of land acquisition. This step is very important step, it is necessary to act careful and continuous. |

(3) Monitoring Period

From Design phase to Operation phase

(4) Executing Agency

- MOWRAM (particularly resettlement unit)
- PDOWRAM
- Local authority
- IRC, if necessary

(5) Evaluation

As the rural authorities will carry out appropriate land acquisition with support from MOWRAM and PDOWRAM for all affected people including people without formal title or rights to maintain their rights to land or property. And land acquisition needs to process of: (i) preparation of land including the set of cut-off date/final deadline, (ii) stakeholder workshop for consensus building, (iii) detailed socio-economic survey, (iv) valuation of affected asset, (v) continuous monitoring so that the Project is sustainable from social and environmental points of view.

### 6.4.2 Water and Soil Monitoring

(1) Purpose

To confirm the effects of water and soil by the project

(2) Objective

- To monitor quality and flow of downstream river water, and quality of drain water
- To monitor soil contamination at irrigation area

(3) Monitoring points (at each six sub-project)

i) River water quality and flow

Confluence point of rivers and drains in the downstream

ii) Drain water quality

In the drainage canal

iii) Soil contamination

Representative points at rehabilitation and/or new irrigation area

(4) Frequency

Two times a year (dry and wet season respectively)

**Items to be surveyed for water and soil monitoring for the project**

| Site | Items |
|---|---|
| i) River water quality and flow | - Flow rate, Color, Odor, Appearance |
| | - Physico-chemical properties (pH, EC, TSS, BOD, DO) |
| ii) Drain water quality | - Temperature of water, flow rate, color, odor, appearance |
| | - Physico-chemical properties (pH, EC, TSS, BOD, DO) |
| | - Organo-chemical substance (N, P) |
| | - Micro-organisms (bacteria, coliform group) |
| iii) Soil contamination | - Total Organic Carbon |
| | - Organo-chemical substance (N, P) |
| | - Micro-organisms (bacteria, coliform group) |

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(5) Items to be surveyed

The index of water and soil monitoring items are tabulated above.

(5) Executing Agency

PDOWRAM

(6) Evaluation

Monitored values should be evaluated with reference to the current date (At the former survey) . If the serious impact is recognized at the sub-project site, particular survey for the factor and proper mitigation measure should be carried out at the effected site as soon as possible.

## 6.5 Activities for Environmental Management after SAPROF Study

After the SAPROF study, two kinds of activity for environmental assessment are proposed as follows.

### 6.5.1 Organizational Structure for EIA under MOWRAM

The Project doesn't require EIA according to the sub-decree of EIA, but it is necessary to consider the environmental impact for the success of the project.

Currently, Resettlement Unit under the MOWRAM is in charge of handling social environmental impact, particularly land acquisitions associated with irrigation development projects. During the project phase, the unit need to cover environmental monitoring for natural environmental impact as well. However, the unit has limited practical knowledge and experience in EIA. In order to properly carry out environmental management for the Project, MOWRAM and MAFF has to organize EIA units through the support of MOE.

### 6.5.2 Capacity Development Plan for Environmental Management

All agricultural developments give impact to peripheral area more or less. Environmental management is prerequisite measures for sustainable development. Therefore, it is important to enhance the capability of MOWRAM, PDOWRAM and village authorities staff in environmental management, among which village authorities should manage their land directly and continuously by their own hands in the future.

Prospective training programs for strengthening the staff capability are: (i) On-the-Job Training for IEIA and preparation of TOR for EIA, (ii) Training for Environmental Impact Mitigation and Management Planning.

## 6.6 Recommendation

### 6.6.1 Land Acquisition (Residential Area)

Large scale involuntary resettlement is not expected by the project. The project's main activity is the rehabilitation of existing irrigation and drainage facilities, therefore, main construction areas are around existing canals, drains, and paddy fields, not in and around residential area.

Resettlement and land acquisition is very sensitive and important issues for success of the project. The resettlement should be carried out in a careful stepwise approach to build consensus among stakeholders with appropriate measure from the project design phase.

If few involuntary resettlements will be generated in D/D phase by the project, Resettlement Unit

under MOWRAM should prepare resettlement plan through the cooperation of Inter-ministerial Resettlement Committee (IRC), and execute the appropriate land acquisition during the project process.

### 6.6.2 Approach on Rural Poverty Alleviation Program Using FWUC – Consideration to Socially Vulnerable Groups

The large problem in rural economy in Cambodia is limited ability of farmers to manage agricultural production and non-farm enterprise.[3] Farmers do not generate enough profits from agricultural products and small non-farm business because they lack access to markets. There is shortage of transportation facilities to go to markets and of knowledge of farm management and non-farm business.

FWUC needs to be established and strengthened to carry out appropriate water management in the project. The organization's purpose is effectively and sustainably to manage and to use the irrigation water, moreover, to equally use water for all farmers without exception: women, old people, and those without title to land, in the sub-project areas. Currently, there isn't such organization in which a lot of people participate like this in the rural community.

Establishment and strengthening of FWUC is one of the activities of the Project. Strengthened FWUC under the Project would obtain a function of mutual help in rural communities. Each of the farmers belonging to FWUC would have a role and responsibility in FWUC, thus socially and economically weak people in the communities such as women, old people, the sick and wounded and those without title to land also would get an opportunity to be employed by FWUC so as to get some roles and responsibilities in FWUC and simultaneously get a way to live stably.

As the next phase of the organization, it is proposed to construct system aiming to solve problems of rural economy, e.g. "construction of the access nets to markets" through the FWUC organization. If the system functions well, various people can use through the organization and access to market easily. Such activity might lead to dissolve rural poverty problem.

### 6.6.3 Construction of Fish Ladder of Downstream Headworks in Pursat River

It is proposed to construct fish ladder in the improvement of the Damnak Ampil headworks to support fish sprawling between the river and the Tonle Sap lake. However, there is the other headworks named Char Rec headworks in the downstream of the Damnak Ampil headworks. The existence of the Char rec headworks would reduces effect of construction of fish ladder of Moung Russei headworks in the project.

Improvement of the Char Rec Headworks is not included in the Project component since it is located outside of the Project area. Therefore, it is proposed that budgetary arrangement be made by MOWRAM to provide Char Rec Headworks with fish ladder in order to maintain fish resources in the whole Pursat River Basin.

[3] JICA, Project on Gender Mainstreaming (2008) PGM Experience on Gender Mainstreaming

# CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

## 7.1 Conclusions

The RGC stresses agriculture and irrigation development in the national development policies and sectoral policies such as (i) National Poverty Reduction Strategy (NPRS) 2003-2005, (ii) National Development Plan (NSDP) 2006-2010 and (iii) Agriculture Sector Strategic Development Plan (ASDP) 2006-2010.

Six sub-projects: (i) Ream Kon, (ii) Por Canal, (iii) Damnak Ampil, (iv) Wat Loung, (v) Wat Chre and (vi) Lum Hach are the target irrigation systems for the SAPROF Study on the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project. According to the result, following project components are recommended for the Project.

**Scope of the Project**

| Area | | | | Scope of the Project |
|---|---|---|---|---|
| **No.** | **Sub Project** | **River Basin** | **Province** | |
| 1 | Ream Kon | Moung Russei | Battambang | Toward: Six Sub-Project Areas<br>*Hardware Component:*<br>(i) Rehabilitation of Irrigation and Drainage Facilities<br>*Software Component:*<br>(i) FWUC Establishment and Strengthening<br>(ii) Agriculture Support Services<br>Toward: Six Sub-Project Areas and River Basins-related<br>*Project Supporting Program:*<br>(i) Meteo-hydrological Observation Strengthening Program<br>*Project Formation Study for Other Potential Areas*<br>Toward: Entire Countries including Six Sub-Project related Provinces<br>*Project Supporting Program:*<br>(ii) Capacity Development of MOWRAM Staffs<br>(iii) Capacity Development of PDOWRAM Staffs |
| 2 | Por Canal | | | |
| 3 | Damnak Ampil | Pursat | Pursat | |
| 4 | Wat Loung | | | |
| 5 | Wat Chre | | | |
| 6 | Lum Hach | Boribo | Kampong Chhnang | |

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By combining hardware and software activities in the Project, the area, 25,610 ha consisting of: (i) primary benefited area (12,760 ha) and (ii) secondary benefited area (12,850 ha) will be benefited from the Project in: (i) effective utilization of available resources through the rehabilitation of irrigation and drainage facilities and (ii) establishment of sustainable O&M system to increase agricultural productivity and to enhance living standard of farmers. From the Project, 32,000 ton of incremental rice production is expected, which correspond to 27 % of a shortage of rice (117,000 tons)[1] in 2020 in the country.

The evaluation shows that the Project is economically feasible and contributing to the enhancement of "capacity to pay" of farmers. In addition, no significant adverse environmental impact will be expected, if proposed mitigation measures are concurrently carried out. In conclusion, the SAPROF Study Team recommends that the Project be carried out in the manner proposed in the SAPROF Study.

1 The figure is according to "Food Balance and Food Security" explained in Section 2.2 based on: (i) Seed and post harvest loss: 13 %, (ii) conversion rate to milled rice: 64 %: the figure utilized for the Food Balance Sheet of 2001 afterward, and (iii) 143 kg/person (MAFF).

## 7.2 Recommendations

Following issues need to be considered as risks for the smooth implementation of the Project.

(1) No large scale resettlement is necessary, instead land acquisition is required for the construction of main, secondary and tertiary canals. Appropriate procedure based on the regulation of the Government through consensus building is important in this process.

(2) Project Management Unit (PMU) Japan Support Fund is primarily in charge of Project implementation. Without constructing coordinating systems among relevant organizations, it will be difficult to smoothly implement the Project. It is necessary to carry out arrangement for the preparation of implementing organization mechanism by coordination with relevant organizations including local administration such as provincial government and commune councils.

(3) Without arranging O&M budget as proposed, the system sustainability will be imperiled. O&M budget necessary for the rehabilitated facilities need to be arranged by both Government and FWUCs based on the analysis in the SAPROF Report.

(4) Although it is an external factor, implementation of the Project will be jeopardized by drastic price increase of construction works-related goods and materials in Cambodia.

After the SAPROF Study, the following preparatory works and arrangement are recommended to be carried out by MOWRAM.

(1) On the basis of the SAPROF Study Report, relevant organizations consisting of MOWRAM, PDOWRAM of Battambang, Pursat and Kampong Chhnang, MEF, MAFF, MOE needs to discuss and exchange opinions to commence the Project in the earliest stage.

(2) Project Management Unit (PMU) Japan Support Fund of MOWRAM is required to start arrangement for the establishment of a project management office and steering committee at the national level and project implementation units at the provincial level. The member of the steering committee would be listed in the following table.

**List of Organizations to be Members of Steering Committee for the Project (at the National Level)**

| No. | Organizations |
|---|---|
| 1. | Ministry of Water Resources and Meteorology (MOWRAM) |
| 2. | Ministry of Agriculture, Forestry and Fisheries (MAFF) |
| 3. | Ministry of Economy and Finance (MEF) |
| 4. | Ministry of Environment |
| 5. | Others (Ministry of Public Works and Transport etc.) |

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(3) PMU Japan Support Fund is requested to explain information on the Project such as contents and implementation schedule to the members of Steering Committee for the necessary arrangement.

(4) PMU Japan Support Fund needs to arrange establishment of PIU at each province. In addition, arrangement with relevant rural administration consisting of provincial government and commune councils needs to be made for smooth commencement and implementation of the Project.

**List of Organizations Relevant to the Project**
**(at the Local Level)**

| No. | Organizations |
|---|---|
| **Provincial Level** | |
| 1. | Provincial Department of Water Resources and Meteorology (PDOWRAM) |
| 2. | Provincial Department of Agriculture (PDA) |
| 3. | Provincial Government (Battambang, Pursat and Kampong Chhnang |
| 4. | Provincial Coordination Committee |
| **Commune Level** | |
| 4. | Commune Councils (CCs) under the sub-projects |

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(5) Resettlement unit under PMU Japan Support Fund is required to carry out pre-arrangement for land acquisition for the Project such as confirmation of latest regulation and discussion with relevant Ministerial organization.

# *PART III*
# *IMPLEMENTATION PROGRAM*

# *TABLE*

## Table III 1.2.1 Five-day Discharge at Basak Reservoir and from Residual Area

Basak Reservoir on Moung Russei river

CA = 598 km2 (m3/s)

| Month | 5-day | Year 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Jan | 1 | 3.18 | 0.26 | 1.37 | 1.32 | 1.73 |
| | 2 | 2.63 | 0.25 | 1.11 | 1.28 | 1.45 |
| | 3 | 2.45 | 0.25 | 1.05 | 1.23 | 1.25 |
| | 4 | 2.43 | 0.25 | 0.99 | 1.15 | 1.07 |
| | 5 | 2.19 | 0.23 | 0.94 | 1.02 | 0.96 |
| | 6 | 2.02 | 0.23 | 0.88 | 0.85 | 0.94 |
| Feb | 1 | 1.92 | 1.62 | 0.85 | 0.74 | 0.90 |
| | 2 | 1.75 | 1.56 | 0.81 | 0.71 | 0.86 |
| | 3 | 1.61 | 1.53 | 0.77 | 0.70 | 0.86 |
| | 4 | 1.52 | 1.50 | 0.72 | 0.68 | 0.83 |
| | 5 | 1.44 | 1.45 | 0.70 | 0.68 | 0.83 |
| | 6 | 1.39 | 1.40 | 0.68 | 0.67 | 0.81 |
| Mar | 1 | 1.29 | 1.43 | 0.68 | 0.66 | 0.80 |
| | 2 | 1.22 | 1.36 | 0.66 | 0.65 | 0.78 |
| | 3 | 1.25 | 1.33 | 0.66 | 0.64 | 0.77 |
| | 4 | 1.34 | 1.32 | 0.66 | 0.62 | 0.75 |
| | 5 | 1.70 | 1.32 | 0.64 | 0.61 | 0.73 |
| | 6 | 3.24 | 1.33 | 0.63 | 0.61 | 0.72 |
| Apr | 1 | 2.83 | 2.04 | 0.62 | 0.60 | 0.73 |
| | 2 | 1.89 | 2.01 | 0.62 | 0.60 | 0.72 |
| | 3 | 1.54 | 1.97 | 0.61 | 0.60 | 0.74 |
| | 4 | 1.43 | 1.93 | 0.60 | 0.62 | 0.86 |
| | 5 | 1.33 | 1.93 | 0.60 | 0.77 | 1.13 |
| | 6 | 1.22 | 3.73 | 0.60 | 0.74 | 1.85 |
| May | 1 | 1.31 | 6.64 | 0.79 | 1.52 | 2.41 |
| | 2 | 1.31 | 4.43 | 1.19 | 2.26 | 2.58 |
| | 3 | 1.39 | 3.88 | 1.34 | 2.68 | 3.21 |
| | 4 | 1.96 | 3.38 | 2.46 | 3.03 | 3.38 |
| | 5 | 1.85 | 3.65 | 2.38 | 2.09 | 2.59 |
| | 6 | 1.61 | 2.86 | 1.96 | 1.43 | 1.97 |
| Jun | 1 | 0.36 | 1.22 | 1.56 | 3.26 | 3.98 |
| | 2 | 0.47 | 1.10 | 1.18 | 4.84 | 5.41 |
| | 3 | 0.56 | 1.14 | 1.10 | 4.71 | 5.11 |
| | 4 | 0.46 | 1.20 | 1.05 | 4.79 | 5.15 |
| | 5 | 0.38 | 1.07 | 1.06 | 5.42 | 5.87 |
| | 6 | 0.34 | 1.03 | 1.04 | 5.99 | 5.68 |
| Jul | 1 | 1.14 | 0.47 | 1.10 | 6.00 | 6.80 |
| | 2 | 1.12 | 0.49 | 1.25 | 7.06 | 8.11 |
| | 3 | 1.06 | 0.42 | 1.64 | 5.65 | 7.18 |
| | 4 | 1.03 | 0.38 | 2.10 | 4.69 | 6.20 |
| | 5 | 1.08 | 0.34 | 2.19 | 4.21 | 5.16 |
| | 6 | 1.33 | 0.32 | 2.24 | 3.49 | 4.36 |
| Aug | 1 | 0.42 | 4.56 | 3.34 | 2.61 | 3.34 |
| | 2 | 0.54 | 4.46 | 4.83 | 2.98 | 3.68 |
| | 3 | 0.67 | 4.45 | 4.96 | 4.16 | 4.88 |
| | 4 | 0.76 | 4.59 | 4.76 | 3.97 | 4.62 |
| | 5 | 0.91 | 4.71 | 4.07 | 3.43 | 3.95 |
| | 6 | 1.12 | 6.04 | 3.01 | 3.76 | 4.71 |
| Sep | 1 | 1.17 | 1.16 | 1.86 | 3.82 | 4.46 |
| | 2 | 1.65 | 1.61 | 1.27 | 4.39 | 5.01 |
| | 3 | 1.88 | 2.00 | 1.19 | 5.53 | 5.92 |
| | 4 | 2.13 | 2.43 | 1.32 | 6.76 | 7.70 |
| | 5 | 2.36 | 3.01 | 1.78 | 7.97 | 8.78 |
| | 6 | 2.46 | 3.41 | 2.52 | 8.38 | 9.60 |
| Oct | 1 | 13.14 | 4.69 | 4.83 | 8.31 | 9.82 |
| | 2 | 13.27 | 4.83 | 7.25 | 7.86 | 9.17 |
| | 3 | 14.01 | 4.25 | 7.69 | 9.53 | 9.19 |
| | 4 | 14.06 | 3.85 | 9.30 | 10.08 | 11.35 |
| | 5 | 12.84 | 3.43 | 10.90 | 8.21 | 11.87 |
| | 6 | 12.07 | 5.09 | 11.78 | 7.45 | 9.96 |
| Nov | 1 | 9.38 | 12.46 | 8.79 | 6.71 | 11.18 |
| | 2 | 9.09 | 11.11 | 6.75 | 5.57 | 9.38 |
| | 3 | 8.40 | 9.50 | 5.63 | 4.60 | 8.31 |
| | 4 | 7.47 | 8.47 | 4.98 | 4.26 | 10.13 |
| | 5 | 6.46 | 8.67 | 4.23 | 3.84 | 12.69 |
| | 6 | 5.02 | 8.85 | 3.57 | 3.57 | 6.90 |
| Dec | 1 | 1.85 | 3.82 | 2.66 | 3.45 | 5.24 |
| | 2 | 1.38 | 3.32 | 1.95 | 3.29 | 4.76 |
| | 3 | 1.07 | 2.77 | 1.66 | 2.80 | 4.12 |
| | 4 | 1.00 | 2.05 | 1.61 | 2.39 | 3.65 |
| | 5 | 0.95 | 1.50 | 1.53 | 2.26 | 3.23 |
| | 6 | 0.84 | 1.27 | 1.51 | 2.10 | 2.79 |
| Annual | | 2.94 | 2.90 | 2.47 | 3.42 | 4.43 |

Residual Area in Moung Russei river basin

CA = 187 km2 (m3/s)

| Month | 5-day | Year 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Jan | 1 | 0.99 | 0.08 | 0.42 | 0.41 | 0.54 |
| | 2 | 0.82 | 0.08 | 0.34 | 0.40 | 0.45 |
| | 3 | 0.76 | 0.08 | 0.33 | 0.38 | 0.39 |
| | 4 | 0.75 | 0.08 | 0.31 | 0.36 | 0.33 |
| | 5 | 0.68 | 0.07 | 0.29 | 0.32 | 0.30 |
| | 6 | 0.63 | 0.07 | 0.27 | 0.26 | 0.29 |
| Feb | 1 | 0.60 | 0.50 | 0.26 | 0.23 | 0.28 |
| | 2 | 0.54 | 0.48 | 0.25 | 0.22 | 0.27 |
| | 3 | 0.50 | 0.47 | 0.24 | 0.22 | 0.27 |
| | 4 | 0.47 | 0.47 | 0.22 | 0.21 | 0.26 |
| | 5 | 0.45 | 0.45 | 0.22 | 0.21 | 0.26 |
| | 6 | 0.43 | 0.43 | 0.21 | 0.21 | 0.25 |
| Mar | 1 | 0.40 | 0.44 | 0.21 | 0.20 | 0.25 |
| | 2 | 0.38 | 0.42 | 0.20 | 0.20 | 0.24 |
| | 3 | 0.39 | 0.41 | 0.20 | 0.20 | 0.24 |
| | 4 | 0.42 | 0.41 | 0.20 | 0.19 | 0.23 |
| | 5 | 0.53 | 0.41 | 0.20 | 0.19 | 0.23 |
| | 6 | 1.00 | 0.41 | 0.20 | 0.19 | 0.22 |
| Apr | 1 | 0.88 | 0.63 | 0.19 | 0.19 | 0.23 |
| | 2 | 0.59 | 0.62 | 0.19 | 0.19 | 0.22 |
| | 3 | 0.48 | 0.61 | 0.19 | 0.19 | 0.23 |
| | 4 | 0.44 | 0.60 | 0.19 | 0.19 | 0.27 |
| | 5 | 0.41 | 0.60 | 0.19 | 0.24 | 0.35 |
| | 6 | 0.38 | 1.16 | 0.19 | 0.23 | 0.57 |
| May | 1 | 0.41 | 2.06 | 0.24 | 0.47 | 0.75 |
| | 2 | 0.41 | 1.37 | 0.37 | 0.70 | 0.80 |
| | 3 | 0.43 | 1.20 | 0.42 | 0.83 | 1.00 |
| | 4 | 0.61 | 1.05 | 0.76 | 0.94 | 1.05 |
| | 5 | 0.57 | 1.13 | 0.74 | 0.65 | 0.80 |
| | 6 | 0.50 | 0.89 | 0.61 | 0.44 | 0.61 |
| Jun | 1 | 0.11 | 0.38 | 0.48 | 1.01 | 1.23 |
| | 2 | 0.15 | 0.34 | 0.37 | 1.50 | 1.68 |
| | 3 | 0.17 | 0.35 | 0.34 | 1.46 | 1.58 |
| | 4 | 0.14 | 0.37 | 0.33 | 1.48 | 1.60 |
| | 5 | 0.12 | 0.33 | 0.33 | 1.68 | 1.82 |
| | 6 | 0.11 | 0.32 | 0.32 | 1.86 | 1.76 |
| Jul | 1 | 0.35 | 0.15 | 0.34 | 1.86 | 2.11 |
| | 2 | 0.35 | 0.15 | 0.39 | 2.19 | 2.51 |
| | 3 | 0.33 | 0.13 | 0.51 | 1.75 | 2.23 |
| | 4 | 0.32 | 0.12 | 0.65 | 1.45 | 1.92 |
| | 5 | 0.33 | 0.11 | 0.68 | 1.31 | 1.60 |
| | 6 | 0.41 | 0.10 | 0.69 | 1.08 | 1.35 |
| Aug | 1 | 0.13 | 1.41 | 1.04 | 0.81 | 1.04 |
| | 2 | 0.17 | 1.38 | 1.50 | 0.92 | 1.14 |
| | 3 | 0.21 | 1.38 | 1.54 | 1.29 | 1.51 |
| | 4 | 0.24 | 1.42 | 1.48 | 1.23 | 1.43 |
| | 5 | 0.28 | 1.46 | 1.26 | 1.06 | 1.22 |
| | 6 | 0.35 | 1.87 | 0.93 | 1.17 | 1.46 |
| Sep | 1 | 0.36 | 0.36 | 0.58 | 1.18 | 1.38 |
| | 2 | 0.51 | 0.50 | 0.39 | 1.36 | 1.55 |
| | 3 | 0.58 | 0.62 | 0.37 | 1.71 | 1.84 |
| | 4 | 0.66 | 0.75 | 0.41 | 2.10 | 2.39 |
| | 5 | 0.73 | 0.93 | 0.55 | 2.47 | 2.72 |
| | 6 | 0.76 | 1.06 | 0.78 | 2.60 | 2.98 |
| Oct | 1 | 4.07 | 1.45 | 1.50 | 2.58 | 3.04 |
| | 2 | 4.11 | 1.50 | 2.25 | 2.44 | 2.84 |
| | 3 | 4.34 | 1.32 | 2.38 | 2.95 | 2.85 |
| | 4 | 4.36 | 1.19 | 2.88 | 3.12 | 3.52 |
| | 5 | 3.98 | 1.06 | 3.38 | 2.55 | 3.68 |
| | 6 | 3.74 | 1.58 | 3.65 | 2.31 | 3.09 |
| Nov | 1 | 2.91 | 3.86 | 2.72 | 2.08 | 3.46 |
| | 2 | 2.82 | 3.44 | 2.09 | 1.73 | 2.91 |
| | 3 | 2.60 | 2.95 | 1.75 | 1.43 | 2.58 |
| | 4 | 2.32 | 2.63 | 1.54 | 1.32 | 3.14 |
| | 5 | 2.00 | 2.69 | 1.31 | 1.19 | 3.93 |
| | 6 | 1.56 | 2.74 | 1.11 | 1.11 | 2.14 |
| Dec | 1 | 0.57 | 1.18 | 0.82 | 1.07 | 1.62 |
| | 2 | 0.43 | 1.03 | 0.60 | 1.02 | 1.48 |
| | 3 | 0.33 | 0.86 | 0.51 | 0.87 | 1.28 |
| | 4 | 0.31 | 0.64 | 0.50 | 0.74 | 1.13 |
| | 5 | 0.29 | 0.47 | 0.47 | 0.70 | 1.00 |
| | 6 | 0.26 | 0.39 | 0.47 | 0.65 | 0.87 |
| Annual | | 0.91 | 0.90 | 0.76 | 1.06 | 1.37 |

Note: Residual Area is between Basak Reservoir and Moung Russei

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

## Table III 1.2.2 Five-day Discharge at Damnak Ampil Weir

CA= 4,480 km2 Pursat river (m3/s)

| | | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | 8.2 | 26.2 | 34.0 | 7.1 | 14.5 | 30.7 | 25.6 | 11.9 | 17.3 | 6.2 | 6.8 |
| | 2 | 6.0 | 23.1 | 26.5 | 6.5 | 13.6 | 26.6 | 21.5 | 11.2 | 15.0 | 5.3 | 6.8 |
| | 3 | 5.1 | 14.6 | 21.5 | 5.8 | 13.1 | 24.8 | 19.2 | 10.8 | 14.0 | 4.9 | 6.6 |
| | 4 | 5.1 | 12.1 | 18.6 | 5.5 | 12.8 | 23.3 | 19.1 | 10.3 | 13.4 | 4.8 | 6.2 |
| | 5 | 5.1 | 11.5 | 17.1 | 5.1 | 12.0 | 22.1 | 16.8 | 9.9 | 12.8 | 4.7 | 5.6 |
| | 6 | 5.1 | 11.0 | 15.9 | 4.7 | 11.4 | 20.8 | 14.7 | 10.5 | 11.7 | 4.7 | 5.4 |
| Feb | 1 | 5.1 | 11.4 | 15.3 | 4.3 | 10.9 | 19.0 | 13.1 | 10.0 | 10.8 | 4.7 | 5.1 |
| | 2 | 5.1 | 9.7 | 15.4 | 4.1 | 10.7 | 20.1 | 11.9 | 9.0 | 10.5 | 3.8 | 4.9 |
| | 3 | 5.1 | 9.1 | 15.4 | 3.7 | 10.1 | 19.3 | 11.0 | 8.7 | 21.6 | 3.2 | 4.9 |
| | 4 | 5.1 | 8.3 | 13.8 | 3.5 | 9.6 | 14.5 | 10.3 | 8.5 | 21.9 | 3.1 | 4.9 |
| | 5 | 4.9 | 8.6 | 10.9 | 3.3 | 9.1 | 11.5 | 9.8 | 8.3 | 9.1 | 3.4 | 4.9 |
| | 6 | 4.9 | 9.0 | 10.4 | 3.1 | 8.8 | 13.9 | 9.5 | 8.2 | 9.0 | 4.0 | 4.9 |
| Mar | 1 | 4.9 | 9.0 | - | 2.8 | 8.4 | 13.2 | 31.2 | 7.9 | 8.9 | 3.2 | 4.7 |
| | 2 | 4.9 | 8.8 | - | 2.8 | 8.3 | 16.5 | 30.9 | 8.1 | 11.5 | 3.2 | 4.7 |
| | 3 | 4.9 | 7.6 | - | 2.8 | 8.3 | 20.9 | 32.8 | 7.6 | 11.3 | 3.2 | 4.7 |
| | 4 | 4.9 | 7.1 | - | 2.7 | 8.2 | 17.9 | 20.3 | 7.5 | 10.5 | 3.2 | 4.6 |
| | 5 | 4.9 | 7.3 | - | 2.5 | 8.0 | 14.5 | 38.6 | 8.1 | 13.1 | 3.1 | 4.1 |
| | 6 | 4.9 | 6.6 | - | 2.4 | 8.6 | 11.2 | 23.9 | 8.1 | 18.7 | 3.0 | 4.1 |
| Apr | 1 | 8.4 | 4.7 | - | 2.2 | 13.2 | 11.5 | 21.3 | 7.9 | 16.9 | 2.5 | 4.9 |
| | 2 | 8.1 | 9.5 | - | 2.1 | 72.5 | 11.8 | 18.0 | 8.4 | 12.2 | 2.3 | 4.9 |
| | 3 | 6.2 | 10.7 | - | 2.1 | 43.9 | 12.9 | 13.1 | 10.5 | 10.1 | 2.3 | 8.3 |
| | 4 | 6.2 | 14.2 | - | 2.2 | 34.2 | 91.6 | 11.6 | 11.1 | 10.0 | 2.8 | 7.9 |
| | 5 | 8.1 | 18.7 | - | 2.5 | 46.4 | 118.8 | 10.8 | 15.1 | 9.6 | 4.6 | 7.7 |
| | 6 | 8.3 | 12.2 | - | 3.5 | 39.4 | 88.2 | 10.8 | 13.2 | 19.6 | 3.7 | 9.4 |
| May | 1 | 9.7 | 20.3 | - | 7.4 | 169.5 | 48.5 | 13.1 | 12.1 | 21.6 | 4.1 | 8.4 |
| | 2 | 9.0 | 19.5 | - | 7.4 | 97.3 | 106.3 | 13.7 | 13.0 | 18.2 | 3.2 | 8.4 |
| | 3 | 10.7 | 19.3 | - | 8.0 | 95.1 | 124.1 | 13.8 | 16.8 | 14.7 | 2.4 | 7.1 |
| | 4 | 7.1 | 56.1 | - | 9.5 | 220.5 | 58.3 | 22.9 | 13.0 | 18.7 | 3.8 | 8.2 |
| | 5 | 6.9 | 68.5 | - | 9.8 | 269.7 | 53.9 | 20.4 | 12.3 | 24.6 | 6.5 | 34.7 |
| | 6 | 4.8 | 34.8 | - | 8.9 | 134.7 | 53.1 | 14.9 | 13.7 | 20.5 | 5.1 | 19.3 |
| Jun | 1 | 9.5 | 90.3 | - | 8.0 | 113.5 | 78.9 | 15.3 | 10.8 | 20.4 | 11.8 | 12.5 |
| | 2 | 13.0 | 93.2 | - | 8.4 | 205.0 | 155.1 | 31.6 | 10.6 | 21.0 | 17.1 | 10.1 |
| | 3 | 11.6 | 152.1 | - | 9.0 | 113.9 | 69.0 | 23.8 | 14.3 | 38.8 | 35.4 | 32.7 |
| | 4 | 15.6 | 165.2 | - | 10.8 | 156.8 | 42.7 | 22.3 | 14.9 | 41.5 | 156.7 | 15.5 |
| | 5 | 16.3 | 103.2 | - | 10.8 | 70.3 | 66.4 | 17.3 | 13.4 | 58.0 | 117.3 | 10.8 |
| | 6 | 21.9 | 57.4 | - | 11.3 | 73.8 | 103.7 | 77.3 | 19.3 | 63.9 | 62.9 | 10.9 |
| Jul | 1 | 15.6 | 85.8 | - | 12.5 | 191.7 | 161.2 | 100.9 | 16.2 | 60.6 | 27.9 | 15.7 |
| | 2 | 34.5 | 92.3 | - | 16.5 | 102.4 | 218.0 | 175.2 | 19.8 | 96.8 | 38.8 | 29.1 |
| | 3 | 34.3 | 141.2 | - | 17.4 | 70.7 | 174.6 | 36.3 | 19.7 | 87.8 | 40.9 | 22.8 |
| | 4 | 37.0 | 201.8 | - | 20.4 | 65.6 | 311.3 | 20.2 | 15.1 | 84.3 | 118.7 | 16.3 |
| | 5 | 77.2 | 85.3 | - | 19.4 | 48.5 | 125.3 | 19.3 | 15.0 | 120.4 | 115.2 | 36.8 |
| | 6 | 40.8 | 294.0 | - | 25.4 | 185.9 | 146.6 | 17.0 | 23.6 | 257.0 | 78.6 | 98.5 |
| Aug | 1 | 275.8 | 211.7 | - | 26.5 | 245.5 | 111.0 | 15.3 | 19.4 | 93.0 | 40.6 | 282.2 |
| | 2 | 133.6 | 116.1 | - | 37.4 | 155.0 | 140.6 | 35.3 | 57.9 | 161.7 | 69.8 | 87.5 |
| | 3 | 87.1 | 160.5 | - | 44.2 | 53.5 | 106.5 | 157.3 | 26.9 | 36.2 | 162.8 | 153.4 |
| | 4 | 109.5 | 80.5 | - | 55.9 | 40.1 | 170.0 | 162.8 | 58.2 | 42.2 | 99.8 | 59.6 |
| | 5 | 113.3 | 121.8 | - | 56.1 | 97.0 | 191.0 | 59.4 | 69.5 | 94.3 | 86.3 | 19.3 |
| | 6 | 333.3 | 130.0 | - | 42.7 | 164.9 | 148.9 | 40.3 | 81.0 | 70.2 | 102.3 | 20.9 |
| Sep | 1 | 446.0 | 121.3 | - | 99.1 | 382.2 | 117.0 | 58.2 | 83.3 | 33.6 | 62.4 | 17.8 |
| | 2 | 145.8 | 270.0 | - | 127.8 | 253.1 | 106.6 | 55.1 | 48.6 | 61.3 | 70.9 | 29.4 |
| | 3 | 158.5 | 399.4 | - | 82.2 | 127.3 | 106.9 | 39.1 | 72.5 | 73.1 | 60.2 | 58.0 |
| | 4 | 319.5 | 306.3 | - | 138.8 | 77.5 | 82.3 | 34.3 | 42.1 | 80.8 | 73.2 | 151.5 |
| | 5 | 288.8 | 137.9 | - | 115.4 | 100.8 | 219.0 | 113.6 | 98.8 | 93.3 | 178.2 | 124.0 |
| | 6 | 304.0 | 370.4 | - | 218.1 | 186.2 | 259.1 | 217.2 | 114.5 | 231.0 | 58.0 | 55.9 |
| Oct | 1 | 393.4 | 534.4 | - | 251.7 | 399.6 | 347.0 | 244.4 | 82.1 | 344.7 | 139.7 | 24.0 |
| | 2 | 523.8 | 340.6 | - | 230.3 | 218.3 | 218.6 | 398.8 | 96.4 | 438.1 | 301.4 | 40.0 |
| | 3 | 569.4 | 326.8 | - | 299.2 | 259.0 | 578.5 | 293.5 | 53.7 | 201.6 | 158.3 | 99.2 |
| | 4 | 260.6 | 363.7 | - | 179.2 | 429.4 | 562.6 | 221.3 | 26.7 | 491.6 | 67.1 | 151.4 |
| | 5 | 117.1 | 562.7 | - | 120.0 | 279.5 | 477.1 | 268.4 | 34.0 | 433.6 | 52.9 | 192.6 |
| | 6 | 174.7 | 641.1 | - | 84.1 | 502.2 | 390.6 | 234.0 | 250.3 | 230.0 | 48.6 | 337.4 |
| Nov | 1 | 232.3 | 388.5 | - | 48.6 | 672.1 | 340.4 | 155.6 | 134.5 | 82.0 | 43.9 | 88.6 |
| | 2 | 115.7 | 293.9 | - | 62.2 | 561.0 | 220.6 | 78.9 | 58.0 | 40.4 | 41.4 | 211.5 |
| | 3 | 260.0 | 261.1 | - | 49.8 | 312.4 | 178.6 | 45.8 | 54.6 | 34.0 | 37.3 | 112.1 |
| | 4 | 91.0 | 263.8 | - | 103.5 | 198.4 | 286.2 | 38.5 | 53.4 | 30.4 | 33.2 | 73.2 |
| | 5 | 58.7 | 247.4 | - | 83.2 | 109.2 | 263.5 | 30.0 | 49.2 | 25.0 | 30.1 | 71.6 |
| | 6 | 45.1 | 172.7 | - | 65.4 | 83.8 | 205.2 | 24.2 | 35.3 | 21.9 | 27.6 | 24.3 |
| Dec | 1 | 28.2 | 383.5 | - | 56.3 | 80.2 | 120.0 | 20.2 | 31.2 | 20.3 | 25.1 | 20.0 |
| | 2 | 23.3 | 177.7 | - | 37.4 | 220.2 | 68.9 | 17.6 | 24.9 | 18.7 | 22.5 | 20.5 |
| | 3 | 18.8 | 89.8 | - | 28.4 | 88.4 | 54.5 | 16.3 | 25.1 | 26.3 | 20.1 | 18.3 |
| | 4 | 42.5 | 56.0 | - | 23.6 | 58.1 | 67.9 | 16.0 | 18.8 | 14.3 | 15.7 | 16.7 |
| | 5 | 38.3 | 43.5 | - | 19.8 | 43.9 | 51.4 | 15.0 | 20.8 | 12.4 | 13.6 | 15.8 |
| | 6 | 30.7 | 33.0 | - | 16.6 | 35.4 | 37.2 | 13.8 | 20.1 | 10.7 | 9.0 | 14.8 |
| Annual | | 86.8 | 134.1 | - | 43.2 | 128.5 | 125.0 | 58.6 | 32.6 | 68.5 | 42.9 | 43.4 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

Annual average 76.4 m3/s

## Table III 1.2.3 Five-day Discharge at Lum Hach Headworks

CA = 735 km2 Boribo river (m3/s)

| | | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1 | - | 1.25 | 8.85 | 8.42 | 2.73 | 9.67 | 12.95 | 5.94 | - | 1.59 |
| | 2 | - | 1.21 | 6.34 | 7.00 | 2.66 | 9.77 | 12.95 | 5.94 | - | 1.79 |
| | 3 | - | 1.25 | 6.18 | 7.96 | 2.23 | 9.23 | 11.82 | 5.94 | - | 1.61 |
| | 4 | - | 1.68 | 5.94 | 8.62 | 1.57 | 8.41 | 10.80 | 5.75 | - | 1.41 |
| | 5 | - | 3.37 | 4.97 | 6.10 | 9.76 | 8.61 | 6.69 | 5.01 | - | 1.25 |
| | 6 | - | 10.95 | 3.97 | 5.04 | 10.61 | 9.64 | 4.63 | 5.01 | - | 1.21 |
| Feb | 1 | - | 8.99 | 6.62 | 4.55 | 8.37 | 10.90 | 4.05 | 4.31 | - | 1.05 |
| | 2 | - | 7.05 | 7.26 | 4.00 | 8.89 | 9.52 | 3.78 | 4.62 | - | 1.05 |
| | 3 | - | 5.88 | 7.00 | 3.35 | 7.96 | 9.53 | 3.49 | 4.25 | - | 1.00 |
| | 4 | - | 3.23 | 3.73 | 2.98 | 9.25 | 9.67 | 3.38 | 4.28 | - | 0.95 |
| | 5 | - | 2.44 | 2.84 | 2.51 | 9.82 | 9.77 | 3.31 | 4.31 | - | 0.83 |
| | 6 | - | 1.81 | 2.27 | 2.43 | 9.64 | 9.97 | 3.18 | 4.26 | - | 0.73 |
| Mar | 1 | - | 2.17 | 2.28 | 2.40 | 5.26 | 10.90 | 4.95 | 4.29 | - | 0.78 |
| | 2 | - | 2.18 | 2.14 | 2.50 | 4.85 | 9.52 | 5.19 | 3.77 | - | 0.72 |
| | 3 | - | 1.93 | 2.27 | 5.82 | 9.18 | 9.53 | 4.69 | 4.05 | - | 0.91 |
| | 4 | - | 1.72 | 2.43 | 6.72 | 9.82 | 9.67 | 3.83 | 3.86 | - | 0.94 |
| | 5 | - | 1.76 | 2.38 | 9.04 | 10.33 | 9.82 | 3.53 | 3.80 | - | 0.85 |
| | 6 | - | 2.60 | 2.79 | 5.63 | 9.60 | 10.33 | 3.28 | 4.10 | - | 0.92 |
| Apr | 1 | - | 1.61 | 2.25 | 4.01 | 7.19 | 8.42 | 3.86 | 30.42 | - | 0.97 |
| | 2 | - | 1.82 | 3.57 | 3.74 | 4.38 | 9.58 | 5.33 | 18.22 | - | 0.87 |
| | 3 | - | 2.95 | 4.73 | 3.80 | 4.95 | 8.67 | 5.38 | 14.78 | - | 0.77 |
| | 4 | - | 2.59 | 5.18 | 3.05 | 6.48 | 9.15 | 4.94 | 9.21 | - | 0.90 |
| | 5 | - | 5.51 | 7.13 | 3.59 | 7.22 | 9.72 | 4.87 | 7.74 | - | 0.85 |
| | 6 | - | 4.15 | 5.96 | 8.85 | 6.55 | 9.05 | 4.35 | 6.55 | - | 0.85 |
| May | 1 | - | 16.22 | 5.22 | 3.87 | 6.92 | 5.82 | 3.50 | 3.37 | - | 1.27 |
| | 2 | - | 13.59 | 4.97 | 3.10 | 6.60 | 2.63 | 3.09 | 3.37 | - | 1.96 |
| | 3 | - | 13.61 | 4.31 | 2.30 | 9.02 | 2.55 | 3.74 | 4.42 | - | 3.05 |
| | 4 | - | 51.18 | 4.15 | 2.08 | 9.97 | 3.58 | 3.62 | 6.96 | - | 3.95 |
| | 5 | - | 92.76 | 4.15 | 2.06 | 10.43 | 4.73 | 4.09 | 9.88 | - | 4.20 |
| | 6 | - | 30.46 | 3.86 | 2.06 | 6.49 | 3.69 | 4.68 | 8.53 | - | 4.55 |
| Jun | 1 | 1.40 | 14.19 | 7.62 | 8.13 | 8.12 | 3.52 | 4.65 | 13.57 | - | 4.48 |
| | 2 | 3.82 | 22.01 | 10.61 | 9.63 | 10.22 | 4.23 | 7.82 | 8.59 | - | 4.78 |
| | 3 | 4.60 | 37.95 | 17.83 | 9.58 | 9.58 | 3.20 | 10.82 | 5.79 | - | 5.76 |
| | 4 | 3.75 | 61.93 | 22.12 | 9.38 | 9.62 | 3.31 | 10.98 | 5.01 | - | 6.32 |
| | 5 | 2.44 | 42.08 | 26.17 | 9.28 | 2.93 | 5.16 | 11.18 | 5.85 | - | 12.89 |
| | 6 | 1.36 | 45.42 | 22.73 | 8.70 | 6.52 | 6.46 | 6.80 | 12.78 | - | 18.76 |
| Jul | 1 | 3.19 | 20.67 | 44.29 | 6.53 | 5.16 | 6.44 | 6.02 | 15.14 | - | 9.06 |
| | 2 | 3.66 | 16.78 | 59.15 | 4.49 | 9.35 | 5.64 | 5.98 | 19.74 | - | 9.45 |
| | 3 | 3.87 | 20.30 | 14.15 | 6.34 | 6.64 | 6.55 | 6.86 | 22.67 | - | 13.40 |
| | 4 | 4.11 | 19.35 | 25.70 | 8.00 | 7.26 | 5.52 | 5.98 | 22.67 | - | 11.80 |
| | 5 | 4.93 | 26.29 | 44.46 | 5.79 | 5.69 | 8.52 | 14.84 | 17.08 | - | 13.95 |
| | 6 | 10.61 | 18.31 | 64.62 | 5.09 | 7.54 | 11.46 | 13.31 | 9.66 | - | 11.48 |
| Aug | 1 | 9.81 | 16.71 | 23.21 | 9.24 | 10.61 | 12.03 | 12.28 | 6.96 | - | 10.10 |
| | 2 | 13.81 | 10.83 | 71.81 | 16.41 | 14.92 | 5.99 | 11.82 | 6.96 | - | 5.26 |
| | 3 | 14.04 | 8.29 | 52.98 | 18.11 | 18.11 | 4.25 | 10.03 | 6.96 | - | 4.37 |
| | 4 | 16.70 | 10.34 | 40.73 | 20.33 | 25.41 | 3.72 | 12.11 | 6.96 | - | 14.31 |
| | 5 | 12.49 | 16.31 | 26.77 | 13.31 | 21.93 | 2.79 | 30.34 | 7.87 | - | 33.76 |
| | 6 | 14.18 | 27.09 | 20.25 | 16.29 | 18.39 | 2.74 | 26.50 | 10.53 | - | 69.62 |
| Sep | 1 | 40.47 | 89.58 | 19.47 | 42.56 | 20.70 | 2.45 | 54.35 | 13.57 | - | 63.74 |
| | 2 | 25.75 | 43.96 | 32.82 | 61.56 | 20.53 | 3.17 | 74.03 | 16.09 | - | 29.90 |
| | 3 | 25.01 | 29.49 | 19.68 | 44.52 | 32.82 | 5.62 | 22.29 | 23.84 | - | 35.17 |
| | 4 | 47.48 | 20.48 | 18.72 | 74.80 | 56.06 | 16.49 | 32.98 | 37.73 | - | 77.02 |
| | 5 | 43.63 | 40.30 | 18.72 | 38.16 | 85.21 | 33.01 | 26.64 | 53.66 | - | 42.30 |
| | 6 | 80.21 | 58.63 | 28.64 | 36.40 | 54.73 | 88.34 | 11.68 | 97.88 | - | 35.00 |
| Oct | 1 | 46.70 | 73.21 | 34.29 | 72.30 | 18.73 | 74.60 | 33.29 | 13.05 | - | 37.82 |
| | 2 | 28.16 | 28.59 | 48.08 | 62.10 | 24.36 | 38.28 | 85.70 | 17.96 | - | 62.85 |
| | 3 | 23.21 | 53.20 | 134.99 | 47.27 | 11.76 | 33.51 | 53.28 | 6.96 | - | 79.15 |
| | 4 | 39.30 | 33.47 | 93.58 | 29.08 | 10.64 | 32.80 | 25.54 | 8.84 | - | 103.37 |
| | 5 | 22.58 | 19.37 | 75.34 | 25.55 | 26.18 | 32.05 | 16.67 | 12.19 | - | 48.52 |
| | 6 | 23.50 | 46.86 | 52.19 | 21.28 | 101.51 | 19.85 | 11.84 | 20.93 | - | 26.60 |
| Nov | 1 | 23.83 | 122.18 | 40.15 | 20.31 | 21.88 | 16.71 | 6.37 | 7.93 | - | 20.66 |
| | 2 | 25.40 | 104.65 | 23.16 | 16.51 | 13.68 | 13.37 | 5.01 | 6.96 | - | 16.07 |
| | 3 | 30.88 | 37.24 | 16.83 | 15.29 | 29.71 | 9.32 | 5.01 | 6.96 | - | 11.98 |
| | 4 | 34.51 | 30.12 | 20.05 | 13.07 | 14.10 | 6.47 | 5.01 | 8.78 | - | 14.84 |
| | 5 | 29.09 | 18.74 | 24.73 | 12.04 | 10.93 | 5.08 | 4.42 | 7.18 | - | 14.91 |
| | 6 | 24.73 | 17.28 | 18.19 | 9.04 | 6.75 | 4.97 | 9.76 | 6.96 | - | 10.86 |
| Dec | 1 | - | 16.83 | 8.85 | 6.50 | 7.86 | 4.20 | 9.56 | 6.96 | 2.43 | 9.29 |
| | 2 | - | 50.51 | 6.34 | 5.26 | 5.99 | 3.86 | 8.09 | 6.96 | 2.43 | 7.99 |
| | 3 | - | 18.30 | 6.18 | 4.32 | 4.94 | 15.74 | 7.61 | 6.96 | 2.43 | 7.19 |
| | 4 | - | 16.12 | 5.94 | 3.09 | 4.65 | 13.64 | 6.96 | 6.96 | 2.43 | 6.21 |
| | 5 | - | 13.59 | 4.97 | 2.55 | 4.55 | 12.72 | 6.96 | 8.78 | 2.25 | 4.60 |
| | 6 | - | 9.80 | 3.97 | 2.09 | 4.45 | 12.71 | 6.96 | 9.23 | 1.86 | 3.80 |
| Annual | | - | 23.96 | 20.65 | 13.72 | 14.02 | 11.84 | 12.45 | 11.46 | - | 14.91 |

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

Annual average 15.38 m3/s

**Table III 1.6.1 Function of Departments under MOWRAM**

| Department | Function |
|---|---|
| 1 Director General of Administration Affairs | - Overall management of administrative services in the Ministry |
| 1.1 Administration and Human Resources Department | - Document control |
| | - Salary and insurance management for staffs |
| | - Capacity development for staffs through external and internal training |
| | - Personal management |
| 1.2 Planning and International Cooperation Department | - Statistical data management |
| | - Planning of public investment |
| | - Coordination among the Ministry and foreign donors |
| 1.3 Financial Department | - Budget control |
| | - Accounting |
| 1.4 Technical Service Center for Irrigation and Meteorology | - Capacity development of staffs in technical aspect |
| | - Technology development of irrigation and meteorology |
| | - Extension of new technology |
| | - Prepare manual relevant to irrigation and drainage engineering |
| | - Technical support for PDOWRAM |
| 2 Director General of Technical | - Overall management of technical services in the Ministry |
| 2.1 Water Management and Conservation Department | - Formulation of policy for water resources management and conservation |
| | - Technical support for conservation of catchments area |
| | - Technical inspection for water resources structures including irrgation |
| 2.2 Hydrology and River Works Department | - Management of river system |
| | - Monitoring of water level and water quality |
| | - Forecast of flood and drought |
| | - Development of geographical information system for hydrological use |
| 2.3 Meteorology Department | - Development of meteorological observation system |
| | - Management of meteorological stations |
| | - Collection of meteorological information |
| 2.4 Irrigated Agriculture Department | - Management of pump station and machine |
| | - Extension of irrigated agriculture with relevant organization |
| 2.5 Water Supply and Sanitation Department | - Monitoring water on land and underground |
| | - Management of sewage water |
| | - Monitoring of water quality |
| 2.6 Engineering Department | - Technical development of construction works (more than 200 ha) |
| | - Monitoring material and machinery for construction |
| | - Technical inspection of geological condition of structures |
| 2.7 FWUC Department | - Support of establishment of FWUC |
| | - Strengthening of capacity of FWUC |
| | - Preparation of documents relevant to FWUC establishment and strengthening |
| | - Preparation of maintenance and improvement plan of irrigation system through participation of FWUC |
| | - Monitoring of FWUC activities in collaboration with PDOWRAM |
| | - Support of transfer of irrigation system management to FWUC |

Source : MOWRAM

Prepared by JICA SAPROF Study Team

## Table III 1.6.2 Budget and Expendures of MOWRAM for 2005-2008

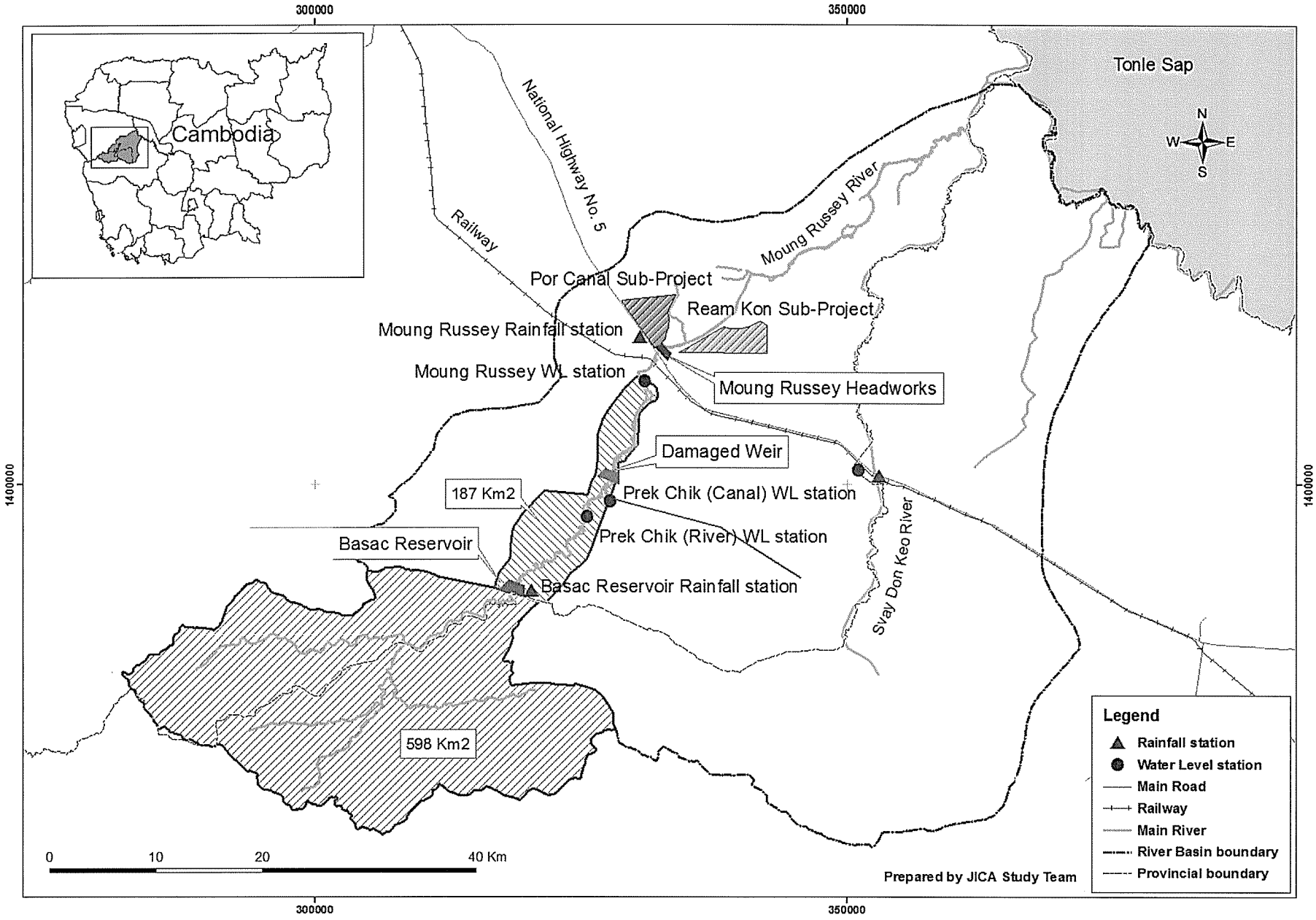
| No. | Year | Item | | MOWRAM Budget | | | Donors | Total | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Estimated Budget | Approved Budget | Actual Expenditures | | | |
| 1 | 2005 | Ordinary Budget | | | | | | | |
| | | National level | Riel | - | 11,335,700,000 | 9,857,989,107 | - | - | |
| | | Provincial level | Riel | - | 4,122,800,000 | 3,837,095,975 | - | - | |
| | | Sub-total | Riel | - | 15,458,500,000 | 13,695,085,082 | - | - | |
| | | Total | Riel | - | 30,917,000,000 | 27,390,170,164 | - | - | |
| | | | US$ | | = | **6,985,506** | | | |
| | | | US$ | | | | | | |
| 2 | 2006 | Ordinary Budget | | | | | | | |
| | | National level | Riel | - | 12,517,402,000 | 11,117,803,108 | - | - | |
| | | Provincial level | Riel | - | 8,018,018,000 | 7,671,117,867 | - | - | |
| | | Sub-total | Riel | - | 20,535,420,000 | 18,788,920,975 | - | - | |
| | | Total | Riel | - | 41,070,840,000 | 37,577,841,950 | - | - | |
| | | | US$ | | = | **9,583,739** | | | |
| | | | US$ | | | | | | |
| 3 | 2007 | Ordinary Budget | | | | | | | |
| | | National level | Riel | - | 13,210,000,000 | 12,392,062,761 | - | - | Exchange rate |
| | | Provincial level | Riel | - | 8,666,638,000 | 8,022,791,619 | - | - | IUS$= |
| | | Sub-total | Riel | - | 21,876,638,000 | 20,414,854,380 | - | - | Riel 3,921 |
| | | Total | Riel | - | 43,753,276,000 | 40,829,708,760 | - | - | |
| | | | US$ | | = | **10,413,086** | | | |
| | | | US$ | | | | | | |
| 4 | 2008 | Ordinary Budget | | | | | | | |
| | | National level | Riel | - | 16,880,800,000 | 15,650,387,295 | - | - | Exchange rate |
| | | Provincial level | Riel | - | 10,500,270,000 | 10,150,858,901 | - | - | IUS$= |
| | | Sub-total | Riel | - | 27,381,070,000 | 25,801,246,196 | - | - | Riel 3,980 |
| | | Total | Riel | - | 54,762,140,000 | 51,602,492,392 | - | - | |
| | | | US$ | | = | **12,965,450** | | | |
| | | | US$ | | | | | | |

Source: MOWRAM

* : *Cambodia Economic Watch*

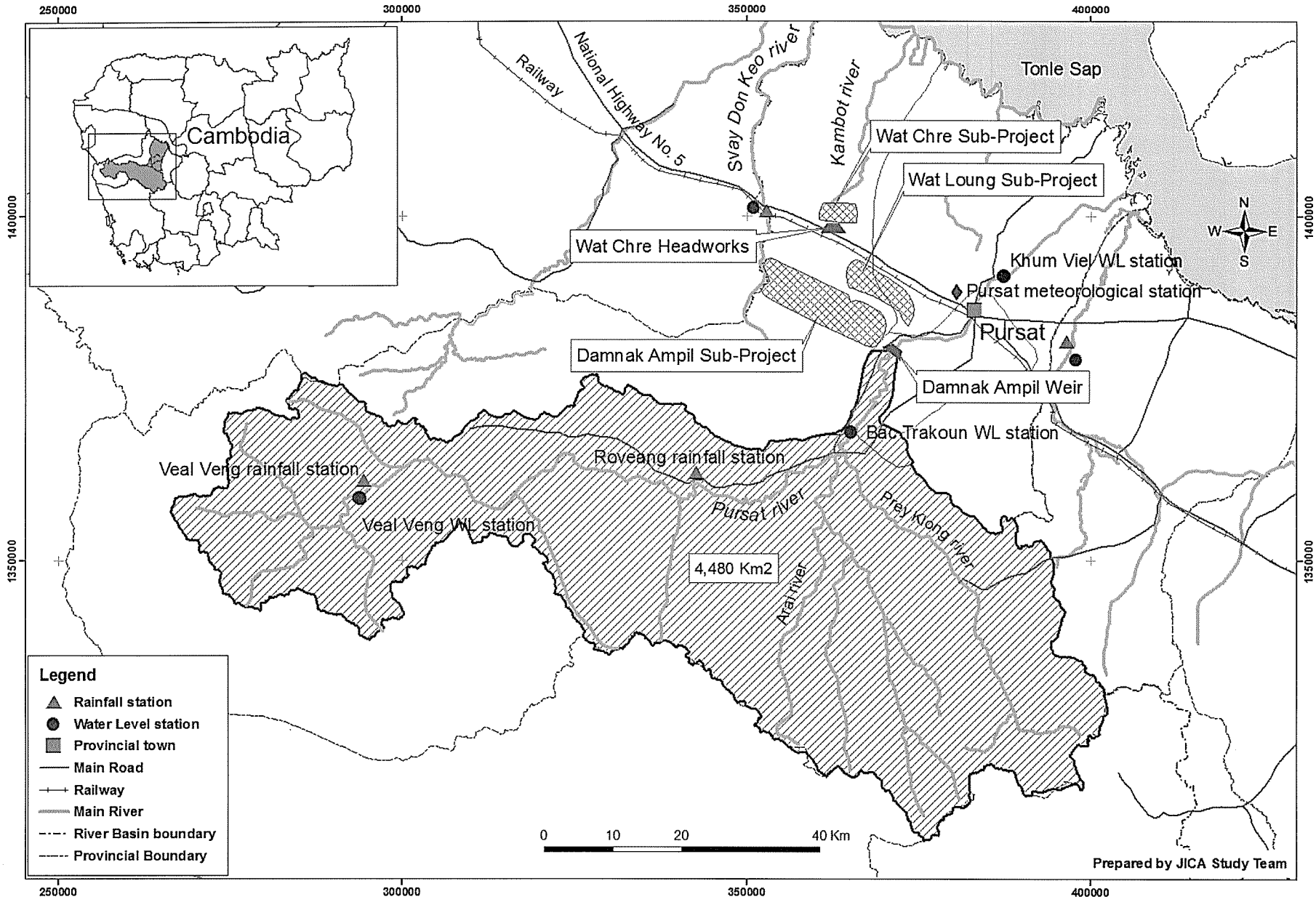
# *PART III*
# *IMPLEMENTATION PROGRAM*

# *FIGURE*



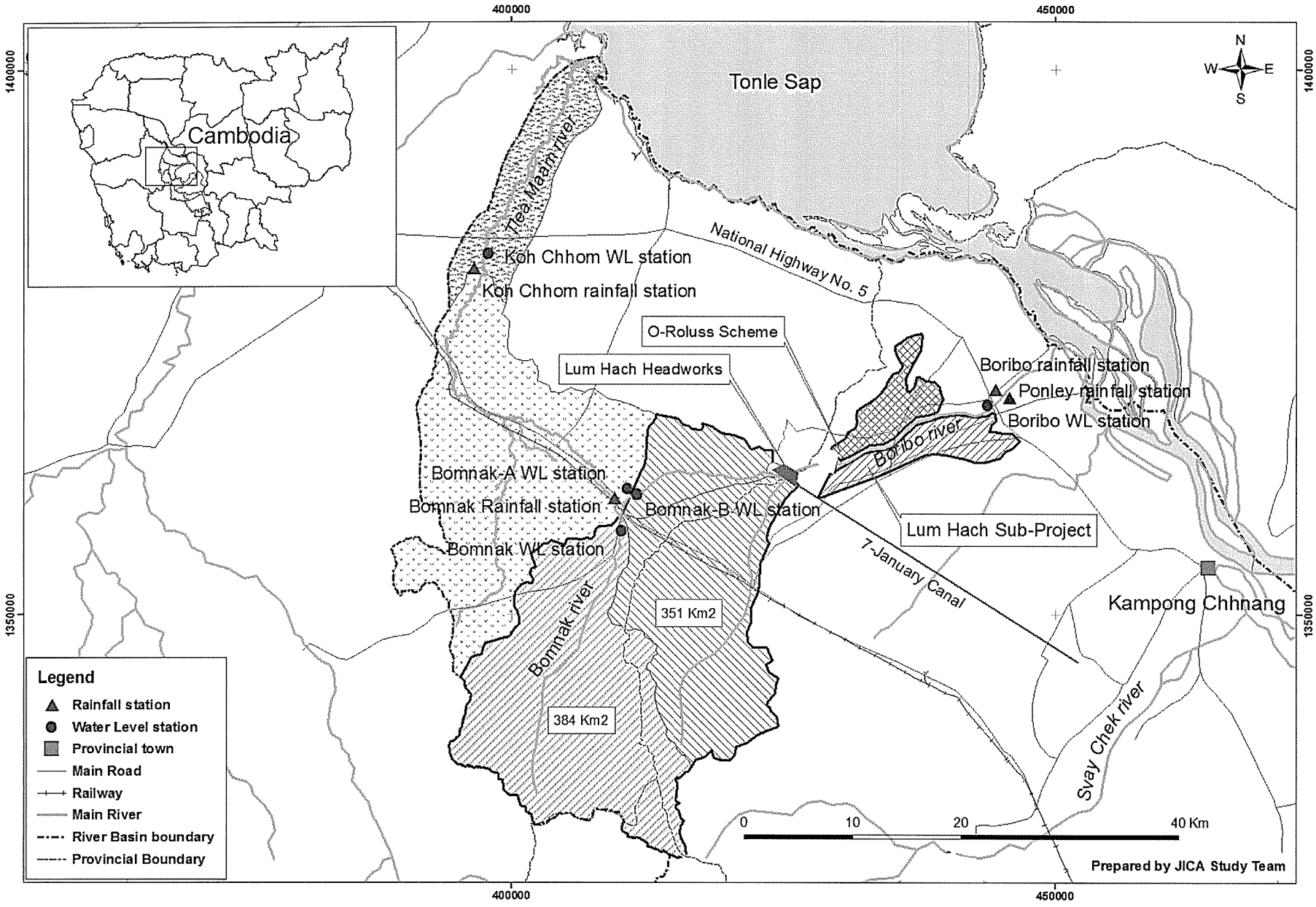

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Figure III 1.2.1 Catchment Area of Moung Russei Headworks, and Ream Kon and Por Canal Sub-Projects**



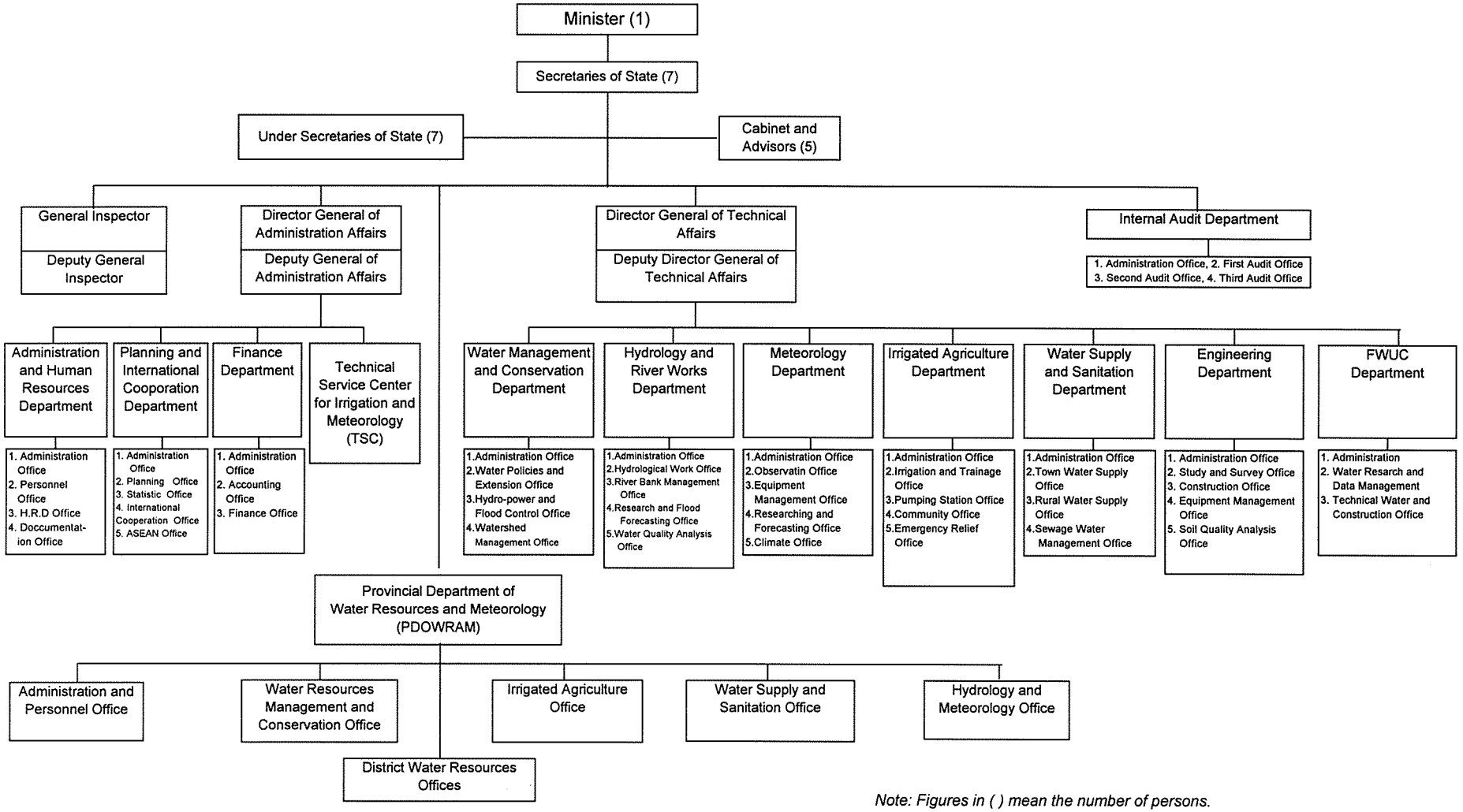

Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Figure III 1.2.2 Catchment Area of Damnak Ampil Headworks, and Damnak Ampil, Wat Loung and Wat Chre Sub-Projects**




Source: JICA (2009), Basin-wide Basic Irrigation and Drainage Master Plan Study

**Figure III 1.2.3 Catchment Area of Boribo River Basin at the Lum Hach Headworks and the Lum Hach Sub-Project**




*Note: Figures in ( ) mean the number of persons.*

Source: MOWRAM

**Figure III 1.6.1 Organizational Structure of Ministry of Water Resources and Meteorology (MOWRAM)**

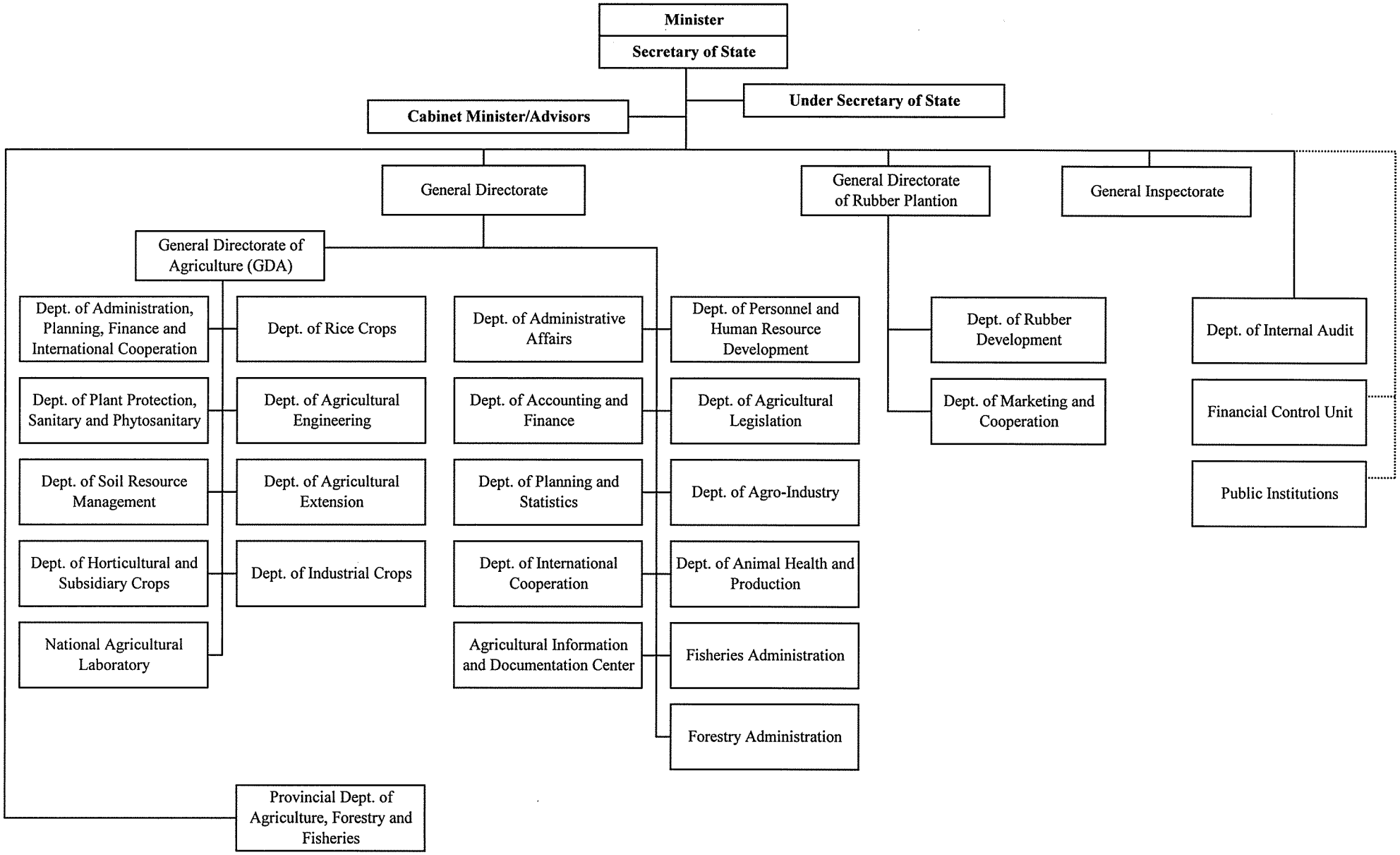



**Figure III 1.6.2 Organizational Structure of Ministry of Agriculture, Forestry and Fisheries (MAFF)**

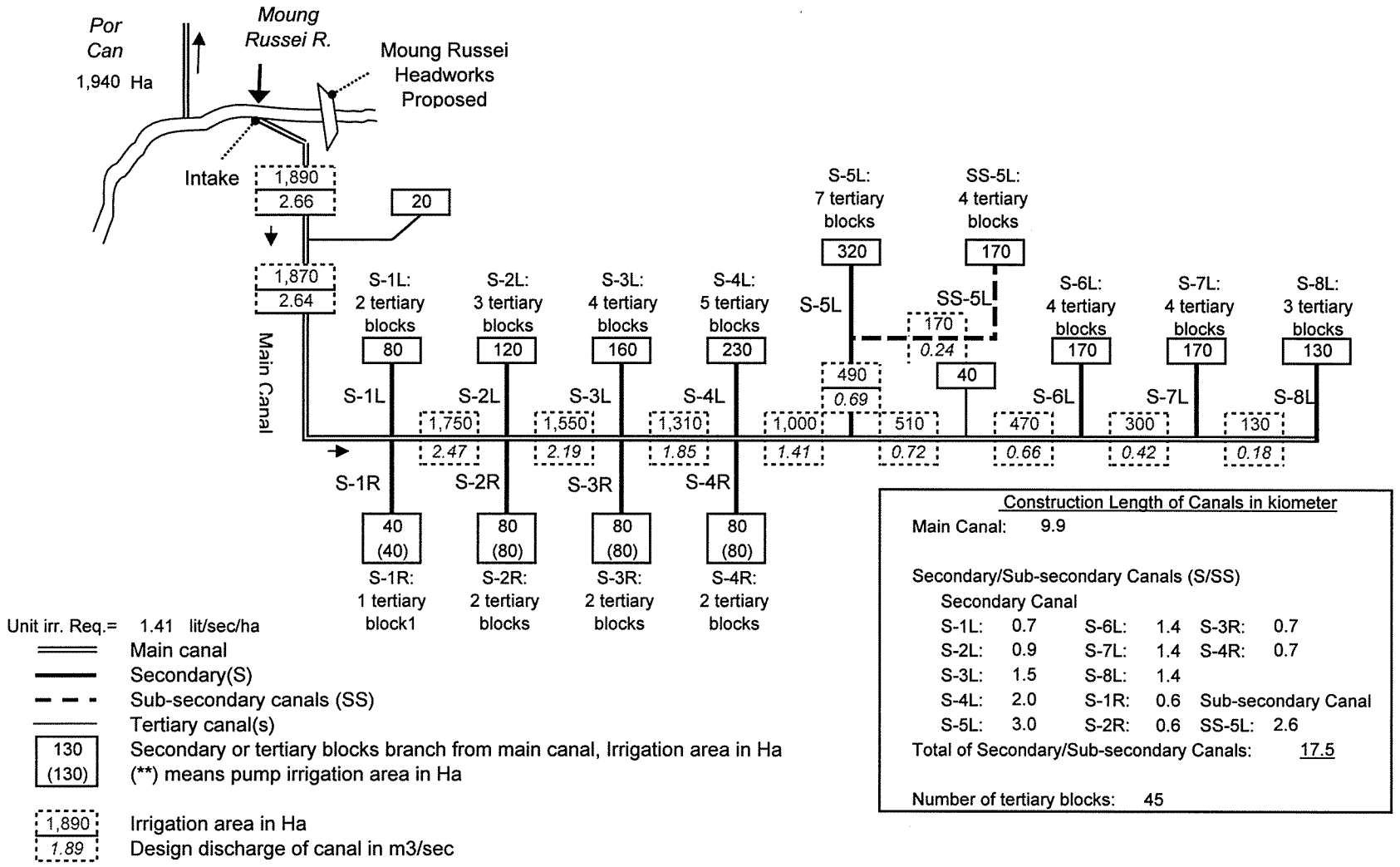



**Figure III 2.3.1 Irrigation Diagram of Ream Kon Sub-project**

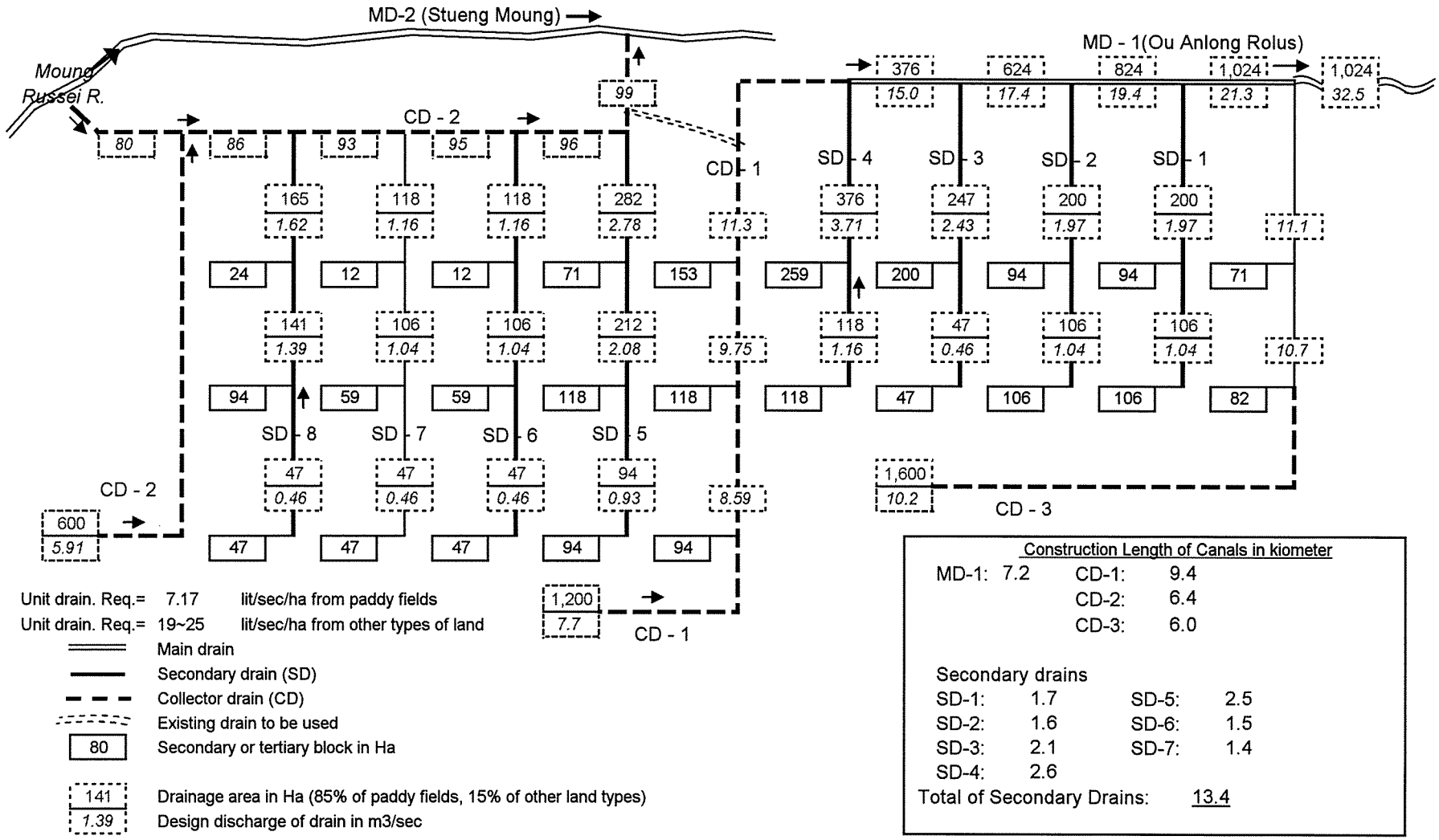
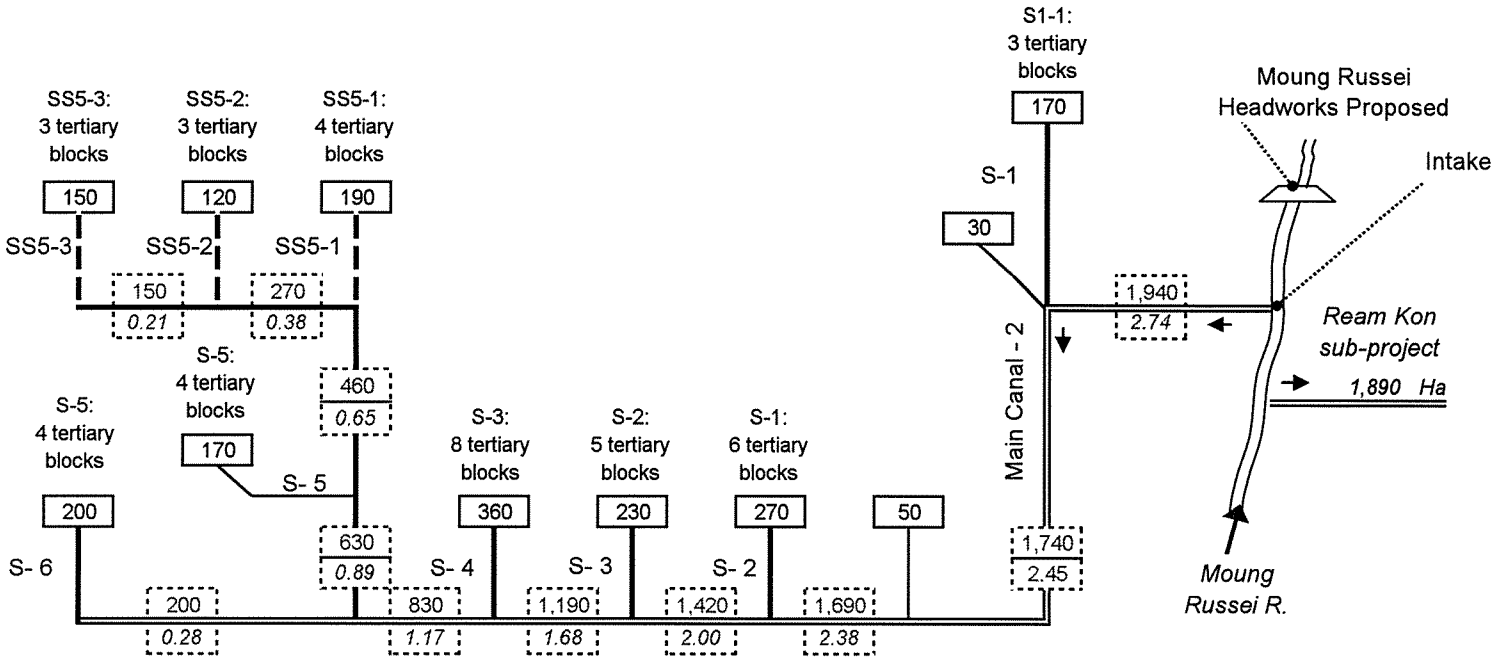



**Figure III 2.3.2 Drainage Diagram of Ream Kon Sub-project**




Unit irr. Req.= 1.41 lit/sec/ha

Main canal

Secondary(S)

Sub-secondary canals (SS)

Tertiary canal(s)

130 Secondary or tertiary blocks branch from main canal, Irrigation area in Ha

1,940 Irrigation area in Ha

1.94 Design discharge of canal in m3/sec

Construction Length of Canals in kiometer

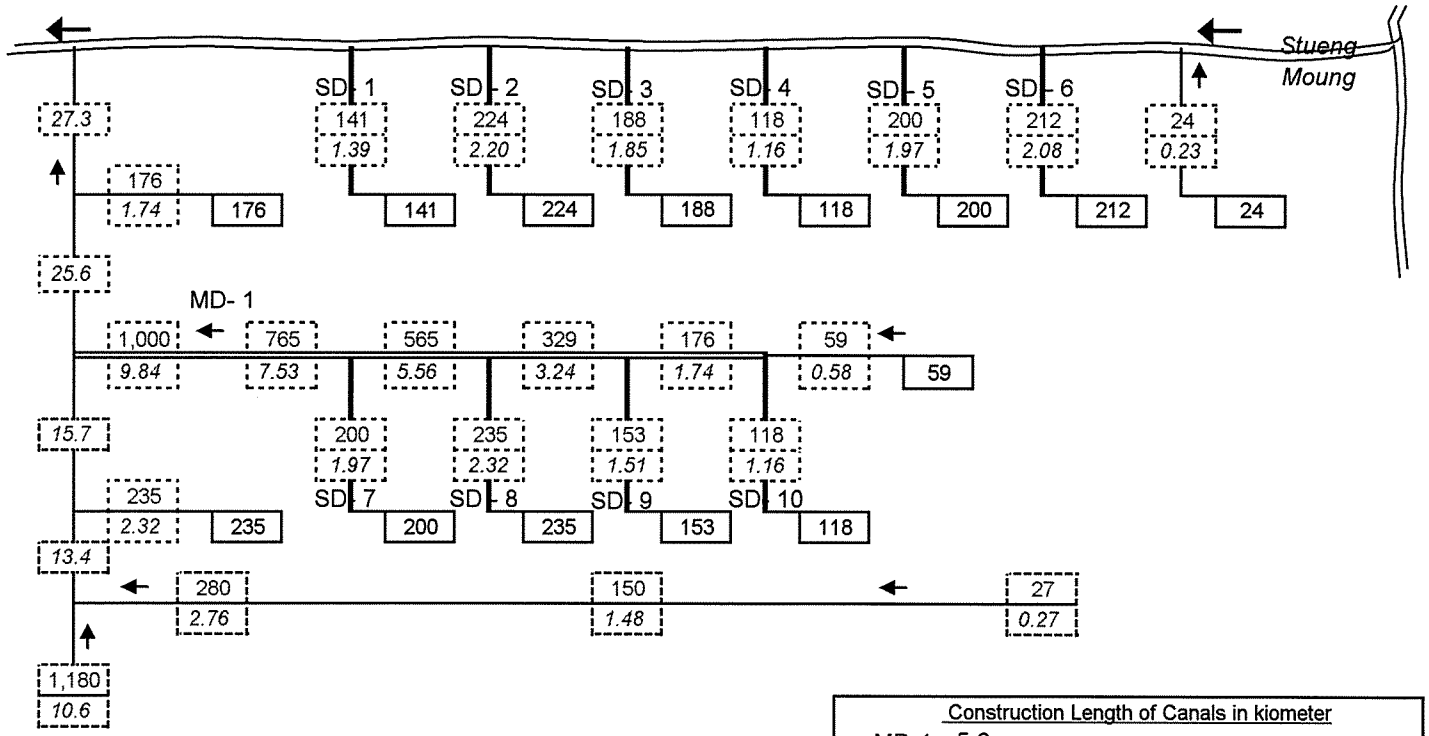
Main Canal: 6.8

| Secondary Canals | | | | Sub-Secondary Canals | |
|---|---|---|---|---|---|
| S-1: | 1.7 | S-5 | 3.8 | SS4-1 | 1.6 |
| S-2: | 2.4 | S-6 | 1.5 | SS4-2 | 1.7 |
| S-3: | 2.0 | | | SS4-3 | 1.5 |
| S-4: | 2.9 | | | | |

Total of Secondary/Sub-secondary Canals : 19.1

Number of tertiary blocks: 42

**Figure III 2.3.3 Irrigation Diagram of Por Canal Sub-project**




Unit drain. Req.= 7.17 lit/sec/ha from paddy fields

Unit drain. Req.= 19~25 lit/sec/ha from other types of land

Main drain

Secondary drain (SD)

Through Existing side ditch

80 Secondary or tertiary block in Ha

235 Drainage area in Ha (85% of paddy fields, 15% of other land types)

2.32 Design discharge of drain in m3/sec

Construction Length of Canals in kiometer

MD-1: 5.6

Secondary drains

| | | | |
|---|---|---|---|
| SD-1: | 1.7 | SD-7: | 1.5 |
| SD-2: | 1.8 | SD-8: | 1.5 |
| SD-3: | 1.9 | SD-9: | 1.4 |
| SD-4: | 1.1 | SD-10: | 0.9 |
| SD-5: | 1.2 | | |
| SD-6: | 1.8 | | |

Total of Secondary Drains: 14.8

**Figure III 2.3.4 Drainage Diagram of Por Canal Sub-project**

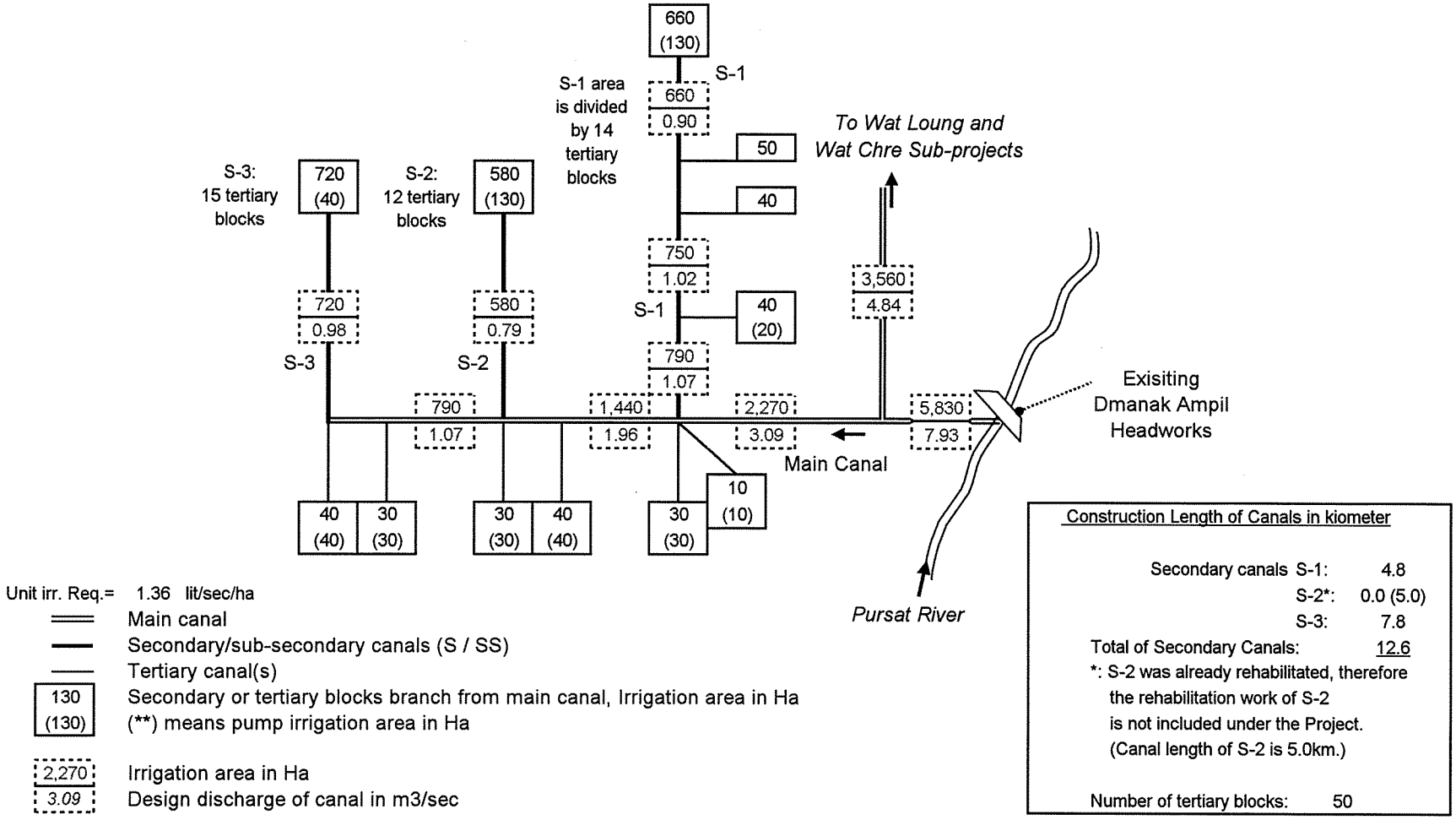
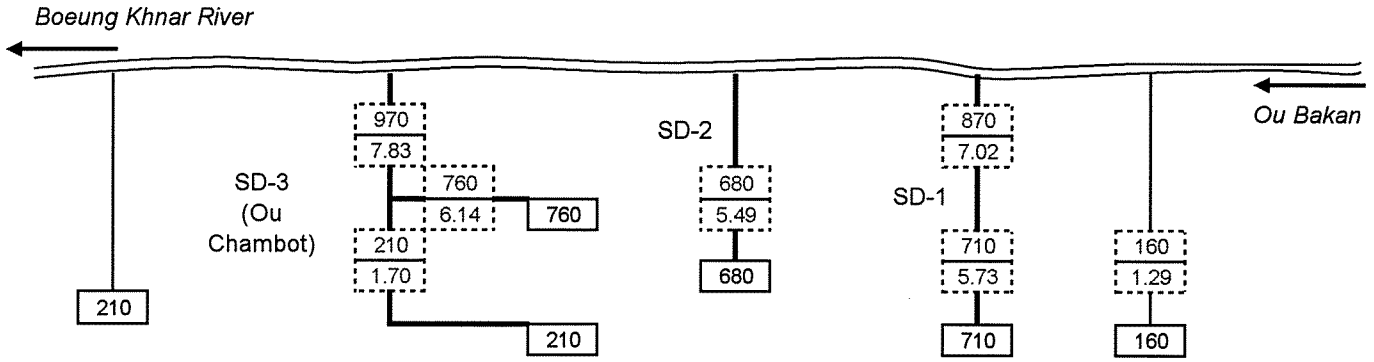



**Figure III 2.3.5 Irrigation Diagram of Damnak Ampil Sub-project**




Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
Unit drain. Req.= 18~25 lit/sec/ha from other types of land

Main drain
Secondary drain
Through Existing side ditch
80 Secondary or tertiary block in Ha

1,060 Drainage area in Ha (85% of paddy fields, 15% of other land types)
9.55 Design discharge of drain in m3/sec

| Construction Length of Canals in kiometer | |
|---|---|
| Seondary Drains | |
| SD-1: | 6.8 |
| SD-2: | 7.8 |
| SD-3: | 7.2 |
| Total of Secondary Drains: | 21.8 |

**Figure III 2.3.6 Drainage Diagram of Damnak Ampil Sub-project**

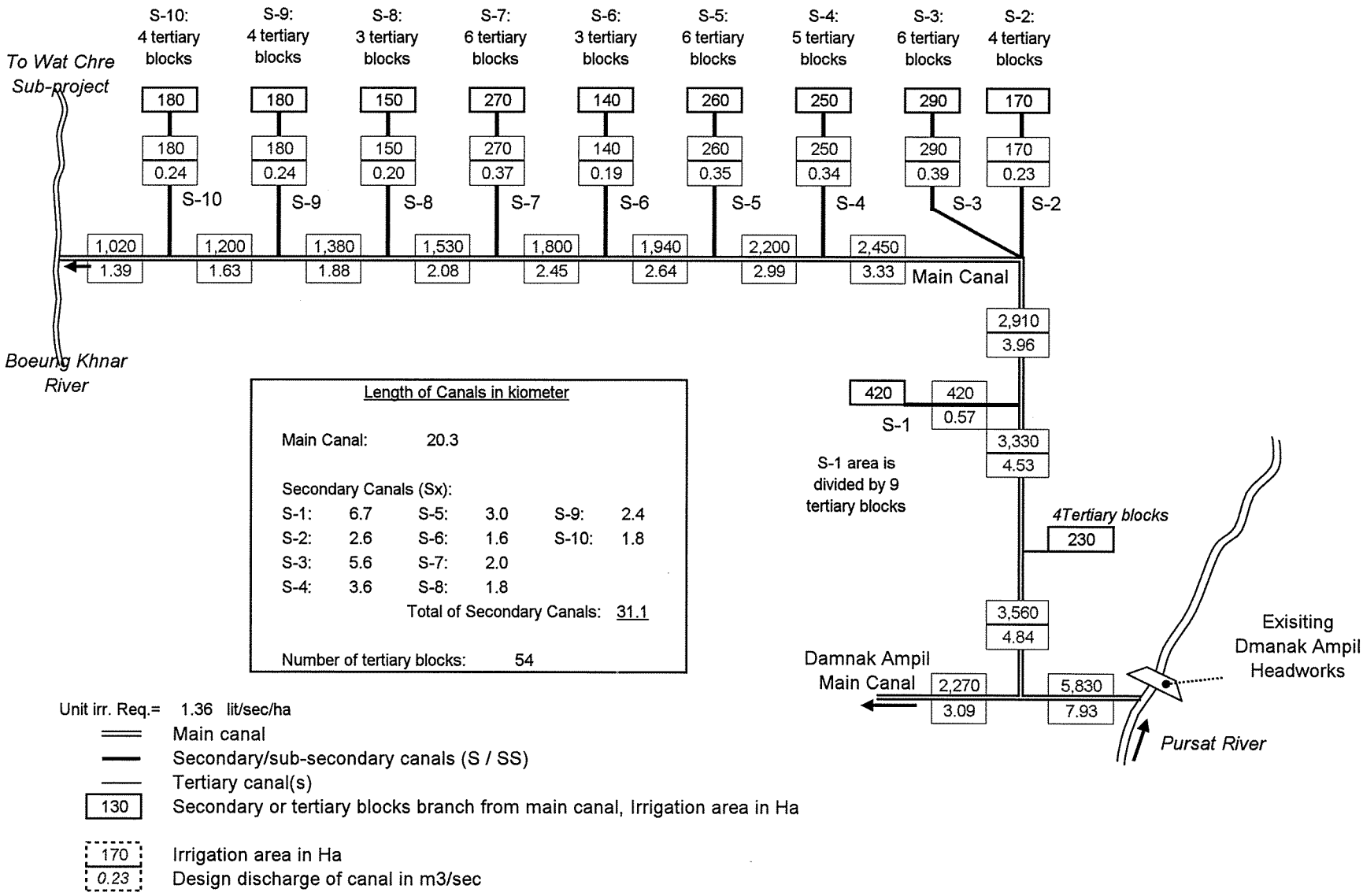
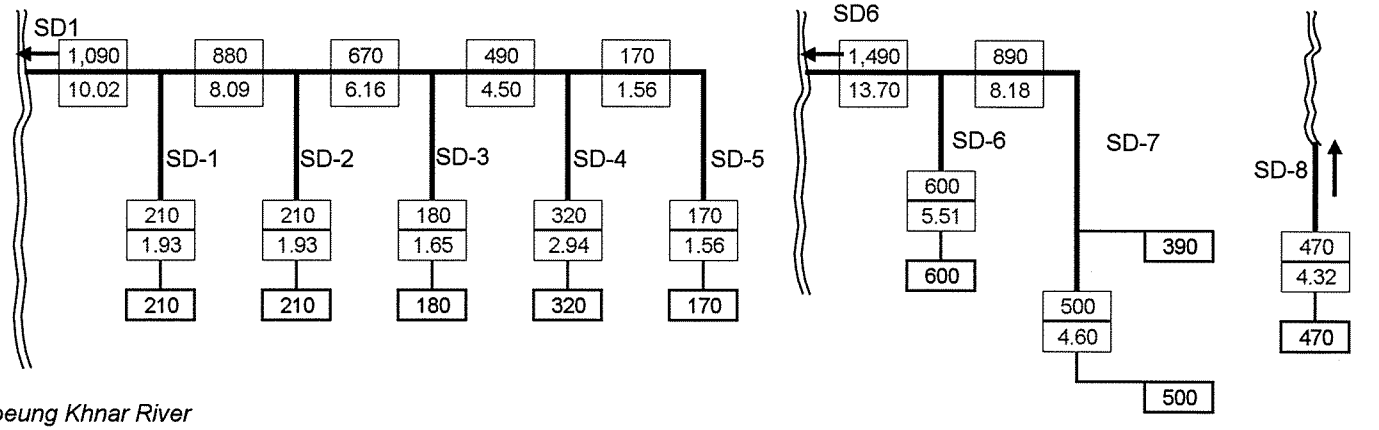



**Figure III 2.3.7 Irrigation Diagram of Wat Loung Sub-project**




| Construction Length of Canals in kiometer | | | |
|---|---|---|---|
| Secondary drains | | | |
| SD-1: | 2.7 | SD-6: | 6.1 |
| SD-2: | 3.3 | SD-7: | 9.5 |
| SD-3: | 4.2 | SD-8: | 3.7 |
| SD-4: | 4.5 | | |
| SD-5: | 3.7 | | |
| Total of Secondary Drains: | 37.7 | | |

Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
Unit drain. Req.= 18~25 lit/sec/ha from other types of land

Main drain

Secondary drain

80 Secondary or tertiary block in Ha

210 Drainage area in Ha (85% of paddy fields, 15% of other land types)
1.93 Design discharge of drain in m3/sec

**Figure III 2.3.8 Drainage Diagram of Wat Loung Sub-project**

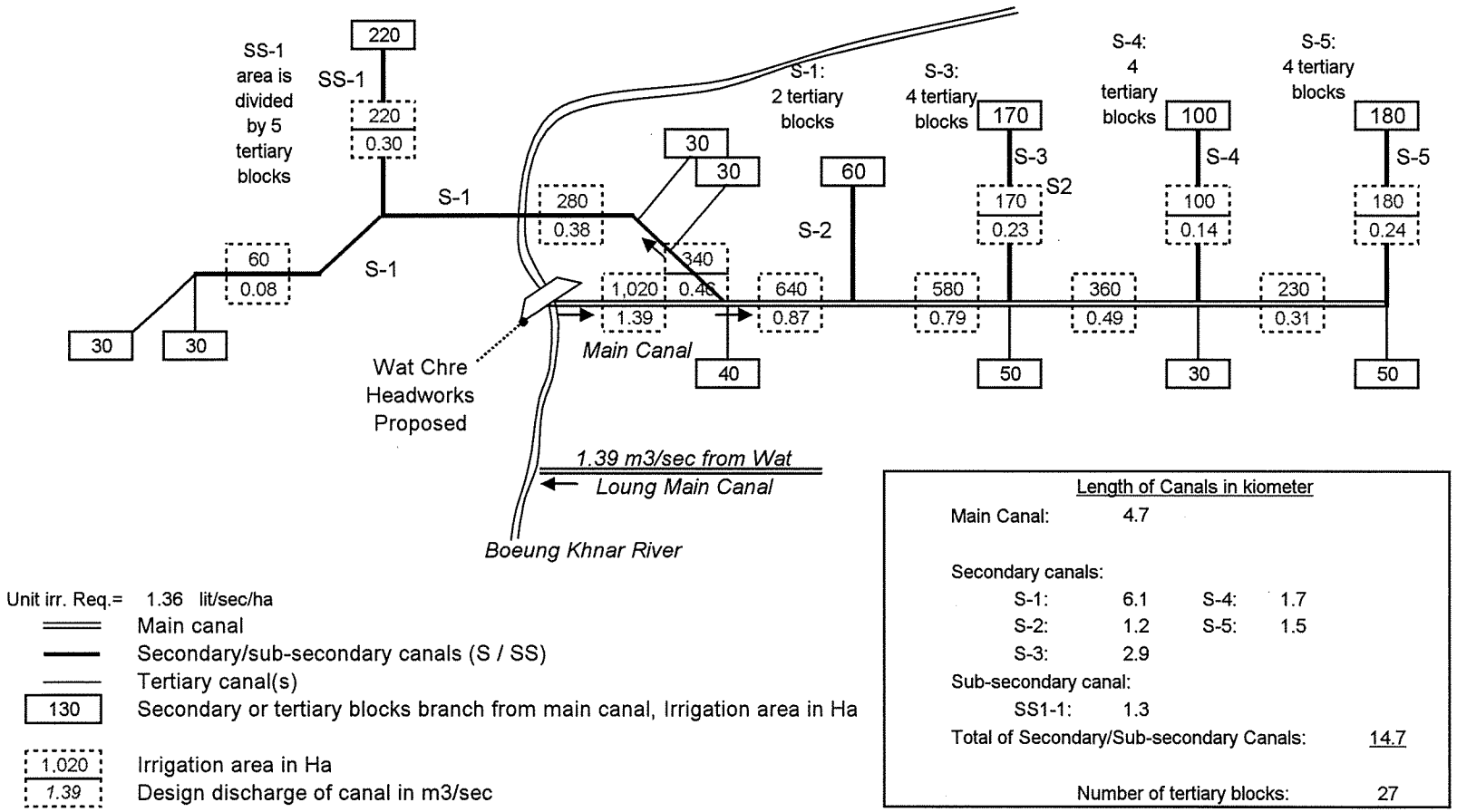
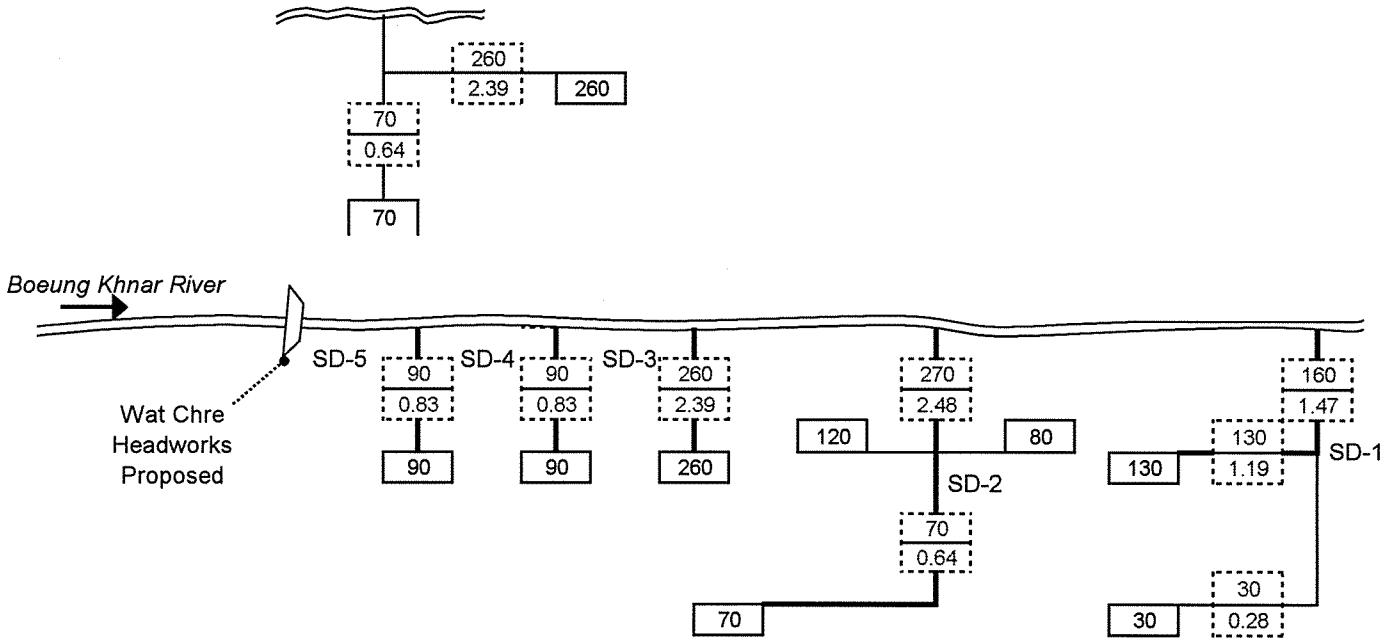



**Figure III 2.3.9 Irrigation Diagram of Wat Chre Sub-project**




Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
Unit drain. Req.= 18~25 lit/sec/ha from other types of land
Secondary drain
Existing side ditch
80 Secondary or tertiary block in Ha
260 Drainage area in Ha (85% of paddy fields, 15% of other land types)
2.39 Design discharge of drain in m3/sec

Construction Length of Canals in kiometer

Secondary drains:

| | | | |
|---|---|---|---|
| SD-1: | 2.2 | SD-4: | 2.1 |
| SD-2: | 2.2 | SD-5: | 1.5 |
| SD-3: | 3.5 | | |

Total of Secondary Drains: 11.5

**Figure III 2.3.10 Drainage Diagram of Wat Chre Sub-project**

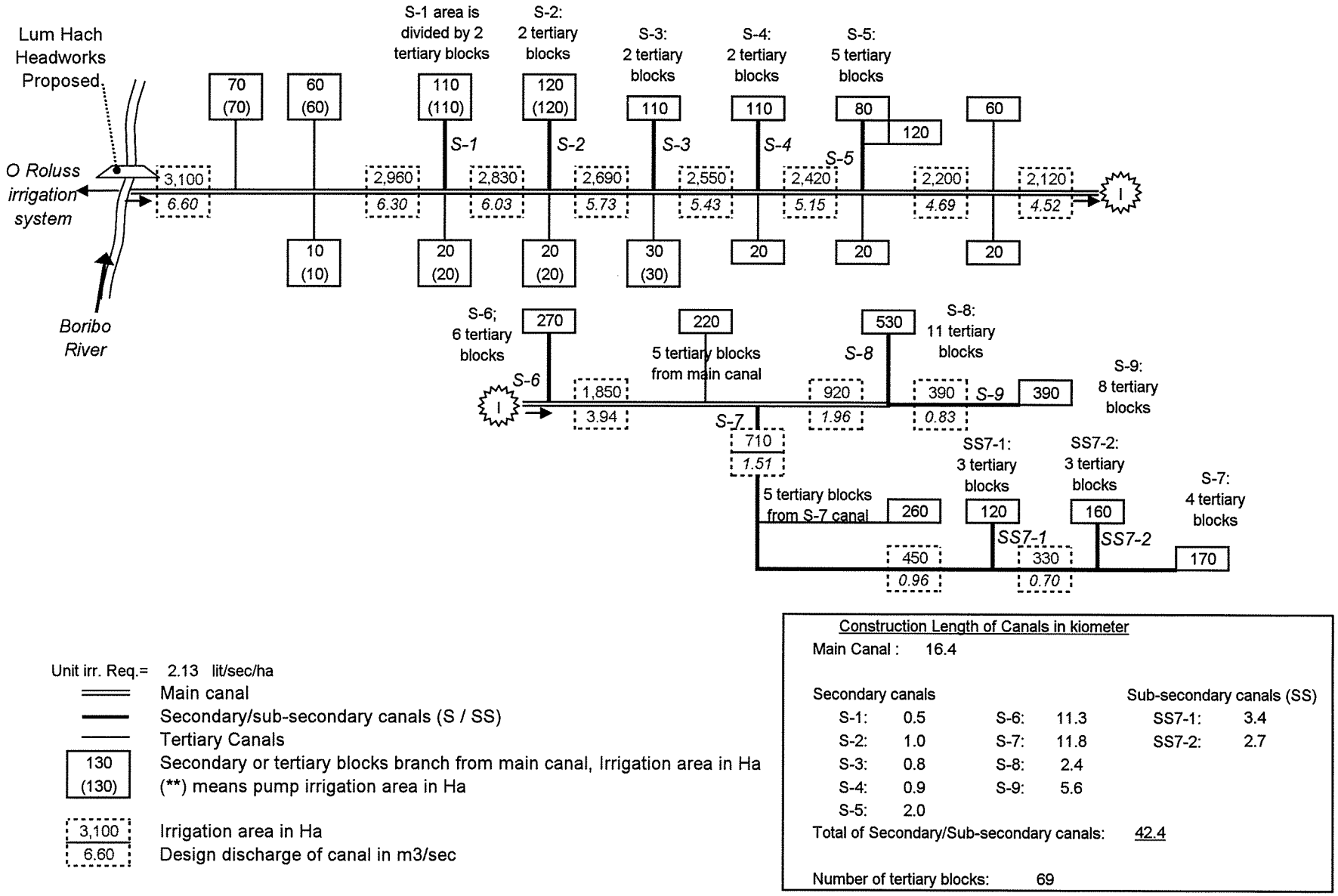



**Figure III 2.3.11 Irrigation Diagram of Lum Hach Sub-project**

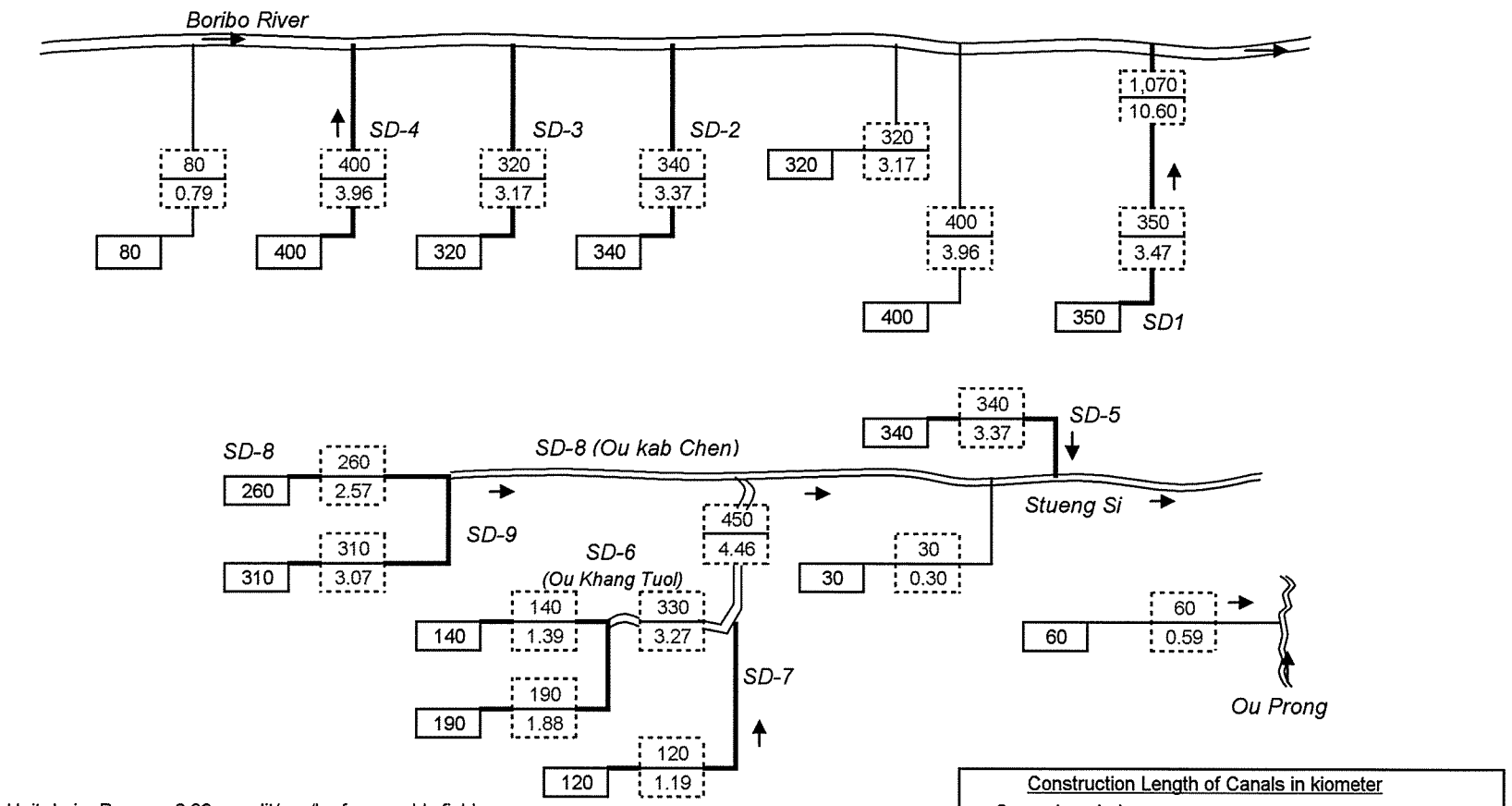



**Figure III 2.3.12 Drainage Diagram of Lum Hach Sub-project**

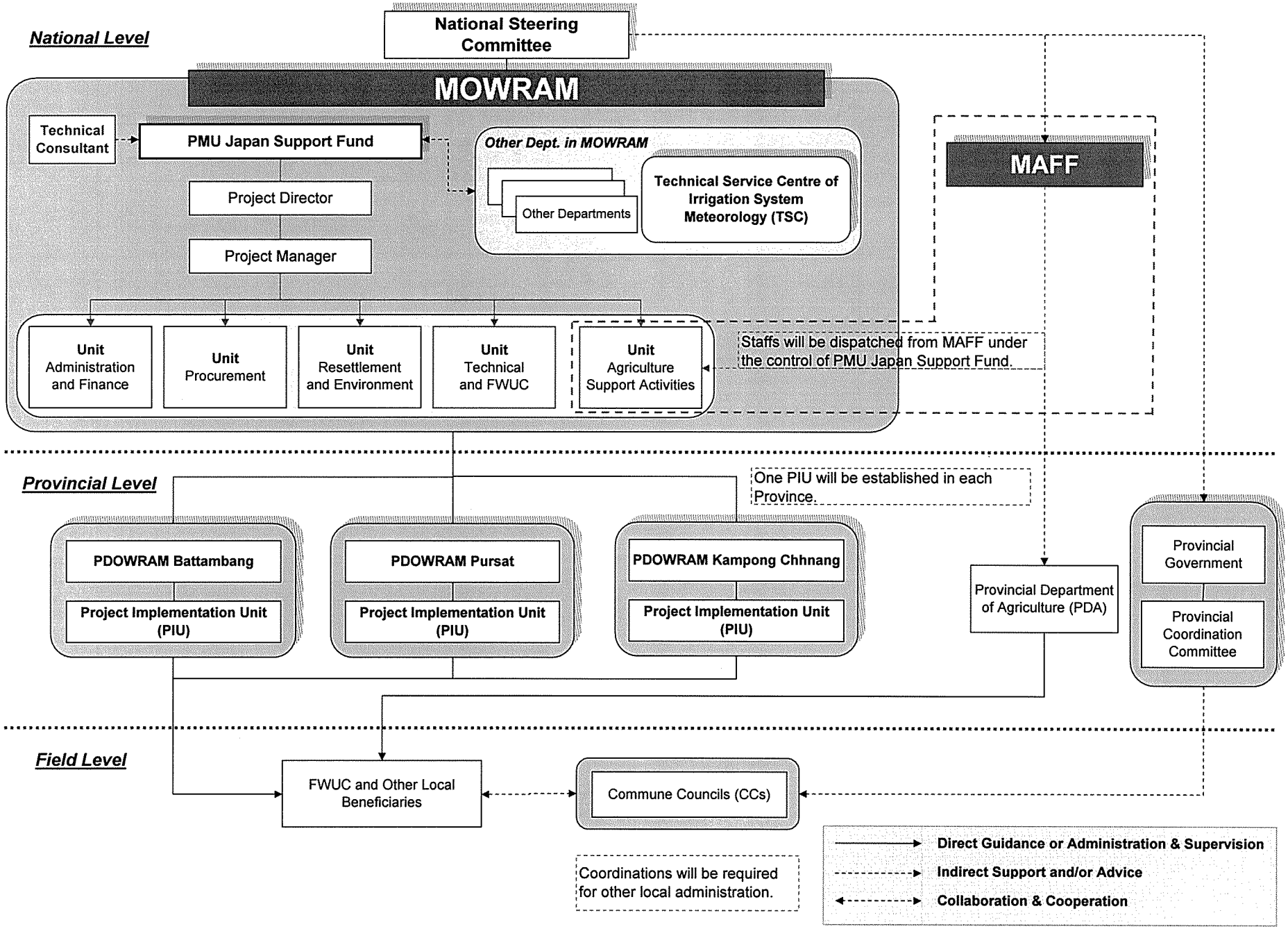
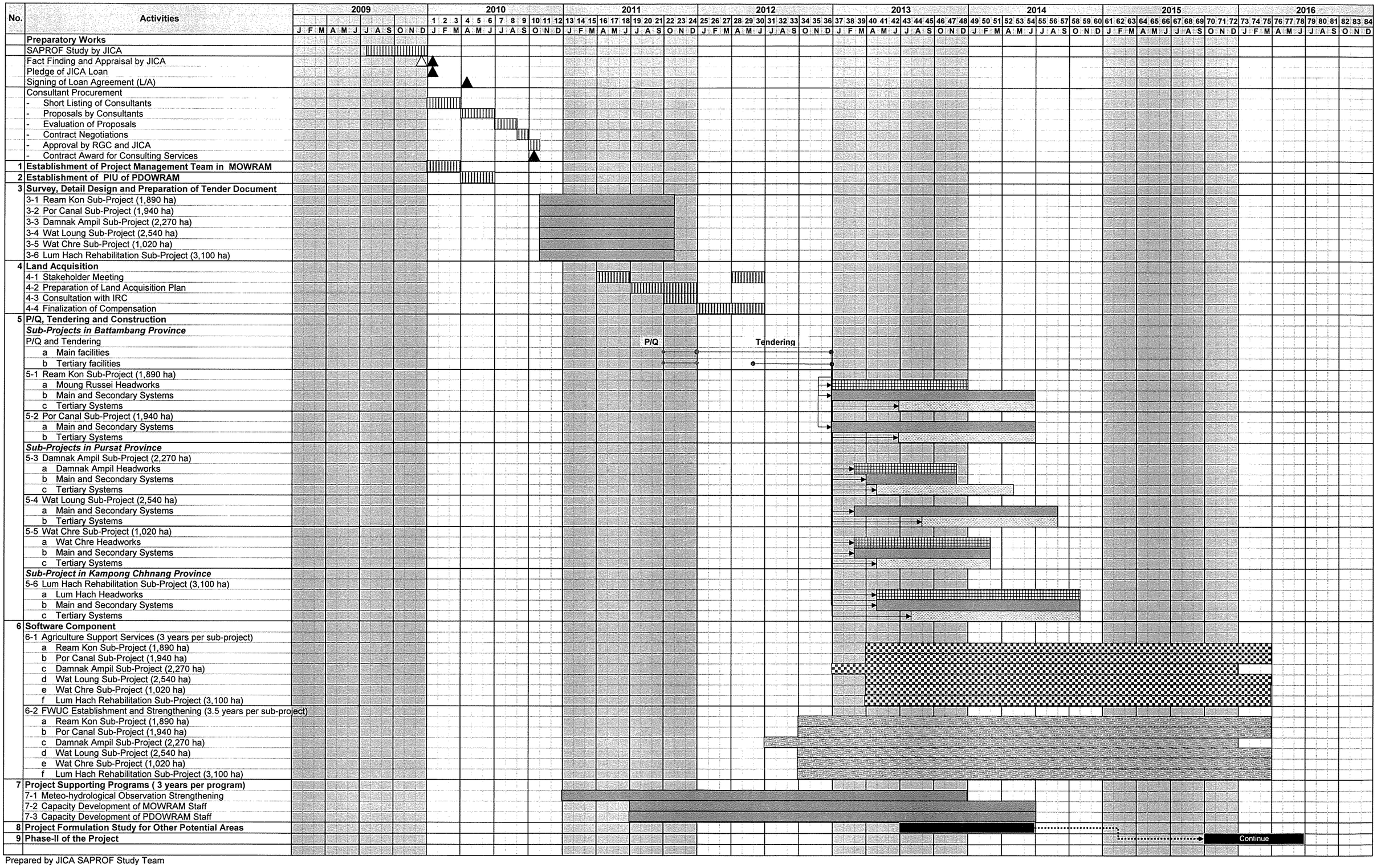



**Figure III 3.1.1 Project Implementing Organization**

| No. | Activities |
|---|---|
| | **Preparatory Works** |
| | SAPROF Study by JICA |
| | Fact Finding and Appraisal by JICA |
| | Pledge of JICA Loan |
| | Signing of Loan Agreement (L/A) |
| | Consultant Procurement |
| | - Short Listing of Consultants |
| | - Proposals by Consultants |
| | - Evaluation of Proposals |
| | - Contract Negotiations |
| | - Approval by RGC and JICA |
| | - Contract Award for Consulting Services |
| 1 | **Establishment of Project Management Team in MOWRAM** |
| 2 | **Establishment of PIU of PDOWRAM** |
| 3 | **Survey, Detail Design and Preparation of Tender Document** |
| | 3-1 Ream Kon Sub-Project (1,890 ha) |
| | 3-2 Por Canal Sub-Project (1,940 ha) |
| | 3-3 Damnak Ampil Sub-Project (2,270 ha) |
| | 3-4 Wat Loung Sub-Project (2,540 ha) |
| | 3-5 Wat Chre Sub-Project (1,020 ha) |
| | 3-6 Lum Hach Rehabilitation Sub-Project (3,100 ha) |
| 4 | **Land Acquisition** |
| | 4-1 Stakeholder Meeting |
| | 4-2 Preparation of Land Acquisition Plan |
| | 4-3 Consultation with IRC |
| | 4-4 Finalization of Compensation |
| 5 | **P/Q, Tendering and Construction** |
| | ***Sub-Projects in Battambang Province*** |
| | P/Q and Tendering |
| | a Main facilities |
| | b Tertiary facilities |
| | 5-1 Ream Kon Sub-Project (1,890 ha) |
| | a Moung Russei Headworks |
| | b Main and Secondary Systems |
| | c Tertiary Systems |
| | 5-2 Por Canal Sub-Project (1,940 ha) |
| | a Main and Secondary Systems |
| | b Tertiary Systems |
| | ***Sub-Projects in Pursat Province*** |
| | 5-3 Damnak Ampil Sub-Project (2,270 ha) |
| | a Damnak Ampil Headworks |
| | b Main and Secondary Systems |
| | c Tertiary Systems |
| | 5-4 Wat Loung Sub-Project (2,540 ha) |
| | a Main and Secondary Systems |
| | b Tertiary Systems |
| | 5-5 Wat Chre Sub-Project (1,020 ha) |
| | a Wat Chre Headworks |
| | b Main and Secondary Systems |
| | c Tertiary Systems |
| | ***Sub-Project in Kampong Chhnang Province*** |
| | 5-6 Lum Hach Rehabilitation Sub-Project (3,100 ha) |
| | a Lum Hach Headworks |
| | b Main and Secondary Systems |
| | c Tertiary Systems |
| 6 | **Software Component** |
| | 6-1 Agriculture Support Services (3 years per sub-project) |
| | a Ream Kon Sub-Project (1,890 ha) |
| | b Por Canal Sub-Project (1,940 ha) |
| | c Damnak Ampil Sub-Project (2,270 ha) |
| | d Wat Loung Sub-Project (2,540 ha) |
| | e Wat Chre Sub-Project (1,020 ha) |
| | f Lum Hach Rehabilitation Sub-Project (3,100 ha) |
| | 6-2 FWUC Establishment and Strengthening (3.5 years per sub-project) |
| | a Ream Kon Sub-Project (1,890 ha) |
| | b Por Canal Sub-Project (1,940 ha) |
| | c Damnak Ampil Sub-Project (2,270 ha) |
| | d Wat Loung Sub-Project (2,540 ha) |
| | e Wat Chre Sub-Project (1,020 ha) |
| | f Lum Hach Rehabilitation Sub-Project (3,100 ha) |
| 7 | **Project Supporting Programs ( 3 years per program)** |
| | 7-1 Meteo-hydrological Observation Strengthening |
| | 7-2 Capacity Development of MOWRAM Staff |
| | 7-3 Capacity Development of PDOWRAM Staff |
| 8 | **Project Formulation Study for Other Potential Areas** |
| 9 | **Phase-II of the Project** |




Prepared by JICA SAPROF Study Team

**Figure III 3.2.1 Project Implementation Schedule**