Ministry of Water Resources and Meteorology,
Ministry of Agriculture, Forestry and Fisheries,
The Kingdom of Cambodia

BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY IN THE KINGDOM OF CAMBODIA

FINAL REPORT

VOLUME-I
MAIN REPORT

MARCH 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

LIST OF VOLUMES

PREFACE

In response to a request from Cambodia, the Government of Japan decided to conduct a study on Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. KODAMA Masayuki of NIPPON KOEI Co., LTD. between January 2007 and February 2009.

The team held discussions with the officials concerned of the Government of Cambodia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Cambodia for their close cooperation extended to the study.

March 2009

MATSUMOTO Ariyuki,
Vice-President
Japan International Cooperation Agency

March 2009

Mr. MATSUMOTO Ariyuki
Vice President
Japan International Cooperation Agency
Tokyo, JAPAN

Letter of Transmittal

Dear Sir,

We are pleased to submit you herewith the Report on the Study on Basin-Wide Basic Irrigation and Drainage Master Plan in the Kingdom of Cambodia. This Report presents the results of all works performed in both Cambodia and Japan during a total period of 26 months from January 2007 to February 2009.

The objectives of the Study are to i) formulate the Master Plan on Irrigation Development in the Target Area consisting of four river basins: Battambang, Moung Russei, Pursat and Boribo, ii) prepare the Detailed Plan for selected sites, iii) update the Master Plan based on the Detailed Plan and iv) transfer technologies to the counterpart personnel on irrigation and drainage planning.

The Study was carried out based on continual partnership with the Counterpart Agency consisting of the Ministry of Water Resources and Meteorology (MOWRAM) and the Ministry of Agriculture Forestry and Fisheries (MAFF), as well as the Ministry of Economy and Finance (MOEF), the Ministry of Environment (MOE), the local authorities, farmers and other stakeholders. Their opinions and intensions were, therefore, fully, incorporated in the Plan.

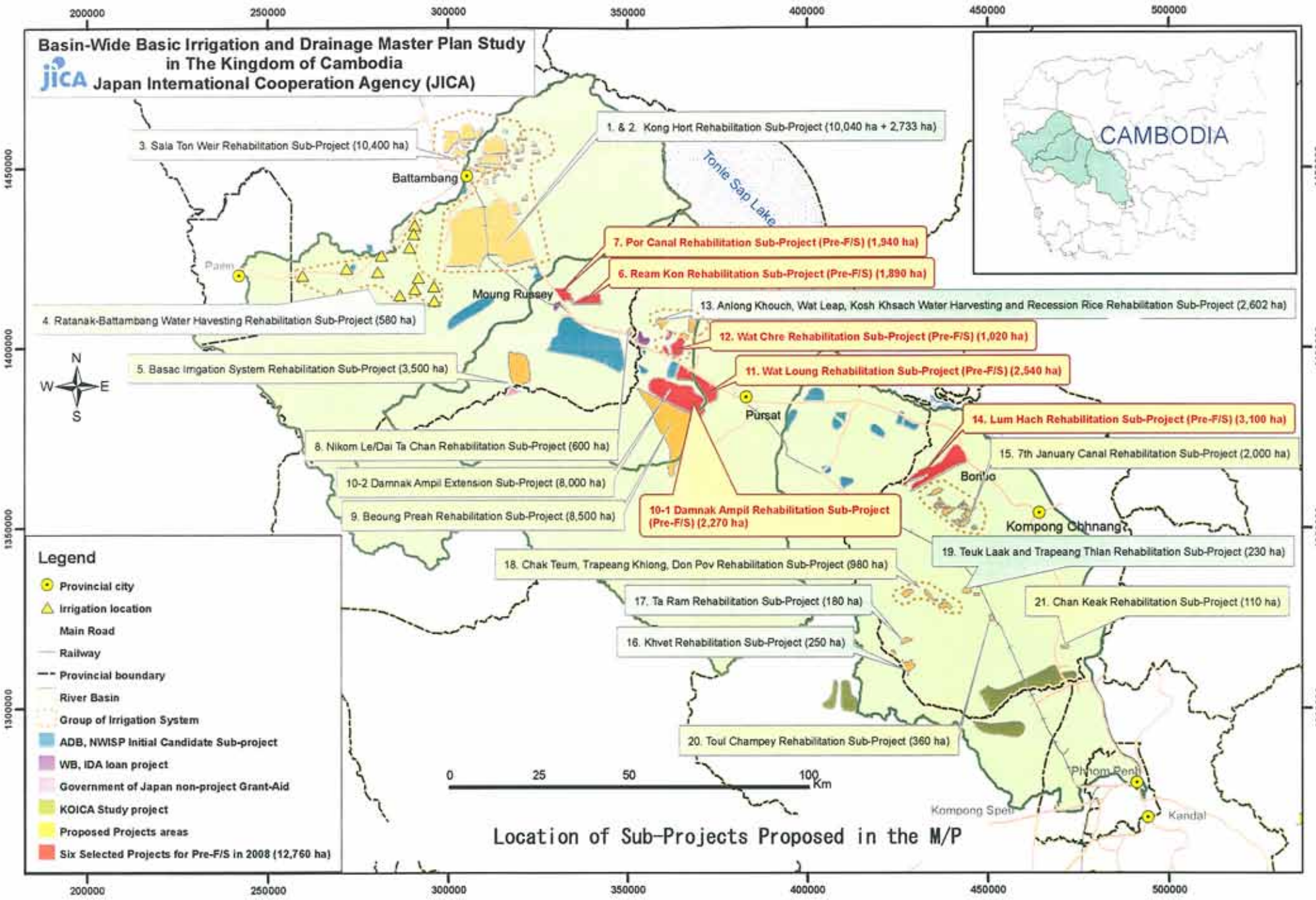
In the first year of the Study, development concept and approach was preliminary prepared. In the second year, the Master Plan was formulated contributing to the enhancement of agricultural production and the alleviation of poverty in the target area. The Master Plan proposed 21 numbers of projects combining facilities' rehabilitation, institutional support and agricultural extension together with four project supporting programs. In addition, the Road Map 2020 was proposed showing the pavement of irrigation development toward year 2020. For the acceleration of the Master Plan, detailed plan, pre-feasibility level, was prepared in the third year for priority projects selected in the Master Plan as development models. In parallel, meteo-hydrological observation was continuously carried out with the counterpart personnel as part of technology transfer.

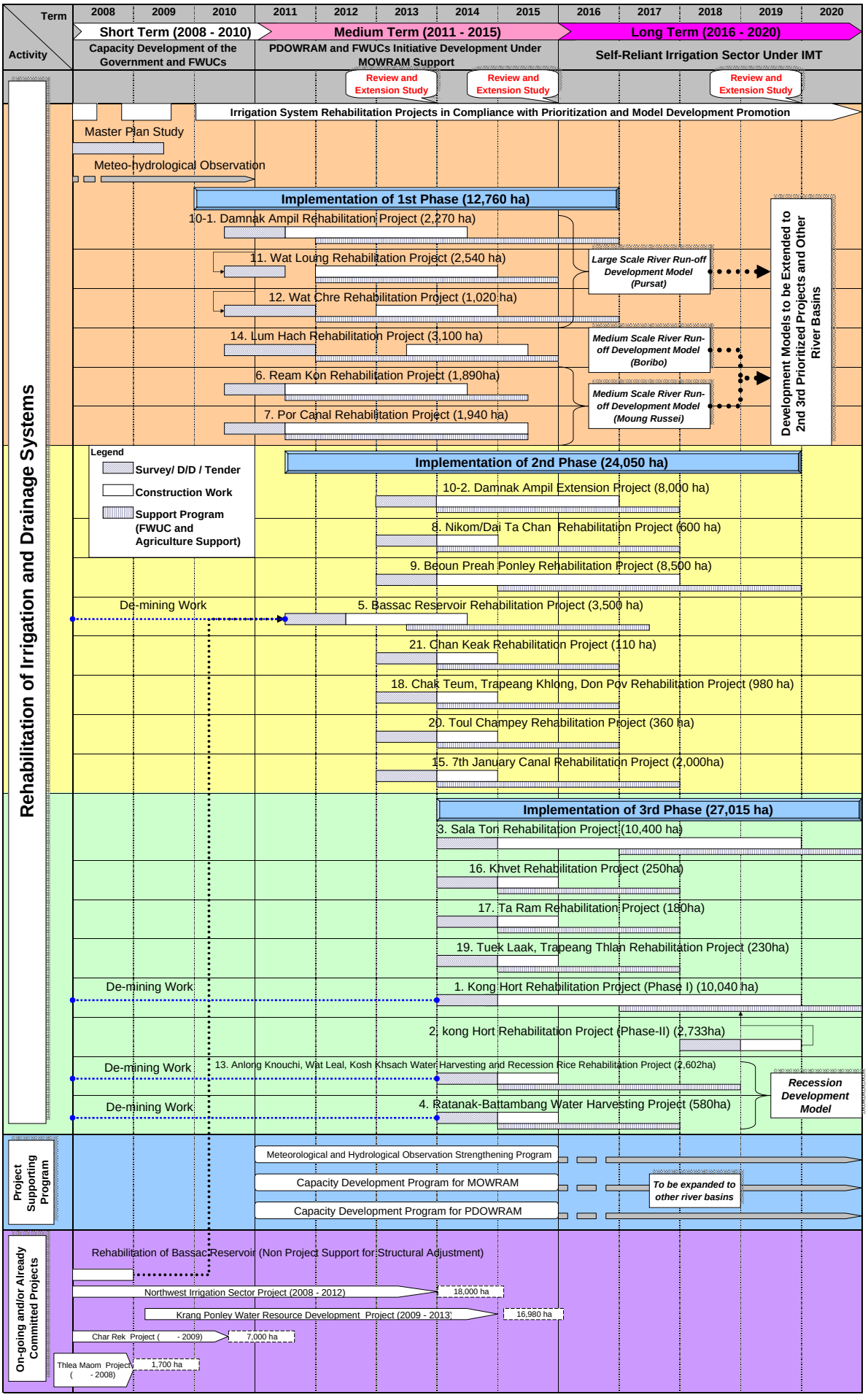
It is the hope that the Government of Cambodia will take necessary action in financial arrangement to promote implementation of the Road Map 2020.

We wish to express our greatest appreciation and sincere gratitude to the officials concerned of your Agency, the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan for the courtesies and cooperation kindly extended to our team. We also wish to express our hearty appreciation and gratitude to the officials concerned of Cambodia Office of your Agency, the Embassy of Japan in Cambodia, MOWRAM, MAFF, MOEF, MOE and other relevant authorities for close cooperation and assistance extended to our team during the study.

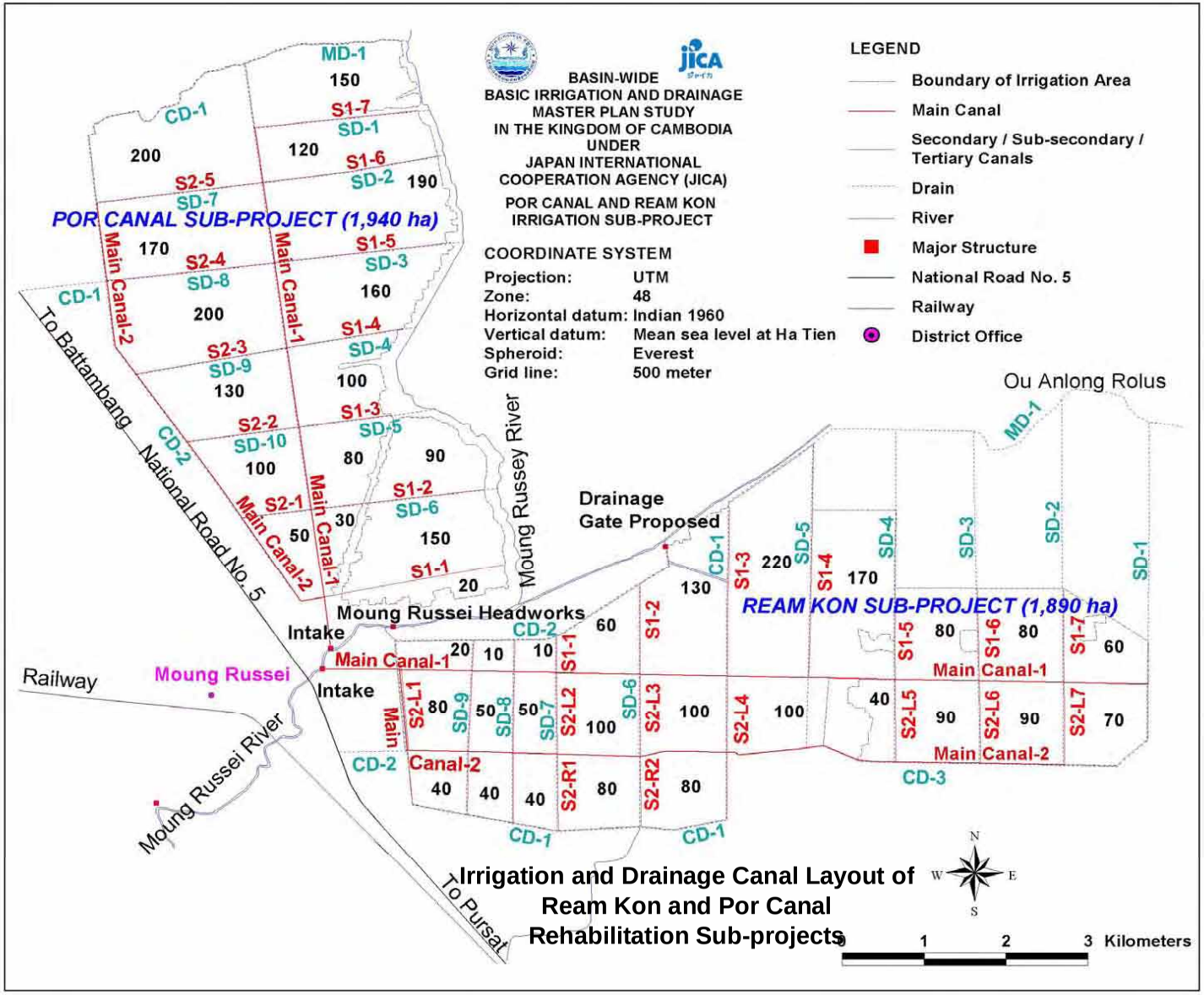
Very truly yours,

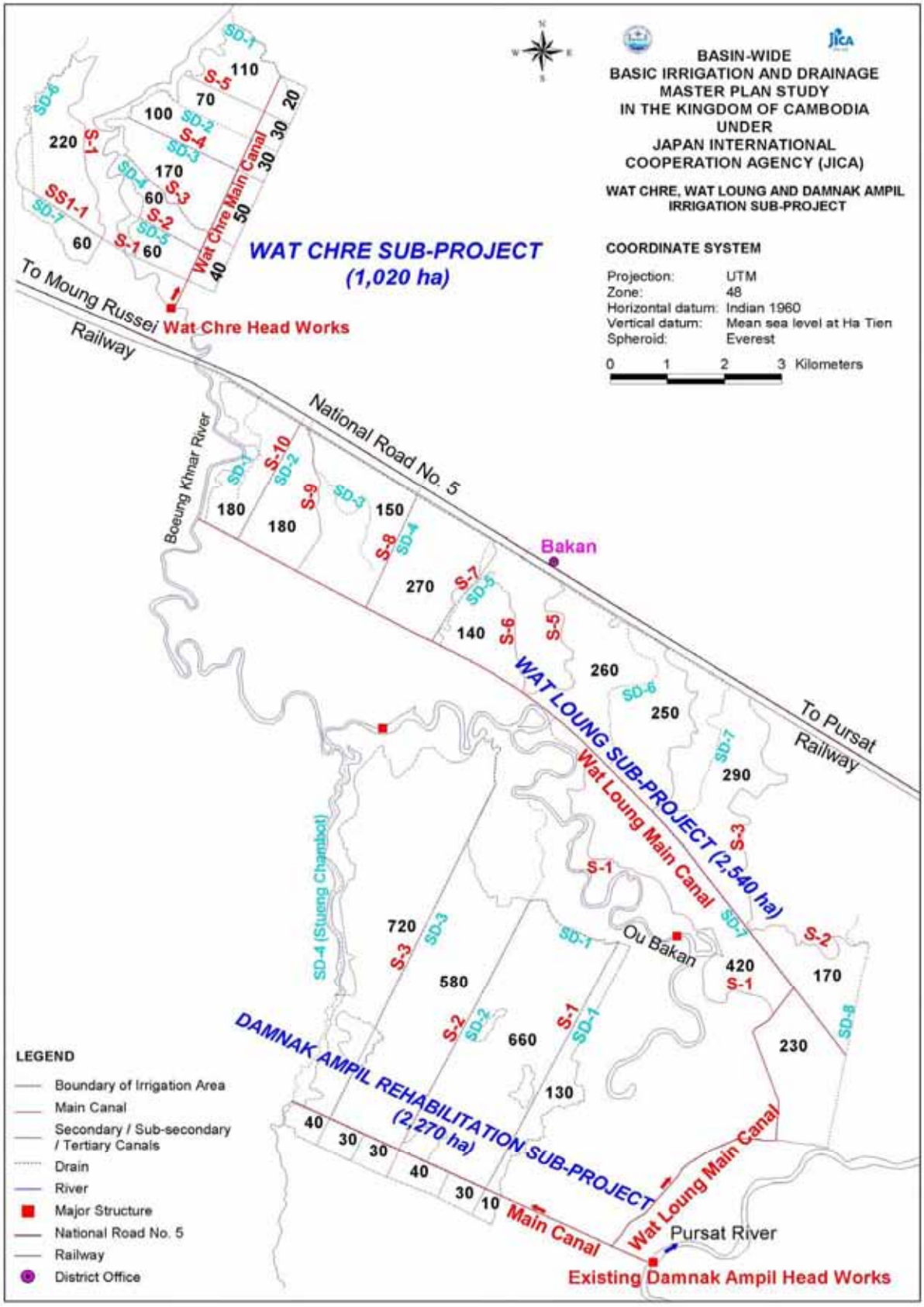
KODAMA Masayuki
Team Leader of
the Study on Basin-Wide Basic Irrigation and Drainage
Master Plan in the Kingdom of Cambodia


Basin-Wide Basic Irrigation and Drainage Master Plan Study
in The Kingdom of Cambodia
JICA Japan International Cooperation Agency (JICA)
CAMBODIA
1. & 2. Kong Hort Rehabilitation Sub-Project (10,040 ha + 2,733 ha)
3. Sala Ton Weir Rehabilitation Sub-Project (10,400 ha)
4. Ratanak-Battambang Water Havesting Rehabilitation Sub-Project (580 ha)
5. Basac Irrigation System Rehabilitation Sub-Project (3,500 ha)
6. Ream Kon Rehabilitation Sub-Project (Pre-F/S) (1,890 ha)
7. Por Canal Rehabilitation Sub-Project (Pre-F/S) (1,940 ha)
8. Nikom Le/Dai Ta Chan Rehabilitation Sub-Project (600 ha)
9. Beoung Preah Rehabilitation Sub-Project (8,500 ha)
10-1 Damnak Ampil Rehabilitation Sub-Project (Pre-F/S) (2,270 ha)
10-2 Damnak Ampil Extension Sub-Project (8,000 ha)
11. Wat Loung Rehabilitation Sub-Project (Pre-F/S) (2,540 ha)
12. Wat Chre Rehabilitation Sub-Project (Pre-F/S) (1,020 ha)
13. Anlong Khouch, Wat Leap, Kosh Khsach Water Harvesting and Recession Rice Rehabilitation Sub-Project (2,602 ha)
14. Lum Hach Rehabilitation Sub-Project (Pre-F/S) (3,100 ha)
15. 7th January Canal Rehabilitation Sub-Project (2,000 ha)
16. Khvet Rehabilitation Sub-Project (250 ha)
17. Ta Ram Rehabilitation Sub-Project (180 ha)
18. Chak Teum, Trapeang Khlong, Don Pov Rehabilitation Sub-Project (980 ha)
19. Teuk Laak and Trapeang Thlan Rehabilitation Sub-Project (230 ha)
20. Toul Champey Rehabilitation Sub-Project (360 ha)
21. Chan Keak Rehabilitation Sub-Project (110 ha)
Battambang
Pailin
Moung Russey
Pursat
Kompong Chhnang
Phnom Penh
Kandal
Kompong Speu
Tonle Sap Lake
Legend
Provincial city
Irrigation location
Main Road
Railway
Provincial boundary
River Basin
Group of Irrigation System
ADB, NWISP Initial Candidate Sub-project
WB, IDA loan project
Government of Japan non-project Grant-Aid
KOICA Study project
Proposed Projects areas
Six Selected Projects for Pre-F/S in 2008 (12,760 ha)
N
W
E
S
0 25 50 100 Km
200000 250000 300000 350000 400000 450000 500000
1450000 1400000 1350000 1300000
Location of Sub-Projects Proposed in the M/P

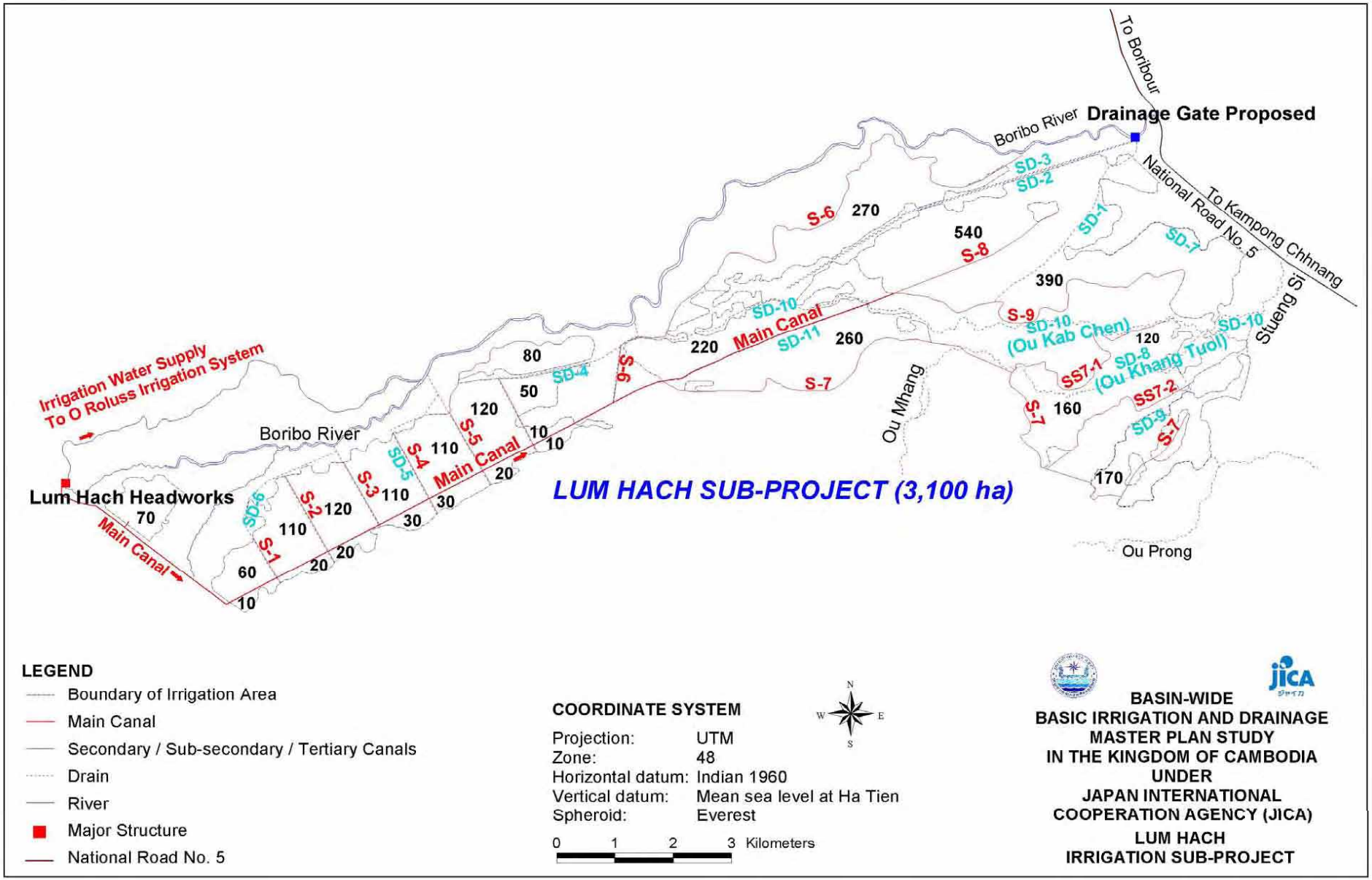


Road Map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020 Proposed in the M/P


BASIN-WIDE
BASIC IRRIGATION AND DRAINAGE
MASTER PLAN STUDY
IN THE KINGDOM OF CAMBODIA
UNDER
JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)
POR CANAL AND REAM KON
IRRIGATION SUB-PROJECT
COORDINATE SYSTEM
Projection: UTM
Zone: 48
Horizontal datum: Indian 1960
Vertical datum: Mean sea level at Ha Tien
Spheroid: Everest
Grid line: 500 meter
LEGEND
Boundary of Irrigation Area
Main Canal
Secondary / Sub-secondary / Tertiary Canals
Drain
River
Major Structure
National Road No. 5
Railway
District Office
POR CANAL SUB-PROJECT (1,940 ha)
REAM KON SUB-PROJECT (1,890 ha)
Main Canal-1
Main Canal-2
Moung Russey River
Moung Russei Headworks
Intake
Drainage Gate Proposed
To Battambang
National Road No. 5
Railway
Moung Russei
Moung Russei River
To Pursat
Ou Anlong Rolus
Irrigation and Drainage Canal Layout of Ream Kon and Por Canal Rehabilitation Sub-projects
N
W
E
S
0 1 2 3 Kilometers



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



LEGEND

- Boundary of Irrigation Area
- Main Canal
- Secondary / Sub-secondary / Tertiary Canals
- Drain
- River
- Major Structure
- National Road No. 5

COORDINATE SYSTEM

Projection:	UTM
Zone:	48
Horizontal datum:	Indian 1960
Vertical datum:	Mean sea level at Ha Tien
Spheroid:	Everest

0 1 2 3 Kilometers

BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY IN THE KINGDOM OF CAMBODIA UNDER JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

LUM HACH IRRIGATION SUB-PROJECT

Irrigation and Drainage Canal Layout of Lum Hach Rehabilitation Sub-prject

PHOTOGRAPHS
BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY (1/3)

Existing Ream Kon Headworks not Functioning
(Ream Kon Rehabilitation Sub-Project)
(May 25th 2008)

Existing Main Canal and Wooden Canal Crossing
(Ream Kon Rehabilitation Sub-Project)
(February 8th 2008)

Rice Noodle Processing in the Ream Kon Village located near the Sub-Project
(Ream Kon Rehabilitation Sub-Project)
(February 8th, 2008)

Existing Intake Structure
(Por Canal Rehabilitation Sub-Project)
(May 25th 2008)

Existing Main Canal at the Beginning Point, Water Quality Problems due to Houses Standing along the Canal(Por Canal Rehabilitation Sub-Project)
(February 8th 2008)

Existing Damanak Ampil Headworks Originally Constructed by MOWRAM in 2006
(Damnak Ampil Rehabilitation Sub-Project)
(February 2nd 2008)

PHOTOGRAPHS
BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY (2/3)

Supplemental Irrigation Area with no Tertiary Canals Developed
(Damnak Ampil Rehabilitation Sub-Project)
(February 2nd 2008)

Water Quality Analysis for the Main Canal Water
(Damnak Ampil Rehabilitation Sub-Project)
(June 12th 2008)

Main Canal Section, severely Deteriorated
(Wat Loung Rehabilitation Sub-Project)
(February 2nd 2008)

No Tertiary Canals Developed, only Grazing during Dry Season
(Wat Loung Rehabilitation Sub-Project)
(February 2nd 2008)

Existing Headworks, already Deteriorated and Not Functioned
(Wat Chre Rehabilitation Sub-Project)
(February 5th 2008)

Fishing Net Installed in the Main Canal by Farmers
(Wat Chre Rehabilitation Sub-Project)
(September 13th 2008)

PHOTOGRAPHS
BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY (3/3)

Interview with Commune Chief for Environmental Activities under the Commune Council
(Wat Chre Rehabilitation Sub-Project)
(August 7th 2007)

Poor Road Network in the Command Area particularly during the Wet Season
(Lum Hach Rehabilitation Sub-Project)
(September 4th 2008)

Tube Well for the Domestic Water Source of Villagers
(Lum Hach Rehabilitation Sub-Project)
(September 5th 2008)

Presentation of M/P by Counterpart Personnel in the Seminar
(February 22nd 2008)

Mini-Workshop on Meteo-hydrological Observation at Battambang Province
(June 29th 2008)

Steering Committee Meeting on Draft Final Report
(January 14th 2009)

I. INTRODUCTION

Authority

01. This Final Report has been prepared in accordance with the Scope of Work (S/W) for the Basin-Wide Basic Irrigation and Drainage Master Plan Study (hereinafter called the Study) agreed upon between the Ministry of Water Resources and Meteorology (MOWRAM) of the Royal Government of Cambodia (RGC) and the Japan International Cooperation Agency (JICA) on 26th October, 2006. The report presents the results of the Master Plan (M/P) for four river basins and the Pre-Feasibility Study (Pre-F/S) for the six sub-projects selected in the course of M/P preparation. The Report consists of the following volumes:

- Volume-I: Main Report
- Volume-II: Appendixes (Master Plan Study for Four River Basins)
- Volume-III: Appendixes (Pre-Feasibility Study for Priority Six Sub-Projects) (1/2)
- Volume-IV: Appendixes (Pre-Feasibility Study for Priority Six Sub-Projects) (2/2)

(1.1 & 1.2)

Background of the Study

02. The Lake Tonle Sap and its catchment have been playing a vital role in contributing country's economy as well as mitigation of rural poverty in the region. Since the development of infrastructures including irrigation facilities is still insufficient in Cambodia, practical and sound development such structures in this region is of critical importance on the basis of a comprehensive study of natural and human resources. Given this background, the Royal Government of Cambodia (RGC) and the Government of Japan (GOJ) agreed on 26th October, 2006 on the S/W for the Study. ***(1.3)***

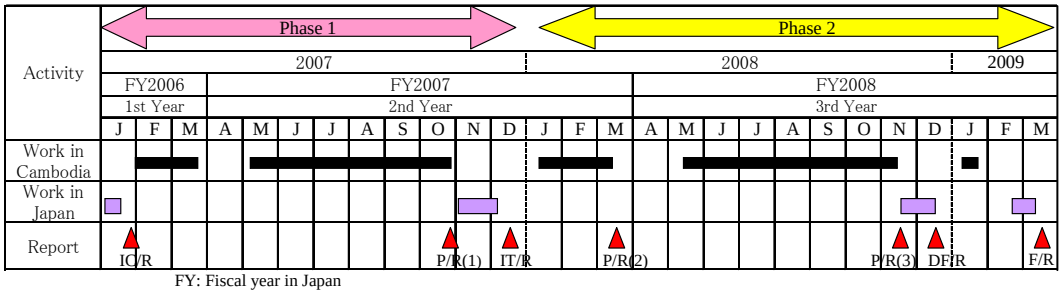
The Study Area

03. The target area covers irrigated agriculture land mainly comprising of paddy fields in the four river basins: the Battambang, the Moung Russei, the Pursat, and the Boribo. All the river basins are located on the west side of the Tonle Sap Lake and River. The study area administratively consists of major parts of three provinces (Battambang, Pursat, and Kampong Chhnanng provinces), and parts of two provinces and one city (*krong*) consisting of Kampong Speu, Kandal Provinces and Pailin City. It has total area of 22,868 km^2. ***(1.4)***

Objective and Scope of the Study

04. The objectives of the Study are: (i) to formulate a M/P on Irrigation and Drainage in order to improve the water management and agricultural productivity in the four river basins, (ii) to formulate detailed plans for selected priority areas in each river basin, and (iii) to transfer technologies to the Cambodian counterpart personnel through on-the-job training during the course of the Study. ***(1.5.1)***

05. The Study was carried out over 27 months from January 2007 and March 2009.



FY: Fiscal year in Japan

Schedule of the Study

The Study consisted of two phases. Phase I between January 2007 and December 2007 involved the formulation of a draft M/P on irrigation and drainage development in the study area, while Phase II, which commenced from January 2008, involved the conduct of a Pre-feasibility Study (Pre-F/S) on priority/urgent projects selected in Phase I and the finalized M/P. ***(1.5.2)***

Technology Transfer

06. Twenty staff members from MOWRAM were assigned as counterparts for the Study. Prior to the commencement of the Study or on 6th August, 2005, the JICA Study Team (JST) submitted the Technology Transfer Plan to the MOWRAM. In line with this plan, the technology transfer to counterpart personnel was carried out mainly through on-the-job training. In addition, in the Steering Committee meeting for Progress Report (2), the outline of the M/P results was presented by the counterpart personnel, and this was a part of technical transfer under the Study. ***(1.6)***

Steering Committee Meetings

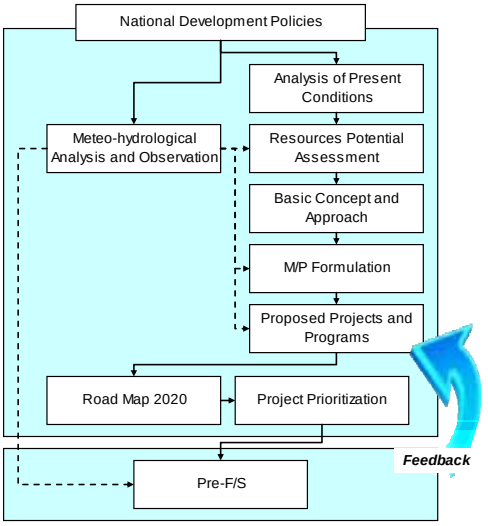
07. Five meetings of the Steering Committee were organized to present and discuss the Reports. These were as follows: (i) Inception Report (21st February, 2007) , (ii) Progress Report (1) (24th October, 2007), (iii) Progress Report (2) (24th February, 2008), (iv) Progress Report (3) (3rd October, 2008), and (v) Draft Final Report (14th January, 2009). Representatives from relevant agencies such as MOWRAM, MAFF, MOE, MEF, the Embassy of Japan, and JICA Cambodia Office attended these meetings. ***(1.7)***

II. OUTLINE OF THE MASTER PLAN STUDY

General

08. The irrigation and drainage development M/P of the four river basins was formulated based on an assessment of natural and socio-economic conditions, present conditions of agriculture, irrigation and drainage, and environment and resources potential through quantitative and qualitative analyses within the framework of national and sectoral

development policies of Cambodia as illustrated on the right. ***(2.1)***

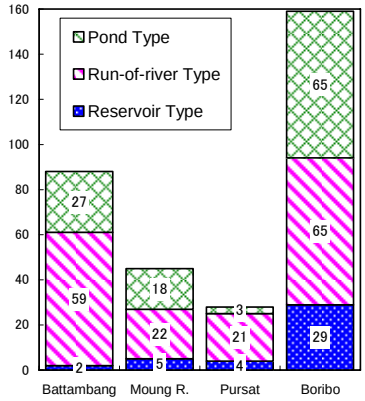


Prepared by JICA Study Team

Study Procedure of M/P

Four River Basins

09. The current conditions of irrigation and drainage systems were studied based on a previous inventory survey conducted by JICA, a topographic survey, and an inventory survey carried out in the course of the Study. There are 320 irrigation systems in the four river basins, the types of which are shown on the right. Some locational characteristics are observed from the figure. In Battambang River Basin, the river type systems are prevailing while in the Boribo River Basin, the pond type systems represent 41% (=65/(65+65+29)) of all the systems in the basin, which is remarkably higher than those in the other basins. This would be in accordance with water resources as well as topographic conditions in the basin. ***(2.3.5)***



Prepared by JICA Study Team

No. of Irrigation Systems by Water Source (No.)

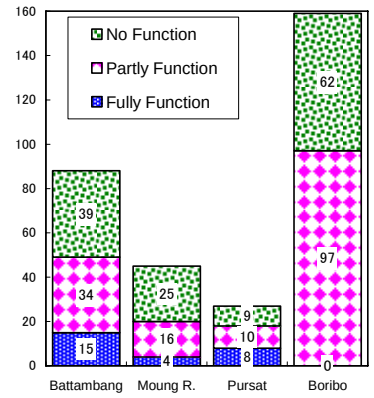
10. Figures of total area served by the various water sources could help clarify some characteristics inherent in the basin. In general, a major part of the basin area is occupied by the river type systems except in the Boribo River Basin where the reservoir type is prevalent and covers 55% (=18,438/(29,109+18,438+4,920) of the total area. In addition, 4,920 ha of pond type systems are used in 9.3% in the Boribo area, but these represent 41% of the total number of systems since most of the pond type systems are developed on a small-scale. ***(2.3.5)***

11. The condition of the irrigation systems have been broken into three categories : (i) fully functional, (ii) partly functional and (iii) non-functional, as shown in the figure on the right. The chart shows that most of the irrigation systems are facing some level of malfunction. Only 27 systems, 8.5% of the systems are categorized as “fully functional.” ***(2.3.5)***

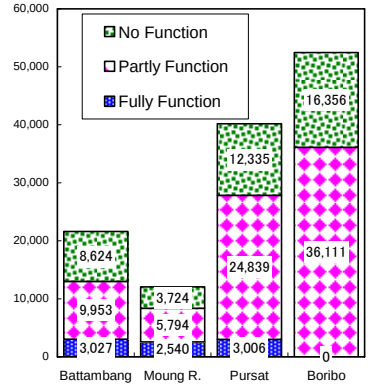
12. Functionality from the viewpoint of total area shows a similar tendency and is observed in the illustration

below. Only 8,537 ha, equivalent to 6.8% of the total area, are covered by "fully functional" systems. ***(2.3.5)***

13. Although rehabilitation was carried out recently, a considerable number of the systems are still not functioning properly. In the case of the Battambang, only 14 out of 52 recently rehabilitated systems have recovered their full function. This is because many of these systems received only emergency rehabilitation such as culvert construction on a portion of the system. Water control structures including checks and turnouts with gates have not been restored in most of the systems possibly due to (i) lack of funds for comprehensive rehabilitation, and (ii) the fundamental lack of canals and water control structures. The major problems that are common in the four river basins are as follows: (i) low ratio of farms under irrigation, (ii) lack of comprehensive rehabilitation work, (iii) deterioration of dykes in pond irrigation systems, (iv) low ratio of establishment of FWUC, (v) lack of canal capacity, (vi) deteriorated irrigation structures, and (vii) lack of irrigation structures. ***(2.3.5)***



Prepared by JICA Study Team
No. of Irrigation Systems by Present Situation (No.)



Prepared by JICA Study Team
Total Area by Present Situation (ha)

14. At present, the development of drainage systems in the irrigation systems significantly lag behind. There are almost no drainage canals that were observed in most of the systems in the four river basins. According to a field survey of 12 irrigation systems of the basins, farmers of seven systems pointed out that they are currently facing some sort of water logging and/or drainage problems in the system areas. Flooding, particularly along the Tonle Sap Lake in the eastern part of the river basins, is observed every wet season. Flooding is a significant part of the regional ecology as flooded forests and seasonal wetlands are important for biodiversity and essential water resources for recession fields, although it also has some negative impacts on farming. An estimated area of 4,240 km^2, representing 18.5% of the total area of the four river basins, is affected by floods of more than eight days duration, a period which causes fundamental damage to crop growth. ***(2.3.5)***

15. In accordance with "Circular No.1 on Implementation Policy for Sustainable Irrigation Systems," one of the principles emphasized is that the FWUCs placed in each irrigation system are the formal legal entities recognized by the Government and civil society. Whether these entities have been officially registered or not is frequently not clear. As

shown in the following table, the establishment of FWUCs is still in progress with only 17% of systems having FWUCs in the basins. ***(2.3.5)***

Number of Irrigation Systems with FWUC already Established in Four River Basins

River Basin	Number of Systems	Number of Systems having FWUCs	%
Battambang	88	20	22.7
Moung Russei	45	7	15.6
Pursat	28	8	28.6
Boribo	159	19	11.9
Total	320	54	16.9

Prepared by JICA Study Team based on Inventory Survey of Irrigation Systems

Assessment of Resources Potential

16. Irrigation development largely depends on three essential resource factors: (i) water resources, (ii) land resources, and (iii) human resources. These factors were assessed under the Study for the preparation of irrigation development plans through the maximum utilization of available resources by considering specific regional characteristics. ***(2.4)***

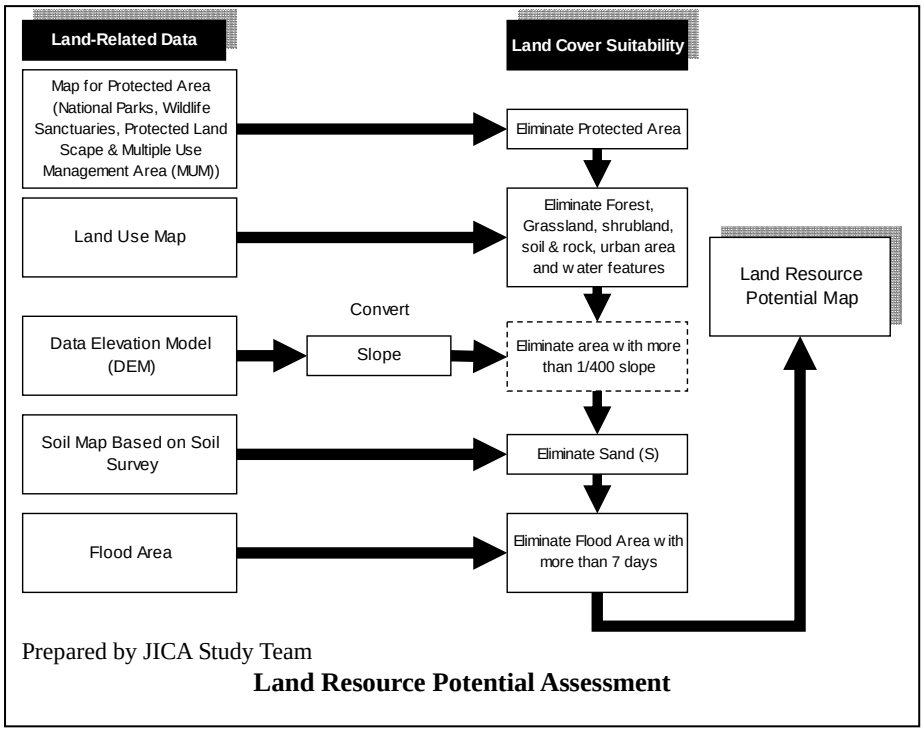
17. In the water resource assessment, the type of water source is defined as: (i) river/stream, (ii) reservoir (Bassac Reservoir in the Moung Russei Basin only as having been proposed by MOWRAM), (iii) pond and (iv) ground water. The assessment method consists of the following six steps: (i) define the catchment area, (ii) calculate monthly discharge, (iii) calculate other water demands, (iv) calculate irrigation water demand, (v) select critical month, (vi) calculate available water amount, and (vii) calculate irrigable area. The irrigable areas in the wet-2 season in each river basin is summarized as follows. ***(2.4.1)***

Irrigable Area of the Four River Basin -Result of Water Resources Assessment-

River Basin	Sub-Basin	Irrigable Area (ha)	Potential/Current
Battambang	Battambang (Main)	28,000	1.53
	Battambang Plain	1,100	0.37
	Residual	2,400	-
Moung Russei	Moung Russei		
	(Without Bassac Reservoir)	2,600	2.45
	(With Bassac Reservoir)	10,000	9.43
	Svay Don Keo	2,400	1.33
	Residual (SRB d2)	800	-
	Residual (SRB d3)	1,100	-
Pursat	Pursat (SRB e1)	45,600	1.12
	Residual (SRB f1)	600	1.06
	Residual (SRB f2)	1,500	-
Boribo	Boribo RB (Bombak – Boribo SRB g1) +g2))	3,400	1.51
	Boribo RB (Bombak – Boribo SRB g1) +g4))	3,700	0.47
	Boribo RB (Boribo-North SRB h1)	900	0.18
	Boribo RB (Boribo-MN SRB i1)	2,320	0.97
	Boribo RB (n, MN Residual SRB h2)+i2))	1,070	-
	Boribo RB (Boribo-MS SRB j1))	3,400	0.17
	Boribo RB (Boribo-South SRB k1))	1,300	0.15
	Boribo RB (MS,S Residual j2)+k2))	600	-
Total		102,790 (without Bassac Reservoir) 110,190 (with Bassac Reservoir)	

Prepared by JICA Study Team

18. Land resources were assessed mainly using GIS data consisting of: (i) protected area, (ii) land use, (iii) Data Elevation Model (DEM), (iv) soil map and (v) flood area as the flow illustrated on the right: The result shown in the table at the right indicates that 417,900 ha representing 18.4 % of the entire river basin areas can be developed for paddy field from the view point of land potential. ***(2.4.2)***



Prepared by JICA Study Team

Land Resource Potential Assessment

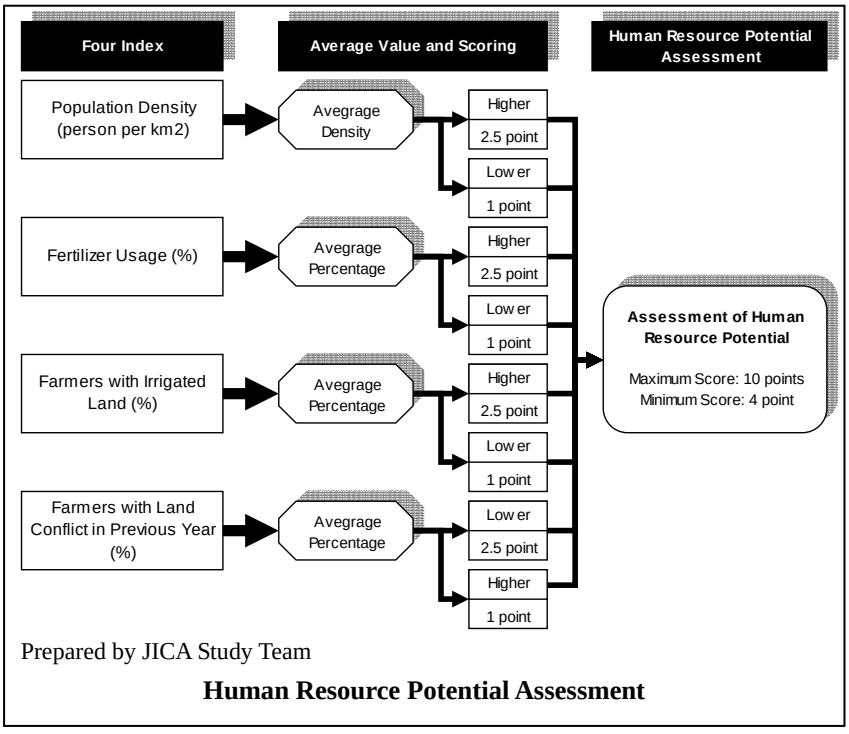
Land Resources in the River Basin

River Basin	Suitable (ha)	% in Basin
Battambang	87,900	14.5
Moung Russei	67,400	18.2
Pursat	93,300	15.7
Boribo	169,300	23.7
Total	417,900	18.4

Prepared by JICA Study Team

19. Human resource potential was assessed at district level through two main aspects: (i) availability of agricultural labor and (ii) level of farmers' agricultural techniques so as to identify the level of irrigated agriculture management.

In this regard, four



Prepared by JICA Study Team

Human Resource Potential Assessment

indexes consisting of: (i) population density, (ii) farmers' experience with fertilizer, (iii) farmers with irrigated farms and (iv) land conflicts in the previous year.[1] Assessment procedure is illustrated above and the results are as summarized in the following table:

Result of Human Resource Potential Assessment (District Level)

Units: Number of Districts

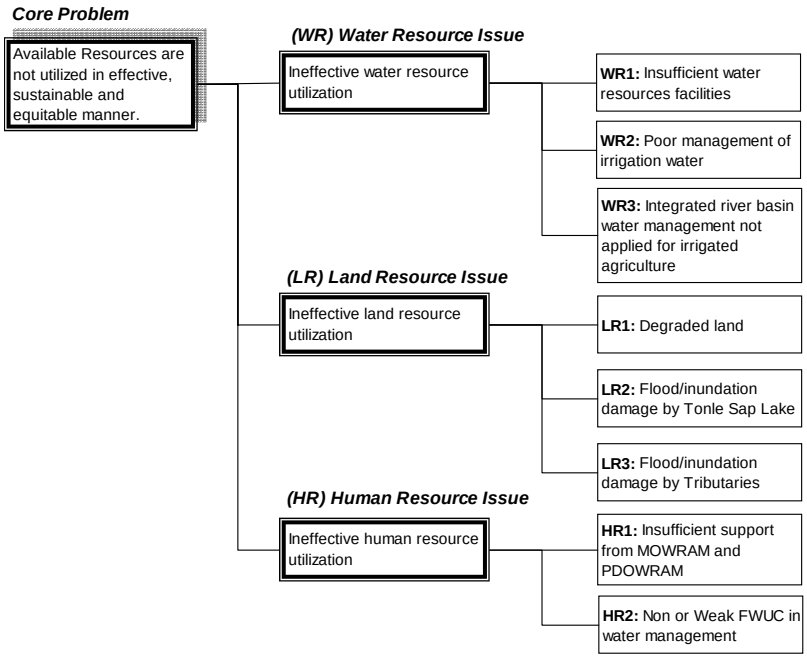
Level	Battambang	Moung Russei	Pursat	Boribo	Total
Very High (8.51-10 points)	0	0	0	3	3
High (7.01- 8.5 points)	0	0	0	3	3
Moderate (5.51 -7.0 points)	3	2	3	4	12
Low (4.0-5.5 points)	2	1	2	2	7
Very Low (4.0 points)	3	2	1	0	6
Total	8	5	6	12	31

Prepared by JICA Study Team

The districts in Boribo River Basin have comparatively high ratings while others have nearly similar ratings concentrating on "moderate" to "very low." These results are utilized as one of the criteria for prioritization of proposed sub-projects. ***(2.4.3)***

Concept and Approach to Basic Irrigation and Drainage Master Plan

20. Based on the field survey and analysis it has been determined that the main problems in the irrigation sector are "ineffective utilization of water, land and human resources." Another way to describe the core problem of irrigation is that "available resources are not utilized in an effective, sustainable and equitable manner." An abstract of the problem tree is shown above. Those problems are not solely independent. Rather, they are mutually correlated. Therefore, it is required to take holistic measures to tackle such problems. Resource utilization from the



Prepared by JICA Study Team

Problem Tree of Irrigation and Drainage in Four River Basins

[1] All the data were derived from the SEILA Database (2005). Village data is reclassified by JICA Study Team to generate district level data for this comparison.

view point of water, land and manpower is highly improved by taking an integrated approach in irrigation development. To improve agricultural productivity, water resource facilities need to be rehabilitated urgently. Land resources can also be effectively utilized by instituting flood management measures in currently affected areas. These water and land resources can be managed by adequately trained and strengthened human resources who are involved irrigation development, and these mainly consist of personnel from MOWRAM and PDOWRAM, and farmers. Food security maintenance is one of the most important commitments by the Government. Thus, the four river basins shall continue to play the important role of powerhouse and granary for the country's food supply in the future. ***(2.5.1)***

21. Cambodia achieved self-sufficiency in rice in 1995 with the support of the production from the four river basins. According to the statistics, the basins have been contributing to 17% of the national rice requirements on average. On this basis, the food balance for the years 2010, 2015 and 2020 were projected using different assumptions as tabulated below.

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 river basins to national production

3/: Paddy production increases required from the present level (802,000 tons) in the river basins

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

Consumption per capita is considered in three cases: (i) 143 kg/person assumed by the MAFF for the Food Balance Sheet, (ii) 155 kg estimated by FAO and (iii) 167 kg/person, the figure of Vietnam as a reference. The case: assumption 2 with 155kg/person consumption is utilized for the targeting setting of the M/P. Therefore, an increase in production is essential in the Four River Basins in order for it to continue to play the important role of powerhouse and granary for the country's food supply in the future. ***(2.5.2)***

22. The development objective is to utilize available resources under irrigation systems in effective, sustainable and equitable manner. In order to enhance the irrigation sector in accordance with this objective, strategies have been delineated in two aspects: (i)

rehabilitation and development of water resources infrastructure, and (ii) formation and strengthening of FWUC and O&M. Regarding the first aspect, the following basic strategies for irrigation and drainage are envisaged:

Basic Strategies for Irrigation and Drainage Rehabilitation and Development

(i) Complete water supply for wet season paddy as first priority,
(ii) Utilization of existing canals,
(iii) Utilization of existing water resources,
(iv) Construction of weirs for river irrigation systems,
(v) Construction of additional canals and structures, and
(vi) Rehabilitation of reservoir and pond irrigation systems for water harvesting.

With respect to the second aspect, there is a need to focus on five points in conformity with the government policy, as shown below.

Basic Strategies for Formation and Strengthen of FWUC and O&M System

(i) Arrangement of clear responsibilities between FWUC and agencies concerned,
(ii) Involvement of rural administration particularly commune councils, village chiefs and village development committees (VDC),
(iii) Preparation of comprehensive O&M training programs,
(iv) Adoption of PIMD, and
(v) Participation of FWUG at the construction stage.

The strategy of the drainage improvement plan is also formulated, and it should focus on: (i) paddy fields as a main target, (ii) maximum utilization of small streams, and (iii) application of extensive drainage improvement in general. In relation to irrigation and drainage development, the proposed agricultural development concept and strategy include the following four points:

Basic Strategy for Agricultural Development

(i) Improvement of productivity and increased production of rice through cropping of medium to late medium rice in the wet season and improved farming practices,
(ii) Strengthening of agricultural support services for farmers' participation,
(iii) Introduction of early rice and upland crops in the early wet and dry season to increase land use intensity, and
(iv) Envisaging the introduction of upland crop production under rainfed conditions in the early wet season.

(2.5.3)

Formulation of the Master Plan for Irrigation and Drainage Development

23. The following 21 projects and four supporting programs are proposed to improve irrigation and drainage in the four river basins. Each project consists of: (i) rehabilitation of irrigation and drainage facilities, (ii) FWUC training, and (iii) agriculture and other support. On the other hand, the supporting programs cover cross-cutting issues as enhancement of the basis of project implementation.

Proposed Irrigation and Drainage Projects

No.	River Basin	Project Name	Proposed Area(ha)	Total Investment Cost (US$ 1,000)	EIRR (%)
1	Battambang	Kong Hort Rehabilitation Project (Phase I)	10,040	28,920	8.2
2	Battambang	Kong Hort Rehabilitation Project (Phase II)	2,733	9,793	3.9
3	Battambang	Sala Taon Weir Rehab. Project	10,400	59,951	2.7
4	Battambang	Ratanak-Battambang Water Harvesting Project	580	3,120	3.0
5	Moung Russei	Bassac Irrigation System Rehabilitation Project	3,500	8,022	2.9
6	Moung Russei	Ream Kon Rehabilitation Project	2,300	5,734	9.8
7	Moung Russei	Por Canal Rehabilitation Project	1,200	2,598	9.5
8	Moung Russei	Nikom/Dai Ta Chan Rehabilitation Project	600	2,250	11.0
9	Pursat	Beoun Preah Ponley Rehabilitation Project	8,500	20,296	7.2
10	Pursat	Damnak Ampil Extension Project	8,000	18,491	12.0
11	Pursat	Wat Loung Rehab. Project	3,940	9,193	9.2
12	Pursat	Wat Chre Rehab. Project	1,000	2,965	10.7
13	Pursat	Anlong Knouchi, Wat Leal, Kosh Khsach Water Harvesting and Recession Rice Rehabilitation Project	2,602	6,463	9.3
14	Boribo	Lum Hach Rehab. Project	3,700	10,785	8.1
15	Boribo	7th January Canal Rehab. Project	2,000	5,668	6.3
16	Boribo	Khvet Rehabilitation. Project	250	928	6.8
17	Boribo	Ta Ram Rehabilitation. Project	180	1,009	7.1
18	Boribo	Chak Teum, Trapeang Khlong, Don Pov Rehabilitation. Project	980	2,626	4.1
19	Boribo	Teuk Laak, Trapeang Thlan Rehabilitation. Project	230	781	10.1
20	Boribo	Toul Champey Rehabilitation.Project	360	747	7.9
21	Boribo	Chan Keak Rehabilitation.Project	110	372	13.7

Prepared by JICA Study Team

Four proposed supporting programs are as follows: (i) Meteorological and Hydrological Observation Strengthening Program, (ii) Capacity Development Support Program of MOWRAM, (iii) Capacity Development Support Program of PDOWRAM and MOWRAM and (iv) Upland Crops Production Promotion Program. ***(2.7)***

Road Map of Irrigation and Drainage Development in the Four River Basins Toward Year 2020

24. Road Map 2020, covering the action plan from 2008 until 2020, was prepared on the basis of following concepts: ***(2.8.1)***

Concept of Road Map 2020

(i) Stepwise approach consistent with relevant policies and plans,
(ii) Supporting Participatory Irrigation Management and Development (PIMD) under Irrigation Management Transfer (IMT),
(iii) Development prioritization through a comprehensive set of criteria,
(iv) Model project implementation for ripple effect, and
(v) Contribution to the maintenance of the country's food self-sufficiency

25. Sub-projects formulated were ranked and prioritized using comprehensive sets of criteria

as follows and the results were shown. ***(2.8.2)***

Criteria and Scores Allocated for Sub-Project Prioritization

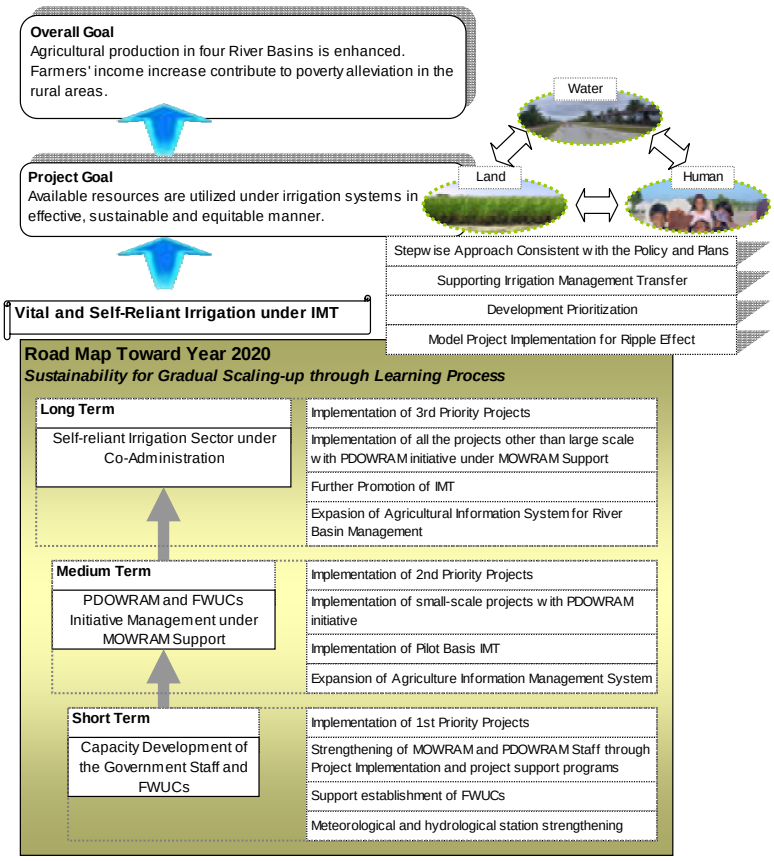
(i) Resource factor (30 points),
(ii) Economic factor (20 points),
(iii) Social factor (20 points),
(iv) Environmental factor (10 points),
(v) Ease of implementation (10 points), and
(vi) Maturity factor (10 points).

Results of the Prioritization of Proposed Projects

No.	Project Name	Resource	Econ.	Social	Envi.	Imple.	Matu.	Total	Rank	UXO
		30	20	20	10	10	10	100		
1	Kong Hort Rehabilitation Project (Phase I)	21	14	9.17	10	6	6	66.17	6	High
2	Kong Hort Rehabilitation Project (Phase II)	21	8	9.17	10	6	6	60.17	16	High
3	Sala Taon Weir Rehab. Project	21.5	11	9.61	0	10	6	58.11	17	Low
4	Ratanak-Battambang Water Harvesting Project	20.3	7	9.07	10	6	2	54.37	20	High
5	Bassac Irrigation System Rehabilitation Project	21	13	9	10	2	10	65.00	10	High
6	Ream Kon Rehabilitation Projct	21	13	9	7	10	6	66.00	7	Low
7	Por Canal Rehabilitation Project	21	12	9	8	10	6	66.00	7	Low
8	Nikom/Dai Ta Chan Rehabilitation Project	21	10	9	10	10	6	66.00	7	Low
9	Beoun Preah Ponley Rehabilitation Project	21	16	8	10	6	6	67.00	5	Low
10	Damnak Ampil Extension Project	23	16	12	10	6	10	77.00	1	Low
11	Wat Loung Rehab. Project	23	13	8.72	10	10	6	70.72	2	Low
12	Wat Chre Rehab. Project	23	12	8	10	6	10	69.00	3	Low
13	Anlong Knouchi, Wat Leal, Kosh Khsach Water Harvesting and Recession Rice Rehabilitation Project	23	11	10.88	10	6	2	62.88	13	High
14	Lum Hach Rehab. Project	22.5	11	10	8	10	6	67.50	4	Low
15	7th January Canal Rehab. Project	21	11	8	10	6	6	62.00	14	Low
16	Khvet Rehabilitation. Project	26	10	8	8	2	2	56.00	18	Low
17	Ta Ram Rehabilitation. Project	26	7	8	10	2	2	55.00	19	Low
18	Chak Teum, Trapeang Khlong, Don Pov Rehabilitation. Project	23	12	10.83	10	2	6	63.83	12	Low
19	Teuk Laak, Trapeang Thlan Rehabilitation. Project	21	7	9.72	10	2	2	51.72	21	Low
20	Toul Champey Rehabilitation.Project	26	14	8	10	2	2	62.00	14	Low
21	Chan Keak Rehabilitation.Project	24.5	10	8	10	10	2	64.50	11	Low

Prepared by JICA Study Team

26. Taking the concept and the results of the prioritization into account, Road Map 2020 is illustrated on the right. Each term has a thematic focal point and quantifiable target. The Road Map 2020 must take into account the learning process with gradual expansion to ensure its sustainability. Thus, periodic revision and update is required based on the collection of new data and experiences gained during project implementation. ***(2.8.3)***



Illustrative Summary of Road Map 2020

27. In Road Map 2020, 63,205 ha of irrigation areas are proposed to be developed, which will contribute to poverty alleviation in rural areas in the four river basins. It is estimated an increase of approximately 259,000 tons of paddy per year as a result of the implementation of 21 proposed projects. This additional production of the four river basins should be able to support the country's food self-sufficiency. It is strongly recommended that relevant value-added support services for agriculture such as agricultural extension, marketing of products, input supply, rural credit and rehabilitation of rural infrastructure, be carried out concurrently with the implementation of the proposed projects. This would ensure that the estimated increase in food production is guaranteed and farmers' incomes are increased. This needs inter-ministerial coordination to be led by MOWRAM and MAFF in collaboration with other relevant ministries. ***(2.8.3)***

Environmental Assessment

28. Initial Environmental Examination (IEE) was carried out for the M/P. The conclusions of the IEE are as follows: (i) the proposed programs and projects are not expected to result in negative environmental impacts in and around sites, if the proposed mitigation measures are concurrently carried out, and (ii) measures for involuntary resettlement are important. Although potential negative impacts have been judged to be small based on the

IEE, it should be emphasized that the resettlement process must be pursued in a careful, stepwise, and gradual approach so as to build consensus among the stakeholders. This consensus-building process must involve various stakeholders since irrigation development gives an impact to local economy, not only to irrigated agriculture. ***(2.9)***

Selection of Sub-Projects for Pre-Feasibility Study and Definition of Terminology

29. The conduct of pre-F/S is done for the purpose of determining the maturity of proposed projects from the viewpoint of technical, economic and social aspects so as to accelerate the implementation of the proposed projects included in the Road Map. The target projects for the conduct of the pre-F/S were selected based on the following concepts:

Criteria of Sub-Project Selection for Pre-F/S
(i) Select highly prioritized sub-projects in the M/P,
(ii) Assist in the preparation of a development model at pre-feasibility level, and
(iii) Ensure security for the study.

Based on the above concepts, the following six sub-projects were selected for the conduct of the pre-F/S. ***(2.10.1)***

List of Sub-Projects for Pre-Feasibility Study

No.	Sub-Project	River Basin	Scale	Model	Area
1.	Damnak Ampil Extension	Pursat	Large	River Run off	8,000 ha
2.	Wat Loung Rehabilitation		Medium	River Run off	3,940 ha
3.	Wat Chre Rehabilitation		Medium	River Run off	1,000 ha
4.	Lum Hach Rehabilitation	Boribo	Medium	River Run off	3,700 ha
5.	Ream Kon Rehabilitation	Moung Russei	Medium	River Run off	2,300 ha
6.	Por Canal Rehabilitation		Medium	River Run off	1,200 ha
	Total Area				20,140 ha

Prepared by JICA Study Team

30. Six pre-F/S sites were proposed for the first phase in Road Map 2020, and these are grouped into one package as a project namely, ***West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project***. In this report, therefore, the words "project" and "sub-project" are defined as follows:

- ***Project***: West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project formulated by grouping six priority sites in Road Map 2020; and
- ***Sub-Project***: Six sites selected for the conduct of pre-F/S consisting of:
  - (i) Ream Kon Rehabilitation Moung Russei River Basin,
  - (ii) Por Canal Rehabilitation Moung Russei River Basin,
  - (iii) Damnak Ampil Rehabilitation Pursat River Basin,
  - (iv) Wat Loung Rehabilitation Pursat River Basin,
  - (v) Wat Chre Rehabilitation Pursat River Basin, and
  - (vi) Lum Hach Rehabilitation Boribo River Basin. ***(2.10.2)***

III. PROJECT AREA

Location and Administration

31. The six selected sub-projects as tabulated below are located in Moung Russei, Pursat and Boribo River Basins, all of which are located in the western Tonle Sap along the National Road No.5. ***(3.1)***

Administration of Sub-Project Areas

No.	Sub-project	Province	Districts	Communes	Villages
1	Ream Kon Rehabilitation	Battambang	Moung Russei	Kear, Chrey, Prey Svay	Kear (1), Chrey (4), Prey Svay (1)
2	Por Canal Rehabilitation	Battambang	Moung Russei	Chrey, Kear, Ta Loas, Kor Koah	Chery (4), Ta Loas (9)
3	Damnak Ampil Rehabilitation	Pursat	Sampov Meas	Lorlok Sar, Snam preah, Trapeang Chong, Phteah Rung, Bak Chenhchien	Dam Nak Ampil
4	Wat Loung Rehabilitation	Pursat	Sampov Meas, Bakan	LorlokSar, Trapeang Chong, Snam Preah, Khnar Totueng, Boeng Khnar	Wat Loung, Kos
5	Wat Chre Rehabilitation	Pursat	Bakan	Boeung Khnar, Me Tuek	Wat Chre
6	Lum Hach Rehabilitation	Kampong. Chhnang	Boribo & Roleaphaea	Krang Skear, Anchanh Rung, Prasneb, Phsar	Anchanh Rung, Damrei Koun, Prey Preal, Andoung Rovieng, Thmei, Trapeang Ampil

Prepared by JICA Study Team

Natural Conditions

32. In the meteo-hydrological study, (i) meteo-hydrological observation and data collection and (ii) analysis for pre-F/S sites consisting of five-day discharge data and probable flood discharges for Moung Russei, Pursat and Boribo Rivers were carried out and utilized for the preparation of the irrigation and drainage plan and facility design at pre-F/S level. The average monthly meteorological values of the three river basins where the six sub-projects are located are tabulated as follows. ***(3.2)***

Average Monthly Meteorological Values at Moung Russei River Basin:

Ream Kon and Por Canal Rehabilitation Sub-Projects

Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean (℃)	25.7	27.7	29.6	30.4	30.1	29.6	29.0	28.7	28.0	27.5	26.6	25.4	28.2
Relative humidity (%)	70	66	67	68	72	73	74	77	79	81	78	74	73
Wind velocity (m/s)	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.1	0.8	0.8	0.9	0.9	1.0
Sunshine hours (hr/day)	9.5	9.0	8.8	7.7	7.3	5.6	6.4	5.0	5.5	6.6	7.4	8.5	7.3
Evaporation (mm/day)	4.0	4.7	4.8	4.9	4.5	4.3	3.7	3.6	3.0	3.2	3.2	3.4	3.9
(mm)	122	131	148	147	138	128	113	111	90	97	95	104	1423

Note: Data = Average of Battambang and Pursat Stations' data except sunshine hours
Sunshine hours = that of Battambang Station ＊Wind velocity is adjusted to the equivalent one at 2 m height.

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Average Monthly Meteorological Values at Purat River Basin:

Damnak Ampil, Wat Loung and Wat Chre Rehabilitation Sub-Projects

Monthly		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature														
Mean	(℃)	26.3	28.1	29.5	30.4	30.2	29.9	29.3	29.1	28.4	27.8	26.8	25.9	28.5
Mean max.	(℃)	31.7	33.9	35.1	35.6	35.3	34.9	34.1	33.7	32.6	31.6	30.9	30.4	35.6
Mean min.	(℃)	20.8	22.2	24.0	25.1	25.2	24.9	24.4	24.5	24.2	24.0	22.8	21.4	20.8
Relative humidity	(%)	66	63	65	66	67	68	68	71	74	76	74	71	69
Wind velocity	(m/s)	0.80	0.78	0.68	0.60	0.48	0.37	0.40	0.37	0.32	0.48	0.50	0.58	0.53
Sunshine hours	(hr/day)	-	-	-	-	-	-	-	-	-	-	-	-	-
Evaporation	(mm/day)	3.7	4.5	4.4	4.5	4.2	4.1	3.3	3.5	2.8	3.2	3.1	3.0	3.7
	(mm)	115	126	138	135	130	121	102	107	83	98	93	92	1340

Prepared by JICA Study Team

Average Monthly Meteorological Values at Boribo River Basin:

Lum Hach Rehabilitation Sub-Project

Boribo River Basin

Monthly		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature														
Mean	(℃)	26.3	27.9	29.4	30.3	30.1	29.4	28.8	28.7	28.2	27.5	26.7	25.9	28.2
Relative humidity	(%)	69	66	67	69	72	73	74	77	79	80	77	73	73
Wind velocity	(m/s)	2.0	2.3	2.4	2.2	2.3	2.5	2.2	2.7	2.3	1.6	2.1	2.1	2.2
Sunshine hours	(hr/day)	8.5	8.5	8.2	8.0	7.2	6.0	5.7	5.6	5.5	5.8	7.4	8.1	7.0
Evaporation	(mm/day)	4.1	5.1	5.4	5.3	4.5	4.4	3.7	3.8	3.2	3.1	3.4	3.6	4.1
	(mm)	127	142	167	158	140	130	115	115	94	96	101	111	1494

Note: Data = Average of Pochentong and Pursat Stations' data except sunshine hours
Sunshine hours = that of Pochentong Station ＊ Wind velocity is adjusted to the equivalent one at 2 m height.

Prepared by JICA Study Team

33. The soils distributed in the individual sub-project areas and their land suitability for rice and upland crop production evaluated according to the FAO classification system (Framework for Land Evaluation, FAO, 1976) are as follows:

Soil Distribution & Land Suitability Classification of Sub-project Areas

Soil Sub-unit	Distribution (%)						Land Suitability Class	
	RK	PC	DA	WL	WC	LH	Rice	Upland Crops
Gleyic Luvisol (LVg)	100	100	-	-	-	-	S2	S3
G. Acrisol/P. Acrisol (ACg/ACp)	-	-	100	100	100	-	S3	S3
Gleyic Acrisol (ACg)	-	-	-	-	-	56	S3	S3
Plinthic Acrisol (ACp)	-	-	-	-	-	38	S3	S3
Dystric Fluvisol (FLd)	-	-	-	-	-	6	S2	S2/S3

Note: RK - Ream Kon, PC - Por Canal, DA - Damnak Ampil, WL - Wat Loung, WC - Wat Chre, LH - Lum Hach G. Acrisol/P. Acrisol (ACg/ACp): association of Gleyic Acrisol & Plinthic Acrisol

The entire areas of Ream Kon and Por Canal are classified as moderately suitable for rice production and marginally suitable for upland crop production. Similarly, all the areas of Damnak Ampil, Wat Loung and Wat Chre and almost the entire area of Lum Hach are classified as marginally suitable for rice and upland crop production. ***(3.2)***

Socio-Economic Conditions

34. Households and population for the six sub-projects are shown in the table below. 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 the sub-project areas.

Population and Households under the Sub-Project

No.	Sub-Project	Household	Population	Member per Household
1	Ream Kon Rehabilitation	900	4,667	5.2
2	Por Canal Rehabilitation	924	4,739	5.1
3	Damnak Ampil Rehabilitation	2,000	10,401	5.2
4	Wat Loung Rehabilitation	1,700	9,232	5.4
5	Wat Chre Rehabilitation	728	3,797	5.2
6	Lum Hach Rehabilitation	2,066	9,624	4.7
	Total	8,318	42,460	5.1

Prepared by JICA Study Team

Based on the poverty ranking gathered from focal group discussions, poor and/or destitute categories range from 55% to 69% in the sub-project areas, which is an indication of the strong desire to improve the living conditions of the people in these communities. Community organization activities varies among the sub-projects, however, as these activities are generally not being done. Only at the Damanak Ampil sub-project was an FWUC established and the registration process was ongoing; there are, however, no substantial activities at present. ***(3.3.1, 3.4.1, 3.5.1, 3.6.1, 3.7.1 & 3.8.1)***

Agriculture

35. Rice production is the most important agricultural activity in all the sub-project areas, where the present land use is paddy field under different irrigable conditions. Accordingly, the land uses of these areas have been classified based on two sub-categories of current irrigation status namely, (i) supplemental irrigation paddy field, and (ii) rainfed paddy field (including fields under rainfed condition). There are no paddy fields under normal irrigation condition in the sub-project areas. ***(3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.7.2 & 3.8.2)***

Paddy Cultivation (Direct Sowing in Early Wet Season) at Por Canal Rehabilitation Sub-Project

36. The current estimated cropped area and cropping intensity in the sub-project areas is tabulated as follows:

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Ream Kon Rehabilitation Sub-Project)

Cropping Season	Irrigation Status	Cropped Area			Cropping Intensity (%)
		Rice		Other Crops	
		Area (ha)	Intensity (%)		
Early Wet Season	Pumping	200	10	10ha	10
Wet Season	Supplemental	50	2	--	2
	Rainfed	1,970	98	-	98
Annual	-	2,220	110	10ha	110

Prepared by JICA Study Team

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Por Canal Rehabilitation Sub-Project)

Cropping Season	Irrigation Status	Cropped Area			Cropping Intensity (%)
		Rice		Other Crops	
		Area (ha)	Intensity (%)		
Early Wet Season	Pumping 1/	410	20	-	20
Wet Season	Supplemental	100	5	-	5
	Rainfed	1,970	95	-	95
Sub-total		2,070	100	-	100
Annual	-	2,480	120	-	120

Prepared by JICA Study Team

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Damnak Ampil Rehabilitation Sub-Project)

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	2,430	-	100
Dry Season	60	-	2
Annual	2,490	-	102

Prepared by JICA Study Team

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Wat Loung Rehabilitation Sub-Project)

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	2,720	-	100
Dry Season	45	30	3
Annual	2,765	30	103

Prepared by JICA Study Team

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Wat Chre Rehabilitation Sub-Project)

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	1,090	-	100
Early Wet Season	-	15	1.4
Dry Season	-	15	1.4
Annual	1,090	30	103

Prepared by JICA Study Team

Estimated Cropped Area & Cropping Intensity in the Sub-project Area (Lum Hach Rehabilitation Sub-Project)

Cropping Season	Cropped Area (ha)		Cropping Intensity (%)
	Rice	Other Crops	
Wet Season	3,320	-	100
Early Wet Season	-	40	1
Annual	3,320	40	101

Prepared by JICA Study Team

Cropping intensity is from 101% at Lum Hach to 120% at Por Canal sub-project. Most of the areas still depend on rainfall and supplemental irrigation. Therefore, yield remains at a low level, from 1.0 ton/ha (rainfed condition) to 2.5 ton/ha (supplemental irrigation). The number of hand tractors in the communes is substantial, however, although land preparation work by draft animal is still a prevailing practice in all the sub-project areas.

The major constraints regarding farming that farmers disclosed during the socio-economic survey are: (i) low paddy yield, and (ii) irrigation water shortage even during the wet season. Therefore, farmers' expectations are: (i) productivity improvement of wet season rice and (ii) adequate irrigation water supply during the wet season. ***(3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.7.2 & 3.8.2)***

37. Threshing of paddy by engine thresher is a predominant practice in the sub-project areas. After threshing, paddies except for those kept for household consumption are generally marketed without drying. Paddies for family consumption are sun-dried in a home yard. The prevailing marketing channels of paddy are generally village collectors and/or rice millers in commune center. The identified constraints in paddy marketing are unstable market prices followed by low and/or unstable market prices. These constraints are common in all the sub-project areas. ***(3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.7.2 & 3.8.2)***


District Market at Bakan in Pursat Province

38. Price competition with Vietnam buyers was reported as one of the constraints by rice millers, particularly at two sub-project areas (Ream Kon and Por Canal Rehabilitation Sub-Projects). In addition, because of the insufficiency of drying space and the absence of drying facilities, the millers can only sell field-dried paddy to Thai buyers who accept such type of paddy (wet paddy). ***(3.3.2, 3.4.2, 3.5.2, 3.6.2, 3.7.2 & 3.8.2)***

Irrigation and Drainage

39. *Ream Kon Rehabilitation Sub-Project*: The system was originally constructed in 1978. Moung Russei River water was planned to be diverted by the headworks so as to provide Ream Kon and Por Canal located in the nearby upstream with irrigation water. However, immediately after its construction, the structure and the canal network were damaged by the frequent floods. Thus, the irrigation system does not function at present. In addition, on-farm facilities have never been sufficiently developed until now. There are no drainage canals in the command area. The drainage water outside of the command area, including the western area (irrigation area under Anlong Koub system) and the southern area flows into irrigation canals leading to breakage of the canal dyke. ***(3.3.3)***


Upstream Feature of Headworks, Gate with no functioning (Ream Kon Rehabilitation Sub-Project)

40. *Por Canal Rehabilitation Sub-Project*: The system was originally constructed in 1978. It was planned that the system shared headworks with the Ream Kon sub-project to divert Moung Russei River water. Although some of the


Cracks of Wing Wall of Intake (Por Canal Rehabilitation Sub-Project)

canals have been rehabilitated recently, there are no water control facilities in the canals. A part of on-farm facilities including secondary and tertiary canals were recently rehabilitated under technical and financial assistance from the SEILA program and NGO, ECOSORN. However, no substantial O&M activities by PDOWRAM and farmers were observed. Similar to Ream Kon, there are no clear drainage canals in the command area. The excess water from west of the sub-project area (Prek Taam irrigation area) flows into the sub-project area. The collector drains need to be developed along the western border of the area. ***(3.4.3)***

41. *Damnak Ampil Rehabilitation Sub-Project*: The system, which was originally constructed in 1976, was damaged by floods in 1979. To irrigate 2,270 ha, the construction of new headworks and canal rehabilitation in the upstream stretch of 7.3 km, with one check structure, nine off-takes and other structures, was carried out by MOWRAM in 2006. The extension of the main canal was proposed by MOWRAM that will connect to Svay Don Keo river to enable irrigation water to be delivered to Damnak Ampil extension area and several irrigation systems located downstream. ***(3.5.3)***

42. The automatic floodgates are equipped with Damnak Ampil headworks. However, the gates hardly stand during the wet season so that the intake water level could not be maintained at El. 17.0 m. The gates are designed to stand with the water level at El. 13.7 m, which is significantly lower than the intake water level (El. 17.00 m). However, the gates seldom stand during the wet season since the water level during this time is usually higher than El. 13.70 m. In addition, there are concerns raised on the excessive friction between the counterweight and the guide hole that impedes the smooth return of the counterweights. Some measures need to be considered under the sub-project to improve the effectiveness of these gates. ***(3.5.3)***

Damnak Ampil Headworks
(Damnak Ampil Rehabilitation Sub-Project)

43. As for the canal network, three secondary canals were constructed. However, these are seriously deteriorated now. No tertiary canals have been constructed even though check structures were constructed in 2006. Since the water level of the main canal is low, such structures are not being used efficiently. ***(3.5.3)***

44. *Wat Loung Rehabilitation Sub-Project*: The system was constructed on the left bank side of the Pursat River in 1977 with a target

Ruins of Pier of Headworks on the Pursat River
(Wat Loung Rehabilitation Sub-Project)

area covering 7,000 ha. The system was, however, damaged in 1979 and is not functioning at present. The original headworks on the Pursat River was completely washed away, and there is no intake structure at present. The main canal, which runs northwest from the Pursat River, does not function well because water inflow from the river is limited, except during the flood period. No secondary and/or tertiary facilities have been developed. There are four existing irrigation systems located upstream of Boeung Khnar River, from which water is delivered. Water use of Wat Loung is required to consider these systems. ***(3.6.3)***

45. *Wat Chre Rehabilitation Sub-Project*: The system was constructed along the Boeung Khnar River in 1977 so that river water can be utilized. The system was, however, damaged between 1979 and 1980, and is not functioning at present. Very few structures exist as indicated in the JICA Inventory Survey carried out in 2006. The area is divided into two: (i) eastern area located on the right side of the river (1,000 ha), and (ii) western area located on the left bank side of the river (300 ha). The headworks does not exist at present because it has been damaged and flushed away by floods. There is no intake structure to control water inflows from the Boeung Khnar River. Two main canals run from the headworks on the Boeung Khnar River to the southeast and the northwest respectively. ***(3.7.3)***

Main canal to Southeast (Wat Chre Rehabilitation Sub-Project)

46. *Lum Hach Rehabilitation Sub-Project*: The system was constructed on the Boribo River between 1976 and 1977 to utilize river water for irrigation. The system, however, was damaged between 1981 and 1982, and is functioning in a limited area with less than 300 ha. The Lum Hach Irrigation System actually involves over 30 irrigation sub-systems with the Boribo River as main water source. Of this total, two systems occupy a major part namely, (i) O Roluss located at the left side of the river, and (ii) Lum Hach system at the right side. The rehabilitation work for the first system commenced in 2006, which was done by MOWRAM and PDOWRAM. Therefore, only the Lum Hach system could be a target for inclusion in the sub-project. The headworks originally constructed was completely washed away because the location was improper from the technical point of view.

Proposed Site of New Lum Hach Headworks

A canal, named 7th January Canal with a length of 27 km is the main canal of the system. It

is no longer in use, however, because of the collapse of the headworks. An existing off-take structure on the existing Secondary Canal No. 1 is extraordinary large for the irrigation area, and its gate sill elevation is higher than the main canal by more than 2.0 m. The structure must be removed so that a new off-take structure can be constructed. There are no tertiary facilities at present. The main rural roads are in fair condition except during the wet season these roads get muddy and are not passable even by 4WD vehicle. ***(3.8.3)***

Environment

47. All the protected or conserved areas stipulated by the Government are located outside of the sub-project areas. Rare animals are not observed in and around the sub-project areas since these have already been cleared for agriculture particularly paddy cultivation. Based on field interviews, animals observed in the sub-projects' areas are wild pig, rabbits or some species of reptiles such as snakes and turtles. No protected areas and/or historical and religious sites are situated in the sub-project areas. ***(3.3.4, 3.4.4, 3.5.4, 3.6.4, 3.7.4 & 3.8.4)***

48. There is no data related to noise and air quality in and around the sub-project areas, as no serious noise pollution sources exist there. With regard to air quality, only power generators of a private company and traffic particularly along National Road No. 5 and access to the command area, would give negative impacts to some extent. The distance from the national road to the command area is 3 to 20 km. These negative impacts are not serious at present. ***(3.3.4, 3.4.4, 3.5.4, 3.6.4, 3.7.4 & 3.8.4***

49. Irrigation water quality was preliminary analyzed at the sub-projects, indices of which consist of: (i) pH, (ii) Electrical Conductivity (EC), and (iii) Total Dissolved Solids (TDS). Most of the sites ranged in "no problem," except for the area where water is stagnant due to poor drainage. In such points, pH showed a higher level than the standard, thus needing drainage improvement under the Project. ***(3.3.4, 3.4.4, 3.5.4, 3.6.4, 3.7.4 & 3.8.4***

50. As for the current water use by communities, farmers under all the sub-projects are dependent primarily on rainfall with limited supplemental irrigation since the facilities have significantly deteriorated. Under such condition, farmers' groups do not function as a group for the O&M of irrigation facilities and water management. In parallel with the rehabilitation of these facilities, the establishment and strengthening of FWUC would be of critical importance for sustainable irrigation development and management. ***(3.3.4, 3.4.4, 3.5.4, 3.6.4, 3.7.4 & 3.8.4***

Agricultural Support Services

51. Six sub-projects belong to three districts under three provinces, as the units that will provide support services in agriculture. These are: (i) Moung Russei (Ream Kon and Por Canal), (ii) Bakan (Damnak Ampil, Wat Loung and Wat Chre) and (iii) Boribo (Lum Hach). The government institution involved in agricultural support services at the provincial level is the Provincial Department of Agriculture (PDA). The PDA has its branch offices at the district level called District Agricultural Office (DAO). The

government extension services at the sub-project area level (commune and village) are basically to be provided by DAO under the support and guidance of PDA. Major agricultural extension activities provided in the province are programs under the Project to Support Democratic Development through Decentralization and Deconcentration (PSDD) by the government and activities under the donors and NGOs. However, current services by the Government appear to be very limited due primarily to financial constraints. ***(3.9)***

52. The primary source of quality seed supply in and around the sub-project areas is provided under support programs of PDA/DAO, donors or others. Commercial seed suppliers supply farm inputs in district centers, but their supply volume is limited. Based on the results of the socio-economic survey, the predominant source of rice seeds is self-multiplied seeds (products of the previous season) followed by seeds exchange with farmers in other areas. Further, seed replacement frequency is also low, and demand for quality seeds appears to be low at present. In contrast to such situation, the survey results indicate that there are no serious constraints for quality seed procurement in the sub-project areas. ***(3.9)***

53. With regard to rural credit accessibility from the sub-projects' communities, the deployment of ACLEDA Bank and MFIs in recent years is rapidly expanding in the country with the sub-projects being implemented in the province. Formal rural credit operators in the project districts primarily include ACLEDA Bank and PRASAC MFI. In addition, non-institutional credit providers such as money lenders, rice millers, farm input suppliers and relatives or friends might continue to be important sources of rural credit. ***(3.9)***

Relevant Institution

54. MOWRAM, first and foremost, is the main institution for the irrigation sector at the national level. Under MOWRAM, a National Project Management Office (NPMO) was established originally in 2006 to coordinate, manage and implement all projects related to the water resources development sector. The NPMO consists of three units: (i) South-East Project Management Unit (SEPMU), (ii) North-West Project Management Unit (NWPMU) and (iii) the Project Management Unit for the Government Budget. PDOWRAM in each province is to: (i) prepare development plans, (ii) research and observe and manage natural disasters, and (iii) collect meteorological and hydrological data. MAFF is another wing to promote irrigated agriculture at the national level and has a PDA in each province. ***(3.10.1 & 3.10.2)***

55. The Provincial Rural Development Committee (PRDC) is generally the center of rural administration. It has control over coordination of relevant sectoral agencies, under which there are district, commune and village organizations performing each task. After the decentralized mechanism assisted by the SEILA program, the Provincial Investment Fund (PIF) was established and directly allocated to the provinces to implement projects based on rural needs. In addition, commune councils have their own budget consisting of

tax and non-tax revenues. Being supported by commune *Sangkat* funds (CSF) allocated from the Government, small-scale rural infrastructures including tertiary irrigation systems are being developed under the communes' initiative. Such new mechanism contributes to the enhancement of capabilities at the local level and is also adaptable to irrigation development. ***(3.10.3 & 3.10.4)***

IV. BASIC DEVELOPMENT CONCEPT AND APPROACH

Development Needs and Strategy

56. As an important granary of the country, the four river basins, including the six sub-projects, have been contributing to 17% of national rice production and are expected to maintain the same levels in the future. As elaborated in the Strategic Development Plan for Water Sector 2006-2010, stabilization of food production at potential areas particularly in the six sub-projects' command areas through irrigation development is justified as a policy target. The justification of the importance of food security is supplemented by recent records of high world food prices. Maintenance of food self-sufficiency of the country is significant in order to alleviate vulnerability in food supply. During the workshop and public consultation at the communities under the six sub-projects, the needs of the people mostly concentrated on "*stabilization of water supply through rehabilitation and improvement of irrigation and drainage facilities"* followed by "*improvement of agricultural technique,*" Therefore, the needs of the project are justified from the viewpoint irrigation beneficiaries. ***(4.1.1)***

57. In the sub-projects, the actual irrigation rate only through supplemental irrigation remains 10% at present. The constraints of irrigation and drainage in these areas can be fundamentally attributed to insufficient design of facilities and quality control in the construction works for the original facilities. As a result, facilities are highly deteriorated so that water cannot be appropriately diverted from the water source. Also, water allocation within the command area cannot be carried out due to insufficiency in on-farm facilities. The lack of capability in irrigation implementation and O&M among relevant institutions and farmers cannot be neglected as one of the constraints for the improvement of irrigation performance under the sub-project command areas. ***(4.1.2)***

Basic Concept and Approach

58. The development objectives of the Project are to utilize available resources under irrigation systems in effective, sustainable and equitable manner, matters of which consist of: (i) effective water resource utilization by the rehabilitation and improvement of irrigation and drainage facilities, (ii) effective land resource utilization by the protection of agricultural field from long-lasting flood and inundation and (iii) effective human resource utilization by enhancing capability of the stakeholders. ***(4.2.1)***

59. Basic development concepts of the Project is: (i) rehabilitation and improvement of irrigation and drainage facilities, (ii) formation and strengthening of FWUC, (iii) practice

of irrigation water management and O&M and (iv) extension of improved farming practice. Basic approach is prepared for each concept as explained afterward. In addition, the Project is the first phase of the sub-projects list in the Road Map 2020. The lessons to be learnt in the implementation are expected to be effectively utilized in pursuing the Road Map 2020 as proposed in the M/P as well as irrigation development in other basins in the country. ***(4.2.2)***

60. Basic approach to rehabilitation and improvement of irrigation and drainage facilities is the following six points: (i) gravity system with clear demarcation of command area and improved water management, (ii) suitable development scale based on the available water resources, (iii) priority given to existing paddy field and facilities, (iv) construction of additional facilities, (x) appropriate drainage and flood protection plan considering allowable flooding depth and inundation period, floods from outside and habitual inundated area due to the Lake Tonle Sap, and (xi) cost-effectiveness in the plan. ***(4.2.2)***

61. Basic approach to formation and strengthening of FWUC is primarily on three points: (i) set-up the structure and responsibilities, (ii) formation of FWUC and its subordinates such as FWUGs and WUGs, and (iii) capacity development by way of participatory tertiary development though community-contract approach. ***(4.2.2)***

62. Practice of irrigation water management and O&M is planned based on the following basic approach: (i) responsibility sharing depending upon the level of facilities and (ii) Stepwise transfer of O&M of irrigation system to FWUC based on the Policy for Sustainability of Operation and Maintenance Irrigation System (June 2000) by MOWRAM. ***(4.2.2)***

63. In relation to irrigation development, development approach of agriculture are as follows with the purpose of productivity improvement and value-addition: (i) introduction of irrigated farming and increase in cropping intensity, (ii) introduction of improved farming practices supported by extension services, (iii) introduction of upland crops and/or vegetables under irrigation in the early wet and dry season, (iv) strengthening of agricultural extension services accommodated as a project component and (v) maintaining of current planting methods of rice in the Project, either transplanting or direct sowing. ***(4.2.2)***

64. On the basis of abovementioned diversified view points for basic concept and approach, the Project is formulated by the following principles: (i) harmonization of facilities rehabilitation and human resources development, (ii) joint efforts among stakeholders consisting of the Government, farmers and international donor agencies and (iii) learning process in irrigation development in the basins based on the Road Map 2020. Based on the principles, the Project consists of: (i) sub-project attached activities including facilities rehabilitation (hardware component) and FWUC establishment and strengthening and agricultural extension activities (soft component) and (ii) cross-cutting subjects as project supporting programs for the enhancement of implementation capacity of MOWRAM and PDOWRAM. ***(4.2.3)***

V. THE PROJECT

General

65. Available topographic maps and aerial photographs were utilized together with additional field investigations for the delineation of the sub-project areas. In parallel with such field investigations, a series of workshops and public meetings were organized at each sub-project site with the farmers and concerned government staffs from the central, provincial and local levels. As a result, alternative sub-project areas to be rehabilitated were determined in order to formulate an optimum rehabilitation plan for each sub-project from technical, economic and social viewpoints. Then, a comparative study of the alternative plans was performed for Ream Kon, Damnak Ampil and Lum Hach Rehabilitation sub-projects, based on the irrigation plan, water balance study, costs and incremental benefits of each of these sub-projects. Based on the results of the comparative study, the optimum size of the area to be rehabilitated for each sub-project was determined, As summarized in the table above, these optimum areas for rehabilitation of the sub-projects were used as the basis for the conduct of the pre-F/S. In applying this process, attention must be made with respect to the Damnak Ampil Rehabilitation sub-project. In the M/P, the extension area (8,000 ha) located downstream of the existing area was selected as one of the priority areas for pre-F/S. However, the existing area, which was already considered as having been developed, was found needing additional rehabilitation and upgrading during the conduct of the pre-F/S. Therefore, prior to the extension sub-project, the development plan in the pre-F/S level was prepared for the rehabilitation of existing area (Damnak Ampil Rehabilitation sub-project: 2,270 ha). ***(5.1)***

Proposed Command Area of the Sub-Projects for Pre-F/S

No.	Sub-Project	Area (ha) (Pre-F/S)	Area (ha) (M/P)
1	Ream Kon Rehabilitation	1,890	2,300
2	Por Canal Rehabilitation	1,940	1,200
3	Damnak Ampil Rehabilitation	2,270	8,000
4	Wat Loung Rehabilitation	2,540	3,940
5	Wat Chre Rehabilitation	1,020	1,000
6	Lum Hach Rehabilitation	3,100	3,700
	Total	12,760	20,140

Prepared by JICA Study Team

66. Irrigation system rehabilitation concepts for the plan are generally focused on five fundamentals as follows: (i) clear delineation of the command area, (ii) higher priority on gravity irrigation, (iii) independent setting of canals and drains, (iv) equal distribution of water from upstream to downstream within the command area, and (v) controlled water management using gated structures. ***(5.1)***

67. The proposed improvements in farming practices of paddy to be adopted include the following: i) proper land levelling and preparation, ii) use of quality seeds and adequate

seeding rate, iii) raising of the nursery bed, planting of younger seedlings, regular planting and reduction of the number of plants per hill (in transplanting), iv) fertilization (increased and timely application of fertilizers, including compost or cow dung), v) introduction of proper on-farm water management and water conservation culture, vi) intensification of weeding, and vii) improvement of post harvesting practices. ***(5.2.1, 5.3.1, 5.4.1, 5.5.1, 5.6.1 & 5.7.1)***

68. Under the Project, substantial increases of yields and the introduction of irrigated upland crops/vegetables production are envisaged, and this involves the introduction of intensified extension activities in the area. The proposed activities for agricultural extension are development interventions aimed at strengthening agricultural extension services to attain the sub-project targets of crop yields and cropping pattern at an earlier stage as possible. Major extension activities include field programs (adaptability test, demonstration plot, farm and area, upland crops/rice seed multiplication), farmer and farmer group training programs (training course, FFS/IPM, study tour), mass guidance/workshops, staff empowerment, support fund for extension staffs, and provision of means of transportation. The implementation of the activities is scheduled for the period of four years attached to each sub-project. ***(5.2.2, 5.3.2, 5.4.2, 5.5.2, 5.6.2 & 5.7.2)***

69. The overall land use plan/irrigation development under the with-project condition is presented in comparison with the present/without-project land use as follows:

Present/Without-Project and With-Project Land Use of the Project Area

Land Use Sub-category	Present		With-project		Increment
	(ha)	(%)	(ha)	(%)	(ha)
Paddy Field					
- Normal Irrigation Paddy Field			12,760	100	12,760
- Supplemental Irrigation Paddy Field	1,040	8			- 1,040
- Rainfed Paddy Field	12,610	92			- 12,610
Sub-total	13,650	100	12,760	100	- 890
Right-of-ways	1,020	7	1,910	13	890
Total	14,670	100	14,670	100	0

Prepared by JICA Study Team

The Project aims to develop 12,760 ha of normal irrigation paddy field through the conversion of 1,040 ha of supplemental irrigation fields and 12,610 ha of rainfed fields. The irrigated fields under the Project will be increased by 11,720 ha, which is about 12 times of the present level. The decrease of paddy fields due to conversion of land use to rights-of-way is estimated at 890 ha. ***(5.2.1, 5.3.1, 5.4.1, 5.5.1, 5.6.1 & 5.7.1)***

70. The overall crop production plan under the with-project condition is summarized as follows:

Present & With-project Overall Crop Production of the Project Area

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		1,300	9	2.0	2,600
Rainfed Paddy Field: Wet Season Rice		13,000	96	1.4	18,200
Annual	Rice	14,400	105	1.5	21,600
	Upland Crops/Vegetables	110	1	-	600
	Overall	14,510	106	-	-
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		14,800	116	3.1	45,880
Rainfed Rice 1/		1,400	11	1.3	1,820
Annual	Rice	16,300	127.4	3.0	48,900
	Upland Crops/Vegetables	2,100	16.2	-	7,400
	Overall	18,400	144	-	-
Increment (II – I)					
Annual	Rice	1,900	22.2	1.5	27,300
	Upland Crops/Vegetables	1,990	15.4	-	6,800
	Overall	3,890	38	-	-

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply

The increase of overall average yield of 1.5 tons/ha from 1.5 to 3.0 ton/ha and annual paddy production increase of some 27,300 tons are expected. Paddy production under the sub-project is about 230% of the current production level in the project areas. Under the sub-projects, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be some 7,400 tons, increase of about 6,900 tons from the present level. ***(5.2.1, 5.3.1, 5.4.1, 5.5.1, 5.6.1 & 5.7.1)***

Ream Kon Rehabilitation Sub-Project

71. The command area under the sub-project covers 1,890 ha of existing paddy field both during the wet and dry seasons. Since the downstream area with elevation of less than 11.0 m is prone to inundation from the water of the Tonle Sap Lake, such areas are excluded from the sub-project. The command area involves both gravity irrigation area (1,610 ha) and pump irrigation area (280 ha). The main water source for the sub-project is the Moung Russei River with the Bassac Reservoir on the upstream to be rehabilitated by MOWRAM under financial support by the Government of Japan. A water balance study for the Moung Russei River Basin including the sub-project was carried out based on the water storage of Bassac Reservoir and the allocation to other existing irrigation systems. The headworks is proposed for reconstruction as one of the primary facilities to divert Moung Russei River water to the system. The major rehabilitation plan for the irrigation system including diversion weir is tabulated as follows: ***(5.2.3, 5.2.4, 5.2.5 & 5.2.6)***

Irrigation and Drainage Rehabilitation Plan for Ream Kon Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (ha)	1,890
	(Pump irrigation area included above)	(280)
2.	Annual irrigation area (ha)	2,413
	- Early wet season paddy (ha)	1,180
	- Medium wet season paddy (ha)	1,180
	- Dry season paddy (ha)	53
3.	Major water source	Moun Russei River
	- Name of headworks	Moung Russei (Reconstruction)
	- Intake water level (EL. m)	15.50
	- Diversion water requirement at intake (m3/sec)	2.66
4.	Main canals (nos.)	2
	- Total length (km)	18.4
	- Capacity (m3/sec)	0.08 – 2.66
5.	Nos. of secondary canals	16
	- Total length (km)	12.9
	- Capacity (m3/sec)	0.09 – 1.48
6.	Number of Tertiary Blocks (no.)	47
	Total length of tertiary canals (km)	57
7.	Main drains	- Moung Russei, - Ou Anlong Rolus
	- Total length (km)	7.2
	- Capacity (m3/sec)	15.0 - 32.5
	- Drainage water requirement from paddy field (lit/sec/ha)	7.17
	- Drainage water requirement from other land (lit/sec/ha)	0.025~0.019
8.	Secondary drains (nos.)	9
	- Total length of secondary drains (km)	25.1
	- Capacity (m3/sec)	0.46 – 3.71
9.	Collector drains (nos.)	3
	- Total length of collector drain (New, km)	19.4
	- Capacity (m3/sec)	5.9 – 11.3

Prepared by JICA Study Team

Moung Russei Headworks and Major Facilities

Items	Description
-Moung Russei Diversion Weir -Design Flood Discharge: Q=180m^3/s (T=100 years) -Design Flood Water Level: WL. 17.2m -with Fish Ladder: B:5.0m x H:3.6m x L:36m	-Floating type movable weir -width x height x length B:39m x H:10.9m x L:44m -Flood Gate: Fixed wheel gate B:11.5m x H:3.8m x 2 nos. -Scouring Sluice Gate: Slide gate B:2m x H:2m x 1 no.
-Ream Kon Intake -Design Discharge: Q=2.66m^3/s	-width x height x length B3.5m x H:3.5m x L:7m -Slide Gate: B:1.0m x H:1.2m x 2nos.

Prepared by JICA Study Team

Por Canal Rehabilitation Sub-Project

72. The sub-project located upstream of the Ream Kon Sub-Project will share the water resources of Moung Russei River by means of the headworks of Moung Russei as

proposed in the Ream Kon sub-project. Main, secondary and tertiary facilities including intake structure are proposed to be rehabilitated under the sub-project works. All the command area will be irrigated by gravity. The major rehabilitation plan is tabulated as follows: ***(5.3.3, 5.3.4, 5.3.5 & 5.3.6)***

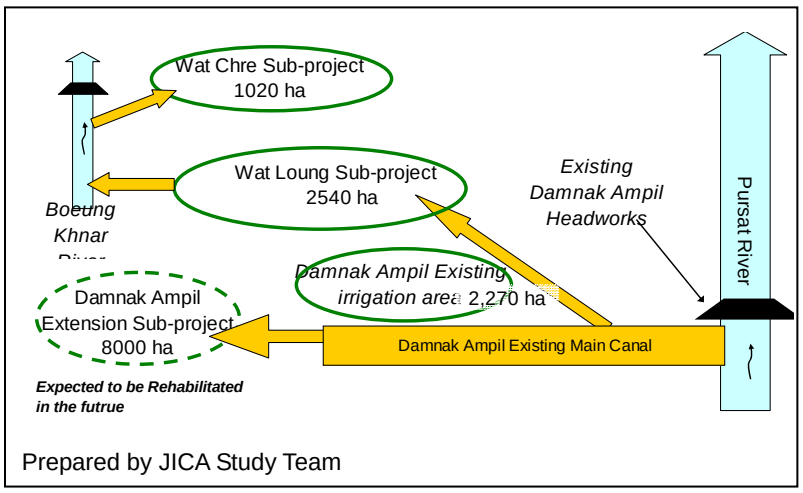
Irrigation and Drainage Rehabilitation Plan for Por Canal Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (ha)	1,940
	(Pump irrigation area included above)	0
2.	Annual irrigation area (ha)	2,494
	- Early wet season paddy (ha)	1,220
	- Medium wet season paddy (ha)	1,220
	- Dry season paddy (ha)	54
3.	Major water source	Moung Russei River
	- Name of headworks	Moung Russei (Reconstruction)
	- Intake water level (EL. m)	15.00
	- Diversion water requirement at intake (m3/sec)	2.74
	- Por Canal Intake -Design Discharge: Q=2.74m3/s	-width x height x length B:3.5m x H:3.6m x L:8m -Slide Gate: B:1.0mx H:1.2m x 2nos.
4.	Main canals (nos.)	2
	- Total length (km)	12.7
	- Capacity (m3/sec)	0.21 – 2.74
5.	Nos. of secondary canals	12
	- Total length (km)	15.8
	- Capacity (m3/sec)	0.14 – 0.28
6.	Number of Tertiary Blocks (no.)	42
	Total length of tertiary canals (km)	55
7.	Main drains	- Moung Russei, - MD-1
	- Total length (km)	9.3
	- Capacity (m3/sec)	0.58 – 27.3
	- 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
	- Capacity (m3/sec)	0.23 – 2.32
9.	Collector drains (nos.)	2
	- Total length of collector drain (New, km)	10.0
	- Capacity (m3/sec)	0.27 – 15.7

Prepared by JICA Study Team

Damnak Ampil Rehabilitation Sub-Project

73. Three sub-projects namely, (i) Damnak Ampil, (ii) Wat Loung and (iii) Wat Chre Rehabilitation are commanded by the Damnak Ampil headworks on the Pursat River. These sub-projects are closely correlated to one another as illustrated above. Therefore, the rehabilitation plan for the Damnak Ampil sub-project involves water distribution among these sub-projects, together with other nearby systems. The Damnak Ampil Rehabilitation sub-project is proposed to be implemented stepwise. Therefore, 2,270 ha including pump irrigation area of 500 ha are the initial targets for the sub-project. The aim is to revive the existing upstream area originally rehabilitated in 2006 by MOWRAM. The downstream development is expected to be implemented in a future stage. The sub-project, details of which are tabulated below, consists of: (i) gate improvement of the Damnak Ampil headworks, (ii) construction of fish ladder equipped with the headworks, and (iii) rehabilitation and/or construction of main, secondary and tertiary irrigation systems. ***(5.4.3, 5.4.4, 5.4.5 & 5.4.6)***



Irrigation and Drainage Rehabilitation Plan for Damnak Ampil Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (ha)	2,270
	(Pump irrigation area included above)	(500)
2.	Annual irrigation area (ha)	2,364
	- Early wet season paddy (ha)	94
	- Medium wet season paddy (ha)	2,270
	- Dry season paddy (ha)	0
3.	Major water source	Pursat River
	- Name of headworks	Damnak Ampil (Existing)
	- Intake water level (EL. m)	17.00
	- Diversion water requirement at intake (m3/sec)	7.93
4.	Main canals (nos.)	1
	- Total length (km)	7.5
	- Capacity (m3/sec)	1.07 – 7.93
5.	Nos. of secondary canals	3
	- Total length (km)	17.6
	- Capacity (m3/sec)	0.79 – 1.07
6.	Number of Tertiary Blocks (No.)	50
	Total length of tertiary canals (km)	85
7.	Main drains	Ou Bakan / Boeung Khnar River
	- Total length (km)	-

No.	Description	Area and/or Number
	- Capacity (m3/sec)	Natural Stream
	- 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.)	4
	- Total length of secondary drains (km)	28.2
	- Capacity (m3/sec)	1.29 – 8.56
9.	Collector drains (nos.)	0
	- Total length of collector drain (New, km)	0
	- Capacity (m3/sec)	-

Prepared by JICA Study Team

Headworks and Major Facilities

Items	Description
- Improvement of Flood gate	Installation of new electric hoist: 7 sets Replacement of bushing: 7 sets
- Improvement of Scouring sluice gate	Replacement with electric hoist: 4 sets
- Construction of Fish Ladder	- width x height x length B:5.0m x H:4.6m x L:46m

Prepared by JICA Study Team

Wat Loung Rehabilitation Sub-Project

74. Irrigation water of the Wat Loung Rehabilitation sub-project should be provided through Damnak Ampil main and secondary canals for to the following reasons: (i) high cost of reconstruction of diversion weir, and (ii) availability of sufficient capacity of the Damnak Ampil headworks and the main canal. The target area is 2,540 ha consisting of gravity irrigation (1,740 ha) and pump irrigation (800 ha). Its components consist of the rehabilitation of main, secondary and on-farm irrigation and drainage facilities and are tabulated below. ***(5.5.3, 5.5.4, 5.5.5 & 5.5.6)***

Irrigation and Drainage Rehabilitation Plan for Wat Loung Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (ha)	2,540
	(Pump irrigation area included above)	(800)
2.	Annual irrigation area (ha)	2,645
	- Early wet season paddy (ha)	105
	- Medium wet season paddy (ha)	2,540
	- Dry season paddy (ha)	0
3.	Major water source	Pursat River
	- Name of headworks	Damnak Ampil (Existing)
	- Intake water level (EL. M)	17.00
	- Diversion water requirement at intake (m^3/sec)	3.45
4.	Main canals (no.)	1
	- Total length (km)	20.3
	- Capacity (m^3/sec)	1.39 – 3.33
5.	Nos. of secondary canals	10
	- Total length (km)	31.1
	- Capacity (m^3/sec)	0.19 – 0.57
6.	Number of tertiary blocks (no.)	54
	Total length of tertiary canals (km)	81
7.	Main drains	Boeung Khnar R.

No.	Description	Area and/or Number
	- Total length (km)	-
	- Capacity (m^3/sec)	Natural Stream
	- 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 (no.)	8
	- Total length of secondary drains (km)	37.7
	- Capacity (m^3/sec)	1.56 – 13.70
9.	Collector drains (no.)	0
	- Total length of collector drain (new, km)	0
	- Capacity (m^3/sec)	-

Prepared by JICA Study Team

Wat Chre Rehabilitation Sub-Project

75. Judging from the technical viewpoint, particularly the elevation of the irrigation command area, new headworks should be constructed 1.6 km upstream of the existing headworks to divert the irrigation water from its source, the Boeung Khnar River. The entire irrigation area of the sub-project will be 1,020 ha with the combination of gravity irrigation (620 ha) and pump irrigation (400 ha). The facilities to be constructed and/or rehabilitated under the sub-project are: (i) Wat Chre headworks equipped with half-cone type fish ladder, (ii) main, secondary and on-farm level irrigation and drainage facilities, details of which are shown below. ***(5.6.3, 5.6.4, 5.6.5 & 5.6.6)***

Irrigation and Drainage Rehabilitation Plan for Wat Chre Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (Ha)	1,020
	(Pump irrigation area included above)	(400)
2.	Annual irrigation area (ha)	1,062
	- Early wet season paddy (ha)	42
	- Medium wet season paddy (ha)	1,020
	- Dry season paddy (ha)	0
3.	Major water source	Pursat River
	- Name of headworks	Wat Chre (Reconstruction)
	- Intake water level (EL. m)	13.0
	- Diversion water requirement at intake (m3/sec)	0.31－1.39
4.	Main canals (nos.)	1
	- Total length (km)	4.7
	- Capacity (m3/sec)	0.31 – 1.39
5.	Nos. of secondary canals	6
	- Total length (km)	14.7
	- Capacity (m3/sec)	0.14 – 0.46
6.	Number of Tertiary Blocks (No.)	27
	Total length of tertiary canals (km)	27
7.	Main drains	- Boeung Khnar River, - Ta Paong stream
	- Total length (km)	-
	- Capacity (m3/sec)	Natural Stream
	- 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.)	7
	- Total length of secondary drains (km)	14.8

No.	Description	Area and/or Number
	- Capacity (m3/sec)	0.64 – 2.48
9.	Collector drains (nos.)	0
	- Total length of collector drain (New, km)	0

Prepared by JICA Study Team

Headworks and Major Facilities

Items	Description
-Wat Chre Diversion Weir Design Flood Discharge: Q=65m^3/s (T=100 years) Design Flood Water Level: WL. 13.6m with Fish Ladder: B:5.0m x H:3.3m x L:33m	Floating type movable weir -width x height x length B:29m x H:8.8m x L:41m -Flood Gate: Fixed wheel gate B:12.5m x H:3.4mx 1 no. -Scouring Sluice Gate: Slide gate B:2m x H:2m x 2 nos.
- Wat Chre Intake Design Discharge: Q=1.39m^3/s	-width x height x length B:1.0m x H:2.4m x L:6m -Slide Gate: B:1.0m x H:1.0m x 1 no.

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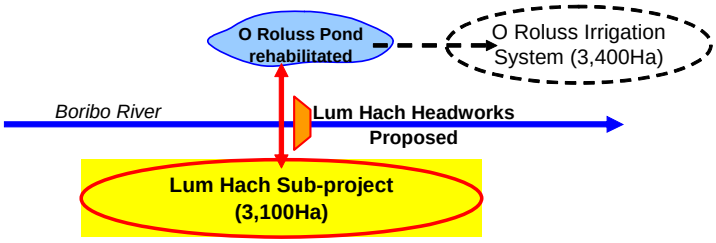
Lum Hach Rehabilitation Sub-Project

76. As described above, Lum Hach irrigation system primarily consists of: (i) Lum Hach, and (ii) O Roluss systems, out of which O Roluss irrigation system rehabilitation was already started by PDWORAM. Therefore, target irrigation command area under the sub-project is determined mainly from Lum Hach systems, taking quantities of water supply to O Roluss system into consideration. The target irrigation area is 3,100 ha including 410 ha of pump irrigation area. The sub-project works consist of: (i) the reconstruction of Lum Hach headworks with fish ladder, and (ii) construction and/or rehabilitation of main, secondary and on-farm irrigation facilities. These are summarized below. ***(5.7.3, 5.7.4, 5.7.5 & 5.7.6)***



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Irrigation area by Lum Hach Headworks (Total 6,500 ha)

Irrigation and Drainage Rehabilitation Plan for Lum Hach Rehabilitation Sub-Project

No.	Description	Area and/or Number
1.	Sub-project area (ha)	3,100
	(Pump irrigation area included above)	(410)
2.	Annual irrigation area (ha)	4,700
	- Early wet season paddy (ha)	1,300
	- Medium wet season paddy (Ha)	3,100
	- Dry season paddy (ha)	300
3.	Major water source	Boribo River
	- Name of headworks	Lum Hach (Reconstruction)
	- Intake water level (EL. m)	38.00 - 36.00
	- Diversion water requirement at intake (m3/sec)	6.60

No.	Description	Area and/or Number
4.	Main canals (nos.)	1
	- Total length (km)	16.4
	- Capacity (m3/sec)	0.83 – 6.60
5.	Nos. of secondary canals	11
	- Total length (km)	42.4
	- Capacity (m3/sec)	0.23 – 1.51
6.	Number of Tertiary Blocks (no.)	67
	Total length of tertiary canals (km)	67
7.	Main drains	Boribo River
	- Total length (km)	-
	- Capacity (m3/sec)	Natural Stream
	- 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.)	11
	- Total length of secondary drains (km)	53.9
	- Capacity (m3/sec)	1.19 – 3.96
9.	Collector drains (nos.)	0
	- Total length of collector drain (New, km)	0
	- Capacity (m3/sec)	-

Prepared by JICA Study Team

Headworks and Major Facilities

Items	Description
-Lum Huch Diversion Weir Design Flood Discharge: Q=430m^3/s (T=100 years) Design Flood Water Level: WL. 38.0m Fish Ladder: B:5.0m x H:3.8m x L:38m	Floating type movable weir -width x height x length B:67m x H:10m x L:44m -Flood Gate: Fixed wheel gate B:15 m x H:4.0m x 3 nos. -Scouring Sluice Gate: Slide gate B:2m xH:3m x 2 nos.
- Lum Hach Intake Design Discharge: Q=6.60m^3/s	-width x height x length B:7.1m x H:3.8m x L:9.5m -Slide Gate: B:1.5m xH:1.5m x 3nos.
- O Roluss Intake Design Discharge: Q=5.70m^3/s	-width x height x length B:5.7m x H:4.8m x L:15m -Slide Gate: B:2.0m x H:1.5mx 2nos.
- Lum Hach Approach Canal Design Discharge: Q=6.60m^3/s (Max.30.0)	-width x height x length B:15m-23m x H:2.0m x L:750 m
- Closure Dyke for 7th January Canal	-width x height B:40m x H:2.4m

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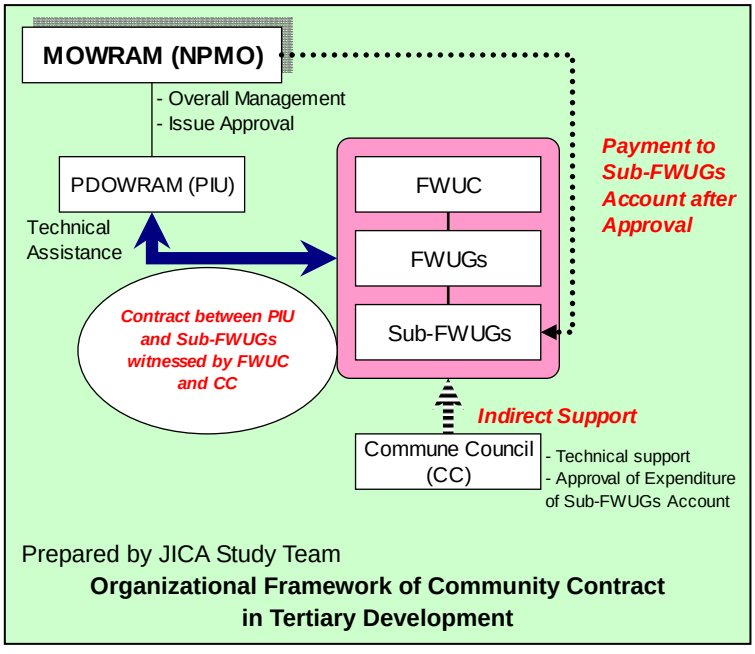
Institutional Development Plan

77. The sub-projects need to be constructed, operated and managed by MOWRAM, PDOWRAM and FWUC based on clear delineation of responsibilities among the parties concerned which shall be determined depending on existing regulations and their capabilities. Therefore, the establishment of ***co-administrative system*** is necessary in the institutional development plan to effectively operate and maintain irrigation and drainage facilities jointly among MOWRAM, PDOWRAM and FWUCs so that the target goals are achieved. ***(5.8.1)***

78. At present, MOWRAM has a plan for the handing-over of O&M to FWUC in accordance

with the Policy for Sustainability of Operation and Maintenance Irrigation System. In this policy, the handing-over period has been set to 5 years. Although the contents of this plan can be adopted basically to the project, the period and the procedure should be determined taking into account the actual situations of FWUCs' ability and the experience of MOWRAM / PDOWRAM's front line staffs who directly take charge of transferring the works. It would be possible to transfer the O&M to FWUCs within 5 years, if they achieve good progress during the training program. However, as stated in the policy, transfer level needs to be determined by considering the capacity of FWUCs. Before the realization of the project, farmers have no experience on O&M of irrigation facilities as a group while all the FWUC under the six sub-projects will be almost newly established. It would be realistic if only main, secondary and lower levels of canals and drains are firstly transferred during this five-year period. On the other hand, O&M of major facilities such as headworks (Ream Kon, Damnak Ampil, Wat Chre and Lum Hach) will remain the responsibility of MOWRAM and PDOWRAM. The proposed transfer process consists of: (i) preparatory works (1year), (ii) strengthening period (3 years), and (iii) transitional period (1 year) before facilities are finally transferred to FWUC. ***(5.8.2)***

79. In the transfer process, needs-based training programme will be implemented for different level of stakeholders, i.e., (i) senior officials of MOWRAM involved in O&M, (ii) officers involved in O&M (technical staffs of MOWRAM and PDOWRAM) and (iii) officials involved in irrigated agriculture in other agencies (PDA, Commune Councils and Village Development Committees). The Technical Service Center (TSC) of MOWRAM would be playing a hub roll to implement training programs as varieties of programs have already been developed. In addition, establishment of monitoring system is also relevant to the technical departments. ***(5.8.2)***



Prepared by JICA Study Team

Organizational Framework of Community Contract in Tertiary Development

80. FWUC's strengthening will be generally carried out on the basis of "Training Manual for Participatory Irrigation and Management (PIMD) in Cambodia" issued by MOWRAM, and lessons learnt from previous support activities such as TSC and JICA Prek Thnot Study. In addition, community-contract tertiary development is proposed for the capacity development of FWUC. Proposed steps are as follows, and the organizational framework is illustrated on above figure: (i) establishment of FWUC at each sub-project, (ii)

preparation of tertiary development plan and selection of sub-FWUCs, (iii) joint-walk-through, (iv) design and cost estimate, (v) contract between PIU and sub-FWUGs, (vi) construction of tertiary canals by FWUGs and (vii) inspection of the work completion. The coverage of sublet works will depend upon the capability of FWUCs. Such works as determination of canal alignment, construction of small tertiary-related structures, excavation of canals, etc, is expected to be sublet to FWUC. In the course of the work, farmers' organizations are supposed to enhance their capability and the payment for the work will be utilized as seed money to expand and diversify their activities. ***(5.8.3)***

VI. SUPPORTING PROGRAMS

81. Three project supporting programs are proposed as to cover cross-cutting issues for enhancement of the basis of project implementation and management capability in MORWRAM and PDOWRAM as tabulated as follows: ***(Chapter 6)***

Proposed Project Support Programs

No.	Program Name	Necessity	Objective
1.	Meteo-hydrological Observation strengthening Program	• Meteorological and hydrological data, currently not collected sufficiently, are essential basic information for irrigation development as well as for future integrated river basin management.	• To enhance the technical ability of MOWRAM and PDOWRAM staffs in meteo-hydrological observation, data processing and analysis
2.	Capacity Development Support 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 projects under the M/P.	• To enhance technical ability of MOWRAM staff in planning, design, construction management and O&M
3.	Capacity Development Support Program for PDOWRAM	• This program will be necessary in order to accelerate decentralized implementation mechanisms under the support of MOWRAM.	• To strengthen technical capability of PDOWRAM staff in O&M of irrigation facilities and river basin control

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VII. ENVIRONMENTAL ASSESSMENT AND MANAGEMENT PLAN

General

82. The Project components consist of: (i) rehabilitation and improvement of irrigation and drainage facilities, (ii) FWUC establishment and strengthening and (iii) agricultural extension activities. Main subjects of FWUC's establishment, strengthening and agriculture support are: (i) awareness program, (ii) module development, (iii) training,

(iv) small-scale pilot exercise in agriculture and irrigation rehabilitation etc. Therefore, adverse potential impact toward environment in and around the Project area is either nil or negligible. Thus activities (ii) and (iii) are screened out from Initial Environmental Impact Assessment (IEIA). IEIA in the Study concentrates on potential impact from the rehabilitation and the improvement of irrigation and drainage facilities. It is carried out for the aspects relevant to system rehabilitation using matrix focusing on the aspects of: (i) social environment, (ii) natural environment and (iii) pollution. ***(7.1)***

Potential Negative Environmental Impact

83. Prospective negative environmental impacts for the six sub-projects identified are summarized as follows: ***(7.2)***

Potential Negative Environmental Impact Anticipated

Item	Remarks
Social Environment	
(i) Involuntary resettlement and/or land acquisition	Land Acquisition for main, secondary and tertiary facilities
(ii) Unequal distribution of damage and benefit	In Damnak Ampil (downstream area excluded) and Lum Hach (land acquisition for upstream of headworks)
(iii) Local conflict over interest	Due to unequal allocation of irrigation water in the O&M stage
(iv) Water use	due to stoppage of irrigation water supply in the construction stage
(v) Sanitation	Deterioration during construction
(vi) Risk against infectious diseases	During construction
Natural Environment	
(i) Coastal area such as mangrove, coral reef and tidal area	By the increase of agricultural input under irrigated conditions
(ii) Flora, fauna and biodiversity	Disturbance of fish sprawling by the construction of headworks
Pollution	
(i) Air pollution	By the operation of construction machineries
(ii) Water pollution	By the construction works and the increase of agricultural input in the O&M stage
(iii) Soil contamination	By the increase of agricultural input in the O&M stage
(iv) Waste	By the construction works
(v) Noise and vibration	By the operation of construction machineries
(vi) Accidents.	By the operation of construction machineries

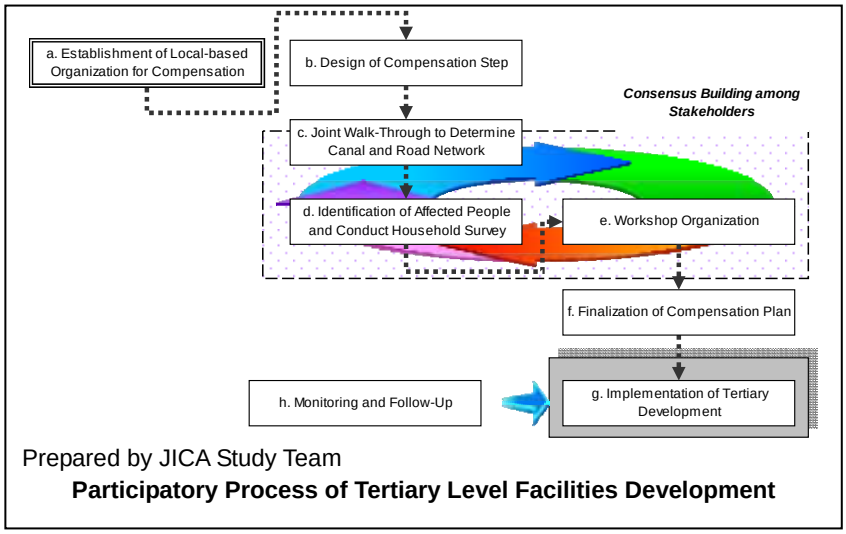
Prepared by JICA Study Team

Environmental Management Plan

84. Six possible mitigation measures are prepared for the preparation, construction and O&M stage based on causal relations of the negative impact: (i) Participatory land acquisition planning for main and secondary level facilities, (ii) participatory tertiary development, (iii) education program for construction labor, (iv) construction of fish ladder, (v) environmental consideration in the technical specifications for construction works and (vi) FWUC establishment and strengthening including system of O&M and water management improvement, and appropriate application of agricultural input. The negative impacts identified in the IEIA are not only problems particular to the Project area, but also

to the whole country. The measures in this section, therefore, should be placed as models for the future sustainable development in the irrigation sector in Cambodia. ***(7.3.1, 7.3.2, 7.3.3 & 7.3.4)***

85. As for the environmental monitoring, two plans are proposed: (i) participatory land compensation process for tertiary development and (ii) soil and water quality monitoring as illustrated and tabulated below. Both of which are relevant to all the six sub-projects. They should be monitored in the long-term in order to realize the project effects through social and natural, environment-friendly manner. ***(7.3.5)***



Prepared by JICA Study Team
Participatory Process of Tertiary Level Facilities Development

Soil and Water Quality Monitoring for the Projects

No.	Indicators	Method	Frequency	In-Charge
1.	pH	pH meter	Two times a year (dry and wet season respectively)	PDOWRAM/PDOE
2.	Electric Conductivity	EC meter		PDOWRAM/PDOE
3.	DO, Coliform, Nitrite, BOD, Total Nitrogen	Gas membrane electrodes		MOWRAM/PDOWRAM/ PDOE
4.	Total Phosphorous	Spectrophotometer		MOWRAM/PDOWRAM/ PDOE
5.	Metals, Nutrients, COD, Total Organic Carbon	Colorimeters		MOWRAM/PDOWRAM/ PDOE

Prepared by JICA Study Team

Conclusions

86. From the field studies, other information gathered and discussions presented, it is concluded that the Project will be extremely beneficial to the communities living in the command area. No adverse environmental impacts are anticipated in the Projects since all components already exist, with no large scale expansion and/or new developments included. Mitigation and enhancement measures are suggested where necessary which will result in overall improvement of environmental quality. Once completed, well managed irrigation systems would enhance the long-term sustainability of the rural environment. In view of the above conclusions arising out of the IEIA of the sub-projects, a full scale Environmental Impact Assessment (EIA) is not considered necessary if abovementioned proposed mitigation measures and monitoring are concurrently carried out. ***(7.6)***

VIII. PROJECT IMPLEMENTATION PLAN

Implementation Organization

87. Within the organization of MOWRAM, Northwestern Area Unit of the National Project Management Office (NPMO) will be in-charge of project implementation with the collaboration and cooperation of concerned technical departments. At the provincial level, Project Implementation Unit (PIUs) will be established under Battambang, Pursat and Kampong Chhnang PDOWRAMs to supervise rehabilitation and construction works. At the field level, support programs such as agriculture extension activities and FWUC establishment and strengthening support will be carried out with the guidance and supervision of PIU, in collaboration with the local authorities including commune councils (CCs) and village development committees (VDCs) relevant to sub-project command areas. Such activities are proposed to be facilitated and assisted by technical consultants and NGOs. For the implementation of the Project, MOWRAM needs to assign professional engineers to the NPMO supported by relevant technical departments at the central level and PIU at the provincial level, who will be responsible for implementing and managing the project. ***(8.2)***

Implementation Schedule

88. The project is expected to be implemented for 7 years, from 2010 to 2016. Two soft components: (i) agriculture extension activities and (ii) FWUC establishment and strengthening will be included and implemented for each sub-project. Agriculture extension activities will be for a period of four years commencing in parallel with the rehabilitation of main and secondary systems. On the other hand, FWUC establishment and strengthening will commence before the tertiary development. The proposed period of FWUC support will be 3.5 years. After the project is completed, the system will be operated and managed jointly by PDOWRAM and FWUCs. The latter will be established and strengthened with the assistance by the Department of Irrigated Agriculture of MOWRAM, as responsible agency at the central level. As explained in Chapter 5, system of O&M will be transferred gradually in five years to FWUCs through designed procedure.

89. Three project supporting programs is expected to be implemented by TSC of MOWRAM as a hub agency, to support upgrading the irrigation performance of the sub-projects as well as enhance the capability of MOWRAM and PDOWRAM. This aims to continue irrigation development in other areas, which are planned to be executed in five years, commencing on 2011. The purpose of project formulation study stretching one year in 2014 is to implement the feasibility study for potential projects in other areas effectively based on lessons to be learnt from the implementation of six-sub projects. ***(8.3)***

IX. COST ESTIMATE

Cost Estimate

90. The initial investment cost for the Project is estimated to be about US$ 97.95 million (Riel 402 billion). In addition, the annual disbursement schedule is prepared according to the implementation schedule covering the period of 2010 to 2016. ***(9.2)***

Annual Disbursement Schedule for the Project

No.	Item	Amount (US$ 1,000)							
		Total	2010	2011	2012	2013	2014	2015	2016
1.	Construction Cost	48,764	0	3,428	23,449	18,587	3,149	151	0
2.	Project Supporting Programs Cost	2,438	0	610	488	488	488	364	0
3.	Physical Contingencies	5,120	0	404	678	1,908	364	50	0
4.	Sub-Total	56,322	0	4,442	26,331	20,983	4,001	565	0
5.	Consulting Services Cost	14,332	2,150	3,153	5,016	2,723	860	287	143
6.	Tax and Duty	7,056	215	760	3,134	2,371	486	85	14
7.	Land Acquisition Cost	841	252	589	-	-	-	-	-
8.	Project Administration Cost	5,632	0	0	2,633	2,098	400	57	0
9.	Price Escalation	13,762	0	0	5,674	5,797	1,361	230	0
10.	Grand Total	97,954	2,617	10,088	42,788	33,972	7,108	1,224	157

Prepared by the JICA Study Team

91. Land acquisition cost for the Project is estimated based on the actual anticipated area for each sub-project. Total area of the land acquisition is expected to be 391.9 ha, and the cost is estimated to be US$ 0.8 million (Riel. 3.4 billions). ***(9.2.4)***

92. O&M cost for the major facilities is classified into two, namely, (i) annual O&M cost (2% of the construction cost for the major facilities) and (ii) major repair cost (10% of the construction cost for the major facilities necessary for every 10 years). The annual O&M cost is estimated to be US$ 0.8 million (Riel 3.4 billions) while major repair cost is about US$ 4.2 millions (Riel 17.0 billions). ***(9.2.5)***

X. PROJECT EVALUATION

Economic Evaluation

93. Irrigation benefits expected are to be derived from the increase in the paddy field area under normal and pump irrigation conditions, coupled with the increase in paddy yield and cultivation area of upland crops and vegetables. On the other hand, economic investment cost are estimated for: (i) direct construction cost including head works and major related structures' rehabilitation, main and secondary system rehabilitation, on-farm development, miscellaneous works and contractor's expenses, (ii) project supporting

program cost, (iii) consulting services cost, and (iv) physical contingencies, with the application of relevant conversion factors. ***(10.1.1, 10.1.2 & 10.1.3)***

94. Based on the above, economic evaluation is carried out. In addition, sensitivity analysis is performed considering the following four cases: (i) Case-1 (Construction cost 10% up), (ii) Case-2 (Irrigation water supply 1 year delay), (iii) Case-3 (Target yield of crops 10% down) and (iv) Case-4 (Case-1 combined with Case-3). The result is shown as follows:

Results of Economic Evaluation and Sensitivity Analysis

Item		EIRR	Net Present Value (8% discount rate)			
			Benefit	Cost	B-C	B/C
		(%)	(Million Riel)			Ratio
Economic Evaluation		12.8	229,181	141,526	87,655	1.62
Sensitivity Analysis	Case-1	11.9	229,181	153,398	75,783	1.49
	Case-2	11.6	211,661	141,504	70,157	1.50
	Case-3	10.3	182,329	141,504	40,825	1.29
	Case-4	9.5	182,329	153,398	28,931	1.19

Prepared by JICA Study Team

It is realized that the proposed project is economically feasible under the conditions set up as described. ***(10.1.4)***

Financial Evaluation

95. The expected impact of the proposed project to beneficiary farmers' capacity to pay is determined by estimating farm budget based on typical farm size and farming practice type of each sub-project area. The increase in net return between the present "Without Project" and future "With Project" conditions reveals the additional capacity to pay, after deducting farming cost which the beneficiary farmers expect to gain through participation to the proposed project. The result shows that beneficiary farmers will gain additional net surplus ranging from 604,000 Riel/ha or 147 US$/ha to 2,182,000 Riel/ha or 531 US$/ha. This reveals that every participating farmer in the proposed project may fully shoulder the annual O&M cost of their on-farm facilities and also pay water charge if it is set up at affordable rates. ***(10.2)***

Indirect Benefit, Intangible Benefit and Socio-Economic Impacts

96. Indirect benefits from the Project are expected from increase in paddy production at the downstream of the Damnak Ampil and the Lum Hach sub-projects through supplemental irrigation water. Corresponding qualitative figures are summarized as follows: ***(10.3.1)***

Anticipated Indirect Benefit

Existing Structure to be Rehabilitated by Project	Scheme Indirectly Benefited	Command Area (ha)
Damnak Ampil Main Canal	Damnak Ampil Extension	7,650
	Bakan and Krouchi Seuchi	1,000
	Svay Daun Keo River	2,200
Lum Hach Headworks	O Roluss Irrigation	3,400
Total		14,250

Prepared by JICA Study Team

97. In addition to the increase in paddy production due to the Project implementation, intangible benefit is expected from production increase downstream, using excess water form the Project and vitalization of rice processed products in the related communes. The availability of rice processed products like rice flour and ancillary business as typical intangible benefits are attributed to the project implementation, which will be enhanced to a larger extent. As a result, such increasing availability will significantly contribute to rural and individual farm economies through increased inputs to be purchased and transported, as well as value addition of outputs in the course of processing, transporting and trading of rice and its product. ***(10.3.2)***

98. In view of socio-economy in the proposed six sub-subject areas, the impact of project implementation can be expressed by increasing hired labor inputs to 82,500 persons or 54% every year. This increase reveals that employment opportunities, although temporary, will be created at the peak time of farm operation like transplanting and harvesting in three rice cropping seasons, i.e., the early wet season, wet season and dry season. ***(10.3.3)***

Increase in Hired Labor Inputs as Socio-economic Impact Indicator

Sub-project	Present Condition		Future Condition		Increased
	Cropped Area (ha)	Hired Labor Input (No.)	Cropped Area (ha)	Hired Labor Input (No.)	Hired Labor Input (No.)
Ream Kon Rehabilitation	2,230	33,800	3,254	54,000	20,200
Por Canal Rehabilitation	2,480	38,300	3,350	56,600	18,300
Dam Nak Ampil Rehabilitation	3,360	20,500	5,020	27,400	6,900
Wat Loung Rehabilitation	2,795	22,600	2,920	30,600	8,000
Wat Chre Rehabilitation	1,120	9,000	1,170	12,300	3,300
Lum Hach Rehabilitation	3,360	27,000	5,020	52,800	25,800
Total	15,345	151,200	20,734	233,700	82,500

Source: JICA Study Team

XI. CONCLUSIONS AND RECOMMENDATIONS

XII. *(Master Plan Study)* The M/P presents the strategies and the approaches for irrigation and drainage development in the four river basins including the road map toward year 2020. Implementing the proposed programs and projects contribute to poverty alleviation in the four river basins. An increase in production of 259,000 tons of paddy per year is expected by year 2020 to meet the needs of an increasing population of the country. Towards this end, it is concluded that the M/P on the basis of Road Map 2020 should be implemented as proposed. ***(11.1)***

XIII. *(Pre-Feasibility Study)* In the M/P, six sub-projects were selected as priority for the conduct of pre-F/S. Six sub-projects were packaged into one project namely, ***West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project***. The Study revealed that the Project is technically feasible and economically viable. From the social, natural and environmental points of view, it is also justified that the Project is wholly

sound. Implementation of the Project is expected to achieve the following principal objectives: (i) stable water supply to irrigate 12,760 ha with the cropping intensity of 144%, (ii) increase of rice production by 27,300 tons, (iii) introduction and increase of upland crops/vegetables by 6,800 tons, (iv) enhancement of the capability of MOWRAM, PDOWRAM and FWUCs in irrigation development and management, and (v) indirect benefit by excess water to be provided in the downstream and the surroundings of Damnak Ampil and Lum Hach sub-projects (14,250 ha). In conclusion from pre-F/S, the project should be carried out in the manner proposed in the Study. ***(11.1)***

XIV. The following issues are recommended on the basis of the M/P and the pre-F/S: (i) urgent commencement of implementation of Road Map 2020, (ii) urgent need of institutional strengthening related with irrigation sector, (iii) need for monitoring and evaluation, and stepwise update and revision of the M/P, (iv) need for financial resources for the implementation of Road Map 2020, and (v) need for inter-sectoral and inter-ministerial coordination involving MOWRAM, MAFF and other relevant agencies. ***(11.2)***

BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT
VOLUME-I: MAIN REPORT

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PART-B PRE-FEASIBILITY STUDY

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Abbreviations

ACIAR	Australian Center for International Agricultural Research
ACLEDA	Association of Cambodian Local Economic Development Agencies
ACR	Australian Catholic Relief
ADB	Asian Development Bank
AEO	Agricultural Extension Offices
AEWs	Agricultural Extension Workers
AMIS	Agricultural Market Information System Project
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
CAAEP	Cambodia Australia Agricultural Extension Project
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
CIAP	Cambodian IRRI Australia Project
CMAC	Cambodia Mine Action Center
CNMC	Cambodian National Mekong Committee
CRS	Christian Relief Service
DAALI	Department of Agronomy and Agricultural Land Improvement
DAFF	Department of Agriculture, Forestry and Fisheries, MAFF
DAE	Department of Agriculture Extension
DAO	District Agricultural Office
DDFC	District Development Facility Committee
DHRW	Department of Hydrology and River Works
DOM	Department of Meteorology
DTR	Department of Training and Research, MRD
ED	Engineering Department, MOWRAM
EDC	Electricite du Cambodia
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMC	Credit for Rural Area
EPP	Extension Program Package
EU	European Union
EXCOM	Executing Committee of SEILA
FAO	Food and Agriculture Organization of the United Nations
FAIEX	Freshwater Aquaculture Improvement & Extension Project
FFS	Farmer Field School
FG	Farmers Group
FLD	Farmer Livelihood Development
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
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
LWF	Lutheran World Federation
MAFF	Ministry of Agriculture, Forestry and Fisheries
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
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
NA	National Assembly
NEC	National Election Committee
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
PMG	Project Management Group
RGC	Royal Government of Cambodia
RIP	Rural Road Improvement Program
RRA	Rapid Rural Appraisal
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)
SLPP	Smallholder Livestock Production Program
SPFS	Special Program for Food Security
SRI	System of Rice Intensification
SMS	Subject Matter Specialist
SWR	Shadow Wage Rate
TB	Tuberculosis
TIP	Technical Implementation Procedures
TOT	Training of Trainers
TSC	Technical Service Center of Irrigation System Meteorology
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNTAC	United Nations Transitional Authority in Cambodia
UXO	Unexploded Ordnance
VAHW	Village Animal Health Worker Associations
VDC	Village Development Committee
VEW	Village Extension Worker
VLA	Village Livestock Agent
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 Samik	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
℃ = degree centigrade
% = percent

Currency

US$ 1.0 = ¥ 107.99 = 4,107 Riel (National Bank of Cambodia as of September 11th 2008)
US$ = United State Dollars
¥ = Japanese Yen
R, Riel = Cambodian Riel

Time

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

THE STUDY
ON
BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT

VOLUME-I: MAIN REPORT

CHAPTER 1 INTRODUCTION

1.1 Authority

The Final Report was prepared in accordance with the Scope of Work for the Study on Basin-Wide Basic Irrigation and Drainage Master Plan agreed between the Ministry of Water Resources and Meteorology (MOWRAM) of the Royal Government of Cambodia (RGC) and the Japan International Cooperation Agency (JICA) on October 26th, 2006 (Attachment-1).

1.2 Composition of the Report

The Final Report presents the results of the Master Plan (M/P) for four river basins and the Pre-Feasibility Study (Pre-F/S) carried out for six sub-projects selected in the M/P. The Report consists of the following volumes:

- Volume-I: Main Report
- Volume-II: Appendixes (Master Plan Study for Four River Basins)
- Volume-III: Appendixes (Pre-Feasibility Study for Priority Six Sub-Projects) (1/2)
- Volume-IV: Appendixes (Pre-Feasibility Study for Priority Six Sub-Projects) (2/2)

This is the volume-I of the Final Report consisting of eleven chapters. Chapter 1 deals with introduction of the Report together with general background of the Study. Chapter 2 explains outline of the M/P Study for four River Basins: Battambang, Moung Russey, Pursat and Boribo formulated in the Phase 1 Study. Chapter 3 shows general conditions of the project area. On the basis of present conditions, Chapter 4 delineates basic concept and approach for the development plan, which is focusing on country's food security, effective resource mobilization backed by institutional aspect for irrigation and drainage development and management. Chapter 5 explains proposed projects' plans based on the concept and the approach.

Chapter 6 is the project supporting programs covering cross-cutting issues to support project implementation effectively. Chapter 7 is the environmental assessment and management plans so that project can be implemented and managed in environment-friendly and sustainable manner. Chapter 8 is the implementation plan including organizational framework and the timeframe. Chapter 9 and 10 shows the estimate of project cost as well as economic and

financial evaluation based on proposed development plan. Chapter 11, finally, shows conclusions and recommendations derived from the Study.

1.3 Background of the Study

The Lake Tonle Sap and its catchment area is a very important region, not only for mitigation of poverty but also for economic development in the country. The region has been remained undeveloped even after the civil war, and development of rural infrastructure has been delayed as well. It is recognized a practical and sound development based on a comprehensive study of the natural and human resources in the region is one of the most important themes in the region to enhance country's economy.

The upstream area of the western region of the Tonle Sap Lake is endowed with high water resource potential as its annual rainfall is over 2,000mm annum corresponding to more than 30% of that in the lakeshore area. Formulation and implementation of river basin-wide irrigation and drainage master plan envisaging effective, sustainable and equitable use of land and water resource is expected to contribute to the enhancement of agricultural production as well as mitigation of poverty in the region.

Based on the above understanding, the Royal Government of Cambodia (RGC) and the Government of Japan (GOJ) agreed on the Scope of Work (S/W) for the Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia on 26 October 2006 to execute technical assistance for the Basin-Wide Basic Irrigation and Drainage Master Plan Study (hereinafter called as the Study).

1.4 The Study Area

The Study Area covers irrigated agricultural land mainly comprising of paddy fields in the Four River Basins: the Battambang, the Moung Russey, the Pursat, and the Boribo, all of which are located on the west side of the Tonle Sap Lake and River. The Study Area administratively consists of its major parts in three provinces: Battambang, Pursat and Kampong Chhnanng Provinces, and smaller parts of two provinces and one city (*krong*) consisting of Kampong Speu and Kandal Provinces and Pailin City with the total area of 22,868 km^2.

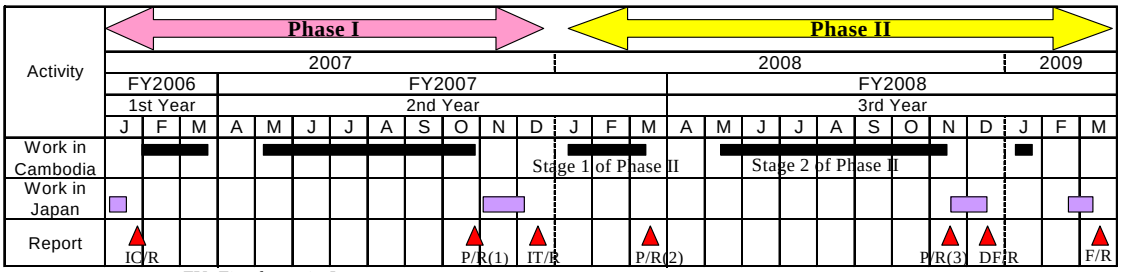
1.5 Objective and Scope of the Study

1.5.1 Objective

The objectives of the Study are: (i) to formulate a master plan on Irrigation and Drainage in order to improve the water management and agricultural productivity in the Four River Basins (hereinafter called as the Master Plan), (ii) to formulate a Detailed Plan for selected priority areas in each river basin, and (iii) to transfer technologies to the counterpart personnel through on-the-job training in the course of the Study.

1.6 Scope

The Study is to be carried out over 27 months between January 2007 and March 2009.



FY: Fiscal year in Japan

Prepared by JICA Study Team

Schedule of the Study

The Study consists of two phases. Phase I, which was implemented between January 2007 and until December 2007, was to formulate a draft Master Plan on irrigation and drainage development in the Study Area, while Phase II, has commenced from January 2008, is to carry out Pre-F/S on priority/urgent projects selected in Phase 1 and finalize the M/P.

1.7 Technology Transfer

The counterpart personnel assigned for the Study are as follows:

Counterpart Personnel Assigned

JICA Study Team	Position	Counterpart Personnel
Mr. KODAMA Masayuki	Team leader/Irrigation and Drainage plan	Mr. Chhea Bunrith (Chief Counterpart Personnel)
		Mr. Doak Bounthon
		Mr. Keo Vey
		Mr. Long Phalkhum
Mr. MASAKI Manabu	Irrigation & drainage facilities and Water Management	Mr. Chreung Phanna
		Mr. Pout Sava
		Mr. Hy Sovan
		Mr. Chheumn Samorn
		Mr. Ket Phal
		Mr. Khay Soda
		Mr. Chuem Rawan
Mr. SHIRAKI Takashi	Agriculture/Farming practice/Market	Ms. Nou Sythan
Mr. KURAUCHI Takashi	Meteorology and Hydrology	Mr. Long Saravuth
		Mr. Horn Sovannah
		Mr. Preap Sameng
		Mr. Im Sophana
		Mr. So Lian
		Mr. Sok Sokhon
		Mr. Lea Sothy
Mr. OTSUKA Shigeya, Mr. MATSUMOT Yutaka	Environmental & Social Consideration/Rural Community & Economy	Mr. Chea Vanarith
Mr. ITO Hajime	Coordinator / Cost Estimate	-

Prepared by JICA Study Team

The technology transfer has been carried out primarily through the on-the-job training in line with the Plan of Technology Transfer submitted to MOWRAM. In addition, in the Steering Committee for the Progress Report (2), technology transfer seminar was organized as outline of the result of M/P was presented by the each subject of counterpart personnel, which was a part of technical transfer under the Study.

1.7 Steering Committee Meetings

The following Steering Committee Meetings were held among the member of the Steering Committee and the JICA Study Team.

Steering Committee Meeting

Steering Committee Meeting	Report Discussed	Date
1	Inception Report	February 21st, 2007
2	Progress Report (1)	October 24th, 2007
3	Progress Report (2)	February 22nd, 2008
4	Progress Report (3)	October 3rd, 2008
5	Draft Final Report	January 14th, 2009

Prepared by JICA Study Team

All the minutes of the meetings are shown in Attachment-2 to Attachment-7. The meetings commenced by the opening-address by H.E. Veng Sakhon, Secretary of State, MOWRAM and then the JICA Study Team briefed the contents of each Report, which was followed by the question and discussion by the Steering Committee members including MOWRAM, MAFF, MOE, MEF, EOJ and JICA Cambodia Office.

Steering Committee Meeting for Progress Report (2) (February 22nd, 2008)