

No.

MINISTRY OF WATER RESOURCES AND METEOROLOGY
KINGDOM OF CAMBODIA

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

FINAL REPORT

VOLUME-II
SUPPORTING REPORT

NOVEMBER 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

APPENDIX-A STUDY ON PROJECT SCOPE

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
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A1. AGRICULTURAL MARKETING AND SIMULATION

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
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CHAPTER A1.1 AGRICULTURAL SUPPORTING PROGRAMS

A1.1.1 Latest Performance of Rice Cultivation

(1) Rice Cultivation in Cambodia

The latest harvested area of rice throughout the country was recorded at 2.61 million ha, comprising 2.25 million ha for wet season rice in 2008 and 0.36 million ha for dry season rice in 2008~2009. The national average paddy yield was 2.54 ton/ha for wet season rice and 4.03 ton/ha for dry season rice. The annual paddy production amounted to 7.17 million tons, consisting of 5.72 million tons or around 80% for wet season rice and 1.45 million tons or around 20% for dry season paddy. The harvested area and paddy production by province is shown in Table A.1.1.1.

Concerning the wet season rice cultivation, farmers are used to select rice varieties with different maturity periods as well as planting time either early wet season or wet season in conformity with locally specified topographic and hydrological conditions as shown in Table A.1.1.2. In brief, early maturity paddy rice varieties share 23.4% of the total planting area of wet season rice, medium maturity varieties 45.8%, late maturity varieties 24.2 %, upland rice varieties 2.2% and floating rice varieties 4.4%. Of the early maturity varieties, 4.1% is grown in early wet season and 19.3% in wet season.

Farm mechanization is still limited, as it is reported that the total number of farm machinery currently operated in the country is 4,611 tractors and 38,912 power tillers. Thus, plowing works were done by cattle in 1.60 million ha or 61% of the total harvested area in 2008~2009 as shown in Table A.1.1.3.

Farmers use movable water pump mainly for supplemental irrigation purposes during the wet season. At present, 135, 561 water pumps are owned by private sector and 500 units are kept by public sector as shown in Table A.1.1.3.

The quality of paddy harvested varies from place to place. Most of paddy harvested is of low quality due to limited care of farmers on paddy in terms of moisture, mixed different varieties, mixture of foreign matters including weed seeds, debris and sand. Such low quality of paddy reduces milling rate of rice. Millers are forced to make frequent adjustment of their milling machine according to moisture, maturity and variety of paddy. Currently available units of post-harvest equipment nationwide are 42 large-scale harvesters, 388 small-scale harvesters, 7,698 generator-operated threshers, and 539 manual threshers. Regarding milling facility, there are 1,169 large-scale millers and 38,260 small-scale millers in the country as shown in Table A.1.1.4.

(2) Rice Balance by Province

Based on the following assumptions, rice balance by province in 2008~2009 season is calculated:

- Seed stocks and post-harvest losses are totally equivalent to 13% of harvested paddy production;
- Milling rate of paddy to rice is 64%;
- Provincial population refers to Population Census 2008; and
- Per capita rice requirement is 143 kg/year.

As given in Table A.1.1.5 and Figure A.1.1.1, the result of calculation reveals that the surplus of rice at the national level is 2.03 million tons. Among 24 provinces/capital, 19 are in a surplus situation and four in a deficit condition. The largest surplus areas with rice surplus of more than 90,000 tons are 11

provinces including Battambang of around 225,000 tons, Kampong Chhnang of around 132,000 tons and Pursat of around 93,000 tons. The largest deficit area is Phnom Penh City of around 185,000 tons.

(3) Paddy Production in Provinces Concerned

The following statistics reveal harvested areas, yield and production of paddy for the wet and dry seasons during the last 3-year period from 2006 to 2008 in three provinces where six sub-projects of the proposed project are located. The annual paddy production in these provinces was 1.13 million tons for 2006, 1.12 million tons for 2007 and 1.30 million tons for 2008, contributing about 15% every year to the whole paddy production in the country,

Last 3-year Performance of Paddy Cultivation in Provinces Concerned

Province	Crop Season	2006			2007			2008		
		H. Area (ha)	Yield (ton/ha)	Product (ton)	H. Area (ha)	Yield (ton/ha)	Product (ton)	H. Area (ha)	Yield (ton/ha)	Product (ton)
Battambang	Wet	243,768	2.56	624,147	240,000	2.30	552,174	244,586	2.66	651,551
	Dry	2,455	3.60	8,838	3,647	4.12	15,026	4,839	4.38	21,214
	Annual	246,223	2.57	632,985	243,647	2.33	567,200	249,425	2.70	672,765
Pursat	Wet	92,070	2.23	205,684	93,500	2.48	232,008	98,810	2.62	259,262
	Dry	3,297	1.25	4,111	3,381	2.28	7,692	3,465	3.25	11,272
	Annual	95,367	2.20	209,795	96,881	2.47	239,700	102,275	2.65	270,534
Kg. Chhnang	Wet	102,996	2.08	214,063	106,000	2.13	225,752	105,222	2.58	271,940
	Dry	20,973	3.52	73,804	21,944	3.91	85,748	22,914	3.83	87,962
	Annual	123,969	2.32	287,867	127,944	2.43	311,500	128,136	2.81	359,632

Note: H. Area; Harvested area, Product; Paddy production, Kg. Chhnang; Kampong Chhnang
Source: Agricultural Statistics 2006-2007 & 2008-2009, Statistical Yearbook of Cambodia 2008

(4) Paddy Production in Communes Concerned

The last 3-year performance of paddy cultivation in the communes covering wholly or partly the proposed project area is as shown below.

Last 3-year Performance of Paddy Cultivation in Communes Concerned

Province & Commune	Crop Season	2006			2007			2008 (estimated)		
		H. Area (ha)	Yield (ton/ha)	Product (ton)	H. Area (ha)	Yield (ton/ha)	Product (ton)	H. Area (ha)	Yield (ton/ha)	Product (ton)
Battambang Major communes	Wet	11,121	1.67	18,559	10,909	1.51	16,419	11,117	1.74	19,374
	Dry	24	3.00	72	0	-	0	0	-	0
	Annual	11,145	1.67	18,631	10,909	1.51	16,419	11,117	1.74	19,374
Total communes	Wet	27,750	2.50	46,682	25,169	1.64	41,299	25,650	1.90	48,732
	Dry	329	3.00	986	0	-	0	0	-	0
	Annual	28,079	2.50	47,668	25,169	1.64	41,299	25,650	1.90	48,732
Pursat Major communes	Wet	13,640	1.88	25,580	15,314	1.88	28,854	16,184	1.99	32,243
	Dry	25	2.32	58	0	-	0	0	-	0
	Annual	13,665	1.88	25,638	15,314	1.88	28,854	16,184	1.99	32,243
Total communes	Wet	27,590	1.66	45,683	29,754	1.73	51,530	31,444	1.83	57,583
	Dry	497	2.24	1,111	0	-	0	0	-	0
	Annual	28,087	1.67	46,794	29,754	1.73	51,530	31,444	1.83	57,583
Kg. Chhnang Major communes	Wet	5,963	1.73	10,306	5,626	1.88	10,588	5,585	1.94	12,754
	Dry	0	-	0	0	-	0	0	-	0
	Annual	5,963	1.73	10,306	5,626	1.88	10,588	5,585	1.94	12,754
Total communes	Wet	7,178	1.77	12,673	6,841	1.96	13,431	6,791	2.38	16,179
	Dry	0	-	0	0	-	0	0	-	0
	Annual	7,178	1.77	12,673	6,841	1.96	13,431	6,791	2.38	16,179
Grand Total	Wet	62,518	1.68	105,038	61,764	1.72	106,260	63,885	1.92	122,494
	Dry	826	2.54	2,097	0	-	0	0	-	0
	Annual	63,344	1.69	107,135	61,764	1.72	106,260	63,885	1.92	122,494

Note: H. Area; Harvested area, Product; Paddy production Kg. Chhnang; Kampong Chhnang
Source: Agricultural Statistics 2006-2007 & 2008-2009, Statistical Yearbook of Cambodia 2008

It is found from the above that the annual paddy for 2008 reached to the level of 122,000 tons as a whole, comprising 49,000 tons for five communes covering a major or minor part of Ream Kon and Por Canal Sub-projects, about 58,000 tons for six communes including a major or minor part of Wat Loung, Wat Chre and Damnak Ampil Sub-projects, and around 16,000 tons for three communes comprising a major or minor part of Lum Hach Sub-project.

(5) Paddy Production in Project Area

The performance of paddy cultivation in the respective sub-projects for 2008 is as shown below. The total paddy production in the project area for 2008 was 21,885 tons with a unit yield of 1.5 ton/ha. It contributed to 18% of the paddy production in the 17 communes concerned.

Estimated Paddy Production in Project Area

Province & Sub-project	Physical Area (ha)	Early Wet Season Paddy			Wet Season Paddy					
		Pump irrigation			Supplemental irrigation			Rain-fed condition		
		(ha)	(ton/ha)	(ton)	(ha)	(ton/ha)	(ton)	(ha)	(ton/ha)	(ton)
Battambang										
Ream Kon	2,020	200		560	50		105	1,970	1.5	2,955
Por Canal	2,070	410	2.8	1,148	100	2.1	210	1,970	1.5	2,955
Purusat										
Dam. Ampil	2,430	0		0	0		0	2,430		3,888
Wat Loung	2,720	0	-	0	0	-	0	2,720	1.6	4,352
Wat Chre	1,090	0		0	0		0	1,090		1,744
Kg. Chhnang										
Lum Hach	3,320	0	-	0	0	-	0	3,320	1.2	3,984
Total/Average	13,650	610	2.8	1,708	150	2.1	315	13,500	1.5	19,862

Prepared by JICA SAPROF Team

Farmers in the project area have practiced two types of planting methods comprising direct sowing and transplanting, depending on their family labor availability. Focal points on the planting methods are as follows:

- Direct sowing method is practiced in Ream Kon and Por Canal Sub-projects at 15% of supplemental irrigated areas and 60% of rain-fed areas. Though labor input requirement can be saved, the average paddy yield is 30% lower compared with the transplanting method; and
- Transplanting method is a common practice among all farmers in Damnak Ampil, Wat Loung, Wat Chre and Lum Hach Sub-project areas.

A1.1.2 Available Post-harvest Facilities in Project Area

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

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

Large and Small Rice Mills operated in Communes Concerned

Province	District	Sub-project	Commune	Large Mill	Custom Mill
Battambang	Moung Russei	Ream Kon & Por Canal	Kear	6	4
			Chrey	4	0
			Prey Svay	5	0
			Ta Loas	2	2
			Kor Koah	1	1
Pursat	Bakan	Wat Loung & Damnak Ampil	Trapeang Chong	4	112
			Smam Preah	3	135
			Khmar Totueng	2	27
		Wat Chre	Boeng Khmar	5	58
			Me Tuek	1	100
Kampong Chhnang	Boribo	Lum Hack	Anhchanh Rung	0	93
			Pech Changvar	0	34
			Popel	0	53
			Phsar	0	54
			Tuek Phos	0	62
				37	824

Prepared by JICA SAPROF Team

A1.1.3 Prevailing Constraints and Required Actions in the Project Area

The following indicate farming and marketing constraints with which farmers in the project area are confronted as well as actions so far taken by them and to be further required for improving paddy productivity in the project area.

Prevailing Constraints and Required Actions

Item	Description
Agronomic and farm management constraints	<ul style="list-style-type: none"> - Weed problem - Crop losses due to pest and disease with difficulties in purchasing agro-chemicals - Insufficient extension services - Labor shortage - Poor soil conditions
Physical constraints	<ul style="list-style-type: none"> - Irrigation water shortage for the both wet and dry seasons - Drainage problem
Marketing constraints	<ul style="list-style-type: none"> - Unstable market prices of paddy/rice - Low market prices of paddy/rice - Limitation of market of paddy/rice
Reasons for low yield of rice	<ul style="list-style-type: none"> - Drought in wet season - Water shortage in dry season - Poor soil conditions
Activities taken for improving rice productivity for the past 3-year period	<ul style="list-style-type: none"> - Increased fertilizer doses - Applied compost/manure - Used quality seed of local varieties - Used quality seed of high yielding varieties
Necessary farming activities to improve rice productivity	<ul style="list-style-type: none"> - Improvement of farming practices - Application of adequate doses of fertilizer - Practice of selection of quality self-stocked seed for local varieties - Use of quality seed for high yielding varieties
Necessary physical works to improve rice productivity	<ul style="list-style-type: none"> - Irrigation water supply in the both wet and dry seasons - Drainage improvement

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

A1.1.4 Agricultural Extension Situation in Cambodia

The Government's policy is aimed to promote agricultural productivity and diversification by addressing the issues of agricultural technology, rural infrastructures including irrigation systems, rural credit, marketing and processing. However, agricultural and water productivity are still quite low due to the lack of farmers' skills, lack of access to agricultural knowledge, information and technology,

low labor productivity, lack of quality inputs such as seeds, fertilizers and credit, poor water management control and low level of support services available to farmers and lack of empowerment of local communities.

Extension workers of the Ministry of Agriculture, Forestry and Fisheries (MAFF), Provincial Department of Agriculture (PDA) and field personnel are mandated to work with farmers. District agriculture offices (DAO) of PDA have a major role to play in field delivery of extension services. The total number of staff under each PDA including DAO is approximately 100 to 300. The number of staff in PDA of Battambang, Pursat and Kampong Chhnang Province is as follows and the organization of each PDA is shown in Figure A1.1.3 to Figure A1.1.5:

Number of Staff in PDA

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

Source: MAFF

However, extension workers are unable to effectively mobilize them due to lack of number and capacity of extension staff at regional and community levels as well as scarcity of resources such as fuel for vehicles and incentives. They are left in such condition as insufficient training centers and demonstration farms, lack of networks to disseminate technologies, and poor communication between research and extension agencies. Hence, extension services are weak overall, and farmers have limited awareness of and access to agriculture and water management.

To complement this situation, it is reported that about 14,000 extension experts/agents in private sectors and NGOs are operational, although less information is available concerning their qualifications, extension work experiences and source of financial support. Furthermore, many on-going projects with technical and financial assistances from donors are providing various kinds of extension services as either full or partly project component as shown below.

List of Donors' Assistance fully or partly related to Agricultural Extension Activities

Project Title	Objectives	Funding Source	Budget (1,000)	Period
1. Improvement of Agriculture Extension in Kandal, Cambodia	To improve the efficiency and effectiveness of agricultural services of district levels	VVOB (Belgium)	EUR 1,200	2008-2013
2. Economic and Social Re-launch of Northwest Provinces (ECOSORN)	To contribute to poverty reduction by way of increased household income through increased agricultural productivity, and increase community empowerment in targeted provinces	EU	EUR 25,000	2005-2010
3. Agricultural Sector Development Project	To provide farmers, including poor and women farmers, with effective agricultural support services to assist increased commercialization of agriculture and reduce rural poverty	ADB Loan (2023-CAM)	USD 4,700	2004-2009
4. Cambodia Agriculture Value Chain Program (CAVAC)	To accelerate growth in the value of agricultural production and smallholder income in the rice based farming systems of target provinces	AusAID	AUD 42,000	2009-2014
5. Rural Livelihood Development Project (RULIP-IFAD)	To improve a sustainable impact of the rural poor in the targeted communities of three provinces	IFAD	USD 11,510	2007-2014

Project Title	Objectives	Funding Source	Budget (1,000)	Period
6. Rural Poverty Reduction Project in Prey Veng and Svay Rieng	To improve rural livelihood and income generation	IFAD	USD 15,490	2004-2011
7. Agriculture Development in Mine-affected Areas of Cambodia (ADMAC)	To strengthen Cambodian institutions for improved implementation of sustainable integrated agriculture development and mine action in support of poverty reduction	CIDA	CAD 5,000	2005-2009
8. Cambodia Agricultural Marketing Improvement Program	To improve agriculture marketing and information	CIDA	CAD 5,000	2005-2010
9. CARE Integrated Rural Development and Disaster Mitigation Project	To improve food security and income generation	USAID	USD 4,600	
10. Battambang Rural Area Nuture and Development Project (BRAND)	To enhance agricultural service delivery to farmers in target communes	JICA	JPY 168,506	2006-2010
11. Strengthening the Formal Education of teaching and Research Staff and Promoting the Short Course Training Programs of RUA	To strengthen overall RUA teaching capacity and improve market-oriented short-term training course	FSP	USD 1,600	2005-2010
12. Improved Feeding Systems for More Efficient Beef Cattle Production in Cambodia	To improve profitability of cattle production and reduce labor demand for feeding cattle in smallholder farming communities	ACIAR	AUSD 622	2008-2011
13. Best Practice Health and Husbandry of Cattle, Cambodia	To improve the profitability of cattle production in Cambodia by evaluating the best practice health and management interventions	ACIAR	AUSD 765	2007-2011
14. Understand Livestock Movement and the Risk of Spread of Boundary Animal Diseases	To predict the risk of disease spread by understanding livestock movement patterns	ACIAR	AUSD 1,257	2007-2012
15. Cambodia Agriculture Value Chain Program in Research Part (CAVAC)	To enhance research in agricultural value chain related area, pest control, food processing, crop production, farming systems and agricultural machinery	AusAID and ACIAR	USD 2,500	2009-2014
16. Analyses of Three Databases of Fisheries Data from the Mekong River	To improve knowledge of the likely response of exploited fish stocks and their species assemblages to forecast changes in the flow regime of the basin	ACIAR	AUSD 150	2008-2009
17. Cambodian Agricultural Research Fund (CARF)	To assist Cambodian scientists in government, university and NGO organizations to compete for agricultural research funds in areas of animal and plant health, and food safety	ACIAR	AUSD 1,280	2002-2011
18. Diversification and Intensification of Rain-fed Lowland Cropping Systems in Cambodia	To increase the range of crops grown under rain-fed lowland conditions by promoting non-rice crop technologies that provide efficient water use and high financial return to the growers	ACIAR	AUSD 900	2007-2010
19. Enhancing Production and Marketing of Maize and Soybean in North-western Cambodia	To develop and disseminate a sustainable model for maize and farmer-ready technological packages across the whole value chain	ACIAR	AUSD 1,169	2008-2011

Project Title	Objectives	Funding Source	Budget (1,000)	Period
20. Improvement of Vegetable production and Post-harvest Management Systems in Cambodia and Australia	To map supply chains and identify constraints to improvement of vegetable industry, develop and demonstrate improved production and post-harvest strategies to underpin quality improvement and improve R&D capacity in vegetable research	ACIAR	AUSD 1,109	2005-2009

Source: Strategy for Agriculture and Water; Cambodian Agricultural and Water Resources Research, Education and Extension

In order to make the extension system effective, therefore, the government officials, farmers and other agri-business interests should have access with necessary equipment to the best available knowledge, information and technology concerning agriculture, agri-business and water management. Furthermore, it is prerequisite to enable rural communities, commune councils and other community-based organizations to participate effectively in aspects of agriculture, agri-business and water management that require community level actions.

Access to markets and market information has been identified as a major bottleneck to food and agricultural production in the country. Access to markets is constrained by physical barriers to markets including roads, processing, storage and packaging facilities as well as technical barriers concerning information about market dynamics and related bio-security, and institutional barriers because of insufficient marketing systems and infrastructure, laws and regulations, and incentives. Although the current extension should focus on production oriented activities, special attention is needed for the future paradigm shift from production-led extension to market-led extension as shown below.

Paradigm Shift of Extension Activities in Future

Features	Production-led Extension	Market-led Extension
Purpose	Yield increase through adoption of production technologies	Income increase through carefully planned investment in technology
Outcome	Attainment of high yields by the majority of farmers	Attainment of high returns from diversified farming
Focus	Yield: (seed-to-seed)	Profit: (Riel-to-Riel)
Technology	Fixed technological packages	Basket of technological choices
Model farmer	High producer	Successful entrepreneur
Extension's role	Passive intermediary between researchers and farmers	Active partner in information and technology generation, assessment and dissemination
Extension workers' skills	Technical and communication	Technical, analytical, communication, market intelligence and ICT
Farmers' role	Passive recipient of technology	Active generator and user of information and technology
Middleman's role		Mutual benefit
Farm input specifications	Supply-driven	Demand-driven
Extension-farmer interaction	Unidirectional essentially top-down approach	Participatory analysis of problems and solutions
Middleman-farmer relations	Exploitative	Mutually beneficial
Contact with farmers	One-to-one	Employing group dynamics
Linkages	Research-extension-farmers	Research-extension-farmers-traders-processors-input providers-other entrepreneurs
Record keeping	Not necessary because of focus on production	Essential for cost-benefit analysis
ICT support	Not as important because of focus on mostly demonstration of material technologies	Essential for collection, analysis and dissemination of market information
Infrastructural support	Road, energy and usual facilities under	Additional provisions needed for rural storage

	rural development programs	and other market infrastructure
Financial support	Credit support for accessing inputs and technologies	Larger investment and credit support for promoting village agro-markets, SME and agri-business capacity

Source: Strategy for Agriculture and Water; Cambodian Agricultural and Water Resources Research, Education and Extension

Administratively, the Department of Agricultural Extension under MAFF has the government mandate to develop a demand-driven, district-implemented, provincially-managed and centrally-overseen extension system appropriate to the needs of Cambodian people. Its objectives are:

- To develop extension/facility and strengthen/expand extension services by making regular improvement on organization structure, role, responsibility and increasing cooperation and collaboration with relevant stakeholders to ensure sustainable extension operation;
- To develop management systems in response to development needs by improving planning, strategy, monitoring and evaluation systems and decision making;
- To develop the capacity of staff and, through private sector/NGO partners at all levels within extension systems, to manage extension programs/activities and provide support to farmers and farming communities in agricultural production, agri-business and processing to respond to market needs and to increase rural farm income;
- To develop and strengthen effectiveness and efficiency of mass media and agricultural technology broadcasting systems to support technology dissemination to farmers and farmers' communities;
- To develop provincial and district management information systems to provide support and facilitate management and implementation of extension programs and activities; and
- To support and encourage the development of farmers' organizations and agricultural communities.

In preparing extension programs for the beneficiary farmers in the project area, thus, it is necessary to consider the huge technology transfer gap, the various weaknesses and almost the total absence of extension on water in agriculture on one hand, and the intention and commitment of the Government to establish a vibrant and responsive extension system on the other hand. Among others, focal points are to reconsider the concept of developing a village extension agent and establish more useful extension systems matching with the above objectives and future changes in extension purposes.

A1.1.5 Seed Production Situation in Cambodia

Seed is the foremost link to food chain and the most critical input used by the farmer. The Cambodian Agricultural Research and Development Institute (CARDI) is the main and only organized center for germplasm collection, evaluation and conservation, varietal development, variety testing and seed production. Up to date, CARDI has released 37 rice varieties comprising 32 for rain-fed and irrigated, two for upland and three for deep water conditions. But, the adoption of these released rice varieties by the farmer is extremely low and hardly five varieties are grown commercially. Such critical gap in flow of quality/certified seeds from the breeder to the farmer is made by the lack of an organized formal seed channel.

As a result, nearly 90% of the seeds are farmers' self-stocked or exchanged seeds. This is largely due to the trust of farmers in their traditional varieties featured by the heavy rice which they prefer for their own consumption. The effectiveness of the improved varieties remains largely undemonstrated, hence

the poor diffusion and acceptability. The extension system has mostly failed in making a systematic effort to convince and motivate the farmers to adopt new varieties and to go for regular seed replacement which is essential for maintaining genetic purity and potential as well as to prevent yield decrease.

The unavailability of certified seed and widespread use of low quality seed are the main reasons behind the poor yields. So far, many activities have been made on the individual project basis aiming to tackle such problems. Among others, improved selection practices of self-stocked seed paddy have been promoted by JICA BRAND-II Project in the targeted communes of Batambang Province, resulting in that germination rate has been much improved and seedlings can be grown in healthy condition after germinated. Through the Agricultural Quality Improvement Project sponsored by AusAID, a commercially viable business for the production and distribution of high quality seed was developed by using about 12 of CARDI released rice varieties in the southeastern part of the country through establishing one each seed production center in the four targeted provinces and a network of seed growers. Unfortunately, the impacts of successful outcomes from these projects have limited to the beneficiaries within the targeted places.

It is therefore essential to have a viable seed program in order to secure continuous supply of good quality of seeds at the right time and at the affordable price for rice grown farmers. Thus, MAFF has a comprehensive plan proposing establishment of a sustainable seed industry capable of ensuring that farmers, especially the small farmers, have timely and reliable access to high quality improved seeds at affordable price. This national seed program is proposing:

- Institutionalized and improved conditions in the seed sector, encompassing national seed policy, national seed corporation/board/authority, and seed laws/acts/regulations;
- Increased capacity for quality seed production through seed production and handling capacity, seed quality control and assurance, seed research and technology development, and training and technical assistance and increased awareness; and
- Production and dissemination of seed, fortified through assessment of requirements of different categories of seed of the different crops, detailed work plan for wet and dry seasons encompassing agronomic practices, harvesting, processing, grading, packaging and storage, variety release, notification and popularization, breeder, foundation and certified seed production, and dissemination of improved/desired seeds, and linkages between seed producers, distributors and buffer stocking.

The program components are:

- Establishment of national seed corporation and seed act;
- Strengthening variety release and notification processes;
- Production of breeder, foundation and certified seeds;
- Seed research and technology development;
- Training;
- Recruitment of international experts;
- Procurement of equipment; and
- Miscellaneous.

The expected implementation period is five years, and the total cost required is estimated at USD 2.28 million.

A1.1.6 Scenario for Paddy Productivity Improvement in the Project Area

(1) Necessity of Supporting Activities

In order to increase the wet season paddy yield in the project area through the guarantee and stabilization of irrigation water supply by means of implementation of the proposed rehabilitation and improvement works of the existing irrigation and drainage facilities, it is also indispensable for extending effective farming methods among beneficial farmers in the project area coping with their capacity to understand and practice what and how to do in growing rice on their irrigated paddy field. For the purpose of corresponding to this required situation, a package of supporting programs should be prepared and practiced in a well coordinated manner between MOWRAM and MAFF, aiming to enable beneficiary farmers of the project to improve their rice cultivation methods under the irrigated condition.

(2) Approach to Preparation of Support Scenario

Considering the existing extension framework of MAFF and the actual farmers’ needs for extension services, the following three scenarios are to be set up for preparing support programs:

- Strengthening a linkage between PDA, commune councils, extension agents and farmers’ groups to be organized on tertiary irrigation block basis;
- Strengthening of extension service systems focusing on utilization of farmer-to-farmer extension system;
- Establishment of technical support systems on farm inputs; and
- Promotion of rice value added activities.

(3) Feed-back of Lessons Learned from Preceding Technical Cooperation Projects

In preparing detailed components of support scenario, lessons learned from the following JICA technical cooperation projects should be fed back aiming to establish more demand-driven support system:

- Battambang Rural Area Nurture and Development Project; and
- Technical Service Center for Irrigation System Project Phase-3 (TSC-3).

A1.1.7 Supporting Programs for Improvement of Paddy Productivity

Based on the above scenarios, the following eight programs are proposed coupled with contents, targets and quantity in a revised manner of the original program.

Revised Agricultural Supporting Programs

Program	Contents	Target	Quantity
1. Government Agricultural Staff Empowerment	1.1 PDA staff empowerment	- extension staff of 3 PDA	2 times in total
	1.2 DAO staff empowerment	- extension staff of 4 DAO	2 times in total
2. Training of Trainers for Capacity Development of Commune Agricultural	2.1 Season-long training of trainers at commune level on pre-harvest technology	- 3 trainees x 17 communes	4 times in total
	2.2 Season-long training of trainers at commune level on post-harvest	- 3 trainees x 17 communes	4 times in total

Program	Contents	Target	Quantity
Extension Agent	technology		
	2.3 Preparation of technical guidance materials	- 3 sets of manuals and 1 set of poster for 1 village	287 manuals & 94 posters
3. Commune Agricultural Extension Agent (CAEA) Development	3.1 Support to establishment of CAEA	- 17 communes	1 time for each commune
	3.2 CAEA working space and seed storage addition to the existing commune office building	- 1 annex to each commune office	17 annexes
	3.3 Bulletin board setting-up	- 1 board per village	94 boards
4. Soil Fertility Diagnosis	4.1 Soil survey and analysis	- 1-sample per tertiary block	287 soil samples
	4.2 Preparation of fertilizer dosage	- 1-dosage per tertiary block	287 dosages
5. Pre-harvest Technology Group Training on Farmer-to-farmer Basis for Improvement of Farmers' Skills on Rice Cultivation	5.1 Training on use of good seed	- 1-key farmer per Sub-FWUG on tertiary block basis	124 times of 1-day training course with 2-content for 9-participant (277- key farmer x 1/9 x 8-content x 1/2)
	5.2 Training on proper land preparation		
	5.3 Training on improved direct sowing & transplanting methods		
	5.4 Training on proper use of fertilizer		
	5.5 Training on producing and application of compost		
	5.6 Training on integrated pest management		
	5.7 Training on controlled irrigation		
	5.8 Training on improved weed control method		
6. Post-harvest Technology Group Training on Farmer-to-farmer Basis	6.1 Training on proper harvesting techniques	- Two trainees from 17 communes	6 times of 4-day training courses with 6-trainee (34 trainees x 1/6)
	6.2 Training on improvement of cutting & threshing techniques		
	6.3 Training on improvement of transporting techniques		
	6.4 Training on utilization and maintenance of farm machinery		
7. Quality Rice Seed Production	7.1 Provision of certified rice seeds	- Annual seed requirement of 600 tons for annual planting area of 20,000 ha with 20% of seed renewal, seed farm yield of 3.0 ton/ha and seed farm area of 40 ha	6 tons in total of certified seeds for 5-year period
	7.2 Selection and training of seed production groups	- 80 farmers in total (seed farm area of 0.5 ha per farmer)	Overall guidance for one crop season
	7.3 Establishment of seed stock and distribution system	- One system per commune	17 systems
8. High Value Added Rice Production Promotion	8.1 Selection of market preferable rice varieties	- 6 sub-project areas	3 times of 1-day seminar
	8.2 Promotion of variety purification and quality uniformity		
	8.3 Establishment of grading system according to quality of paddy on moisture, foreign matter & impurities		
	8.4 Strengthening of coordination with commune based commercial rice millers		

Prepared by JICA SAPROF Team

A1.1.8 Implementation Plan of Supporting Programs

(1) Implementation Schedule

In the initial stage of detailed design works of the project, detailed agricultural supporting programs will be prepared with technical assistance of a consultant team to be appointed by MOWRAM. Aiming at feedback on lessons learned from the on-going JICA technical cooperation projects implemented in the three provinces concerned, the said program preparation should be made by the consultant team in

corporation with stakeholders of MOWRAM and MAFF as well as through confirmation of local administrative conditions as shown in Table A1.1.6.

The program preparation will be commenced from the beginning of 2011, and the first batch of program implementation focusing on capacity development of government extension staff and farmers group leaders is scheduled to be started from the middle of 2011 as shown in Figure A1.1.2.

(2) Implementation Organization

In line with the close coordination policy between MOWRAM and MAFF based on the Government's Strategy for Agriculture and Water, MAFF is responsible for undertaking implementation of the proposed agricultural supporting programs under an umbrella of the MOWRAM management framework of the proposed project.

The local organization structure is illustrated in Figure A1.1.6.

CHAPTER A1.2 SIMULATION OF MARKET FLOW

A1.2.1 Land Holding Status

The following table shows the land holding status in the respective communes where sub-projects are located, based on the Commune Survey on Crops and Livestock, 2003, MAFF.

Land Holding Status in Communes Concerned with Sub-projects

Sub-project & Commune	No. of Total Farmers	No. of Landless Farmers	No. of Land-own Farmers	No. of Land-holders by Land Holding Size		Wet Season Rice Cultivation		
				<0.1 ha	0.1 ha<	Cropped Area (ha)	Total No. Growers	Average Size (ha)
Ream Kon & Por Canal Sub-projects								
Prey Svey	2,672	53	2,619	1,019	1,600	7,001	2,582	2.7
Kear	2,974	984	1,970	1,000	970	3,500	1,500	2.3
Ta Loas*	1,724	85	1,639	90	1,549	3,503	1,122	3.1
Kakaoh*	2,286	532	1,754	35	1,719	5,680	1,700	3.3
Chrey*	2,210	341	1,869	97	1,772	4,003	1,800	2.2
Total	11,866	1,995	9,851	2,241	7,610	23,687	8,704	2.7
Wat Loung, Wat Chre & Damnak Ampil Sub-projects								
Trapeang Chong	3,326	390	2,936	498	2,438	2,979	2,936	1.0
Snam Preah	3,110	300	2,810	0	2,810	3,841	2,810	1.4
Boeng Khnar*	2,344	252	2,092	0	2,092	2,564	2,092	1.2
Khnar Totueng*	1,478	96	1,382	0	1,478	2,967	1,382	2.1
Me Tuek*	2,443	117	2,126	120	2,006	3,411	2,126	1.6
Ou Ta Paong*	2,877	169	2,708	65	2,643	5,115	2,708	1.9
Total	15,578	1,324	14,054	683	13,467	20,877	14,054	1.5
Lum Hach Sub-project								
Anhchanh Rung	1,037	0	1,037	0	1,037	463	331	1.4
Phsar	1,109	55	1,054	0	1,054	1,565	1,037	1.5
Krang Skear*	2,246	150	2,096	0	2,096	3,337	2,096	1.6
Pech Changvar*	700	40	660	0	660	1,145	660	1.7
Popel*	922	23	899	0	899	1,065	899	1.2
Total	6,014	268	5,746	0	5,746	7,575	5,023	1.5

Note: *; A minor part of sub-project area is located in marked communes.

Source: Commune Survey on Crops and Livestock, 2003, MAFF

A1.2.2 Typical Farm Budget

The results of the Socio-economic Survey conducted in 2007 under the JICA M/P and Pre-F/S Study reveal that farmers who grew rice under the rain-fed condition by practicing transplanting method could make a small amount of surplus in their family budgets. On the other hand, those who put direct sowing method into practices were suffered from a deficit in their family budgets to a certain extent, even though they filled partly their deficits by earning non-farm cash income. The following show family budget situation of typical model rice farmers practicing transplanting method in the respective sub-project areas.

Family Budget of Typical Model Farmers in Sub-project Areas

Item/Sub-project	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Weighted Average
Typical Farm Size (ha)	2.2	2.4	1.2	1.4	1.6	1.4	1.5
Gross Value (Riel 1,000)	7,300	8,840	5,020	5,100	4,670	2,970	4,930
- Farm product value	5,240	6,860	3,100	3,410	2,930	2,400	3,470
- Non-farm cash income	2,060	1,980	1,920	1,690	1,740	570	1,460
Gross Expenses (Riel 1,000)	6,740	7,250	4,820	4,470	4,000	2,700	4,390
- Farm product cost	2,740	3,580	1,420	1,600	1,540	1,420	1,780
- Non-farm cash expenses	4,000	3,670	3,400	2,870	2,460	1,280	2,610
Net Surplus/Deficit	560	1,590	200	630	670	270	540

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

A1.2.3 Farmers' Intention Survey

Aiming to clarify the current utilization of harvested paddy by farmers in the respective sub-project areas, an Additional Farmers' Intention Survey was carried out at this time by applying the face-to-face interview method between each enumerator and respondent. The said survey was designed with a total of 303 respondents citing the land holding status and family budget condition in the above. They were selected based on four categories of the land holding size and their distribution in each sub-project area as below.

Sampling Design of Additional Farmers' Intention Survey

Farm land holding size / Sub-project	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Total
Less than 0.3 ha	3	3	11	14	3	6	40
0.3 ha to 1.0 ha	14	13	27	21	10	35	120
1.0 ha to 3.0 ha	10	11	39	26	11	25	122
More than 3.0 ha	3	3	5	4	2	4	21
Total	30	30	82	65	26	70	303

Prepared by JICA SAPROF Team

A1.2.4 Utilization of Harvested Paddy by Farmers

(1) Respondents' Features

Salient features of 303 respondents are as follows:

- Average family size is 5 persons;
- Average size of cultivated area is 1.5 ha;
- Status land holding status is 242 owner cultivators, three tenant farmers and 58 owner cultivators cum tenant farmers;
- Early wet season paddy is grown by 36 respondents and wet season paddy by all respondents;
- Total harvested paddy for the wet season is below 2.0 ton/farmer for 179 respondents, 2.0~6.0 ton/farmer for 103 respondents, and above 6.0 ton/farmer for 21 respondents;
- Total harvested paddy for the early wet season with less than 2.0 ton/farmer is 34 respondents, and 2.0~6.0 ton/farmer for two respondents;
- Sources of farm income in cash are paddy for 85% of respondents, vegetables & fruits grown in home yards for 41%, chickens & ducks for 63%, and animals & fishes for 33%; and
- Sources of non-farm income in cash are daily labor for 75% of respondents, small business for 27%, monthly salary of workers and civil servants for 15%, and rental charges, gift, etc. for 10%.

(2) Utilization of Harvested Paddy

In utilizing harvested paddy, farmers in the project area are reportedly to take priority over home consumption for the purpose of meeting various requirements for supplying food to family members, reserving stocked seed for the next crop season, paying rent in kind to land owners, repaying principles and interests of loans, settling rental fees of animals and machineries, and contributing to monks and ceremonies. Therefore, they are used to sell the remaining paddy, when they need to earn some amount of cash income.

The results of the additional farmers' intention survey have clearly testified to such a vague view. The following shows the number of respondents who choose the concerned items of home consumption.

Number of Respondents by Home Consumption Item of harvested Paddy

Family consumption item / Sub-project	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Total/ Project
No. of respondents	30	30	82	65	26	70	303
Food for family	30	30	80	64	26	70	298
Stock of self-supply seed	29	30	78	65	26	69	297
Rent payment to land owner	11	9	10	3	3	10	46
Loan repayment	5	4	3	10	7	12	41
Rental fee payment	2	2	8	2	1	8	23
Contribution to monks/ceremony	14	16	45	33	16	47	171
Average of total harvested paddy (kg)	3,585	5,722	2,416	1,777	1,187	2,088	2,541
Average of home consumption (%)	68	42	68	57	76	82	63
Average of selling quantity (%)	32	58	32	43	24	18	37

Prepared by JICA SAPROF Team

After keeping necessary quantity of harvested paddy for various home consumption purposes, farmers sell their surplus to rice mills and/or assemblers such as collectors and middlemen. In case of respondents, 37% of the annual harvested paddy is estimated to be sold to buyers. The number of respondents who sell their harvested paddy is 196 persons as shown below.

Number of Respondents Selling Surplus Paddy by Range of Quantity

Buyer	Quantity sold	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Total
No. of respondents selling paddy		20	26	52	35	16	47	196
Assemblers	~ 500 kg	5	2	19	13	12	33	84
	501 ~ 1,000 kg	5	0	15	7	4	8	39
	1,001 ~ 1,500 kg	3	3	8	6	0	4	24
	1,501 ~ 2,000 kg	2	2	5	6	0	0	15
	2,001 ~ 3,000 kg	3	4	2	1	0	1	11
	3,001 ~ 4,000 kg	0	6	2	2	0	0	10
	4,001 ~ 5,000 kg	0	2	0	0	0	0	3
Rice mills	5,001 kg ~	2	7	1	0	0	0	10
	~ 500 kg	0	0	0	11	0	0	11
	501 ~ 1,000 kg	0	0	4	0	0	1	5
	1,001 ~ 1,500 kg	0	0	0	0	0	0	0
	1,501 ~ 2,000 kg	0	0	0	4	0	0	4
	2,001 kg ~	0	0	2	0	0	0	2

Prepared by JICA SAPROF Team

A1.2.5 Current Flow of Forwarded Paddy in Communes Concerned

According to common knowledge of District Agricultural Officers, rice mill owners and village chiefs, about 20% to one-third of the total harvested paddy is usually forwarded from farmers in Battambang, Pursat and Kampong Chhnang Provinces every year. The Additional Farmers' Intention Survey also indicates a similar trend concerning the average selling quantity of paddy by respondent farmers in the project area.

Taking into account the above outputs of the Additional Farmers' Intention Survey and the estimated processing capacity of commercial and custom mills currently operated in the communes concerned, thus, the current situation of harvested paddy utilization for 2008 is assumed as below and illustrated in Figure A1.2.1.

- Total harvested paddy in communes concerned is 122,500 tons including 21,900 tons from the project area as mentioned in Section A1.1.1 (4) and (5);
- Of these, farmers stock 7,400 tons as seeds of the next cropping season, reserve 57,600

tons as food for their family members, use 9,800 tons for repayment their debts in kind, contribute 2,500 tons to monks and ceremonies, and sell 45,200 tons to local assemblers and commercial rice mills;

- Farmers use 824 custom mills to polish rice for daily consumption purposes from their reserves of 57,600 tons;
- As these custom mills have the average daily processing capacity of 824 tons (= 0.2 ton/hr x 5 hr/day x 824) in total, annual operation period required is 70 days. Therefore, they have enough capacity to response farmers' frequent orders to polish rice;
- Of 45,200-ton paddy forwarded from farmers, it is estimated that 37 commercial mills can directly collect 19,900-ton paddy at moment within their maximum limitation of operation budgets. Although these mills have the average daily processing capacity of 296 tons (1.9 ton/hr x 8 hr/day x 37) as a whole, therefore, their annual operation period remains as short as 67 days;
- The remaining 25,300 tons are bought by local assemblers such as collectors and middlemen. Mostly, these assemblers resale paddy on hands to cross border traders, and a few act as agents of either local commercial mills or large-scale commercial mills in other areas. In order to maximize their profit, the assemblers buy wet paddy at lower price compared with millers' offered prices when harvested in paddy field; and
- After processing 19,900-ton paddy, 37 commercial mills forward 12,700-ton milled rice to wholesalers. All of milled rice are transported to Phnom Penh and marketed to consumers through retailers.

As clearly in the above, the local commercial mills because of their limited operation budgets trigger irregular flows to cross border traders estimating at 56% of forwarded paddy from farmers. Furthermore, farmers due to lack of their immediate needs for cash income and awareness to quality improvement of paddy are resigned to ill-treatment as producers of cheap paddy. According to the Cambodia Agriculture and Agribusiness Support Program paper prepared within the framework of Strategy for Agriculture and Water, it is estimated that the average additional cost of local assemblers is equivalent tot 14% of purchased price of wet paddy from farmers. From the viewpoint of rural economy, there exist large losses of value added in the main industry which is the main actor to increase regional gross domestic product.

A1.2.6 Simulated Future Market Flow of Paddy in Communes Concerned

(1) Simulation Cases

Through the Additional Farmers' Intention Survey, it has been clarified that the bottleneck is the shortage of operation funds for the existing local commercial rice millers in increasing farm gate prices of paddy at farmers' level, operation hours of commercial mills and contributions to rural economy. With the financial assistance of JICA, the Rural Development Bank of Cambodia has started to provide small and medium scale industries with two-step loan menus at affordable rates.

In this context, the simulation of the future flow of paddy after implementation of the proposed project is to be made for the following three cases:

- Case-1 is to take no action by local commercial rice millers for increasing their operation budgets;

- Case-2 is to take a financial arrangement by local commercial rice millers for securing their operation budgets to maintain sustainable operation of their milling facilities at full capacity levels and to offer attractive purchase price of wet paddy to farmers; and
- Case-3 is to keep the current local assemblers' share of purchasing wet paddy from farmers by reducing their margin in order to compete to local commercial rice millers' offered price attractive to farmers.

(2) Future Quantity of Paddy Forwarded from Farmers

Through implementation of the proposed project, the future paddy production is predicted as below, including the both harvests in the primary and secondary benefit areas.

Predicted Paddy Production in Project Area

Sub-project	Physical Area (ha)	Early Wet Season Paddy (ton)				Wet Season Paddy (ton)				Total Product (ton)
		Gravity irrigated		Pump irrigated		Gravity irrigated		Pump irrigated		
		TP*	DS**	TP	DS	TP	DS	TP	DS	
Primary Benefit Area										
Ream Kon	1,890	-	2,880	-	510	2,880	1,950	510	330	9,060
Por Canal	1,940	-	3,720	-	-	3,720	2,294	-	-	9,734
Damnak Ampil	2,270	-	429	-	132	5,841	-	1,650	-	8,052
Wat Loung	2,540	-	429	-	198	5,742	-	2,640	-	9,009
Wat Chre	1,020	-	165	-	99	2,046	-	1,320	-	3,630
Lum Hach	3,100	3,270	-	540	-	7,980	-	440	-	12,230
Sub-total	12,760	3,270	7,623	540	939	28,209	4,244	6,560	330	51,715
Secondary Benefit Area										
Ream Kon	90	-	162	-	-	270	-	-	-	432
Por Canal	430	-	496	-	-	1,333	-	-	-	1,829
Damnak Ampil	8,930	-	2,211	-	-	29,469	-	-	-	31,680
Lum Hach	3,400	-	4,080	-	-	10,200	-	-	-	14,280
Sub-total	12,850	-	6,949	-	-	41,272	-	-	-	48,221
Total	25,610	3,270	14,572	540	939	69,481	4,244	6,560	330	99,936

Note: TP; transplanting method DS: direct sowing method

Prepared by JICA SAPROF Team

The Additional Farmers' Intention Survey reveals that half of respondent farmers in the project area intend to increase reserved quantity of stocked seeds and food for their family members when they will be able to improve their paddy productivity resulting from the stabilization of irrigation water supply during the wet season. Based on the survey result, the average quantity of paddy is estimated to be 139 kg/respondent for self-stocked seeds for the next crop season and 660 kg/respondent for family food. On the other hand, the remaining half of respondent farmers consider to sell all of harvested paddy additionally increased in the future.

Compared with the current paddy production, the harvested paddy will increase by 29,800 tons from 21,900 tons to 51,700 tons in the primary benefit area. From this net increase, farmers will use 1,100 tons for additional seed stocks and 10,200 tons for further food supply to their family members according to the additional farmers' intention survey. Thus the surplus of 18,500 tons or 62% of the net increase will be additionally forwarded from farmers.

Based on such assumption that the current paddy production in the secondary benefit area is 19,200 tons in total, the net increase in paddy production is estimated to be 29,000 tons. As farmers are assumed to use this additional paddy with the same purposes as the above, the surplus to be forwarded from farmers is estimated to be 18,000 tons. Accordingly, the additional net increase in forwarded paddy will be 36,500 tons.

Of the total paddy production of 200,500 tons in the communes concerned in the future, it is estimated

that 9,600 tons will be stocked as seeds for the next crop season, 77,700 tons used for home consumption, 9,800 tons allocated to debt payment in kind and 2,500 tons spent for contribution. Thus, the remaining 100,900-ton wet paddy will be forwarded from farmers.

(3) Simulation Results

The simulation results for the three cases are as follows:

- Case-1 reveals that the whole benefits additionally created will fall into local assemblers’ hands resulting in that no increase in farm gate price of paddy for farmers and gross receipt of commercial millers is expected. Furthermore, the local assemblers will irregularly resell most of 81,000-ton purchased wet paddy to cross-boarder traders resulting in no contribution to rural economic generation. The future flow of forwarded paddy is illustrated in Figure A1.2.2;
- Case-2 shows that the existing 37 commercial mills in the communes concerned will be able to process the whole quantity of forwarded wet paddy from farmers as they have annual processing capacity of 97,680-ton wet paddy at full operation level (= 1.0 ton/hr x 8 hr/day x 330 day/yr x 37) and add extra operation of 87 hours by each mill. All rice farmers in the communes concerned including beneficiary farmers in the project area will expect to increase their selling price of wet paddy by 7% which is equivalent to half of local assemblers’ charges. The remaining half will be used by local rice millers for the purpose of covering their increasing cost to dry purchased wet paddy from farmers. The value added by processing wet paddy will fully contribute to generate rural economy in the communes concerned. The quantity of marketed milled rice will increase by 51,900 tons. Considering the current deficit of 184,800 tons in Phnom Penh city and the latest urban population increasing rate of 2.21% per annum, such increase in market supply will be easily absorbed by a large number of end consumers in the capital city. The future flow of forwarded paddy is illustrated in Figure A1.2.2; and
- Case-3 indicates that local assemblers will be forced to reduce their charge by at least 7% for attracting farmers and also to pay in cash at full amount when purchased. The future flow of forwarded paddy is illustrated in Figure A1.2.3.

The results of simulation are summarized below.

Summary of Simulation Results

Simulation Case	Total Paddy Production (ton)	Output from Project (ton)	Farmers’ Consumption (ton)	Forwarded Paddy (ton)	Millers’ Handling (ton)	Marketed Milled Rice (ton)	Assemblers’ Handling (ton)
Current	122,500	21,900	77,300	45,200	19,900	12,700	25,300
Case-1	200,500	99,900	99,600	100,900	19,900	12,700	81,000
Case-2	200,500	99,900	99,600	100,900	100,900	64,600	0
Case-3	200,500	99,900	99,600	100,900	75,600	48,400	25,300

Prepared by JICA SAPROF Team

From the viewpoint of strengthening the farmers’ and rural economy, the Case-2 is most preferable, but the vitalization of rice mill industry currently operated in the communes concerned is prerequisite to realize the impact of this case. In addition, it is necessary to take effective policies for encouraging traders to switch their trading systems from irregular export of paddy to authorized export of milled rice. Therefore, it is indispensable for encouraging the existing commercial mills through provision of short-term credit services at affordable interest rate to finance initial operation funds.

Table A1.1.1 Paddy Harvested Area, Yield and Production by Province in 2008-2009

Province/Town	Wet Season in 2008			Dry Season in 2008-2009			Total in 2008-2009		
	Harvested Area (ha)	Paddy Yield (ton/ha)	Paddy Production (ton)	Harvested Area (ha)	Paddy Yield (ton/ha)	Paddy Production (ton)	Harvested Area (ha)	Paddy Yield (ton/ha)	Paddy Production (ton)
Banteay Mean Chey	213,841	2.53	541,445	2,350	3.45	8,108	216,191	2.54	549,553
Battambang	244,586	2.66	651,551	4,830	4.39	21,214	249,416	2.70	672,765
Kampong Cham	166,285	3.01	500,352	52,993	3.78	200,310	219,278	3.20	700,662
Kampong Chhnang	105,222	2.58	271,940	22,914	3.83	87,692	128,136	2.81	359,632
Kampong Speu	105,141	2.33	245,504	146	2.86	417	105,287	2.34	245,921
Kampong Thom	164,279	2.19	359,114	20,468	3.74	76,627	184,747	2.36	435,741
Kampot	125,605	2.75	345,105	2,375	3.80	9,018	127,980	2.77	354,123
Kandal	43,507	2.93	127,304	57,170	4.15	236,996	100,677	3.62	364,300
Koh Kong	9,619	2.34	22,518	-	-	-	9,619	2.34	22,518
Kratie	29,778	2.58	76,857	13,979	2.52	35,196	43,757	2.56	112,053
Mondulhiri	16,392	1.83	29,932	-	-	-	16,392	1.83	29,932
Phnom Penh City	5,031	3.40	17,116	200	5.25	1,050	5,231	3.47	18,166
Praah Vihear	37,624	2.00	75,248	18	2.11	38	37,642	2.00	75,286
Prey Veng	250,339	2.35	589,434	72,654	4.20	305,146	322,993	2.77	894,580
Pursat	98,810	2.62	259,262	3,465	3.25	11,272	102,275	2.65	270,534
Rotanakiri	24,346	1.86	45,332	-	-	-	24,346	1.86	45,332
Siem Reap	178,778	1.97	352,347	16,000	3.80	60,800	194,778	2.12	413,147
Preah Sihanouk	12,732	2.50	31,830	-	-	-	12,732	2.50	31,830
Stueng Treng	23,045	2.50	57,613	-	-	-	23,045	2.50	57,613
Svay Rieng	160,250	2.24	359,573	14,828	3.95	58,570	175,078	2.39	418,143
Takeo	181,383	2.99	541,853	74,224	4.50	334,031	255,607	3.43	875,884
Otdar Mean Chey	50,390	2.07	104,509	57	-	-	50,447	2.07	104,509
Kep	3,000	2.61	7,833	-	-	-	3,000	2.61	7,833
Pailin	2,750	3.12	8,570	1,950	3.50	6,825	4,700	3.28	15,395
Total	2,252,733	2.50	5,622,142	360,621	4.03	1,453,310	2,613,354	2.71	7,075,452

Source: MAFF's Annual Report on Agriculture, Forestry and Fisheries 2008-2009

Table A1.1.2 Rice Planted Area by Province for Wet Season in 2008

Province/Town	Early Wet	Wet Season						Total Paddy Rice Area (ha)	Total Planted Area of Rice (ha)
	Season	Early	Medium	Late	Paddy	Upland	Floating		
	Early Maturity (ha)	Maturity Varieties (ha)	Maturity Varieties (ha)	Maturity Varieties (ha)	Rice Sub-total (ha)	Rice Varieties (ha)	Rice Varieties (ha)		
Banteay Mean Chey	1,252	38,028	92,966	60,706	191,700	-	21,388	192,952	214,340
Battambang	5,425	31,155	67,970	118,927	218,052	2,052	19,598	223,477	245,127
Kampong Cham	12,465	12,505	55,362	79,653	147,520	5,250	1,050	159,985	166,285
Kampong Chhnang	1	26,514	61,732	13,093	101,339	38	3,844	101,340	105,222
Kampong Speu	1,442	29,036	66,234	8,121	103,391	357	-	104,833	105,190
Kampong Thom	1,953	33,336	55,518	44,646	133,500	3,222	25,604	135,453	164,279
Kampot	5,361	3,015	100,665	16,100	119,780	114	350	125,141	125,605
Kandal	2,621	3,544	18,949	15,704	38,197	1,027	1,789	40,818	43,634
Koh Kong	-	1,838	4,953	1,630	8,421	1,198	-	8,421	9,619
Kratie	399	8,081	12,833	8,063	28,977	402	-	29,376	29,778
Monduliri	-	2,616	6,449	2,549	11,614	4,892	-	11,614	16,506
Phnom Penh City	-	805	3,340	886	5,031	-	-	5,031	5,031
Praah Vihear	-	4,013	19,230	12,177	35,420	2,435	-	35,420	37,855
Prey Veng	8,062	59,618	137,560	44,715	241,893	-	384	249,955	250,339
Pursat	3,782	27,711	29,464	23,082	80,257	1,467	13,304	84,039	98,810
Rotanakiri	-	2,640	4,785	3,525	10,950	13,956	-	10,950	24,906
Siem Reap	8,570	35,595	83,450	36,815	155,860	5,600	8,760	164,430	178,790
Preah Sihanouk	-	1,357	8,821	2,569	12,747	-	-	12,747	12,747
Stueng Treng	615	9,346	9,170	1,740	20,256	2,174	-	20,871	23,045
Svay Rieng	4,183	41,634	82,223	32,373	156,230	-	-	160,413	160,413
Takeo	35,199	49,303	83,028	11,868	144,199	-	2,045	179,398	181,443
Otdar Mean Chey	-	11,988	24,999	7,103	44,090	6,300	-	44,090	50,390
Kep	10	602	2,114	274	2,990	-	-	3,000	3,000
Pailin	5	1,570	1,030	145	2,745	-	-	2,750	2,750
Total	91,345	435,850	1,032,845	546,464	2,015,159	50,484	98,116	2,106,504	2,255,104

Source: MAFF's Annual Report on Agriculture, Forestry and Fisheries 2008-2009

Table A1.1.3 Available Land Preparation Equipment and Plowing Area by Province in 2008

Province/Town	Tractor		Power Tiller		Annual Plowing Area			Water Pump	
	Public Sector's Owned (unit)	Private Sector's Owned (unit)	Public Sector's Owned (unit)	Private Sector's Owned (unit)	By Farm Machinery (ha)	By Draft Animals (ha)	Total Plowing Area (ha)	Public Sector's Owned (ton/yr)	Private Sector's Owned (ton/yr)
Banteay Mean Chey	1	66	-	36	199,422	14,918	214,340	16	1,183
Battambang	4	235	5	97	374,108	39,899	414,007	58	16,453
Kampong Cham	-	351	-	1,299	71,824	98,258	170,082	11	20,522
Kampong Chhnang	-	344	1	541	63,893	151,957	215,850	48	4,234
Kampong Speu	8	272	-	2,269	29,706	161,797	191,503	41	20,738
Kampong Thom	-	211	-	1,522	45,118	119,161	164,279	-	28,120
Kampot	-	153	-	450	49,434	76,975	126,409	-	1,768
Kandal	-	81	-	1,785	30,711	32,824	63,535	17	2,668
Koh Kong	12	1,109	10	10,530	2,535	7,560	10,095	28	8,994
Kratie	9	928	13	12,948	4,681	24,992	29,673	39	2,490
Monduliri	1	130	-	514	11,004	6,949	17,953	54	2,211
Phnom Penh City	-	15	5	1,482	1,062	4,395	5,457	39	11,462
Praah Vihear	-	8	-	253	23,006	12,142	35,148	8	46
Prey Veng	-	12	-	482	98,477	191,788	290,265	-	1,886
Pursat	-	38	-	50	43,321	55,549	98,870	-	-
Rotanakiri	-	58	2	1,330	16,280	10,955	27,235	63	3,779
Siem Reap	-	8	-	56	54,540	150,960	205,500	-	43
Preah Sihanouk	-	46	-	232	6,785	5,962	12,747	-	376
Stueng Treng	-	33	4	256	2,445	18,524	20,969	8	52
Svay Rieng	2	2	2	66	27,113	133,693	160,806	3	54
Takeo	4	76	-	572	115,702	249,838	365,540	49	3,306
Otdar Mean Chey	-	1	-	5	25,554	25,826	51,380	-	21
Kep	-	109	5	243	124	2,876	3,000	5	49
Pailin	-	24	-	977	2,725	-	2,725	-	-
DOAM*	25	-	26	-	-	-	-	-	-
Other Departments	74	161	382	462	-	-	-	13	5,106
Total	140	4,471	455	38,457	1,299,570	1,597,798	2,897,368	500	135,561

Note: DOAM; Department of Agricultural Machinery under MAFF

Source: MAFF's Annual Report on Agriculture, Forestry and Fisheries 2008-2009

Table A1.1.4 Available Post-harvest Equipment and Facilities by Province in 2008

Province/Town	Harvester		Thresher		Miller		Estimated Milling Capacity*		
	Large Scale (unit)	Small Scale (unit)	Generator Operated (unit)	By Foot Operated (unit)	Large Scale (unit)	Small Scale (unit)	Large Scale (ton/yr)	Small Scale (ton/yr)	Total Capacity (ton/yr)
Banteay Mean Chey	1	-	25	31	26	91	62,400	18,200	80,600
Battambang	-	16	345	52	267	1,742	640,800	348,400	989,200
Kampong Cham	-	-	1,183	-	74	5,645	177,600	1,129,000	1,306,600
Kampong Chhnang	7	51	446	21	19	1,071	45,600	214,200	259,800
Kampong Speu	17	84	1,972	14	65	6,364	156,000	1,272,800	1,428,800
Kampong Thom	-	190	451	249	52	3,219	124,800	643,800	768,600
Kampot	-	-	202	-	20	2,315	48,000	463,000	511,000
Kandal	-	8	556	8	51	4,050	122,400	810,000	932,400
Koh Kong	7	8	739	-	199	364	477,600	72,800	550,400
Kratie	6	9	583	7	207	750	496,800	150,000	646,800
Mondulkiri	-	-	26	-	5	146	12,000	29,200	41,200
Phnom Penh City	-	6	168	-	10	2,089	24,000	417,800	441,800
Praah Vihear	-	-	140	-	-	294	-	58,800	58,800
Prey Veng	-	-	33	44	16	2,465	38,400	493,000	531,400
Pursat	-	-	2	-	2	181	4,800	36,200	41,000
Rotanakiri	-	-	26	60	68	3,640	163,200	728,000	891,200
Siem Reap	-	-	20	-	4	217	9,600	43,400	53,000
Preah Sihanouk	-	2	132	-	3	878	7,200	175,600	182,800
Stueng Treng	-	2	40	0	3	766	7,200	153,200	160,400
Svay Rieng	-	-	11	-	-	61	-	12,200	12,200
Takeo	1	12	406	40	1	1,599	2,400	319,800	322,200
Otdar Mean Chey	-	-	4	-	-	45	-	9,000	9,000
Kep	-	-	30	-	-	26	-	5,200	5,200
Pailin	-	-	63	-	-	-	-	-	-
Other Departments	3	-	95	13	77	242	184,800	48,400	233,200
Total	42	388	7,698	539	1,169	38,260	2,805,600	7,652,000	10,457,600

Note: Annual milling capacity is assumed to be 2,400-ton paddy for a large-scale mill (= 1.0 ton/hr x 8 hr/day x 300 day/yr) and 200-ton paddy for a small-scale mill (= 0.2 ton/hr x 5 hr/day x 200 day/yr)

Source: MAFF's Annual Report on Agriculture, Forestry and Fisheries 2008-2009

Table A1.1.5 Rice Balance Sheet by Province in 2008

Province/Town	Paddy				Milled Rice				
	Annual Paddy Production (ton)	Paddy Production Share (%)	Seed & Post-harvest Losses (ton)	Paddy for Food Supply (ton)	Milled Rice Supplied (ton)	Population Census 2,008 (person)	Milled Rice Required (ton)	Surplus/Deficit Condition (ton)	Surplus Share of Production (%)
Banteay Mean Chey	549,553	7.7	71,442	478,111	305,991	688,678	98,481	207,510	59.0
Battambang	672,765	9.4	87,459	585,306	374,596	1,048,025	149,868	224,728	52.2
Kampong Cham	700,662	9.8	91,086	609,576	390,129	1,688,089	241,397	148,732	33.2
Kampong Chhnang	359,632	5.0	46,752	312,880	200,243	477,323	68,257	131,986	57.3
Kampong Speu	245,942	3.4	31,972	213,970	136,941	729,343	104,296	32,644	20.7
Kampong Thom	435,741	6.1	56,646	379,095	242,621	637,300	91,134	151,487	54.3
Kampot	354,123	4.9	46,036	308,087	197,176	591,078	84,524	112,652	49.7
Kandal	364,300	5.1	47,359	316,941	202,842	1,285,706	183,856	18,986	8.1
Koh Kong	22,518	0.3	2,927	19,591	12,538	140,504	20,092	-7,554	-
Kratie	112,053	1.6	14,567	97,486	62,391	324,607	46,419	15,972	22.3
Monduliri	29,932	0.4	3,891	26,041	16,666	64,636	9,243	7,423	38.8
Phnom Penh City	18,166	0.3	2,362	15,804	10,115	1,363,065	194,918	-184,803	-
Praah Vihear	75,286	1.0	9,787	65,499	41,919	176,986	25,309	16,610	34.5
Prey Veng	994,580	13.9	129,295	865,285	553,782	1,117,613	159,819	393,963	61.9
Pursat	270,534	3.8	35,169	235,365	150,633	399,887	57,184	93,449	54.0
Rotanakiri	45,332	0.6	5,893	39,439	25,241	156,972	22,447	2,794	9.6
Siem Reap	413,147	5.8	53,709	359,438	230,040	918,986	131,415	98,625	37.3
Preah Sihanouk	31,830	0.4	4,138	27,692	17,723	204,900	29,301	-11,578	-
Stueng Treng	57,613	0.8	7,490	50,123	32,079	115,321	16,491	15,588	42.3
Svay Rieng	418,143	5.8	54,359	363,784	232,822	483,220	69,100	163,722	61.2
Takeo	875,884	12.2	113,865	762,019	487,692	849,501	121,479	366,214	65.3
Otdar Mean Chey	104,509	1.5	13,586	90,923	58,191	201,428	28,804	29,386	43.9
Kep	7,833	0.1	1,018	6,815	4,361	36,543	5,226	-864	-
Pailin	15,395	0.2	2,001	13,394	8,572	78,404	11,212	-2,640	-
Total	7,175,473		932,811	6,242,662	3,995,303	13,778,115	1,970,270	2,025,033	44.1

Source: MAFF's Annual Report on Agriculture, Forestry and Fisheries 2008-2009

Table A1.1.6 Local Administrative Structure

Province	Battambang		Pursat		Kampong Chhnang
District	Moung Russei		Bakan		Boribo
			Sampov Meas		
			Lolok Sar		Krang Skear
			Trapeang Chong		Anchanh Rung
Commune	Prey Svay	Ta Loas	Snam Preah		Prasneb
		Kor Koah		Boeng Khnar	Phsar
			Phteah Rung		
			Bak Chenhchien	Khnar Totueng	
Villages in number	10	26	12	11	21
Sub-project	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre
Irrigation area (ha)	1,890	1,940	2,270	2,540	1,020
Beneficiary (hh)	900	920	2,000	1,700	730
Water users organization at tertiary canal level of about 50 ha					
Sub-FWUG (unit)	47	42	50	54	27
Water users organization at secondary canal level of about 200 ha					
FWUG (unit)	16	12	3	10	5
Water users organization at sub-project level					
FWUC (unit)	1	1	1	1	1
Administration					
PDOGRAM		Battambang		Pursat	Kampong Chhnang
PDA		Battambang		Pursat	Kampong Chhnang
DAO		Moung Russei (10 skilled staff)		Bakan (1 skilled staff)	Baribour (2 skilled)
				Sampov Meas (1 skilled staff)	

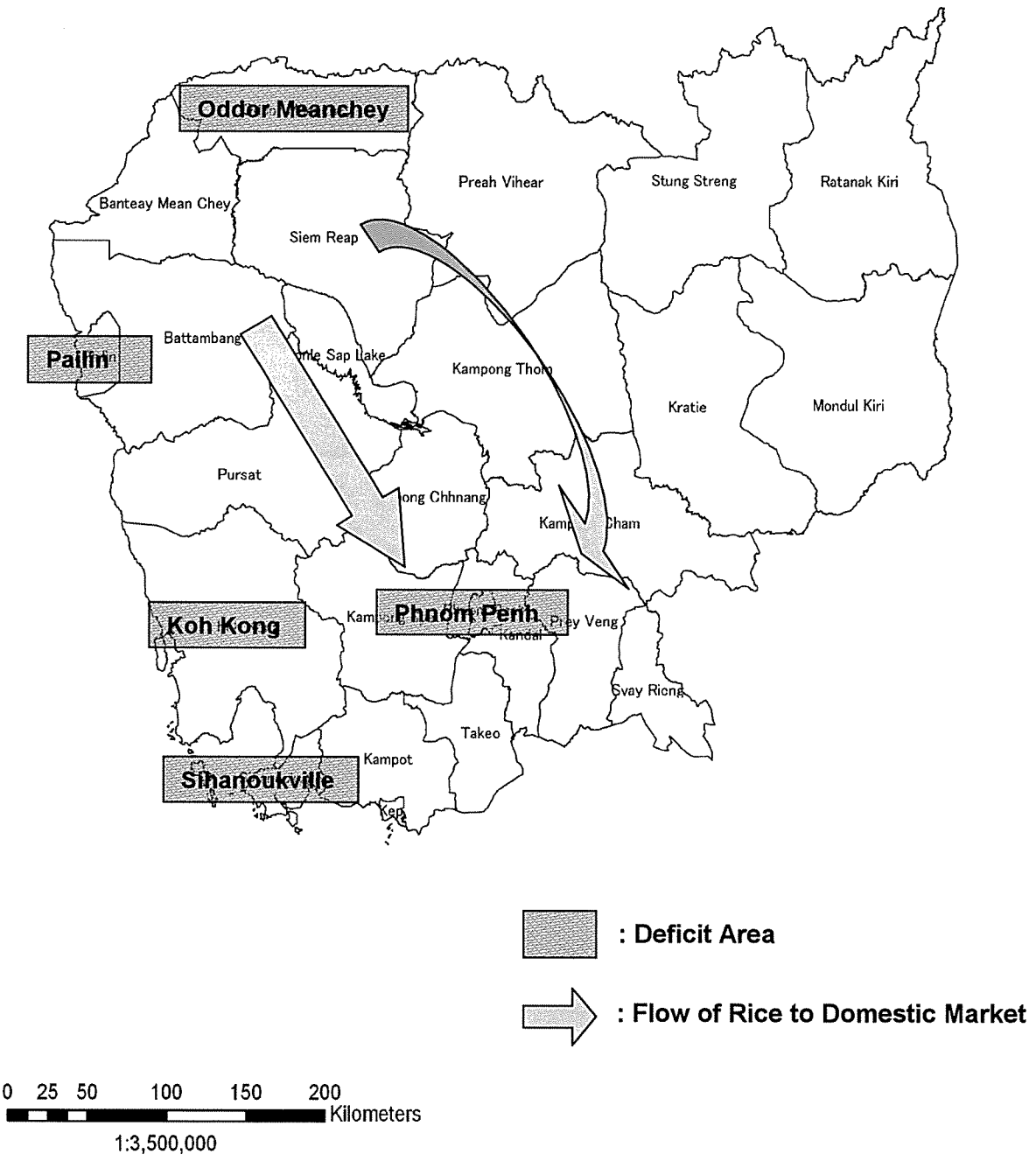


Figure A1.1.1 Deficit Area and Flow of Rice to Domestic Market

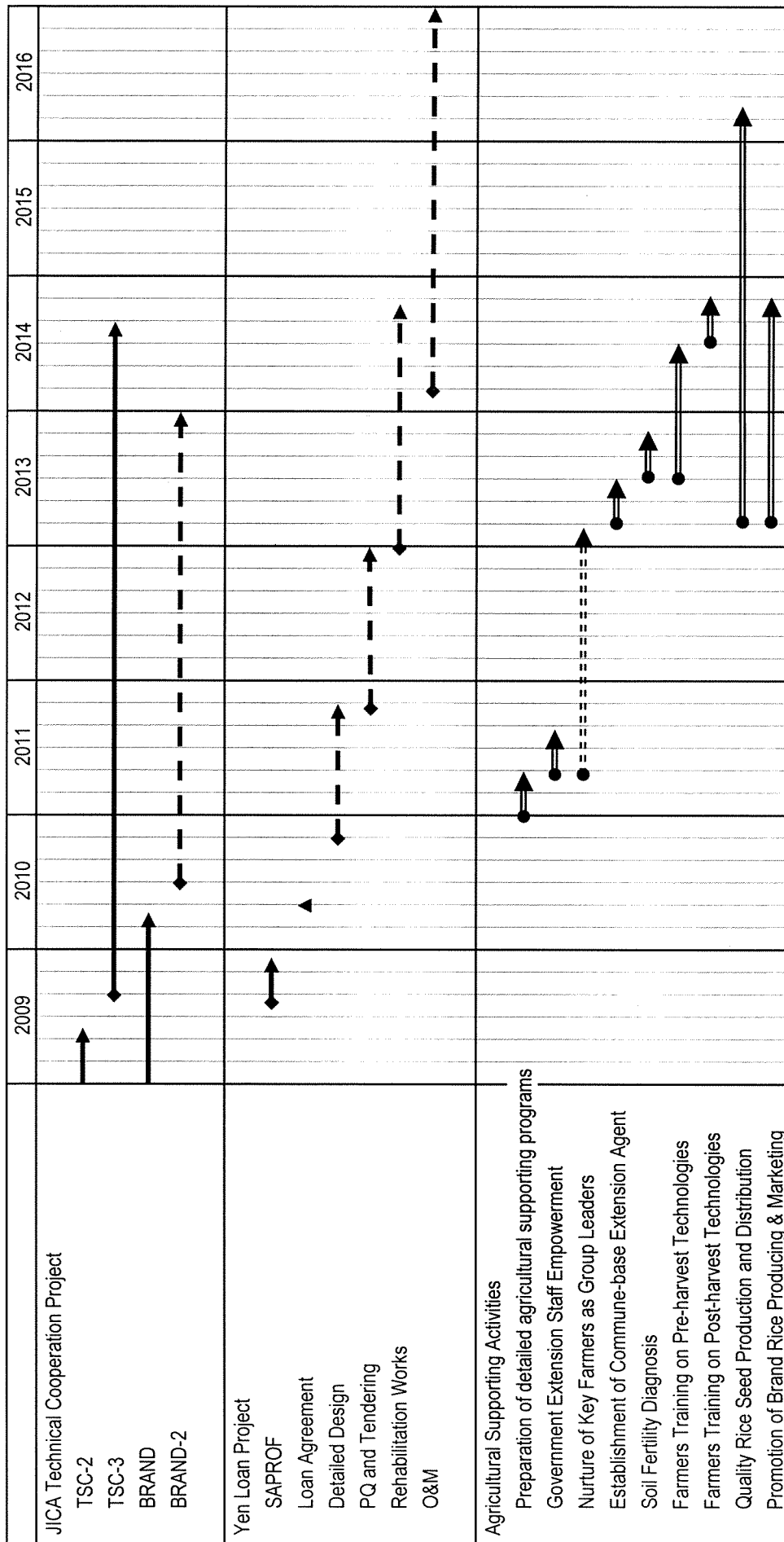


Figure A1.1.2 Implementation Schedule

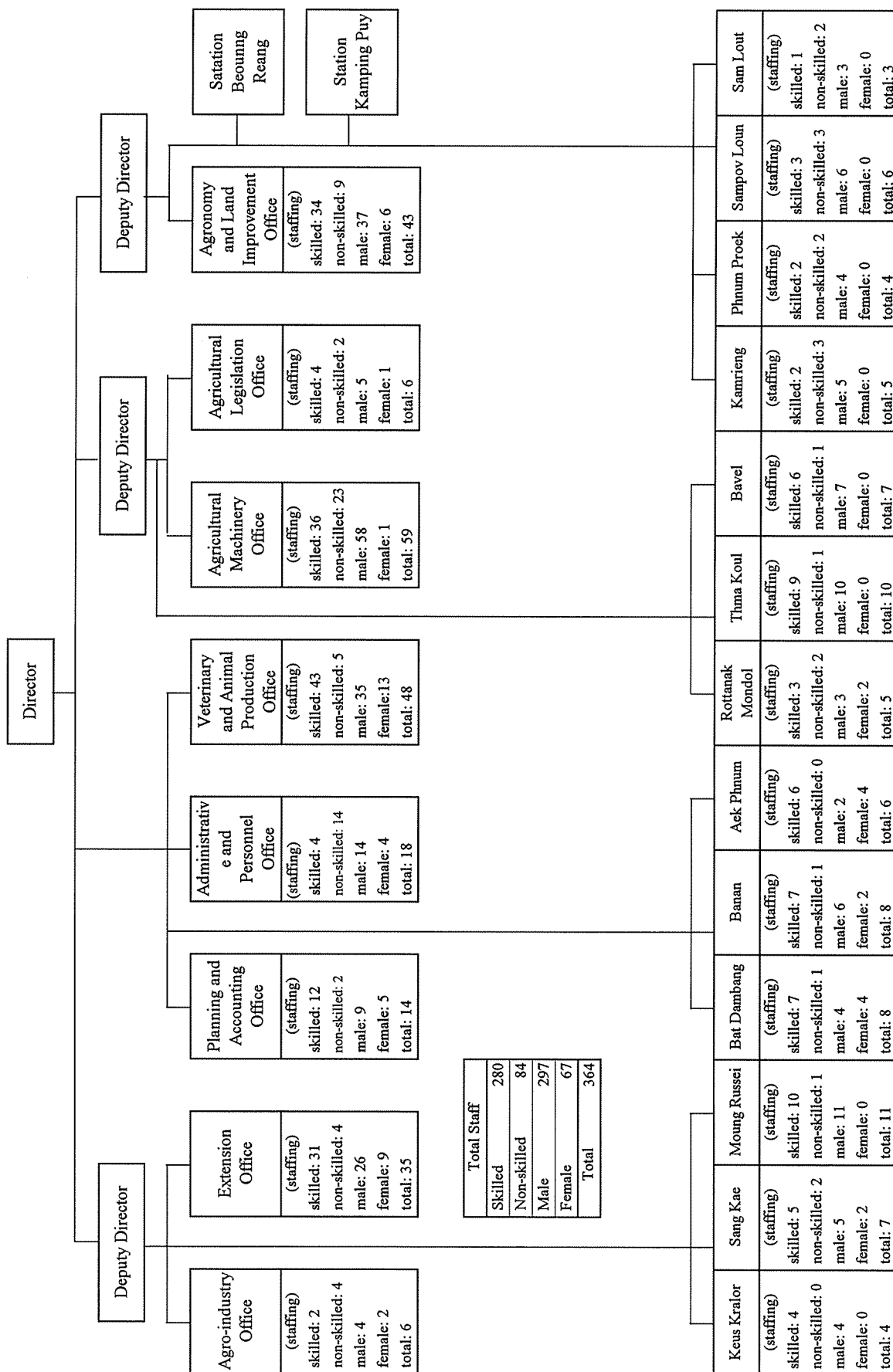


Figure A1.1.3 Organization Structure of Provincial Department of Agriculture (PDA) of Battambang

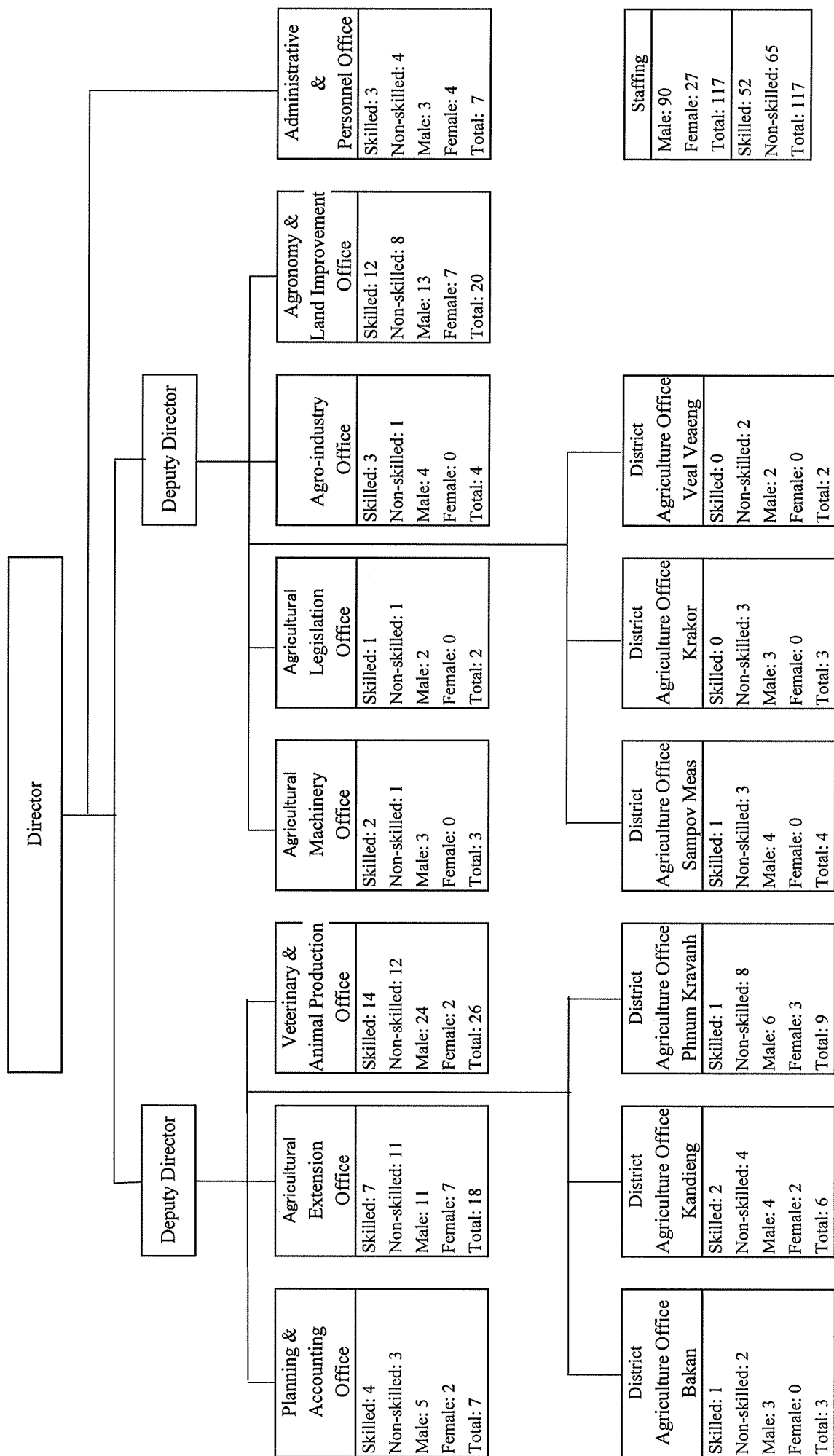
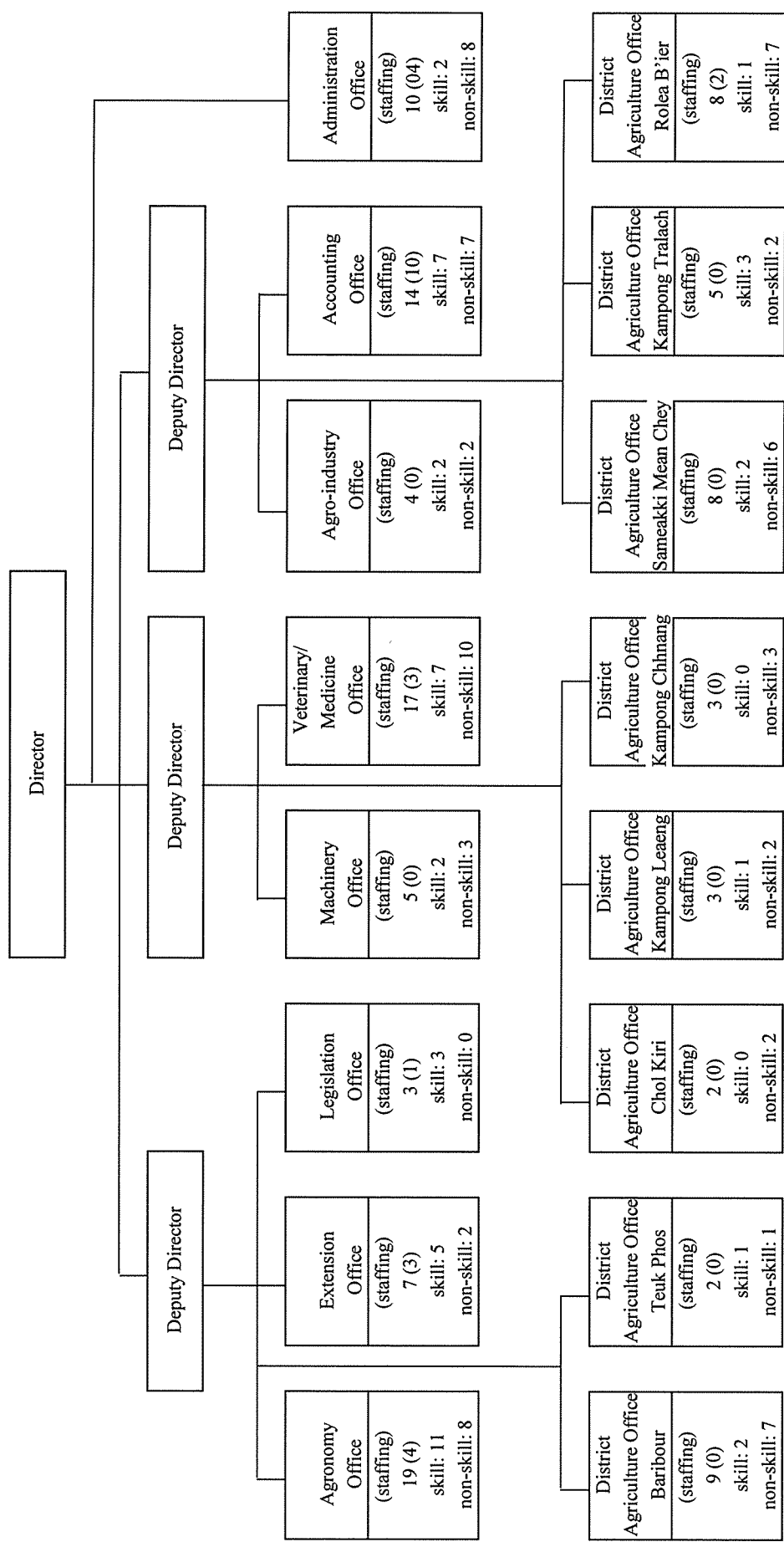


Figure A1.1.4 Organization Structure of Provincial Department of Agriculture (PDA) of Pursat



Total Staffing:	123
Skilled:	54
Non-skilled:	69
Male:	96
Female:	27

Figure A1.1.5 Organization Structure of Provincial Department of Agriculture (PDA) of Kampong Chhnang

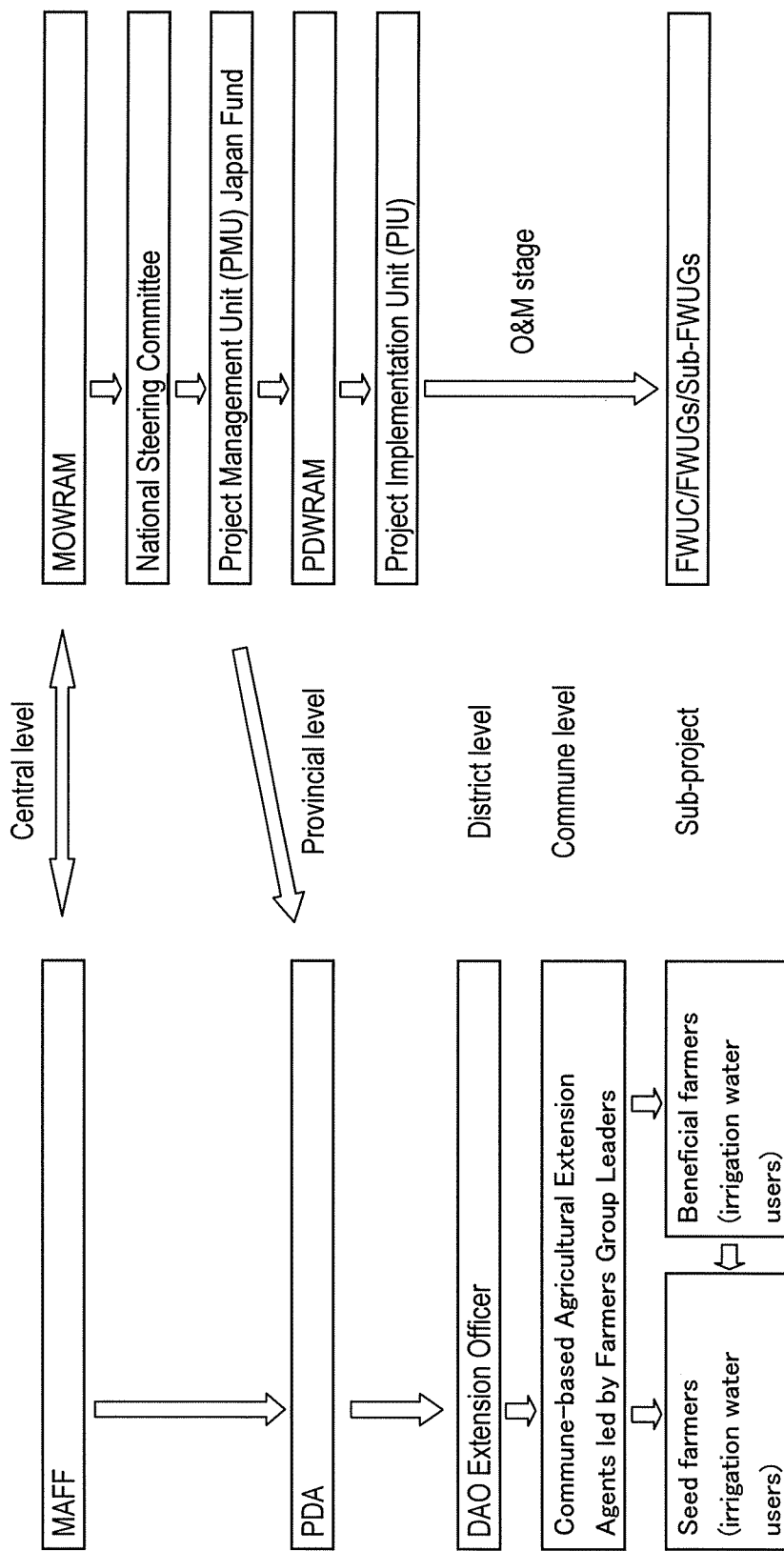


Figure A1.1.6 Implementation System

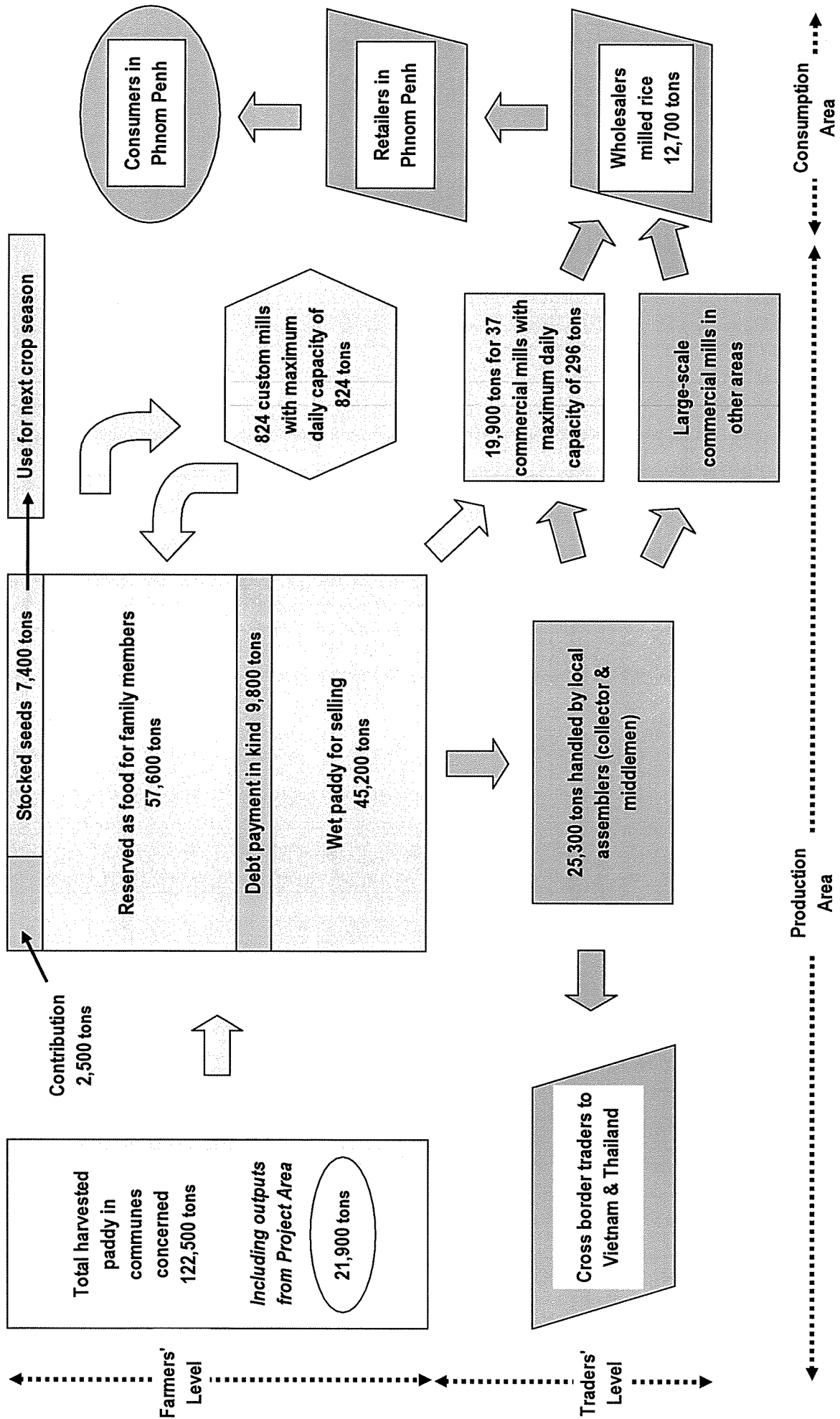


Figure A1.2.1 Current Utilization and Market Flow of Harvested Paddy in Communes Concerned

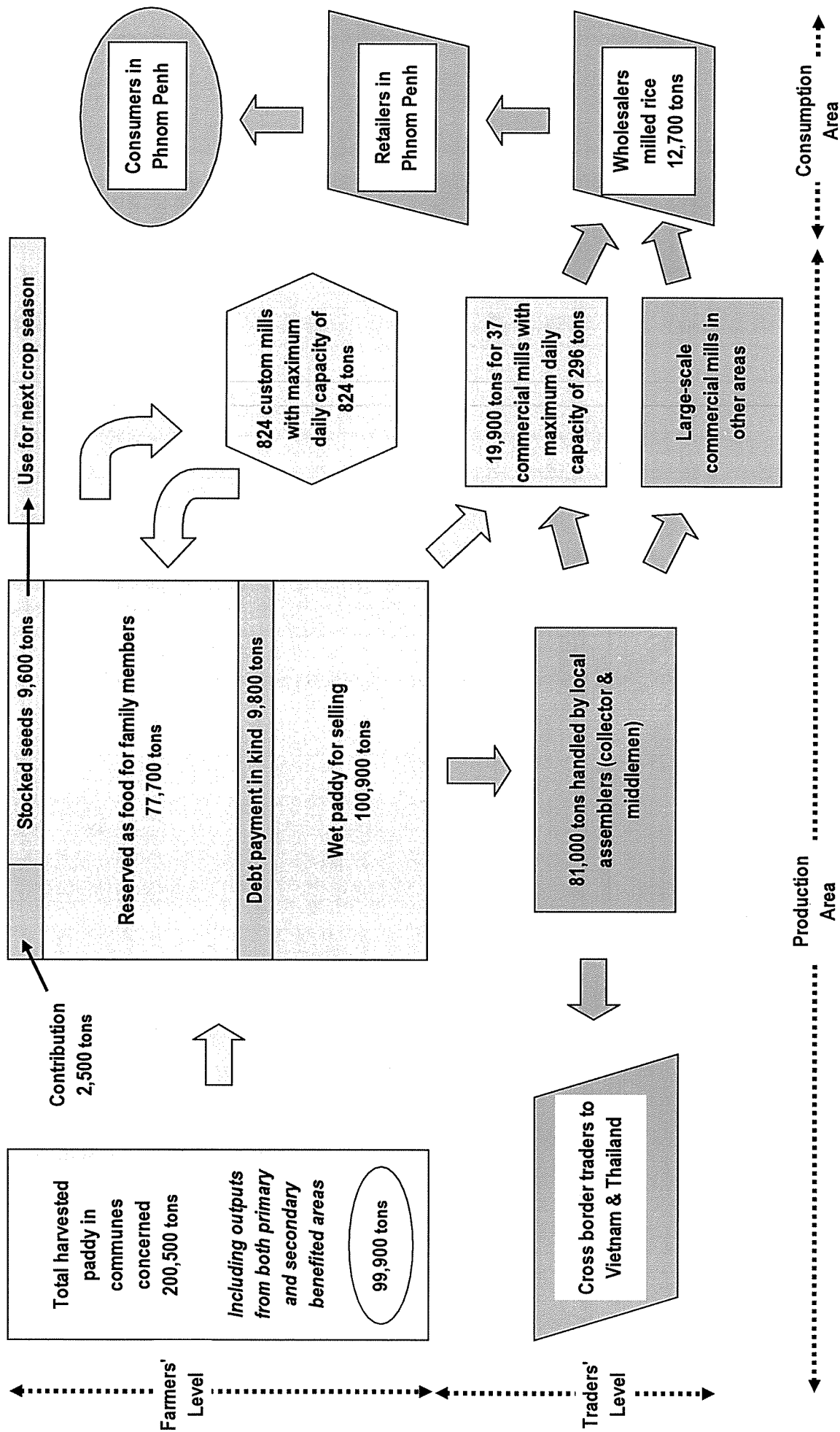


Figure A1.2.2 Simulation Case-1 for Future Utilization and Market Flow of Harvested Paddy in Communes Concerned

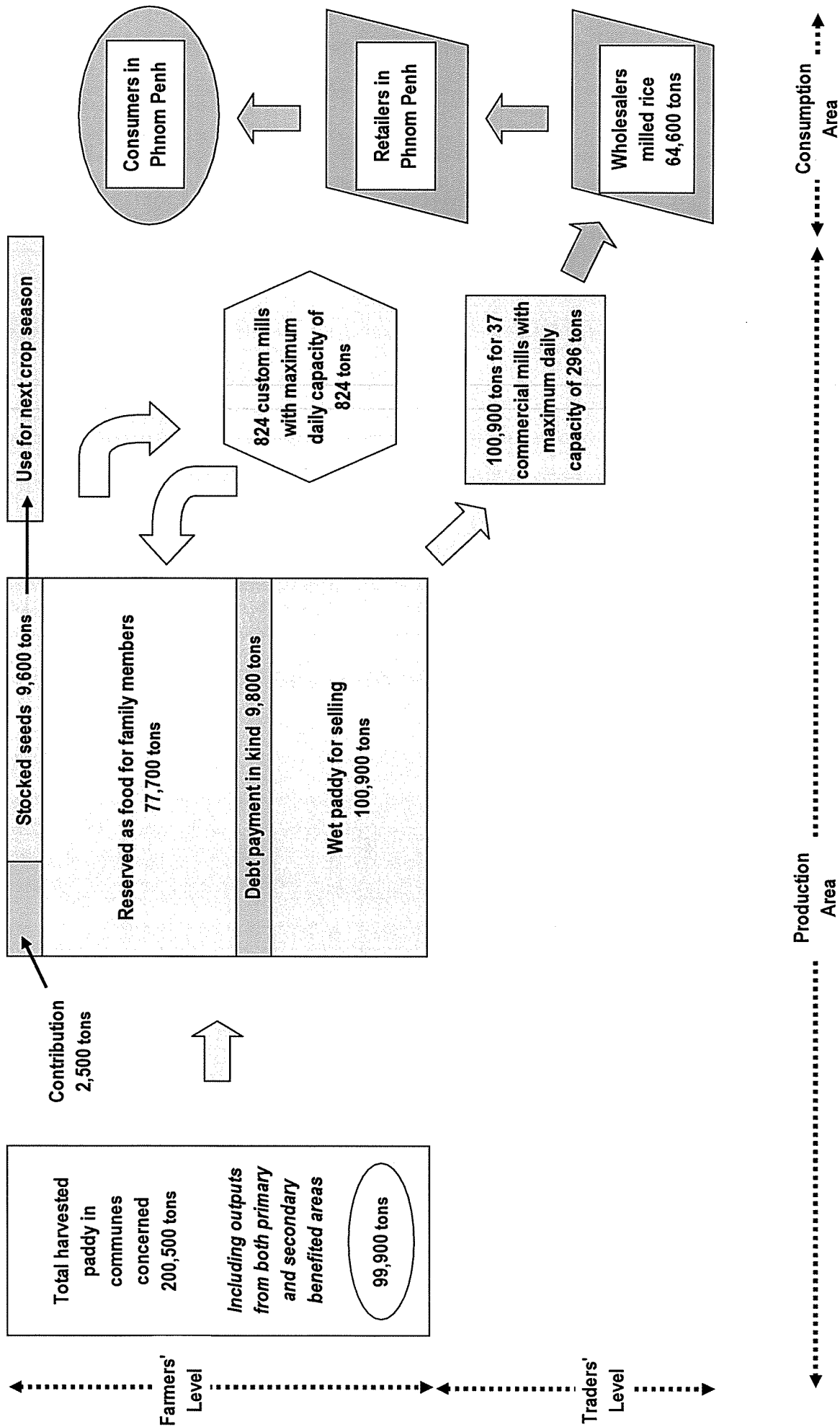


Figure A1.2.3 Simulation Case-2 for Future Utilization and Market Flow of Harvested Paddy in Communes Concerned

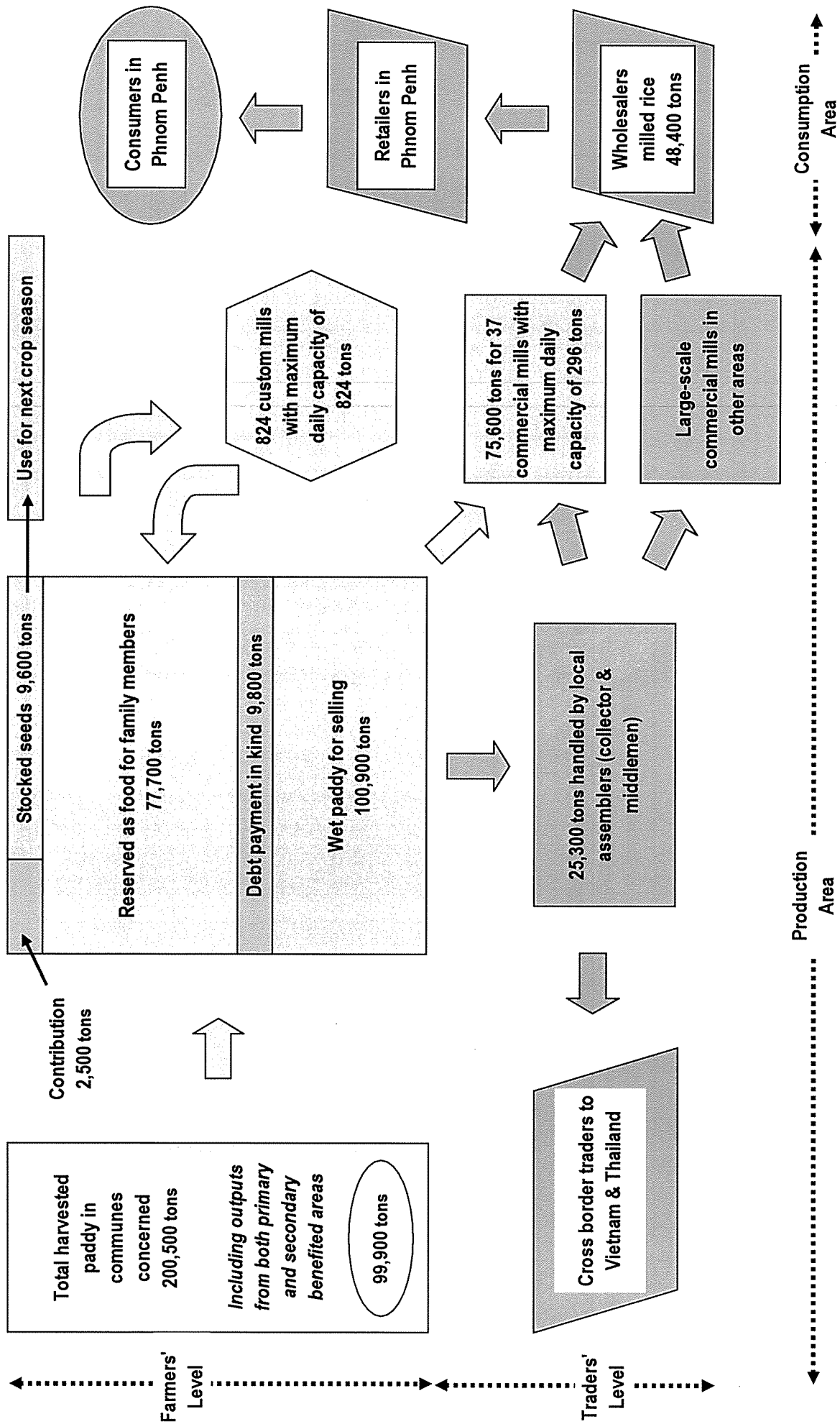


Figure A1.2.4 Simulation Case-3 for Future Utilization and Market Flow of Harvested Paddy in Communes Concerned

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

A2. TECHNICAL ASSISTANCE ON SOFT COMPONENT

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
IMPROVEMENT PROJECT

IN
THE KINGDOM OF CAMBODIA

FINAL REPORT

APPENDIX A2 TECHNICAL ASSISTANCE ON SOFT COMPONENT

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Table A2.1 Summary of Technical Assistance on FWUC Establishment and Strengthening Program

Name of the Program	FWUC Establishment and Strengthening Program	
Duration	From July 2011 to September 2015 (3.5 years for each sub-project))	
Target Group	Farmer Water User Community (FWUC)	
Objective :	To materialize sustainable organizational set-up for irrigation water management and facilities' O&M	Expected Outputs : FWUC for each sub-project will be established and FWUCs' skills for water management and facilities' O&M will be developed
Strategies 1. Establishment of FWUC based on new layout of each sub-project 2. Enhancement of FWUC's water management capacity 3. Strengthening of FWUC's capacity in O&M of irrigation and drainage facilities 4. Strengthening of organizational management capacity 5. Establishment of water fee collection system		
Activities 1. Support establishment of FWUC 1-1 Confirmation of current Government policy on establishment of FWUC 1-2 Tertiary alignment will be determined through walk-through survey among farmers, engineers and related Government officers 1-3 Awareness program on FWUC's functions and responsibilities will be held 1-4 Support organizational set-up of FWUC based on new layout of each sub-project 2. Implementation of training programs with coordination of relevant organizations 2-1 FWUCs' and FWUGs' members will receive the training programs related to organizational management, water management and facilities' O&M 2-2 FWUCs' and FWUGs' members will receive the training of trainers to train Sub-FWUGs' and WUGs' members in coordination with local NGOs, if necessary 2-3 Training programs conducted by FWUCs' and FWUGs' members to enhance skills of Sub-FWUGs' and WUGs' members will be monitored 2-4 Follow-up workshops on sustainable irrigation system		
Work Quantity - Number of FWUCs, FWUGs, Sub-FWUGs and WUGs to be established: 6 FWUCs, 52 FWUGs, 287 sub-FWUGs and 2,552 WUGs - 6 (six) times of walk-through survey to determine the tertiary alignment - 3 (three) times of awareness program on FWUC's functions and responsibilities - 3 (three) times of training programs on organizational management, water management and facilities' O&M - 3 (three) times of training of trainers to train Sub-FWUGs' and WUGs' members - 3 (three) times of follow-up workshops on sustainable irrigation system usage - 6 sets of manuals on irrigation water management and O&M activities - 6 sets of manuals on training of Sub-FWUGs' and WUGs' members		
Inputs - Experts (A: Professional A, B: Professional B) O&M and Water Management Expert (A and B) Institutional Development Expert (A and B) Tertiary Planning and Design Engineer (B) - Cost for organizing workshops and employment of NGO personnel, if necessary, for trainings		

Table A2.2 Summary of Technical Assistance on Agriculture Support Services

Name of the Program	Agriculture Support Activities	
Duration	From January 2012 to September 2015 (3 years for each sub-project)	
Target Group	Group Leaders, Government Agricultural Staff	
Objective :	To increase and stabilize rice farming in the sub-project areas	Expected Outputs : Group leaders will be trained to expand the new agriculture technology and practices introduced by the Project, with technical support from Government Agricultural Staff
<p>Strategies</p> <ol style="list-style-type: none"> 1. Enhancement of both agricultural staff' and farmers' capacity 2. Training of trainers 3. Commune-based Agricultural Extension 4. Improvement of pre-harvest and post-harvest technology 5. Introduction of quality seed 		
<p>Activities</p> <ol style="list-style-type: none"> 1. Government agricultural staff empowerment program <ol style="list-style-type: none"> 1-1 Confirmation of current roles and responsibilities of government agricultural staff 1-2 Government agricultural staff will receive the training program including OJT 2. Training of trainers program for capacity development of group leaders acting as agricultural extension agent <ol style="list-style-type: none"> 2-1 Formulation of group for each activity 2-2 Selection of group leaders 2-3 Group leaders will receive the training of trainers for agricultural extension activities 3. Commune-base agricultural extension agent development program <ol style="list-style-type: none"> 3-1 Monitoring of extension works to be conducted by group leaders with technical support from government agricultural staff 4. Needs analysis on agriculture support programs with focusing on the following aspects: <ol style="list-style-type: none"> 4-1 Soil fertility diagnosis program 4-2 Pre-harvest technology group training 4-3 Post-harvest technology group training program on farmers field school basis 4-4 Quality rice seed production and distribution program 4-5 High value added rice production promotion program 		
<p>Work Quantity</p> <ul style="list-style-type: none"> - 3 (three) times of government agricultural staff empowerment program - 6 (six) times of training of trainers program - 6 (six) times of training programs for each program identified by needs analysis - Commune-base agricultural extension manual - Materials for training programs 		
<p>Inputs</p> <ul style="list-style-type: none"> - Experts (A: Professional A, B: Professional B) Agriculture Expert (A and B) - Cost for organizing workshops and employment of NGO personnel, if necessary, for trainings - Cost for initial inputs such as quality seeds, pre and post-harvest equipment, etc. 		

Table A2.3 Summary of Technical Assistance on Meteo-hydrological Observation Strengthening Program

Name of the Program	Meteo-hydrological Observation Strengthening Program	
Duration	From January 2011 to December 2013 (3 years)	
Target Group	MOWRAM and PDOWRAM Staff	
Objective :	To collect basic agro meteo-hydrological data, and to increase technical capability of MOWRAM and PDOWRAM in meteo-hydrological observation, data processing and analysis	Expected Outputs : Meteo-hydrological observation system including capability of relevant staff covering the Project area will be improved in number and functions
Strategies 1. Enhancement of technical capability of relevant staff through On-the Job Training		
Activities 1. Preparation of manual on meteo-hydrological observation 1-1 Confirmation of present observation system including organization in the Project area 1-2 Preparation of manual on meteo-hydrological observation taking into consideration of newly installed observation equipments 2. Training of meteo-hydrological data collection, processing and analysis 2-1 Workshop on how to use the manual on meteo-hydrological observation 2-2 Monitoring of meteo-hydrological data collection, processing and analysis conducted by MOWRAM and PDOWRAM staff using the manual 2-3 To advice and provide trainings to MOWRAM and PDOWRAM staff, whenever necessary 2-4 Follow-up workshops on sustainable water resources development 3. Installation of equipment of meteo-hydrological observation in the selected points in the river basins 3-1 Survey on existing observation conditions 3-2 Selection of priority areas and points 3-3 Installation of equipments at the selected points		
Work Quantity - 4 (four) sets of manual on meteo-hydrological observation - 4 (four) times of workshop on introduction of manuals - On-the-Job Trainings - Follow-up workshop on sustainable water resources development - Installation of equipments for meteo-hydrological observation at 12 points (20% increase in number from present conditions)		
Inputs - Experts (A: Professional A, B: Professional B) Water Resources Engineer (A and B) - Cost for organizing workshops - Cost for procurement of equipment for meteo-hydrological observation (12 nos.)		

Table A2.4 Summary of Technical Assistance on Capacity Development of MOWRAM and PDOWRAM Staff

Name of the Program	Capacity Development of MOWRAM and PDOWRAM Staff	
Duration	From July 2011 to June 2014 (3 years)	
Target Group	MOWRAM and PDOWRAM Staff	
Objective :	To increase technical capability of MOWRAM and PDOWRAM staff in construction supervision of irrigation and drainage facilities at each level	Expected Outputs : Technical know-how on construction supervision of MOWRAM and PDOWRAM staff will be enhanced.
<p>Strategies</p> <p>To MOWRAM staff</p> <ol style="list-style-type: none"> 1. Preparation of practical manual for construction supervision based on hardware component 2. Dissemination workshops and training programs <p>To PDOWRAM staff</p> <ol style="list-style-type: none"> 1. Preparation of practical manual for office-use for construction supervision based on hardware component 2. Dissemination workshops and training programs 		
<p>Activities</p> <ol style="list-style-type: none"> 1. Preparation of construction supervision manual mainly on main facilities for MOWRAM and PDOWRAM staff <ol style="list-style-type: none"> 1-1 Review of present conditions 1-2 Confirmation of existing manuals in MOWRAM 1-3 Preparation of construction supervision manuals for MOWRAM and PDOWRAM staff 2. Dissemination and training workshops for the manuals prepared by the Project <ol style="list-style-type: none"> 2-1 Training needs assessment 2-2 Dissemination and training workshops related to the manuals 3. Periodical revision of manuals <ol style="list-style-type: none"> 3-1 Monitoring of status of manuals 		
<p>Work Quantity</p> <ul style="list-style-type: none"> - Construction supervision manual - Construction supervision manual for field use - 8 (eight) times of dissemination and training workshops (two for MOWRAM, six for PDOWRAM) 		
<p>Inputs</p> <ul style="list-style-type: none"> - Experts (A: Professional A, B: Professional B) <ul style="list-style-type: none"> Irrigation Development Advisor (A and B) - Cost for organizing workshops 		

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

**APPENDIX-B
REHABILITATION OF IRRIGATION
AND
DRAINAGE FACILITIES**

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

B1. IRRIGATION AND DRAINAGE PLAN

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
IMPROVEMENT PROJECT

IN
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Table B1.2 Selection of Gate Type for Moug Russei Headworks

Item	Slide Gate		Fixed Wheel Gate		Flap Gate (Steel)		Flap Gate (Rubber Textile)		Radial Gate	
	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge
Downstream water level	No influence	◎	No influence	◎	Influence	△	Influence	△	Influence	△
Operation	So difficult	△	Easy	◎	Easy	◎	Easy	○	Easy	◎
Maintenance	Easy	◎	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○
Pier height	High	△	High	△	Low	◎	Low	◎	Low	◎
Cost	Low	◎	High	○	High	○	Moderate	○	High	○
Hoisting load	Large	△	Moderate	○	Large	△	Large	△	Light	◎
Vibration	No	◎	No	◎	Moderate	○	Moderate	○	Occurence	△
Reliability	High	◎	High	◎	Low	△	Low	△	Low	△
Height/width ratio	No influence	◎	No influence	◎	Influence	△	Influence	△	Influence	△
Suitability for Moug Russei H.W.	Moderate	○	High	◎	Low	△	Low	△	Moderate	○
Over-all Evaluation	Hoisting load becomes large for large sized gate leaf and operation will be difficult No suitable for large gate		Reliability is high and hoist load is relatively low for large sized gate Suitable for large gate	◎	Reliability is low under influence of downstream water level/ back water of Lake Tonle Sap.		Reliability is low under influence of downstream water level/ back water		Reliability is low under influence of downstream water level/ back water No suitable for large gate	

Prepared by JICA SAPROF Study Team

Table B1.3 Irrigation Water Requirement of Wet Season Paddy by Transplanting in Damnak Ampil, Wat Loung, and Wat Chre Sub-projects (1/2)

Item	Jun					Jul					Aug					Sep					Oct					Nov					Dec							
	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	
	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	(mm/day)	
Eto	3.9	3.9	3.9	3.9	4.1	4.1	4.1	4.1	4.1	4.1	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5		
Percolation	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
After transplanting, β																																						
In reproductive, β																																						
Effective rainfall, β																																						
Overall irrigation efficiency	2.1	2.2	1.5	1.8	2.3	1.9	1.5	2.7	2.9	2.1	2.2	2.6	2.7	2.4	2.9	2.1	3.1	3.3	3.9	4.1	3.3	2.3	4.0	2.6	5.0	1.7	3.2	2.8	0.6	0.4	0.7	0.7	0.7	0.7	0.0	0.0		
1st rotation																																						
Land preparation, LP	8.5	10.0	12.1	13.5																																		
Percolation, P x m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Crop coefficient, Kc	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	
Consumptive use, Eto(kc + P x β)	6.0	6.0	5.5	5.5	5.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	
FW=ETc + P - ER	3.6	4.1	3.9	2.8	2.6	3.3	2.9	2.5	2.3	2.6	2.9	2.5	2.3	2.6	2.1	2.8	1.8	3.1	2.5	1.3	2.1	3.1	1.4	2.8	0.0	4.3	2.9	2.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net field water req FW + LP	8.5	10.0	12.1	13.5																																		
Unit irrigation water requirement (l/ha/day)	12.8	15.7	18.4	20.3	5.5	6.2	6.7	4.3	4.0	5.1	4.4	4.4	3.7	3.6	4.0	3.3	4.5	2.9	2.4	1.5	3.4	4.7	2.1	4.3	0.6	5.6	3.4	3.5	7.9	8.2	6.4	6.3	0.0	0.0	0.0	0.0	0.0	
Unit irrigation water requirement (l/ha/day)	1.49	1.73	2.13	2.37																																		
2nd rotation																																						
Land preparation, LP	8.5	10.4	11.9	13.1																																		
Percolation, P x m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Crop coefficient, Kc	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	
Consumptive use, Eto(kc + P x β)	6.0	6.0	5.5	5.5	5.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	
FW=ETc + P - ER	4.1	4.4	2.8	2.6	3.3	2.9	2.5	2.3	2.6	2.1	2.8	1.8	3.1	2.5	1.3	2.1	3.1	1.4	2.8	0.0	4.3	2.9	2.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net field water req FW + LP	8.5	10.4	11.9	13.1																																		
Unit irrigation water requirement (l/ha/day)	12.8	15.7	18.0	19.9	6.2	6.7	4.3	4.0	5.1	4.4	4.4	3.7	3.6	4.0	3.3	4.5	2.9	2.4	1.5	3.4	4.7	2.1	4.3	0.6	5.6	3.4	3.5	7.9	8.2	6.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	
Unit irrigation water requirement (l/ha/day)	1.48	1.82	2.08	2.30	0.71	0.78	0.49	0.46	0.58	0.51	0.43	0.41	0.46	0.38	0.43	0.34	0.49	0.57	0.37	0.27	0.22	0.37	0.54	0.24	0.37	0.54	0.18	0.59	0.34	0.40	0.40	0.40	0.40	0.40	0.40	0.40		
3rd rotation																																						
Land preparation, LP	8.6	10.2	11.6	13.6																																		
Percolation, P x m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Crop coefficient, Kc	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	
Consumptive use, Eto(kc + P x β)	6.0	6.0	5.5	5.5	5.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	
FW=ETc + P - ER	4.4	4.4	3.3	2.6	3.3	2.9	2.5	2.3	2.6	2.1	2.8	1.8	3.1	2.5	1.3	2.1	3.1	1.4	2.8	0.0	4.3	2.9	2.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net field water req FW + LP	8.6	10.2	11.6	13.6																																		
Unit irrigation water requirement (l/ha/day)	13.0	15.5	17.5	20.6	6.7	7.0	5.8	4.0	5.1	4.4	4.4	3.7	3.6	4.0	3.3	4.5	2.7	2.4	1.5	3.4	4.7	2.1	4.3	0.6	5.6	3.4	3.5	7.9	8.2	6.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	
Unit irrigation water requirement (l/ha/day)	1.51	1.79	2.03	2.39	0.78	0.88	0.58	0.46	0.58	0.51	0.43	0.41	0.46	0.38	0.43	0.34	0.49	0.57	0.37	0.27	0.22	0.37	0.54	0.24	0.37	0.54	0.18	0.59	0.34	0.40	0.40	0.40	0.40	0.40	0.40	0.40		
4th rotation																																						
Land preparation, LP	8.5	10.0	11.9	14.0																																		
Percolation, P x m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Crop coefficient, Kc	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	
Consumptive use, Eto(kc + P x β)	6.0	6.0	5.5	5.5	5.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	
FW=ETc + P - ER	3.3	3.1	3.3	2.9	2.5	2.3	2.6	2.1	3.0	1.8	1.6	2.5	2.3	2.1	3.1	1.4	2.8	0.4	3.3	2.9	3.3	4.3	4.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Net field water req FW + LP	8.5	10.0	11.9	14.0																																		
Unit irrigation water requirement (l/ha/day)	12.9	15.2	18.1	21.3	5.0	4.7	5.1	4.4	3.7	3.6	4.0	3.3	4.5	2.7	2.4	3.8	3.4	3.2	4.7	2.1	4.3	0.6	5.0	4.4	5.0	4.4	5.0	6.5	6.8	6.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	
Unit irrigation water requirement (l/ha/day)	1.50	1.76	2.09	2.46	0.58	0.54	0.54	0.58	0.51	0.43	0.41	0.46	0.38	0.53	0.31	0.28	0.44	0.40	0.37	0.54	0.24	0.50	0.07	0.58	0.51	0.58	0.75	0.78	0.74	0.74	0.74	0.74						

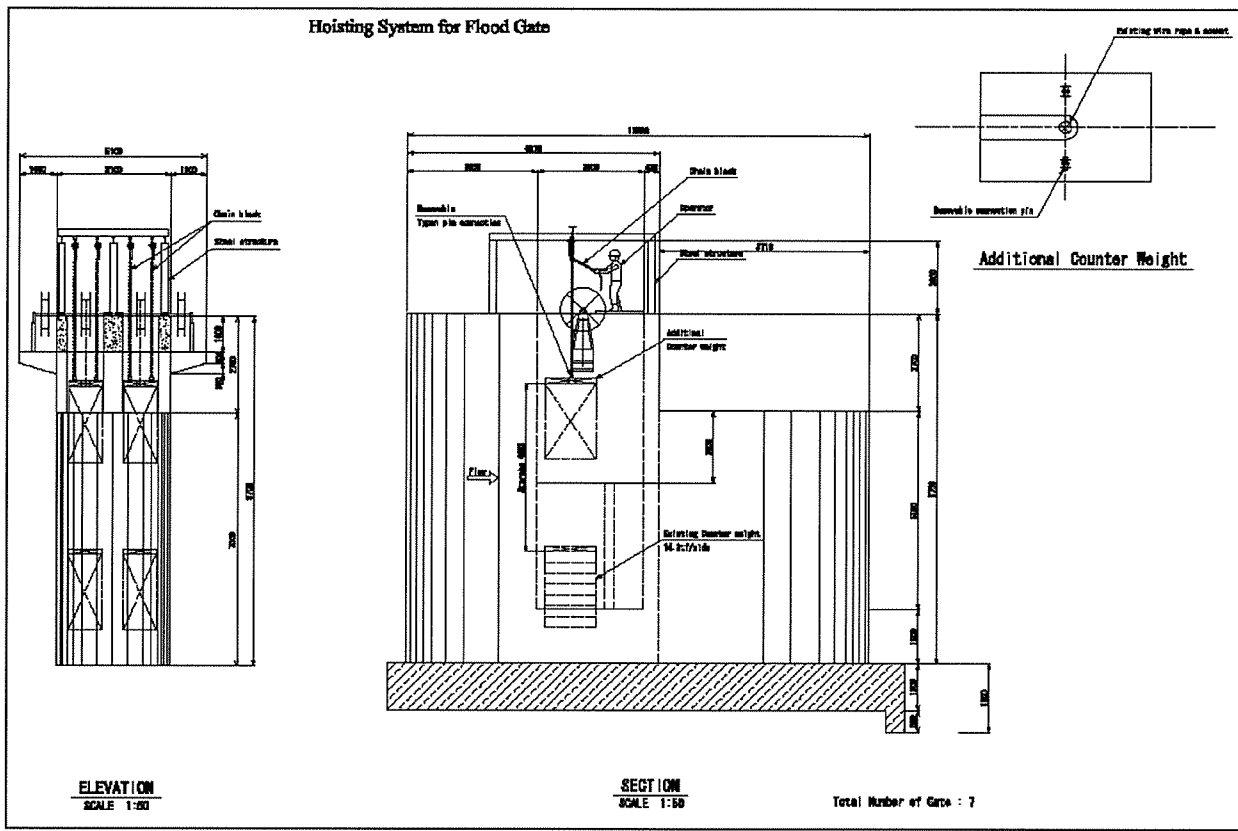
Table B 1.4 Selection of Method for Gate Improvement at Damnak Ampil Headworks (1/2)

Alternatives	Alternative 1 Chain Block Manual Type	Alternative 2 Electric Type	Description
1. Proposed Plan	See 2/2	See 2/2	
Drawing number in the SAPROF Report (Image of improvement works)			
1.1 Design Flood Discharge	1,560 m ³ /sec		Same design condition is applied for alternative 1 and alternative 2.
1.2 Design River Bank Elevation	El. 19.00-20.00m		
1.3 Design Irrigation Water Level	WL. 17.00m		
1.4 Design River Bed Elevation (upstream)	El. 12.00m		
1.5 Design River Bed Elevation (downstream)	El. 12.00m		
1.6 Design Gate Sill Elevation	El. 13.50m		
1.7 Design Discharge of Intake	7.93 m ³ /sec		
1.8 Design Discharge of Fish ladder	4.71 m ³ /sec		
1.9 New installation	- Additional counter weight, 2.5tf/gate for left Flood gate and right respectively - Chain block - Steel structure to install chain block	- New electric hoist system (7 sets) - Exchange of bushing scouring sluice gate - New hoist system (4 sets)	
2. Operation	4 persons	1 person	Employment of capable gate operators would be somehow constraints in the rural areas. Therefore, alternative 2 would be advantageous.
2.1 Gate Operator			
2.2 Emergency (Flood)	In general, gates fall down automatically when water level is more than 16.85m.	Gates fall down automatically when water level is more than 16.85m.	Both system guarantee that gates fall down automatically in the flood time.
2.3 Easiness	Gates rise up automatically up to 15.10m. Operators need to lift up with manual operation up to EL. 16.85 m to ensure design intake water level	Gates can be easily operated by electric motor.	As for the easiness of the operation, Alternative 2 would have advantage.
3. Maintenance	All spare parts are locally available in Cambodia.	Some of the parts needs to be imported.	Alternative 1 would have advantageous since it will be comparatively easier to maintain in Cambodia.
3.1 Spare Parts Availability			
3.2 Easiness	It is comparatively easier. Only small maintenance works will be necessary such as oiling.	It is comparatively difficult. Regular. Mechanical engineer needs to be employed when the gates are checked.	Alternative 1 would be advantageous in terms of easiness of maintenance of the gate system.
3.3 Frequency	Less	More	Alternative 1 need less frequency in maintenance since the system is simple.
4. Cost			
4.1 Initial Investment Cost (USD 1 = JPY 95)	USD 17,600/gate, therefore, USD 123,200 (for 7gate) in total	USD 328,800/gate, therefore, USD 2,301,600 (for 7gate) in total	Initial investment cost as well as O&M cost of alternative 2 is significantly higher than that of alternative 1.
4.2 Annual O&M Cost	USD 1,232	USD 23,016	Annual O&M cost is estimated for 1 % of initial investment cost.
4.3 Major Repairing Cost	USD 12,320	USD 230,160	Major repairing cost is estimated for 10% of construction cost in every 5 years.
Overall Evaluation	Not Recommended	Recommended	
Comment:	Alternative 1 is more simple and easier improvement method and operation and maintenance. Although O&M is simple, employment of regular staffs would be difficult particularly in the rural area like Damnak Ampil. Damnak Ampil Headworks is one of the largest and most important water resource structures in the country. Improvement works by combining new hoisting system and automatic gate would be a model project in the country. Therefore, alternative 2 will be recommended for the Project.		

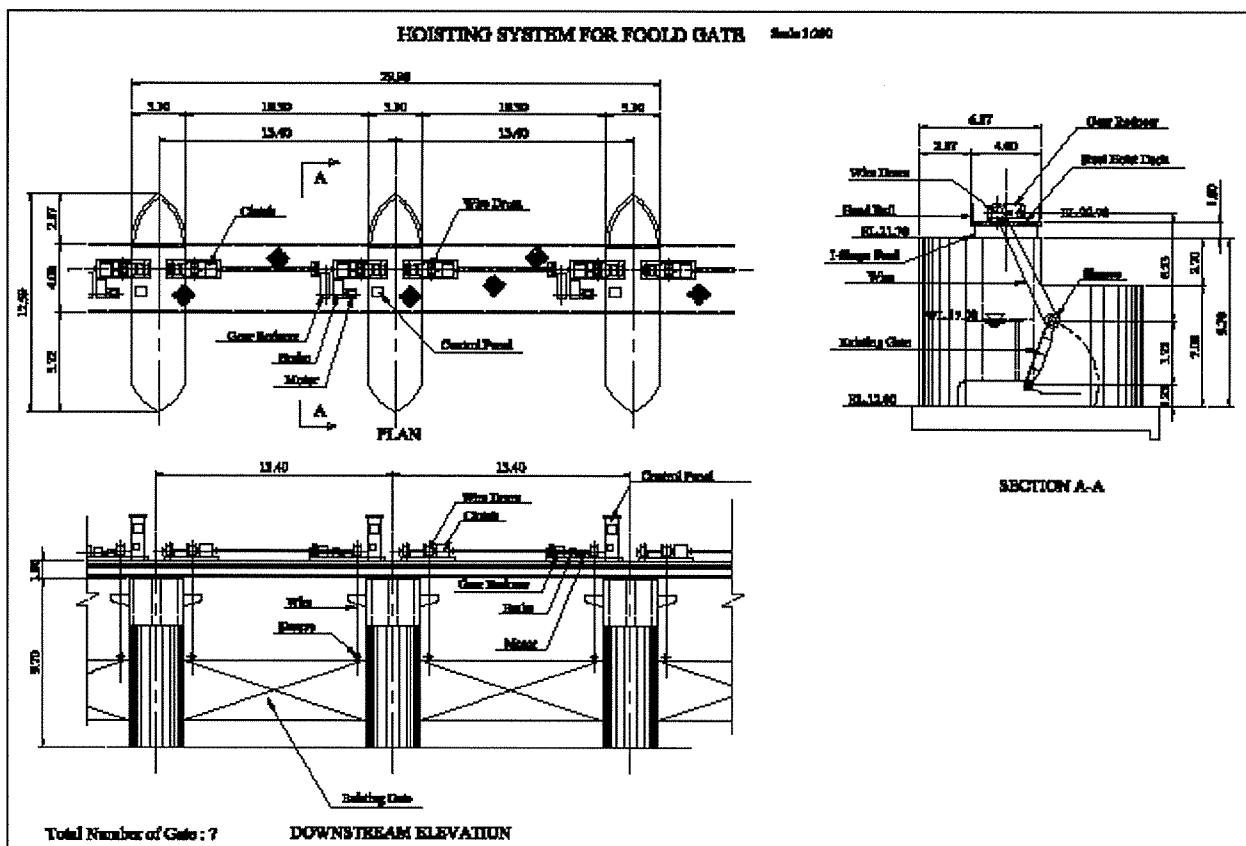
Table B 1.4 Selection of Method for Gate Improvement at Damnak Ampil Headworks (2/2)

5. Drawing of Gate

Alternative 1 Chain Block Manual Type



Alternative 2 Electric Type



Prepared by JICA SAPROF Study Team

Table B1.5 Selection of Gate Type for Wat Chre Headworks

Item	Slide Gate		Fixed Wheel Gate		Flap Gate (Steel)		Flap Gate (Rubber Textile)		Radial Gate	
	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge
Downstream water level	No influence	⊙	No influence	⊙	Influence	△	Influence	△	Influence	△
Operation	So difficult	△	Easy	⊙	Easy	⊙	Easy	○	Easy	⊙
Maintenance	Easy	⊙	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○
Pier height	High	△	High	△	Low	⊙	Low	⊙	Low	⊙
Cost	Low	⊙	High	○	High	○	Moderate	○	High	○
Hoisting load	Large	△	Moderate	○	Large	△	Large	△	Light	⊙
Vibration	No	⊙	No	⊙	Moderate	○	Moderate	○	Occurrence	△
Reliability	High	⊙	High	⊙	Low	△	Low	△	Low	△
Height/width ratio	No influence	⊙	No influence	⊙	Influence	△	Influence	△	Influence	△
Suitability for Wat Chre H.W	Moderate	○	High	⊙	Low	△	Low	△	Moderate	○
Overall Evaluation	Hoisting load becomes large for large sized gate leaf and operation will be difficult.		Reliability is high and hoist load is relatively low for large sized gate.		Reliability is low under influence of downstream water level/ back water of Lake Tonle Sap.		Reliability is low under influence of downstream water level/ back water.		Reliability is low under influence of downstream water level/ back water.	
				⊙						

Prepared by JICA SAPROF Study Team

Table B1.6 Irrigation Water Requirement of Ealy Wet Season Paddy by Transplanting in Lum Hach Sub-project (1/2)

Item	Apr							May							Jun							Jul							Aug															
	1-5	6-10	11-15	16-20	21-25	26-30	28-31	1-5	6-10	11-15	16-20	21-25	26-30	28-31	1-5	6-10	11-15	16-20	21-25	26-30	28-31	1-5	6-10	11-15	16-20	21-25	26-30	28-31	1-5	6-10	11-15	16-20	21-25	26-30	28-31	1-5	6-10	11-15	16-20	21-25	26-30	28-31		
ETo (mm/day)	5.3	5.3	5.3	5.3	5.3	5.3	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Percolation (mm/day)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
After transplanting, β In vegetating, β In reproductive, β In maturing, β								0.4	0.4	0.4	0.4	0.4	0.4								0.6	0.6	0.6	0.6	0.6	0.6								0.6	0.6	0.6	0.6	0.6	0.6	0.6				
Effective rainfall (mm/day)								0.4	0.3	0.3	0.3	0.4	0.4								0.4	0.3	0.3	0.3	0.3	0.4								0.4	0.3	0.3	0.3	0.3	0.4	0.4				
Overall irrigation efficiency 66%								0.4	0.3	0.3	0.3	0.4	0.4								0.4	0.3	0.3	0.3	0.3	0.4								0.4	0.3	0.3	0.3	0.3	0.4	0.4				
1st block																																												
Land preparation, LP (mm/day)	9.1	11.9	14.8	17.6																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.6	7.6	6.7	6.7	6.7	8.3	8.3	8.3	8.3	8.3	6.7	6.7	6.7	7.9	7.9	7.4	6.2	6.2	6.2	6.2	4.2	0.0																						
FW=ETc + P - ER (mm/day)	7.3	7.2	5.7	5.6	5.6	7.3	7.2	7.2	6.3	5.6	4.6	4.6	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
Net field water req FW +LP (mm/day)	9.1	11.9	14.8	17.6	7.3	7.2	5.7	5.6	4.6	4.6	6.4	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
Unit diversion water requirement (l/sec/ha)	13.8	18.1	22.4	26.7	11.0	10.9	8.7	8.4	6.9	7.1	8.5	9.6	6.6	8.3	8.0	5.4	4.5	4.5	4.5	4.5	3.0	3.2																						
Unit diversion water requirement (mm/day)	1.60	2.09	2.60	3.09	1.28	1.26	1.01	0.97	0.80	0.82	0.98	1.11	0.76	0.75	1.00	0.63	0.53	0.52	0.53	0.52	0.34	0.37																						
2nd block																																												
Land preparation, LP (mm/day)	9.1	12.0	14.8	17.6																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.6	7.3	6.7	6.7	6.7	8.3	8.3	8.3	7.3	6.7	6.7	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
FW=ETc + P - ER (mm/day)	7.2	6.3	5.6	5.6	5.6	7.2	7.2	7.2	6.3	5.6	4.6	4.6	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
Net field water req FW +LP (mm/day)	9.1	12.0	14.8	17.6	7.2	7.2	5.6	5.6	4.6	4.6	6.4	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
Unit diversion water requirement (l/sec/ha)	13.8	18.1	22.4	26.6	10.9	9.6	8.4	8.4	6.9	7.1	8.5	9.6	6.6	8.4	8.4	5.7	4.5	4.5	4.5	4.5	3.0	3.2																						
Unit diversion water requirement (mm/day)	1.60	2.10	2.59	3.08	1.26	1.11	0.97	0.80	0.82	0.82	0.98	1.11	0.76	0.75	1.00	0.63	0.53	0.52	0.53	0.52	0.34	0.37																						
3rd block																																												
Land preparation, LP (mm/day)	9.1	11.9	14.8	17.5																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.3	7.3	6.7	6.7	6.7	8.3	8.3	8.3	7.3	6.7	6.7	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	1.9	2.1																						
FW=ETc + P - ER (mm/day)	6.3	6.2	4.6	4.6	4.6	6.4	6.4	6.4	5.5	4.3	4.3	4.3	4.3	5.2	5.2	4.2	3.0	3.0	3.0	3.0	2.1	0.5																						
Net field water req FW +LP (mm/day)	9.1	11.9	14.8	17.5	6.3	6.2	4.6	4.6	4.0	4.0	6.4	6.4	4.3	5.2	5.2	4.2	3.0	3.0	3.0	3.0	2.1	0.5																						
Unit diversion water requirement (l/sec/ha)	13.8	18.1	22.4	26.5	9.6	9.3	6.9	7.1	6.1	6.1	9.6	8.4	6.5	6.8	7.9	6.4	4.5	4.5	4.5	4.5	3.0	3.2																						
Unit diversion water requirement (mm/day)	1.60	2.10	2.59	3.07	1.11	1.08	0.80	0.82	0.71	0.71	1.11	0.97	0.75	0.79	0.92	0.74	0.62	0.61	0.62	0.61	0.41	0.44																						
4th block																																												
Land preparation, LP (mm/day)	9.1	11.9	14.7	16.5																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.3	7.3	6.7	6.7	6.7	8.3	8.3	8.3	7.3	6.7	6.7	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	2.1	0.5																						
FW=ETc + P - ER (mm/day)	6.2	6.2	5.2	5.2	5.2	6.4	6.4	6.4	5.5	4.3	4.3	4.3	4.3	5.2	5.2	4.2	3.0	3.0	3.0	3.0	2.1	0.5																						
Net field water req FW +LP (mm/day)	9.1	11.9	14.7	16.5	6.2	6.2	5.2	5.2	4.7	4.0	4.8	5.5	5.5	4.5	4.5	4.0	4.7	4.7	4.7	4.7	3.0	3.2																						
Unit diversion water requirement (l/sec/ha)	13.8	18.1	22.2	25.0	9.3	9.3	7.8	7.8	7.1	6.1	7.3	8.4	8.3	6.8	6.1	7.1	6.3	6.3	6.3	6.3	4.1	4.4																						
Unit diversion water requirement (mm/day)	1.60	2.09	2.58	2.89	1.08	0.91	0.82	0.71	0.84	0.71	0.84	0.97	0.96	0.79	0.70	0.82	0.73	0.73	0.73	0.73	0.41	0.44																						
5th block																																												
Land preparation, LP (mm/day)	9.1	11.9	14.0	16.3																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.3	7.3	6.7	6.7	6.7	8.3	8.3	8.3	7.3	6.7	6.7	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	2.1	0.5																						
FW=ETc + P - ER (mm/day)	6.2	6.2	5.2	5.2	5.2	6.4	6.4	6.4	5.5	4.3	4.3	4.3	4.3	5.2	5.2	4.2	3.0	3.0	3.0	3.0	2.1	0.5																						
Net field water req FW +LP (mm/day)	9.1	11.9	14.0	16.3	6.2	6.2	5.2	5.2	4.7	4.0	4.8	5.5	5.5	4.5	4.5	4.0	4.7	4.7	4.7	4.7	3.0	3.2																						
Unit diversion water requirement (l/sec/ha)	13.8	18.1	22.2	24.6	7.8	7.8	7.1	7.1	6.1	6.1	7.3	8.4	8.3	6.8	6.1	7.1	6.3	6.3	6.3	6.3	4.1	4.4																						
Unit diversion water requirement (mm/day)	1.60	2.08	2.45	2.85	0.91	0.93	0.71	0.84	0.71	0.84	0.97	0.96	0.79	0.70	0.82	0.73	0.61	0.61	0.61	0.61	0.41	0.44																						
6th block																																												
Land preparation, LP (mm/day)	9.1	11.5	13.8	15.1																																								
Percolation, P*mm (mm/day)	1.8	1.8	1.2	1.2	1.2	3.0	3.0	3.0	3.0	3.0	1.8	1.8	1.8	1.8	1.8	3.0	3.0	3.0	1.8	1.8	0.0	0.0																						
Crop coefficient, Kc (mm/day)	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	1.05	0.95	0.95	0.95	0.95	0.95	0.00																						
Consumptive use, ET _{oxKc} + P×β (mm/day)	7.3	7.3	6.7	6.7	6.7	8.3	8.3	8.3	7.3	6.7	6.7	6.4	4.3	5.7	5.7	4.8	3.0	3.0	3.0	3.0	2.1	0.5																						
FW=ETc + P - ER (mm/day)	5.2	5.3	4.0	4.0	4.0	4.8	4.8	4.8	4.0	4.0	4.8	5.5	5.5	4.5	4.5	4.0	4.7	4.7	4.7	4.7	3.0	3.2																						
Net field water req FW +LP (mm/day)	9.1	11.5	13.8	15.1	5.3	5.3	4.0	4.0	4.0	4.0	4.8	5.5	5.5	4.5	4.5	4.0	4.7	4.7	4.7	4.7	3.0	3.2																						
Unit diversion water requirement (l/sec/ha)	13.8	17.4	20.9	22.9	8.0	7.0	7.3	6.0	6.1	7.3	8.4	8.3	6.8	6.1	7.5	6.3	5.2	5.2	5.2	5.2	3.0	3.2																						
Unit diversion water requirement (mm/day)	1.59	2.01	2.42	2.65	0.93	0.81	0.84	0.70	0.69	1.00	0.92	0.61	0.60	0.61	0.60	0.94	0.89	0.89	0.89	0.89	0.41	0.44																						

To be continued

Table B1.6 Irrigation Water Requirement of Early Wet Season Paddy by Transplanting in Lum Hach Sub-project (2/2)

Item	Apr			May			Jun			Jul			Aug													
	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-30		
7th block																										
Land preparation, LP (mm/day)							8.9	11.4	13.0	15.2																
Percolation, Pxm (mm/day)							1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	
Crop coefficient, Kc (mm/day)							1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	
Consumptive use, EToKc + PxB (mm/day)							7.3	7.3	7.3	7.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	
FW=ETc + P - ER (mm/day)							4.6	5.4	4.0	3.9	4.2	5.2	4.7	3.4	4.2	5.5	3.5	2.7	2.4	1.2	1.1	0.0	0.0	0.0	0.0	
Net field water req FW +LP (mm/day)							8.9	11.4	13.0	15.2	4.6	5.4	4.0	3.9	4.2	5.5	3.5	2.7	2.4	1.2	1.1	0.0	0.0	0.0	0.0	
Unit diversion water requirement (mm/day)							13.5	17.2	19.6	23.0	7.0	8.2	6.0	5.9	6.3	7.9	7.1	5.2	3.6	1.8	1.6	0.0	0.0	0.0	0.0	
Unit diversion water requirement (l/sec/ha)							1.57	1.99	2.27	2.67	0.81	0.95	0.70	0.69	0.73	0.92	0.82	0.60	0.42	0.21	0.19	0.00	0.00	0.00	0.00	
8th block																										
Land preparation, LP (mm/day)							8.9	10.8	13.1	14.4																
Percolation, Pxm (mm/day)							1.8	1.8	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Crop coefficient, Kc (mm/day)							1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	
Consumptive use, EToKc + PxB (mm/day)							7.3	6.9	6.3	6.3	6.3	6.3	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
FW=ETc + P - ER (mm/day)							5.4	4.6	3.9	4.2	3.7	4.7	4.6	4.2	4.3	4.0	3.9	2.4	3.0	1.1	1.2	0.0	0.0	0.0	0.0	
Net field water req FW +LP (mm/day)							8.9	10.8	13.1	14.4	5.4	4.6	3.9	4.2	3.7	4.7	4.6	4.2	4.3	4.0	3.9	2.4	3.0	1.1	1.2	
Unit diversion water requirement (mm/day)							13.5	16.4	19.8	21.9	8.2	6.9	5.9	6.3	5.5	7.1	7.0	6.3	6.6	6.0	5.9	3.6	4.5	1.6	1.8	
Unit diversion water requirement (l/sec/ha)							1.56	1.90	2.29	2.53	0.95	0.80	0.69	0.73	0.64	0.82	0.82	0.82	0.73	0.76	0.70	0.68	0.42	0.52	0.19	
9th block																										
Land preparation, LP (mm/day)							8.7	10.9	12.5	15.4																
Percolation, Pxm (mm/day)							1.8	1.8	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Crop coefficient, Kc (mm/day)							1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	
Consumptive use, EToKc + PxB (mm/day)							6.9	6.9	6.3	6.3	6.3	6.3	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
FW=ETc + P - ER (mm/day)							4.6	4.5	4.2	3.7	3.1	4.6	4.6	4.5	4.4	4.3	4.0	3.9	2.4	3.0	2.9	1.2	0.9	0.0	0.0	
Net field water req FW +LP (mm/day)							8.7	10.9	12.5	15.4	4.6	4.5	4.2	3.7	3.1	4.6	4.6	4.5	4.4	4.3	4.0	3.9	2.4	3.0	2.9	
Unit diversion water requirement (mm/day)							13.2	16.5	18.9	23.3	6.9	6.8	6.3	5.5	4.7	7.0	8.2	6.6	6.0	5.9	3.6	4.5	1.6	1.8	0.0	
Unit diversion water requirement (l/sec/ha)							1.53	1.91	2.19	2.69	0.80	0.79	0.73	0.64	0.54	0.82	0.82	0.82	0.73	0.76	0.49	0.76	0.63	0.52	0.19	

Summary table of unit diversion water requirement

Item	Apr			May			Jun			Jul			Aug			Total (mm)												
	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15		16-20	21-25	26-30									
1st block (l/sec/ha)	1.60	2.09	2.60	3.09	1.28	1.26	1.01	0.97	0.80	1.09	0.98	0.90	0.76	0.96	0.92	0.62	0.53	0.21	0.34	0.00						951		
2nd block (l/sec/ha)	1.60	2.10	2.59	3.08	1.26	1.11	0.97	0.80	0.82	0.98	1.11	0.76	0.75	1.00	0.83	0.53	0.52	0.34	0.37	0.00						931		
3rd block (l/sec/ha)		1.60	2.10	2.59	3.07	1.11	1.08	0.80	0.82	0.71	1.11	0.84	0.71	0.97	0.75	0.79	0.92	0.74	0.52	0.66	0.37	0.10	0.00			896		
4th block (l/sec/ha)			1.60	2.09	2.58	2.89	1.08	0.91	0.82	0.71	0.84	0.97	0.96	0.79	0.70	0.82	0.73	0.66	0.68	0.10	0.16	0.00				868		
5th block (l/sec/ha)				1.60	2.08	2.45	2.85	0.91	0.93	0.71	0.84	0.70	0.96	1.00	0.70	0.61	0.82	0.87	0.68	0.41	0.16	0.10	0.00			837		
6th block (l/sec/ha)					1.59	2.01	2.42	2.65	0.93	0.81	0.84	0.70	0.69	1.00	0.92	0.61	0.80	0.94	0.89	0.41	0.47	0.10	0.21	0.00		812		
7th block (l/sec/ha)						1.57	1.99	2.27	2.67	0.81	0.95	0.70	0.69	0.73	0.92	0.82	0.80	0.73	0.97	0.92	0.47	0.42	0.21	0.19	0.00	792		
8th block (l/sec/ha)							1.56	1.90	2.29	2.53	0.95	0.80	0.69	0.73	0.64	0.82	0.82	0.73	0.76	0.70	0.68	0.42	0.52	0.19	0.21	0.00		
9th block (l/sec/ha)							1.53	1.91	2.19	2.69	0.80	0.79	0.73	0.64	0.54	0.82	0.82	0.82	0.94	0.76	0.49	0.76	0.63	0.52	0.16	0.00		
Maximum	1.60	2.09	2.60	3.09	3.08	3.07	2.89	2.85	2.65	2.67	2.53	2.69	0.97	0.96	1.00	0.92	0.82	0.82	0.94	0.97	0.70	0.76	0.63	0.52	0.51	0.21	0.16	0.00

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

Table B1.7 Selection of Gate Type for Lum Hach Headworks

Item	Slide Gate		Fixed Wheel Gate		Flap Gate (Steel)		Flap Gate (Rubber Textile)		Radial Gate	
	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge	Characteristic	Judge
Downstream water level	No influence	◎	No influence	◎	Influence	△	Influence	△	Influence	△
Operation	So difficult	△	Easy	◎	Easy	◎	Easy	○	Easy	◎
Maintenance	Easy	◎	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○	Slightly difficult	○
Pier height	High	△	High	△	Low	◎	Low	◎	Low	◎
Cost	Low	◎	High	○	High	○	Moderate	○	High	○
Hoisting load	Large	△	Moderate	○	Large	△	Large	△	Light	◎
Vibration	No	◎	No	◎	Moderate	○	Moderate	○	Occurrence	△
Reliability	High	◎	High	◎	Low	△	Low	△	Low	△
Height/width ratio	No influence	◎	No influence	◎	Influence	△	Influence	△	Influence	△
Suitability for Lum Hach H.W	Moderate	○	High	◎	Low	△	Low	△	Moderate	○
Over-all Evaluation	Hoisting load becomes large for large sized gate leaf and operation will be difficult		Reliability is high and hoist load is relatively low for large sized gate		Reliability is low and not recommended because the headworks is located at the remote area from the National Road No. 5.		Reliability is low under influence of downstream water level/ back water		Reliability is low under influence of downstream water level/ back water	
			◎							

Prepared by JICA SAPROF Study Team

Table B1.8 List of Canals in Six Sub-Projects

Ream Kon			Por Canal			Dammak Ampil			Wat Chre			Lum Hach			
Irrigation Canal	Existing (m)	New	Main Canal	Secondary Canals	Total	Existing (m)	New	Irrigation Canal	Secondary Canals	Total	Existing (m)	New	Irrigation Canal	Secondary Canals	Total
1 S-1L	700	0	1 S-1	1,700	1,700	0	0	S1-1	4,800	4,800	0	0	S-1	3,000	3,000
2 S-2L	900	0	2 S-2	2,400	2,400	300	300	S1-2	7,800	7,800	0	0	S-2	1,200	1,200
3 S-3L	1,700	400	3 S-3	2,000	600	1,400	1,900	Total of SC	12,600	12,600	0	0	S-3	2,900	2,900
4 S-4L	2,400	1,100	4 S-4	2,900	1,000	1,900	1,900	Drainage Canal	6,800	6,800	0	0	S-4	1,700	1,700
5 S-5L	3,000	600	5 S-5	3,800	1,700	2,100	2,100	SD-1	7,800	7,800	0	0	S-5	2,000	2,000
6 S-6L	1,400	1,200	6 S-6	1,500	1,500	0	0	SD-2	7,800	7,800	0	0	S-6	11,300	11,300
7 S-7L	1,400	1,200	7 S-7L	14,300	8,600	5,700	5,700	SD-3	7,200	7,200	0	0	S-7	11,800	11,800
8 S-8L	1,400	1,200	Sub-secondary Canals	1,600	1,600	0	0	Total of SD	21,800	21,800	14,600	14,600	S-8	2,400	2,400
9 S-9L	700	0	7 SSS-1	1,700	1,700	0	0	Drainage Canal	20,300	20,300	17,200	17,200	S-9	5,600	5,600
10 S-2R	700	0	8 SSS-2	1,500	0	1,500	1,500	SD-1	2,200	2,200	0	0	Sub-secondary Canals	3,400	3,400
11 S-3R	700	0	9 SSS-2	4,800	3,300	1,500	1,500	Main Canal No.1	6,700	6,700	0	0	SS7-1	2,700	2,700
12 S-4R	700	0	Total of SC + Sub SC	19,100	11,900	7,200	7,200	Secondary Canals	2,600	2,600	0	0	SS7-2	2,100	2,100
Sub-secondary Canals	15,700	5,700	Drainage Canal	5,600	5,600	0	0	S-1	3,700	3,700	0	0	Total of SC + Sub SC	42,400	42,400
1 SS-5L	2,600	1,000	MD-1	1,700	1,700	0	0	S-2	3,600	3,600	0	0	Drainage Canal	11,500	11,500
Total of SC + Sub SC	18,300	6,700	Secondary Drainage Canals	1,700	0	1,700	1,700	S-3	3,000	3,000	0	0	SD-1	4,000	4,000
Secondary Drainage Canals	1,700	0	SD-1	1,800	0	1,800	1,800	S-4	1,600	1,600	0	0	SD-2	2,900	2,900
SD-1	1,600	0	SD-2	1,900	0	1,900	1,900	S-5	2,000	2,000	0	0	SD-3	3,200	3,200
SD-2	2,100	0	SD-3	1,100	0	1,100	1,100	S-6	1,800	1,800	0	0	SD-4	1,000	1,000
SD-3	2,570	0	SD-4	1,200	0	1,200	1,200	S-7	2,400	2,400	0	0	SD-5	3,300	3,300
SD-4	2,500	0	SD-5	1,800	0	1,800	1,800	S-8	1,800	1,800	0	0	SD-6	6,100	6,100
SD-5	1,500	0	SD-6	1,500	0	1,500	1,500	S-9	1,800	1,800	0	0	SD-7	3,000	3,000
SD-6	1,400	0	SD-7	1,500	0	1,500	1,500	S-10	3,100	3,100	1,800	1,800	SD-8	8,300	8,300
SD-7	1,370	0	SD-8	1,400	0	1,400	1,400	Total of SC	2,700	2,700	0	0	SD-9	3,900	3,900
Total of SD	13,370	0	SD-9	900	0	900	900	Drainage Canal	4,500	4,500	0	0	Total of SD	35,700	35,700
Drainage Canal	7,200	0	SD-10	14,800	0	14,800	14,800	SD-1	3,300	3,300	0	0	SD-1	4,000	4,000
MD-1	9,400	0	Total of SD	20,400	0	20,400	20,400	SD-2	4,200	4,200	0	0	SD-2	2,900	2,900
CD-1	6,400	0	Total of Drainage	20,400	0	20,400	20,400	SD-3	3,700	3,700	0	0	SD-3	3,200	3,200
CD-2	6,000	0	MD-1	9,400	0	9,400	9,400	SD-4	6,100	6,100	0	0	SD-4	1,000	1,000
CD-3	21,800	0	CD-1	6,400	0	6,400	6,400	SD-5	9,500	9,500	0	0	SD-5	3,300	3,300
Total of CD	42,370	0	CD-2	6,000	0	6,000	6,000	SD-6	3,700	3,700	0	0	SD-6	6,100	6,100
Total of Drainage	42,370	0	CD-3	21,800	0	21,800	21,800	SD-7	9,500	9,500	0	0	SD-7	3,000	3,000
Grand Total			Total of SD	37,700		37,700	37,700	SD-8	3,700	3,700	0	0	SD-8	8,300	8,300

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Table B1.9 List of Structures in Six Sub-Projects (1/3)

Type	Design Q (m ³ /sec)	Ream Kon			Por Canal			Dannak Ampil			Wat Loung			Wat Chre			Lum Hach		
		MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total
Tourn Out																			
TO 01	0.06	1	14	15	1	6	7	1	3	4	0	6	6	1	8	9	8	5	13
TO 02	0.15	6	29	35	1	35	36	1	41	42	4	44	48	5	13	18	8	48	56
TO 03	0.28	5	0	5	2	3	5				3	2	5	2	1	3	4	1	5
TO 04	0.40	1	0	1	2	0	2				2	0	2	2	0	0	0	1	1
TO 05	0.60				1	0	1				2	0	2	1	0	1	2	0	2
TO 06	0.80	1	0	1							1	0	1				2	0	0
TO 07	1.20				1	0	1										2	0	2
TO 08	1.60																1	0	1
TO 11	5.40							1	0	1									
TO LH	6.60																1	0	1
Total		14	43	57	8	44	52	3	44	47	12	52	64	9	22	31	26	55	81
Check Structure																			
Check Structure with Drop																			
CS 01	0.13	0	13	13	0	10	10				0	16	16	0	8	8	0	9	9
CS 02	0.18	0	4	4	0	4	4	0	1	1	0	3	3	0	4	4	0	3	3
CS 03	0.22				0	3	3	0	1	1	0	2	2	0	2	2	0	3	3
CS 04	0.34	0	2	2	0	3	3	0	2	2	0	4	4	1	0	1	0	4	4
CS 05	0.40	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	4	4
CS 06	0.51				0	1	1	0	2	2	0	1	1	1	0	1	0	4	4
CS 07	0.65							0	4	4							0	2	2
CS 08	0.99				0	2	2	0	4	4				2	0	2	1	3	4
CS 09	1.30																0	3	3
CS 11	1.97										1	0	1						
CS 12	2.50																		
CS 13	3.50										1	0	1				1	0	1
CS 14	5.00										3	0	3				2	0	2
CS 15	6.30																2	0	2
Check Structure with Drop																			
CD 08	0.99	1	0	1															
CD 10	1.68										2	0	2						
CD 12	2.70	1	0	1							1	0	1						
Total		2	20	22	0	24	24	0	15	15	8	26	34	4	13	17	7	31	38

Prepared by JICA SAPROF Study Team

Table B1.9 List of Structures in Six Sub-Projects (2/3)

Type	Design Q (m3/sec)	Ream Kon			Por Canal			Dannak Ampil			Wat Loung			Wat Chre			Lum Hach		
		MC	SC/SSC	Total	MC	SD/CD	Total	MC	SD/CD	Total	MC	SD/SSC	Total	MC	SD/CD	Total	MC	SD/SSC	Total
Road Culvert																			
RC 701	0.13	0	4	4				28	28	4	0	4	4	1	1	0	12	12	12
RC 702	0.18							1	1	1	0	1	1			0	1	1	1
RC 703	0.22									1	0	1	1						
RC 704	0.34																0	2	2
RC 705	0.40																0	1	1
RC 706	0.51							2	2	1	0	1	1			0	1	1	1
RC 707	0.65							1	1	4	0	4	4			0	1	1	1
RC 708	0.99															0	3	3	3
RC 709	1.30															0	4	4	4
RC 710	1.68									1	0	1	1			1	0	4	4
RC 712	2.70															1	0	1	1
RC 1014	4.00															2	0	2	2
RC 2504	0.34	0	1	1															
Length=20m																			
DBC1001	5.00																		
Total		0	5	5	0	0	0	32	32	13	2	11	13	1	2	3	28	28	31
Bridge																			
Type	Design Q (m3/sec)	MC	SD/CD	Total	MC	SD/CD	Total	MC	SD/CD	Total	MC	SD/SSC	Total	MC	SD/CD	Total	MC	SD/SSC	Total
BR 2035	Length 20m Width 3.5m	1	2	3	0	2	2	0	1	1									
BR 2045	Length 20m Width 4.5m										0	5	5	0	1	1	0	1	1
BR 2545	Length 25m Width 4.5m																1	0	1
BR 3035	Length 30m Width 3.5m	0	3	3															
Total		1	5	6	0	2	2	0	1	1	0	5	5	0	1	1	1	1	2
Foot Path Bridge																			
FB 1020	Length 10m Width 2.0m				1	3	4										0	120	120
FB 1520	Length 150m Width 2.0m				0	1	1				0	8	8						
Total		0	0	0	1	4	5	0	0	0	0	8	8	0	0	0	0	120	120

Foot path bridges of Wat Loung Sub-Project are provided in each secondary drainage canals.
Foot path bridges of Lum Hach Sub-Project are provided every 100m along the main road.

Table B1.9 List of Structures in Six Sub-Projects (3/3)

Type	Design Q (m3/sec)	Ream Kon			Por Canal			Dammak Ampil			Wat Loung			Wat Chre			Lum Hach		
		MD	SD/CD	Total	MD	SD/CD	Total	MD	SD/CD	Total	MD	SD/CD	Total	MD	SD/CD	Total	MD	SD/CD	Total
Cross Drainage (Drainage Culvert)																			
Length=10m																			
DC 1504	0.34				0	1	1												
DC 1506	0.51	0	2	2												0	1	1	
DC 1507	0.65				1	0	1									0	2	2	
DC 1508	0.99	0	1	1												0	1	1	
DC 1509	1.30	0	1	1												0	1	1	
DC 1510	1.68				0	1	1									0	3	3	
DC 1511	1.97	0	4	4	1	3	4									0	1	1	
DC 1512	2.70	0	3	3	0	3	3									0	2	2	
DC 1513	3.00															0	2	2	
Drainage Box Culvert																			
Length=20m																			
DBC 2001	5.00				2	0	2									0	1	1	
DBC 2002	8.20	0	3	3	0	2	2									0	2	2	
Total		0	14	14	4	9	13									0	13	13	9
9 drainage culverts are provided in secondary drainage canals.																			
Type	Design Q (m3/sec)	Ream Kon			Por Canal			Dammak Ampil			Wat Loung			Wat Chre			Lum Hach		
		MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total
Terminal Structure																			
CS 01	0.13	0	12	12	0	8	8									1	5	6	
CS 02	0.18	1	0	1															
CS 03	0.22				0	1	1												
CS 04	0.34				1	0	1												
Total		1	12	13	1	9	10									1	5	6	10
Syphone																			
SY 01	4.84																		
SY 02	0.38															0	1	1	
SY 03	0.96																		
Total		0	0	0	0	0	0									0	1	1	1

Prepared by JICA SAPROF Study Team

Table B1.10 Summary of Irrigation and Drainage Plan of Six Sub-projects

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

Prepared by JICA SAPROF Study Team

Alternatives of Water Balance Study of Moung Russei River Basin

Alternatives	Crops			Evaluation indicators				Evaluation
	Early paddy (ha)	Medium paddy (ha)	Dry season paddy (ha)	Annual irrigation area (ha)	Development area (ha)	Annual incremental paddy production (ton)	Paddy production per Sub-project area (ton/ha)	
1	300	10,100	200	10,600	10,100	20,289	2.01	<ul style="list-style-type: none"> ◆ 2nd in annual irrigation area ◆ Largest in development area ◆ 2nd in annual incremental production ◆ 4th in production per cost
2	900	1,500	5,100	7,500	5,100	19,935	3.91	<ul style="list-style-type: none"> ◆ 3rd in annual irrigation area ◆ Smallest in development area ◆ 3rd in annual paddy production ◆ 1st in production per cost
3	6,300	500	200	7,000	6,300	14,145	2.25	<ul style="list-style-type: none"> ◆ Smallest in annual irrigation area ◆ 3rd in development area ◆ Smallest in annual paddy production ◆ 3rd in production per cost
4	5,200	5,200	300	10,700	8,300	21,128	2.54	<ul style="list-style-type: none"> ◆ 1st in annual irrigation area ◆ 2nd in development area ◆ 1st in annual incremental production ◆ 2nd in production per cost

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

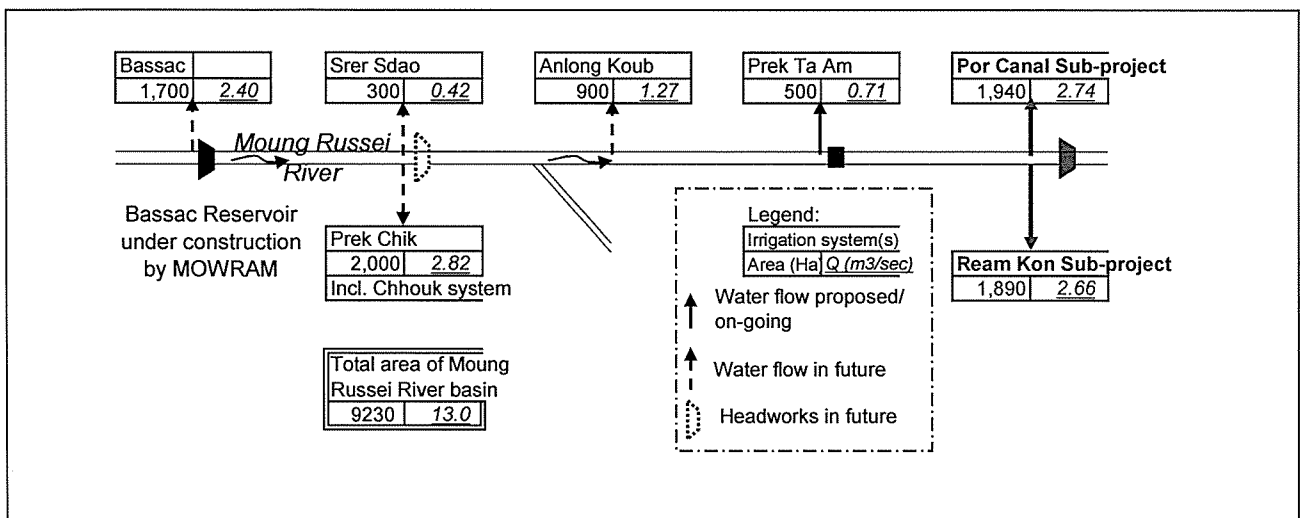
Figure B1.1 Water Distribution within the Moung Russei River Basin (1/2)

Basic Conditions on Water Balance Study

Cropping season:	<ul style="list-style-type: none"> ◆ Early growing paddy (by Direct sowing), Medium growing paddy(Direct sowing : Transplanting =1:1) ◆ Dry season paddy means early growing paddy by direct sowing
Bassac Reservoir related data	<ul style="list-style-type: none"> ◆ Catchment area: 598km² ◆ Effective storage capacity: 32 MCM ◆ Design maximum height: 10.55m (FWL) ◆ Approximate reservoir area: maximum 500 ha, minimum 12 ha ◆ River Discharge: Mean 5-days discharge in the Moug Russei (Dauntri) River for over 5 years. ◆ Seepage loss of reservoir: 0.05% of Total Storage Volume per day ◆ Evaporation from reservoir: Reference crop evapotranspiration estimated by Penman-Montieth method and meteorological data
Data on related Project	<ul style="list-style-type: none"> ◆ Irrigation water requirement: Mean 5-days irrigation water requirement estimated based on the proposed cropping calendars. ◆ Design irrigation target area: To be determined based on the result of the water balance study

Judgment

- ◆ Alternative-4 is recommendable as it has the largest incremental production, and second largest of production per Sub-project area.
- ◆ Potential irrigation area of the Moug Russei River Basin is 9,200 ha, the average figure of 8,300 ha (Alternative-4) and 10,100 ha (Alternative-1).



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

Figure B1.1 Water Distribution within the Moug Russei River Basin (2/2)

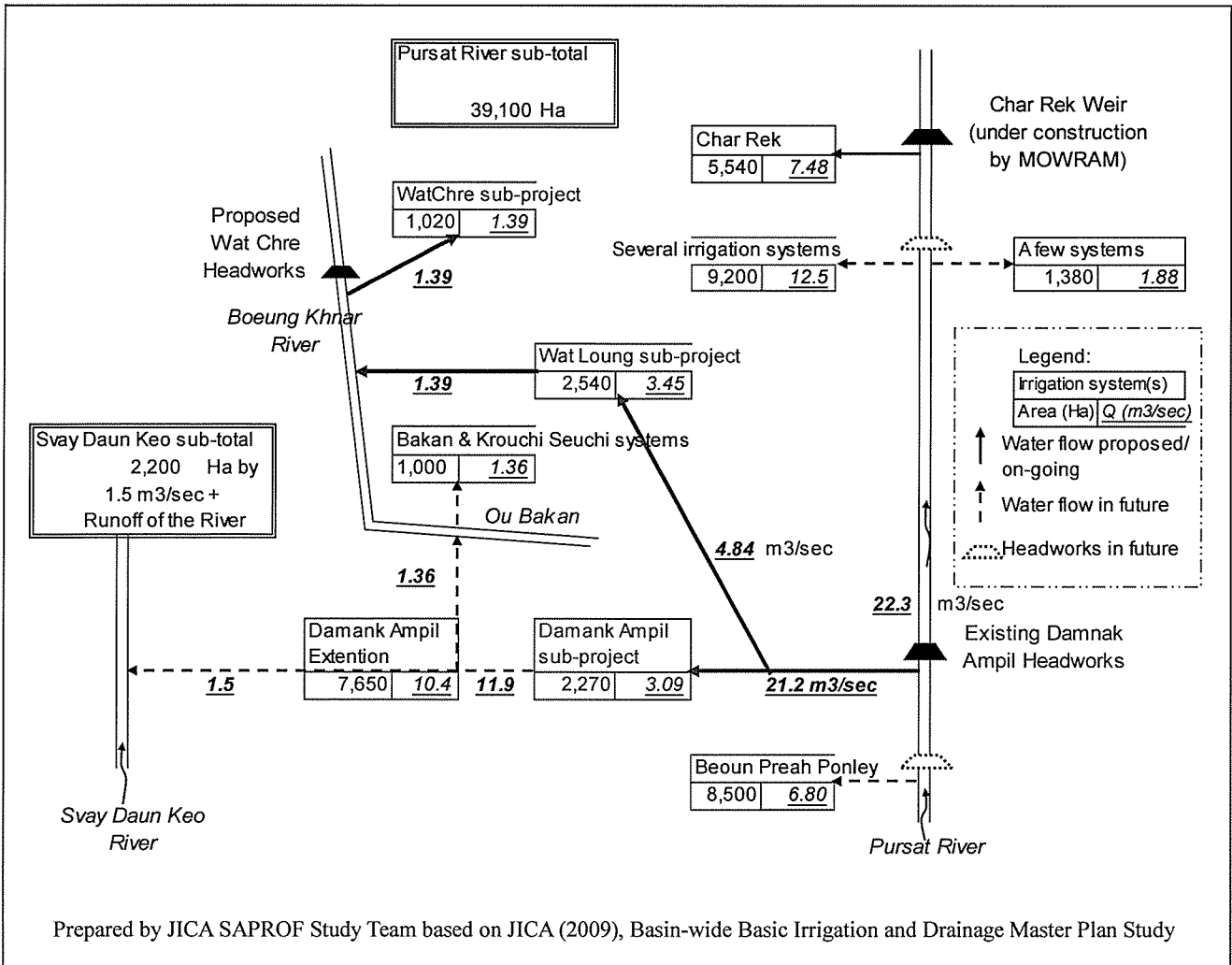


Figure B1.2 Water Distribution within the Pursat River Basin including Svy Don Keo River

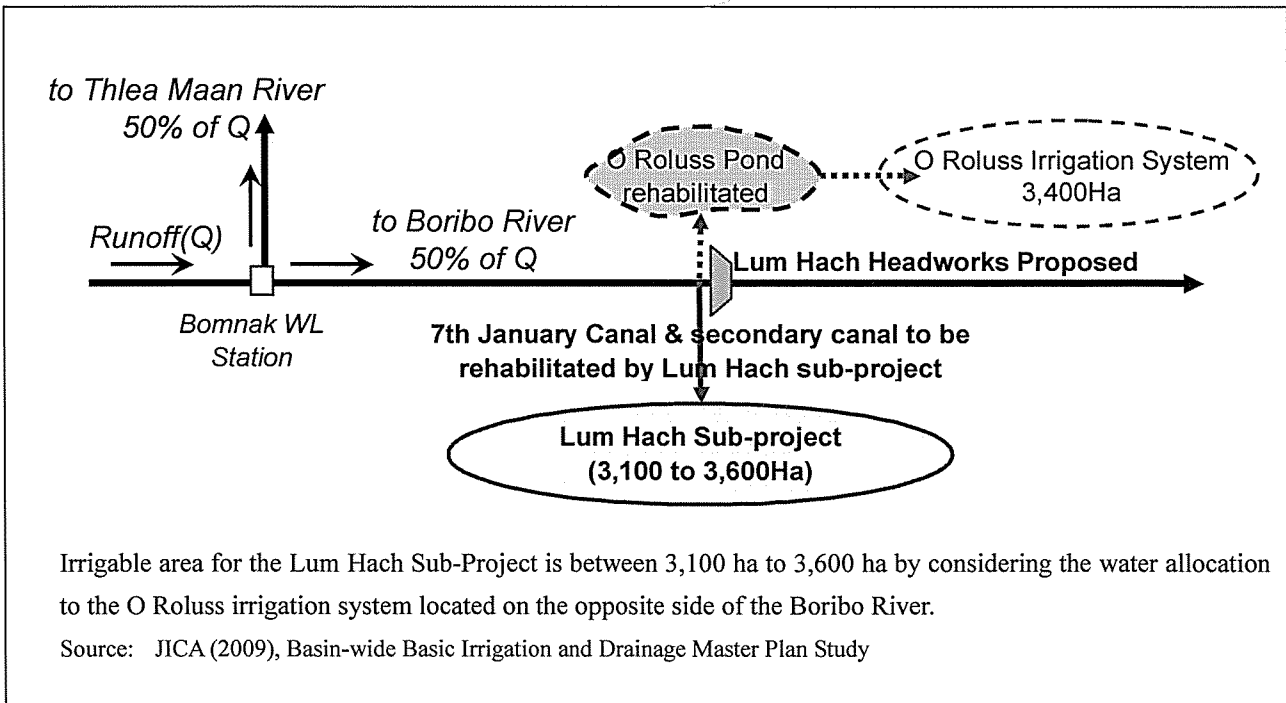


Figure B1.3 Water Distribution within the Boribo River Basin including O Roluss Irrigation System

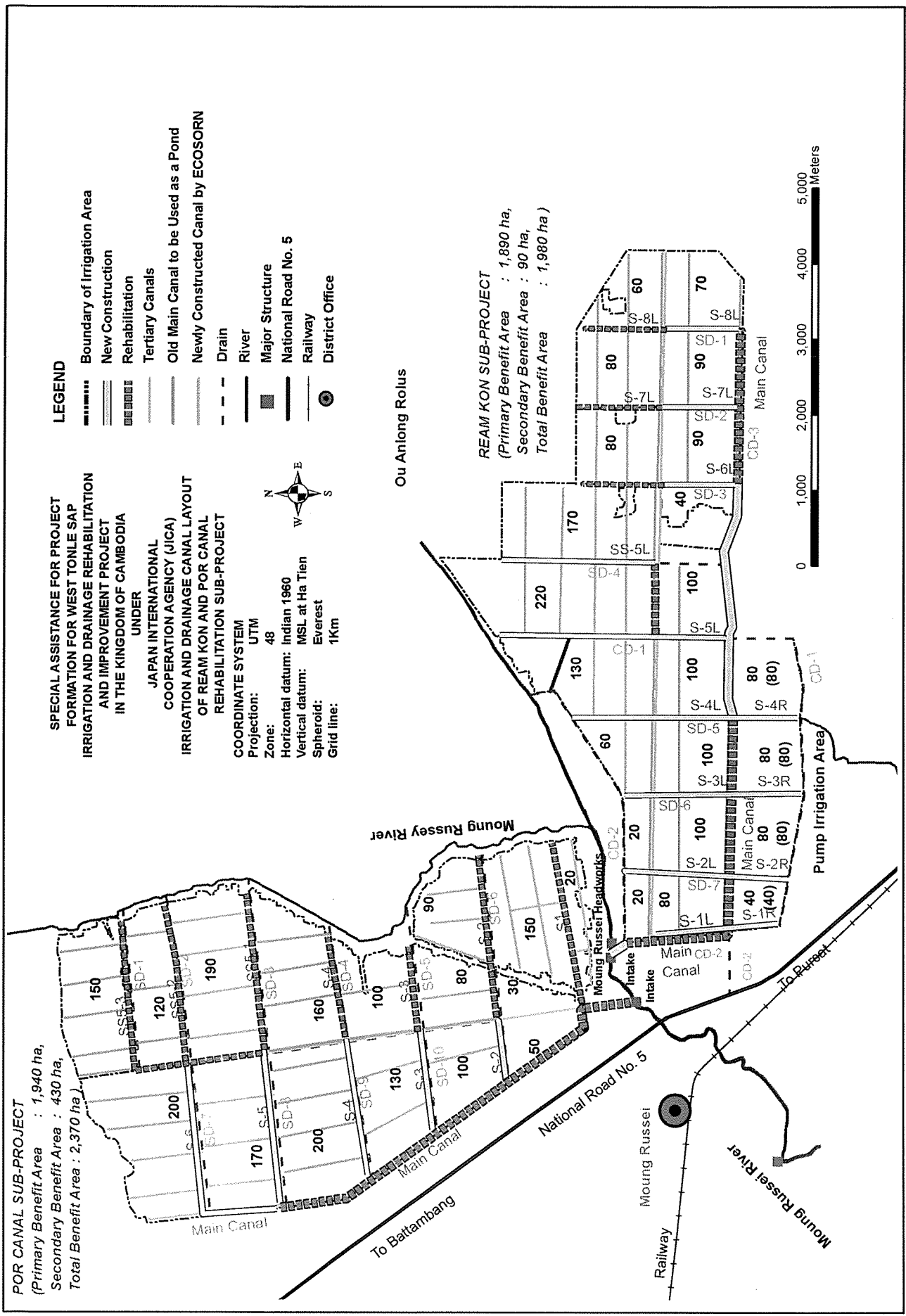
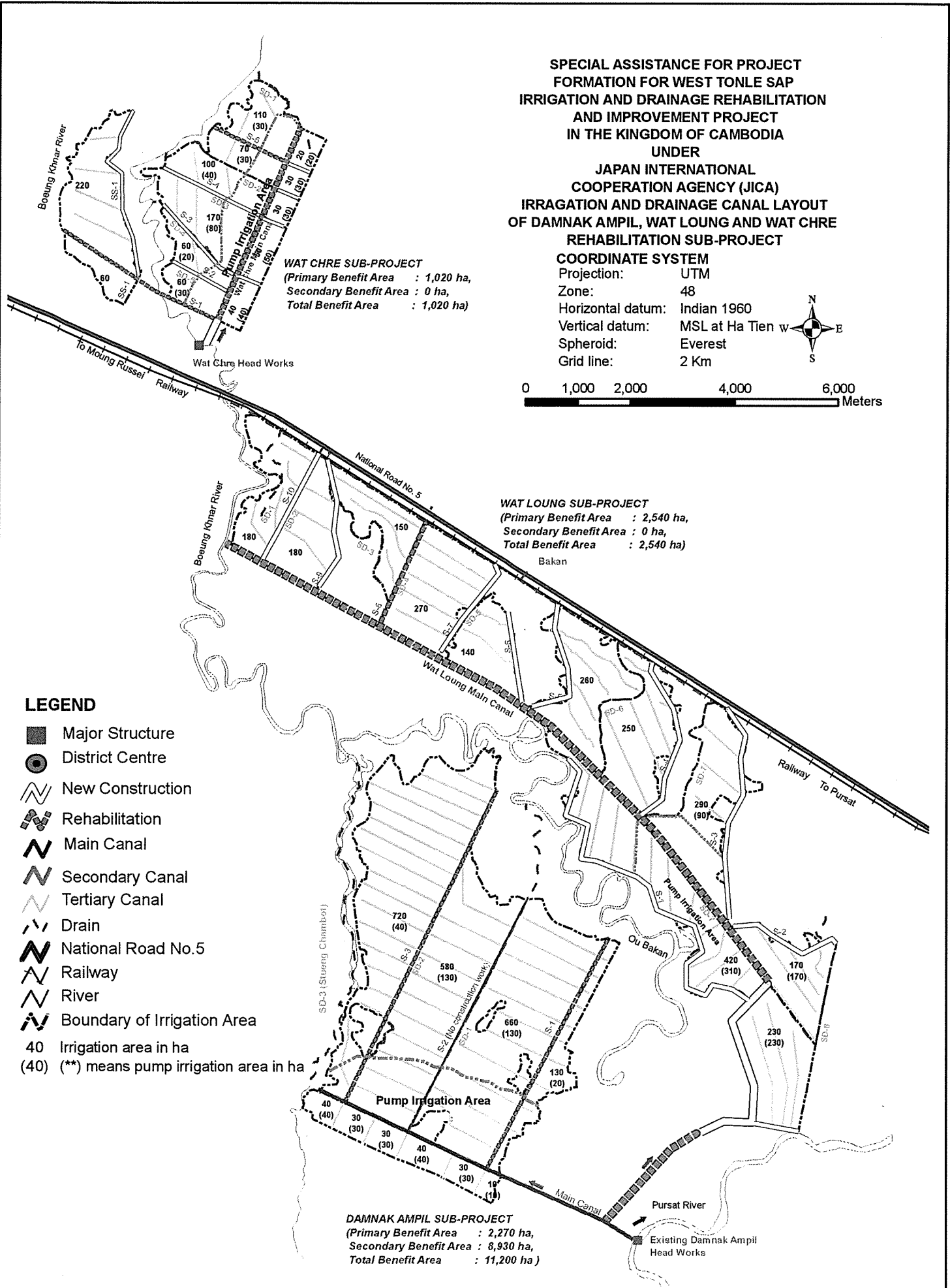


Figure B1.4 Sections of New Construction and Rehabilitation of Main and Secondary Canals in Ream Kon and Por Canal Sub-projects

**SPECIAL ASSISTANCE FOR PROJECT
FORMATION FOR WEST TONLE SAP
IRRIGATION AND DRAINAGE REHABILITATION
AND IMPROVEMENT PROJECT
IN THE KINGDOM OF CAMBODIA
UNDER
JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)
IRRIGATION AND DRAINAGE CANAL LAYOUT
OF DAMNAK AMPIL, WAT LOUNG AND WAT CHRE
REHABILITATION SUB-PROJECT**

COORDINATE SYSTEM

Projection: UTM
 Zone: 48
 Horizontal datum: Indian 1960
 Vertical datum: MSL at Ha Tien w
 Spheroid: Everest
 Grid line: 2 Km



WAT CHRE SUB-PROJECT
 (Primary Benefit Area : 1,020 ha,
 Secondary Benefit Area : 0 ha,
 Total Benefit Area : 1,020 ha)

WAT LOUNG SUB-PROJECT
 (Primary Benefit Area : 2,540 ha,
 Secondary Benefit Area : 0 ha,
 Total Benefit Area : 2,540 ha)
 Bakan

DAMNAK AMPIL SUB-PROJECT
 (Primary Benefit Area : 2,270 ha,
 Secondary Benefit Area : 8,930 ha,
 Total Benefit Area : 11,200 ha)

LEGEND

- Major Structure
- District Centre
- ~ New Construction
- ~ Rehabilitation
- ~ Main Canal
- ~ Secondary Canal
- ~ Tertiary Canal
- ~ Drain
- ~ National Road No.5
- ~ Railway
- ~ River
- ~ Boundary of Irrigation Area
- 40 Irrigation area in ha
- (40) (**) means pump irrigation area in ha

**Figure 1.5 Sections of New Construction and Rehabilitation of Main and Secondary Canals
in Damnak Ampil, Wat Loung and Wat Chre Sub-projects**

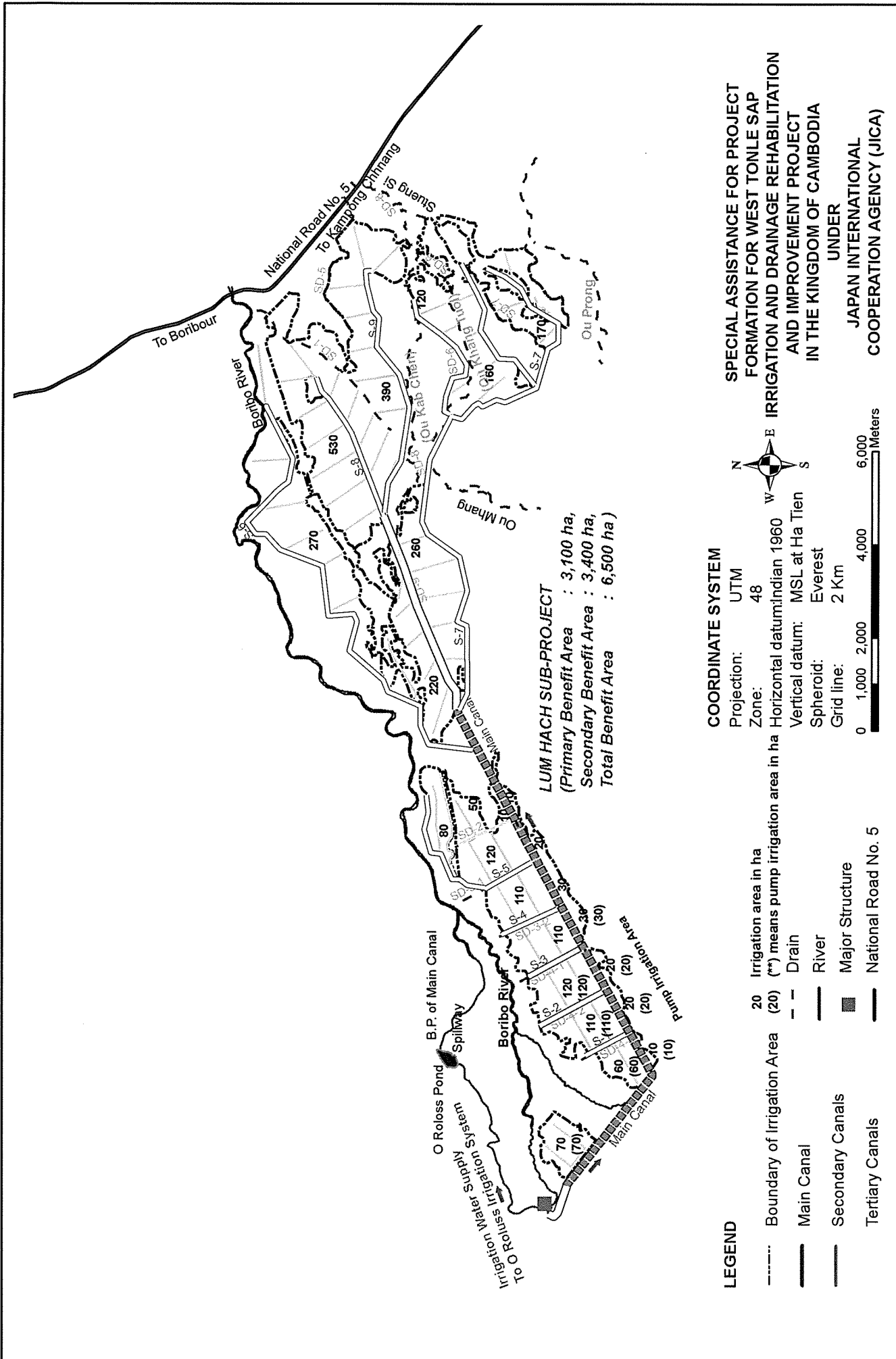


Figure B1.6 Sections of New Construction and Rehabilitation of Main and Secondary Canals in Lum Hach Sub-project

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

B2. DRAWINGS FOR IRRIGATION AND DRAINAGE FACILITIES

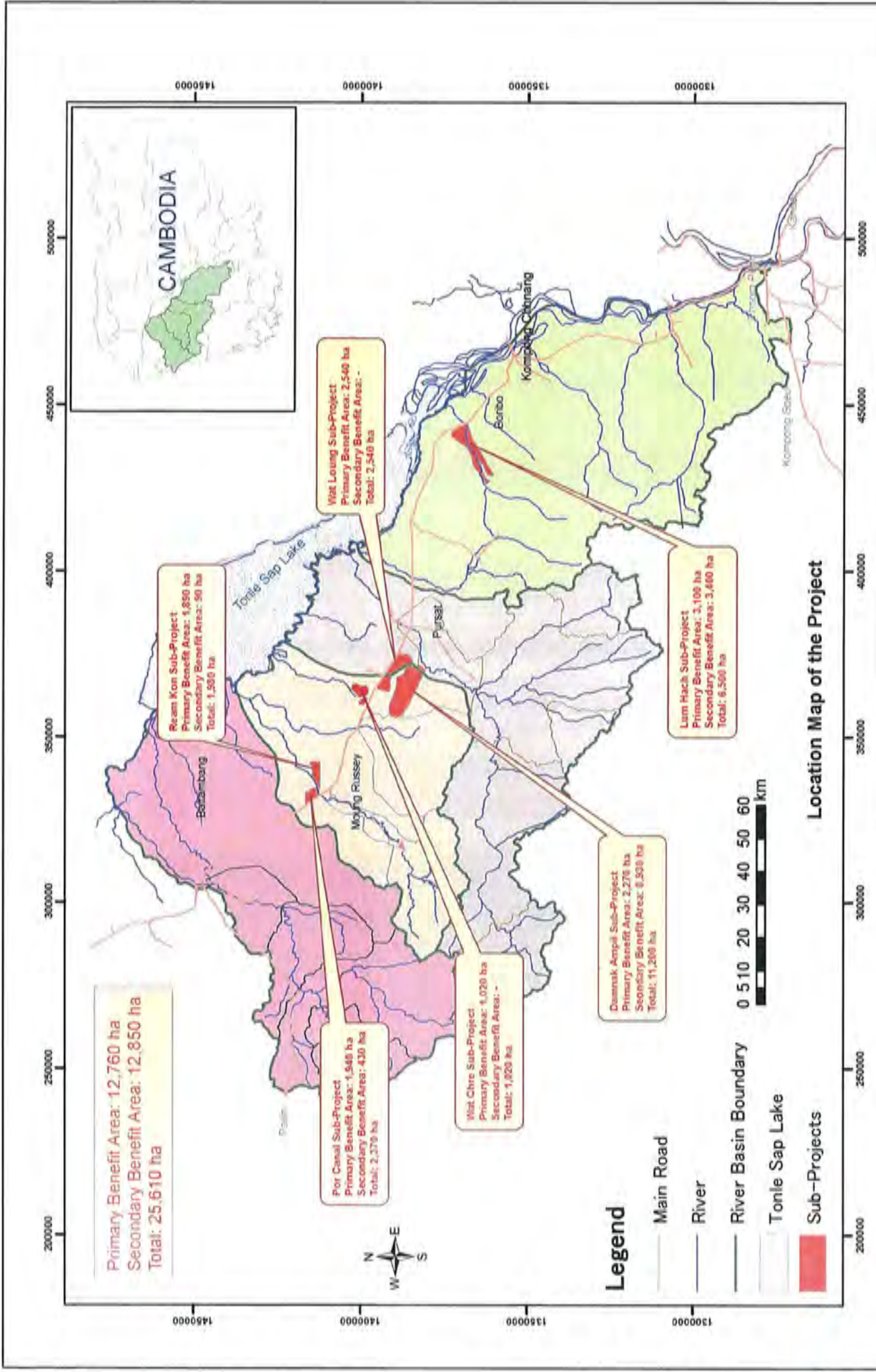
**SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
IN
THE KINGDOM OF CAMBODIA**

LIST OF DRAWING

DRWING No.	TITLE
GENERAL	
G-01	Location Map of the Project
SUB-PROJECTS IN BATTAMBANG PROVINCE	
B-01	General Layout of Ream Kon and Por Canal Sub-Projects
Moung Russei Headworks	
B-02-01	Overview of Moung Russei Headworks Site
B-02-02	Layout of Moung Russei Headworks
B-03	Profile of Moung Russei Headworks
B-04	Section of Moung Russei Headworks (1/2)
B-05	Section of Moung Russei Headworks (2/2)
B-06	Intake of Moung Russei Headworks
B-07	Geological Profile of Moung Russei Headworks
Ream Kon Sub-Project	
B-08	Irrigation Diagram of Ream Kon Sub-Project
B-09	Drainage Diagram of Ream Kon Sub-Project
B-10	Profile of Main Canal, Ream Kon Sub-Project
Por Canal Sub-Project	
B-11	Irrigation Diagram of Por Canal Sub-Project
B-12	Drainage Diagram of Por Canal Sub-Project
B-13	Profile of Main Canal, Por Canal Sub-Project
SUB-PROJECTS IN PURSAT PROVINCE	
P-01	General Layout of Damnak Ampil, Wat Loung and Wat Chre Sub-Projects
Wat Chre Headworks	
P-02-01	Overview of Wat Chre Headworks Site
P-02-02	Layout of Wat Chre Headworks
P-03	Profile of Wat Chre Headworks
P-04	Section of Wat Chre Headworks (1/2)
P-05	Section of Wat Chre Headworks (2/2)

DRWING No.	TITLE
P-06	Intake of Wat Chre Headworks
P-07	Geological Profile of Wat Chre Headworks
Rehabilitation of Damnak Ampil Headworks	
P-08	Hoisting System for Flood Gate (Electric Type)
P-09	Layout of Fishladder for Damnak Ampil Headworks
P-10	Section of Fishladder for Damnak Ampil Headworks
Damnak Ampil Sub-Project	
P-11	Irrigation Diagram of Damnak Ampil Sub-Project
P-12	Drainage Diagram of Damnak Ampil Sub-Project
P-13	Profile of Secondary Canal No.1, Damnak Ampil Sub-Project
Wat Loung Sub-Project	
P-14	Irrigation Diagram of Wat Loung Sub-Project
P-15	Drainage Diagram of Wat Loung Sub-Project
P-16	Profile of Main Canal, Wat Loung Sub-Project (1/2)
P-17	Profile of Main Canal , Wat Loung Sub-Project (2/2)
Wat Chre Sub-Project	
P-18	Irrigation Diagram of Wat Chre Sub-Project
P-19	Drainage Diagram of Wat Chre Sub-Project
P-20	Profile of Main Canal, Wat Chre Sub-Project
SUB-PROJECT IN KAMPONG CHHNANG PROVINCE	
K-01	General Layout of Lum Hach Sub-Project
Lum Hach Headworks	
K-02-01	Overview of Lum Hach Headworks Site
K-02-02	Layout of Lum Hach Headworks
K-03	Profile of Lum Hach Headworks
K-04	Section of Lum Hach Headworks (1/3)
K-05	Section of Lum Hach Headworks (2/3)
K-06	Section of Lum Hach Headworks (3/3)
K-07	Intake of Lum Hach Headworks
K-08	Intake of O Roluss Irrigation System
K-09	Geological Profile of Lum Hach Headworks
Lum Hach Sub-Project	
K-10	Irrigation Diagram of Lum Hach Sub-Project
K-11	Drainage Diagram of Lum Hach Sub-Project
K-12	Profile of Main Canal, Lum Hach Sub-Project

DRAWING No.	TITLE
Canal-related Structures for Six Sub-Projects	
CR-01	Location of Canal-related Structures in Ream Kon and Por Canal Sub-Projects
CR-02	Location of Canal-related Structures in Damnak Ampil, Wat Loung and Wat Chre Sub-Projects
CR-03	Location of Canal-related of Structures in Lum Hach Sub-Project
CR-04	Canal-related Structures for Six Sub-projects, Turnout
CR-05	Canal-related Structures for Six Sub-projects, Check Structure
CR-06	Canal-related Structures for Six Sub-projects, Terminal Structure
CR-07	Canal-related Structures for Six Sub-projects, Road Culvert
CR-08	Canal-related Structures for Six Sub-projects, Concrete Bridge and Footpath Bridge
CR-09	Canal-related Structures for Six Sub-projects, Syphon
CR-10	Canal-related Structures for Six Sub-projects, Drainage Culvert (Cross Drainage)



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)		Drawing No.	G - 01
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT			
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Location Map of the Project

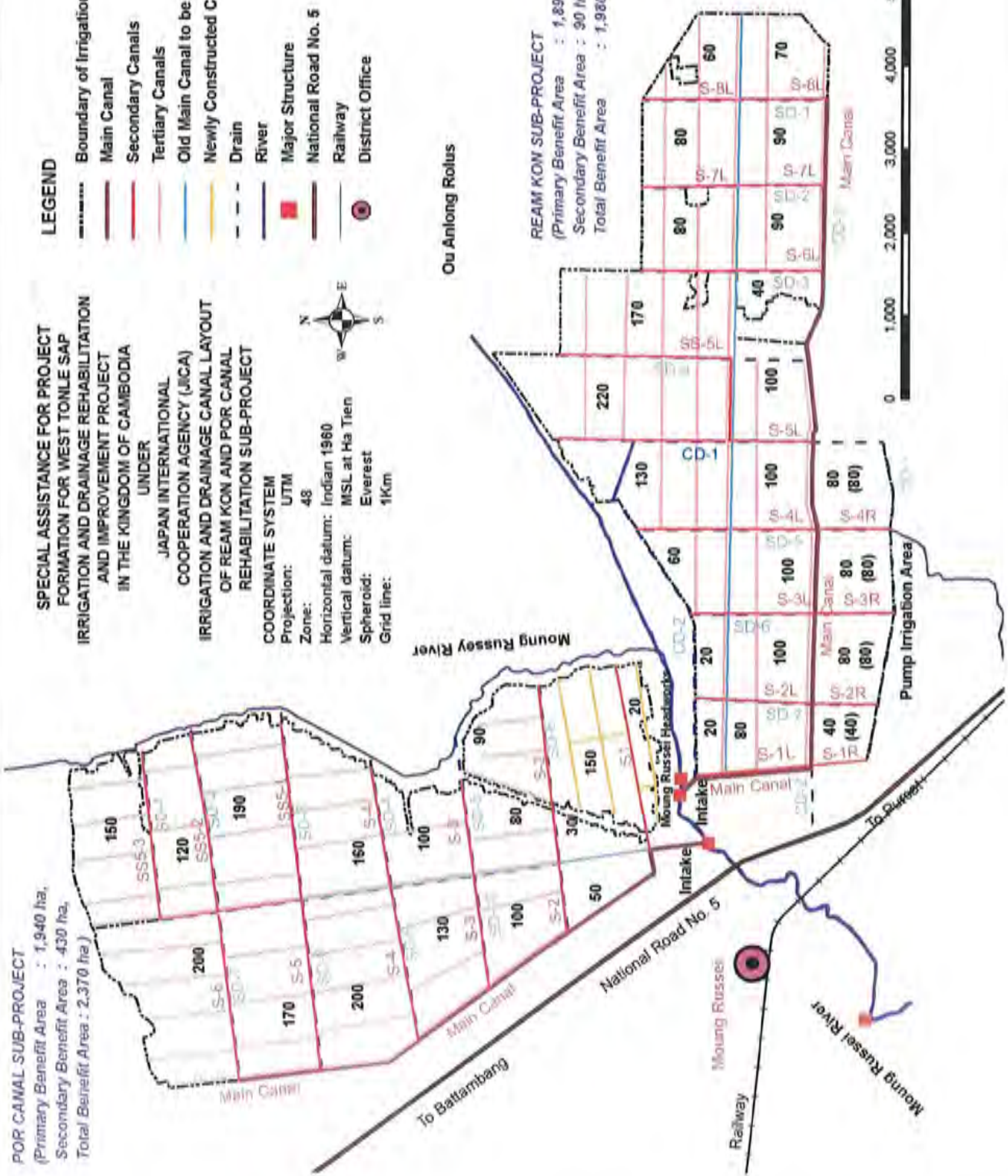
POR CANAL SUB-PROJECT
 (Primary Benefit Area : 1,940 ha,
 Secondary Benefit Area : 430 ha,
 Total Benefit Area : 2,370 ha)

REAM KOW SUB-PROJECT
 (Primary Benefit Area : 1,890 ha,
 Secondary Benefit Area : 90 ha,
 Total Benefit Area : 1,980 ha)

SPECIAL ASSISTANCE FOR PROJECT FORMATION FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT IN THE KINGDOM OF CAMBODIA UNDER
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
IRRIGATION AND DRAINAGE CANAL LAYOUT OF REAM KON AND POR CANAL REHABILITATION SUB-PROJECT

COORDINATE SYSTEM
 Projection: UTM
 Zone: 48
 Horizontal datum: Indian 1960
 Vertical datum: MSL at Ha Tien
 Spheroid: Everest
 Grid line: 1Kkm

- LEGEND**
- Boundary of Irrigation Area
 - Main Canal
 - Secondary Canals
 - Tertiary Canals
 - Old Main Canal to be Used as a Pond
 - Newly Constructed Canal by ECOSORN
 - - - Drain
 - River
 - Major Structure
 - National Road No. 5
 - Railway
 - ⊙ District Office



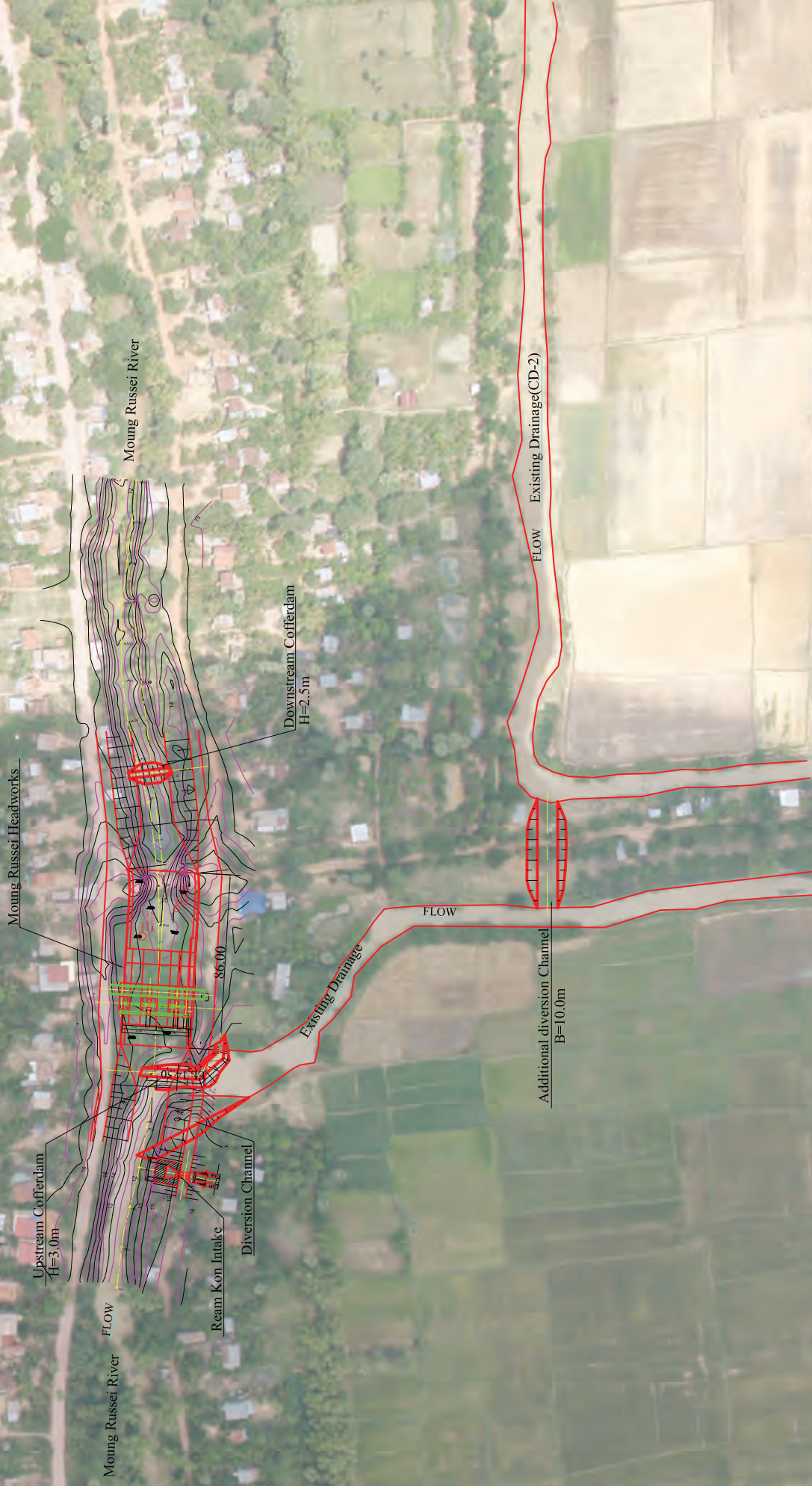
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.
 Drawing Title

B - 01
 General layout of Ream Kon and Por Canal Sub-Projects

OVERVIEW OF MOUNG RUSSEI HEADWORKS SITE

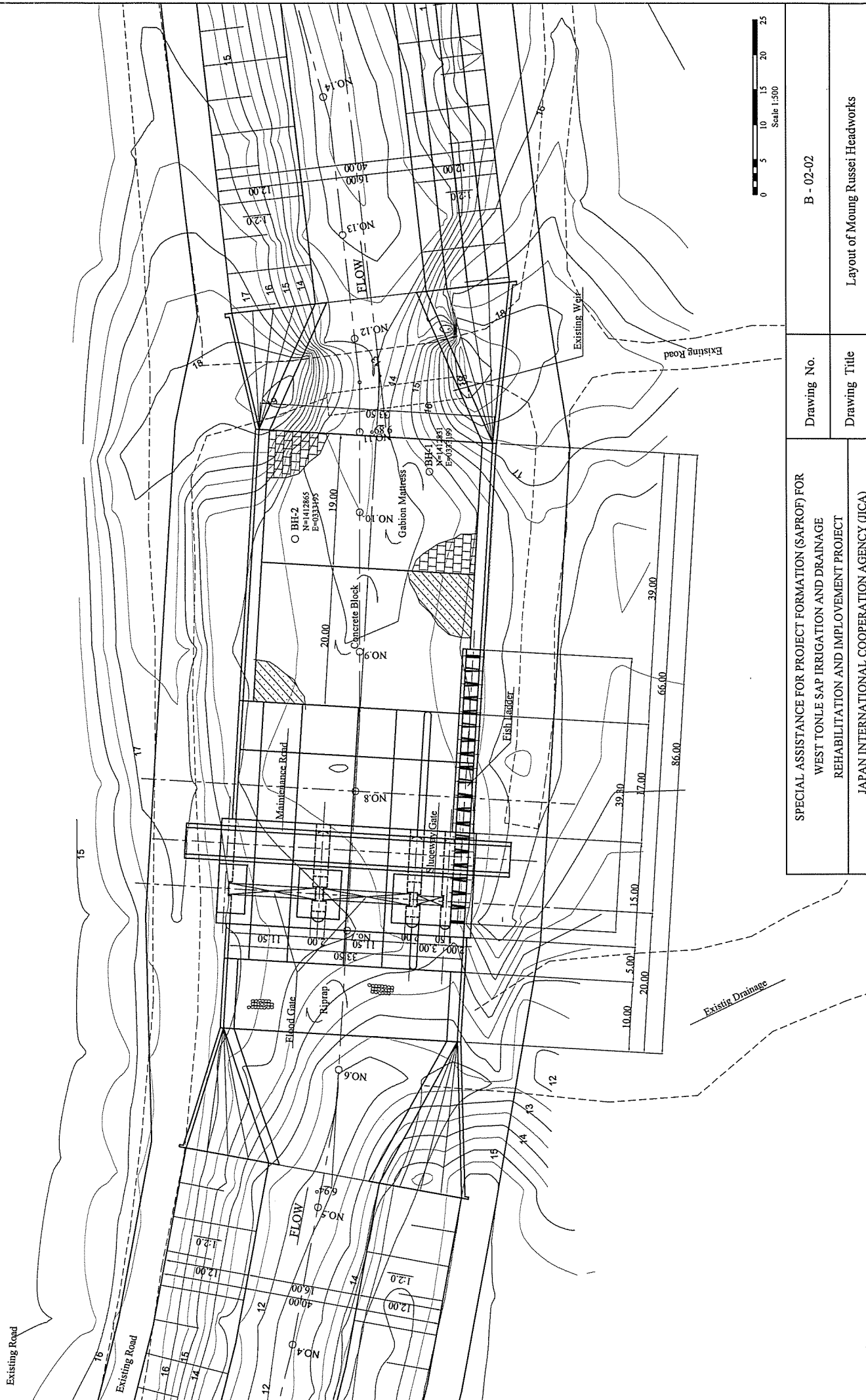
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SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	B - 02 - 01
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Overview of Moung Russei Headworks Site

LAYOUTPLAN OF MOUNG RUSSEI HEADWORKS

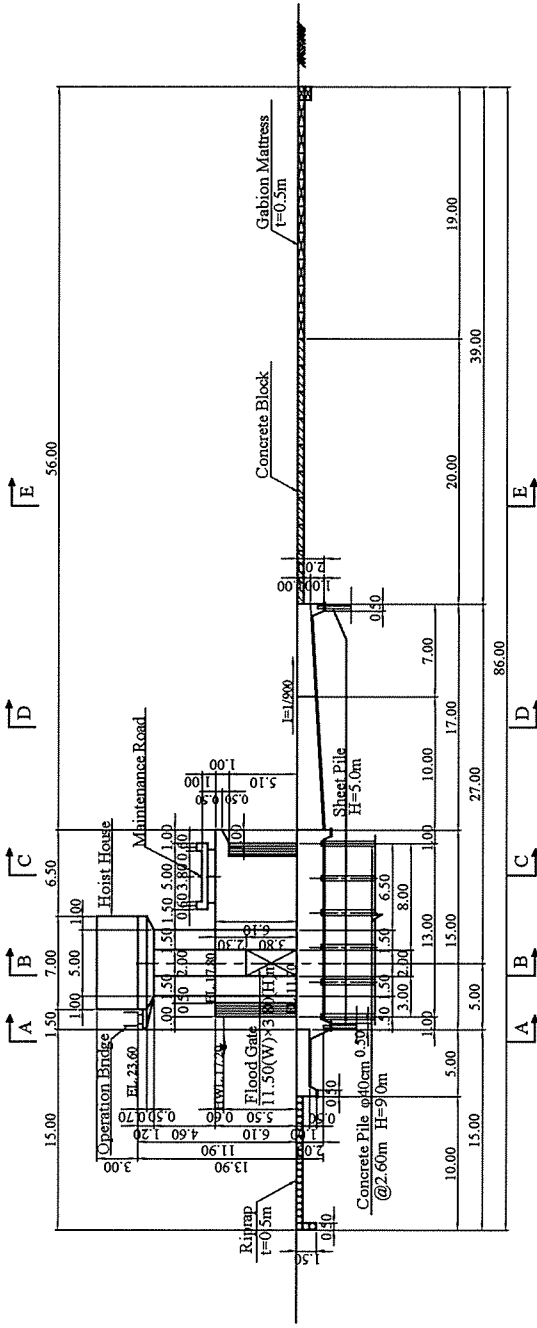
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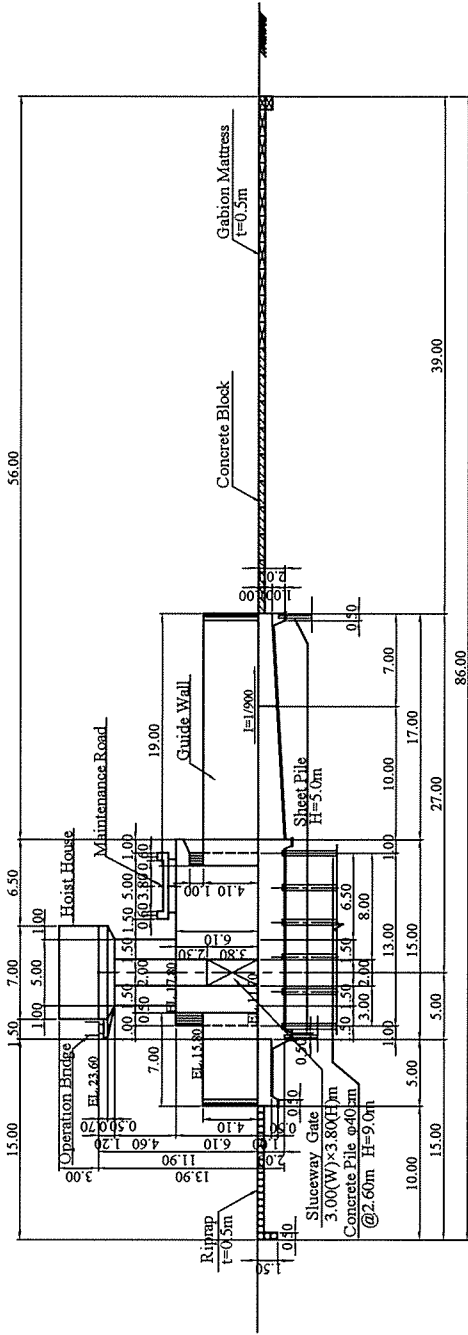
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No.	B - 02-02
		Drawing Title	Layout of Moug Russei Headworks

PROFILE OF MOUNG RUSSEI HEADWORKS

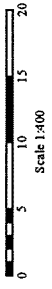
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FLOOD GATE SECTION



SLUEWAY GATE SECTION



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

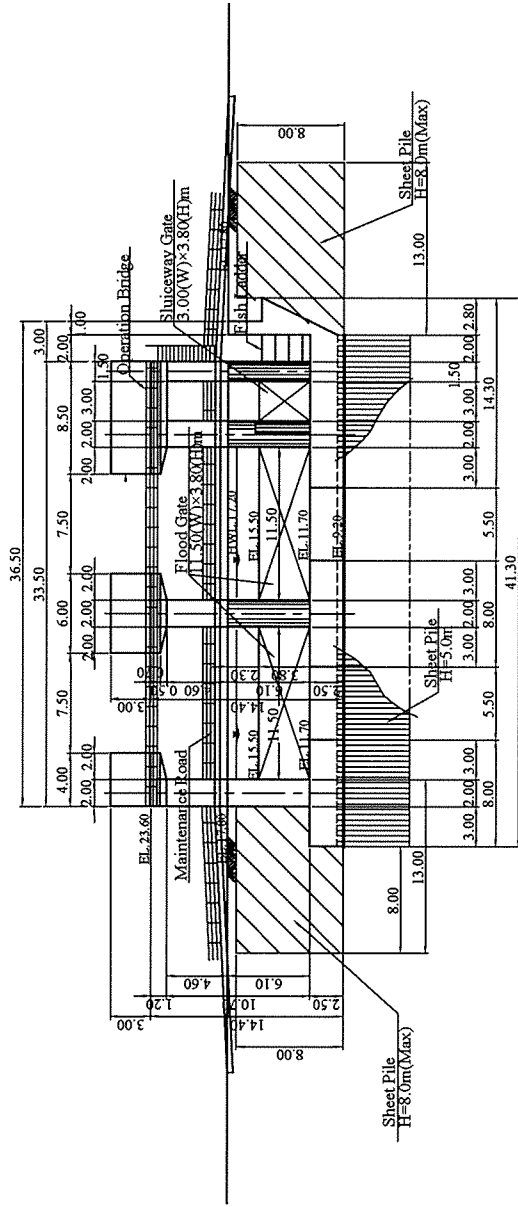
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Drawing Title

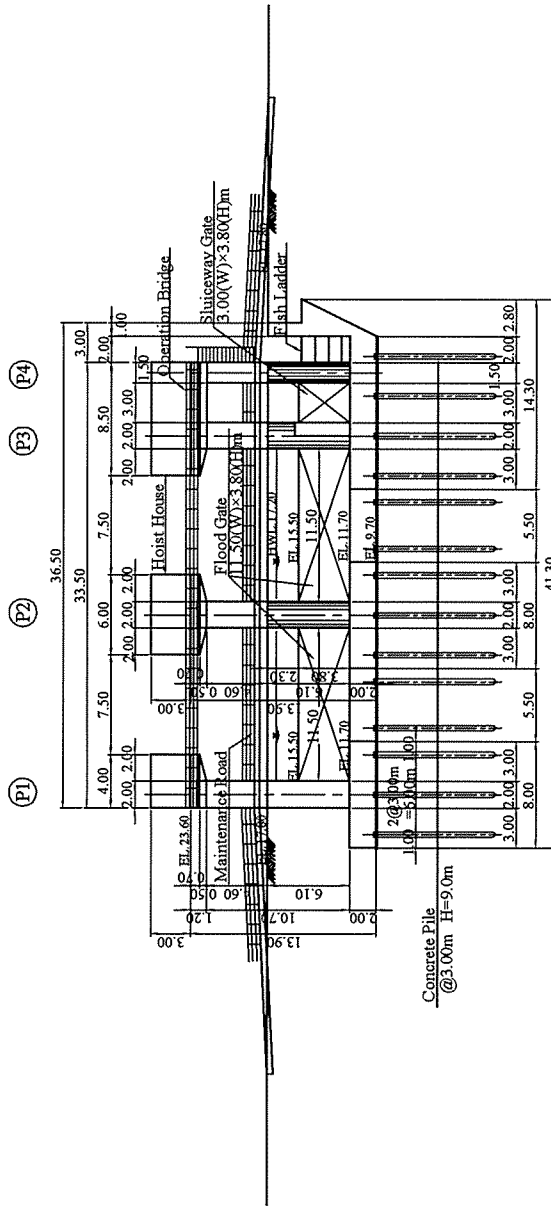
Profile of Mounng Russei Headworks

SECTION

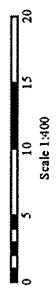
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SECTION A-A



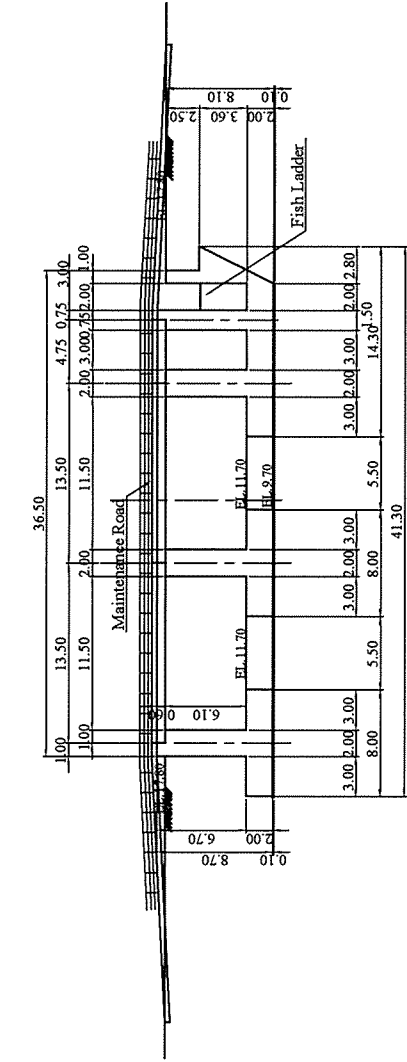
SECTION B-B



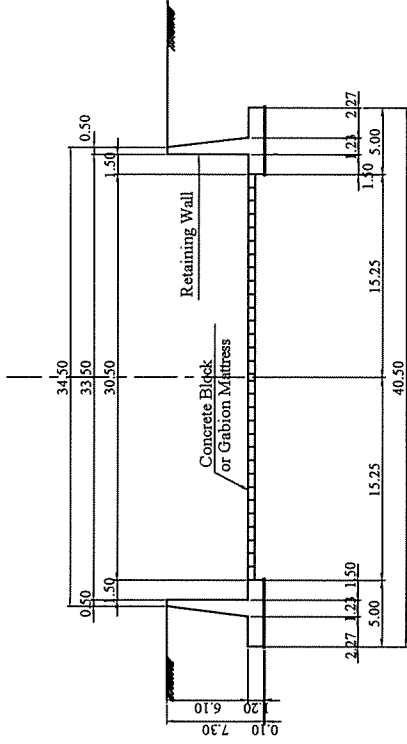
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No.	B-04
		Drawing Title	Section of Moung Russei Headworks (1/2)

SECTION

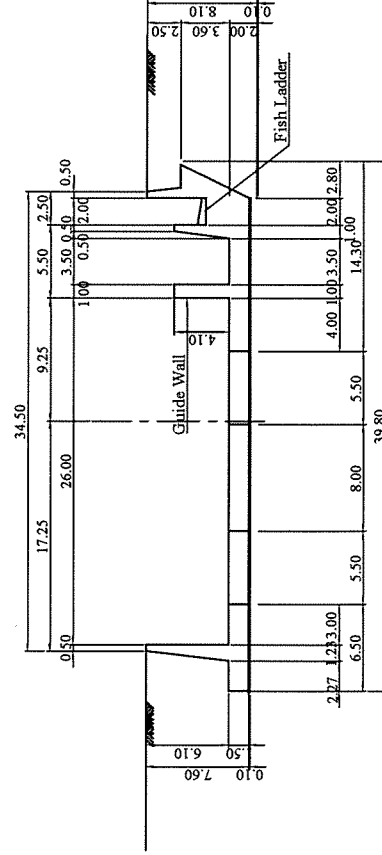
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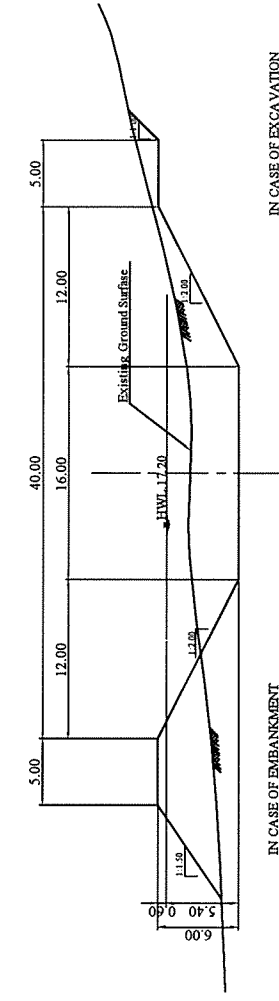
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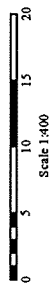
SECTION E-E



SECTION D-D



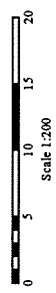
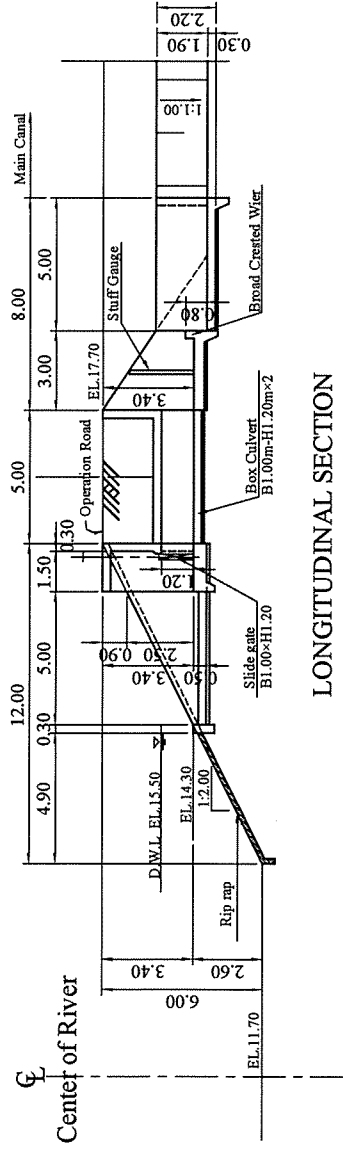
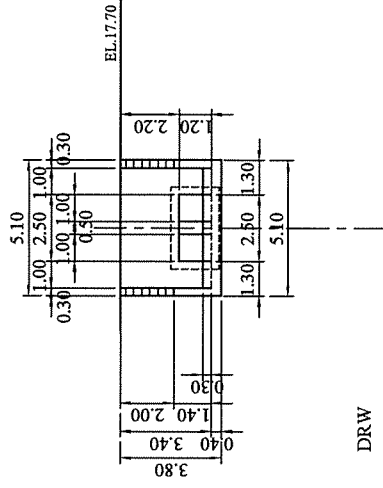
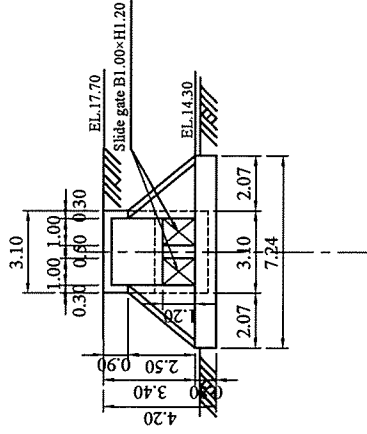
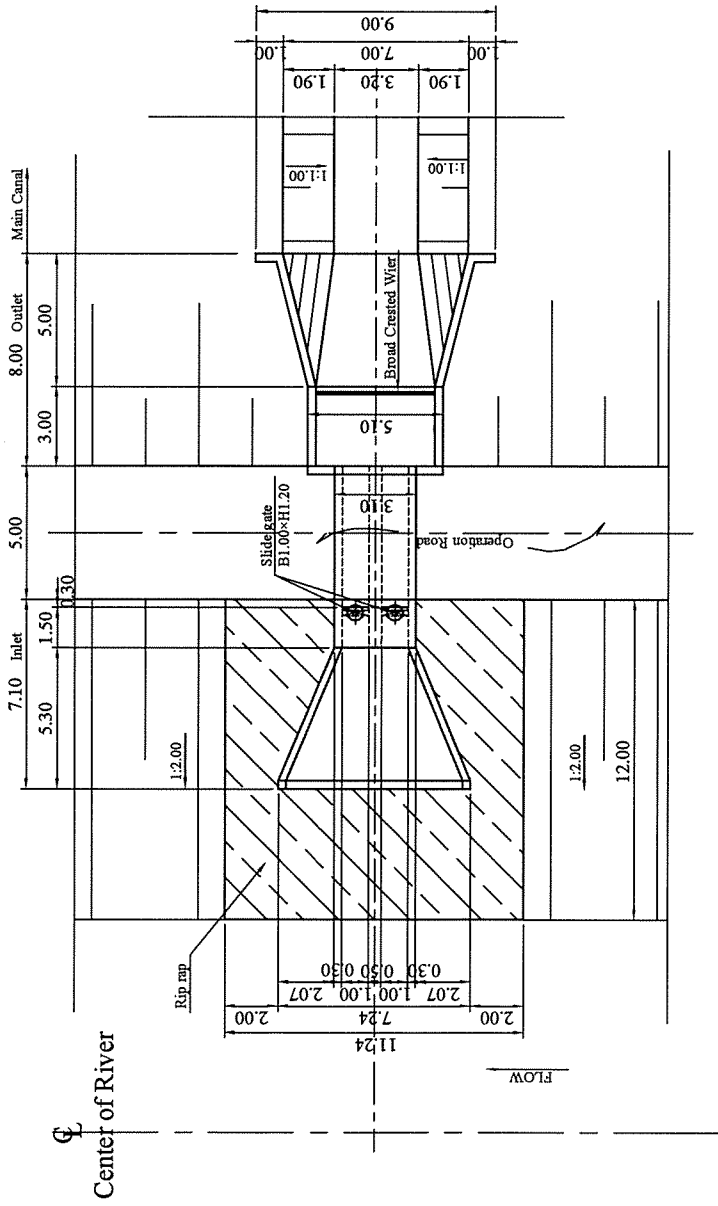
RIVER SECTION



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	B - 05
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)			
Section of Moung Russei Headworks (2/2)		Drawing Title	

INTAKE OF MOUNG RUSSEI HEADWORKS

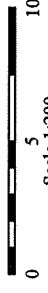
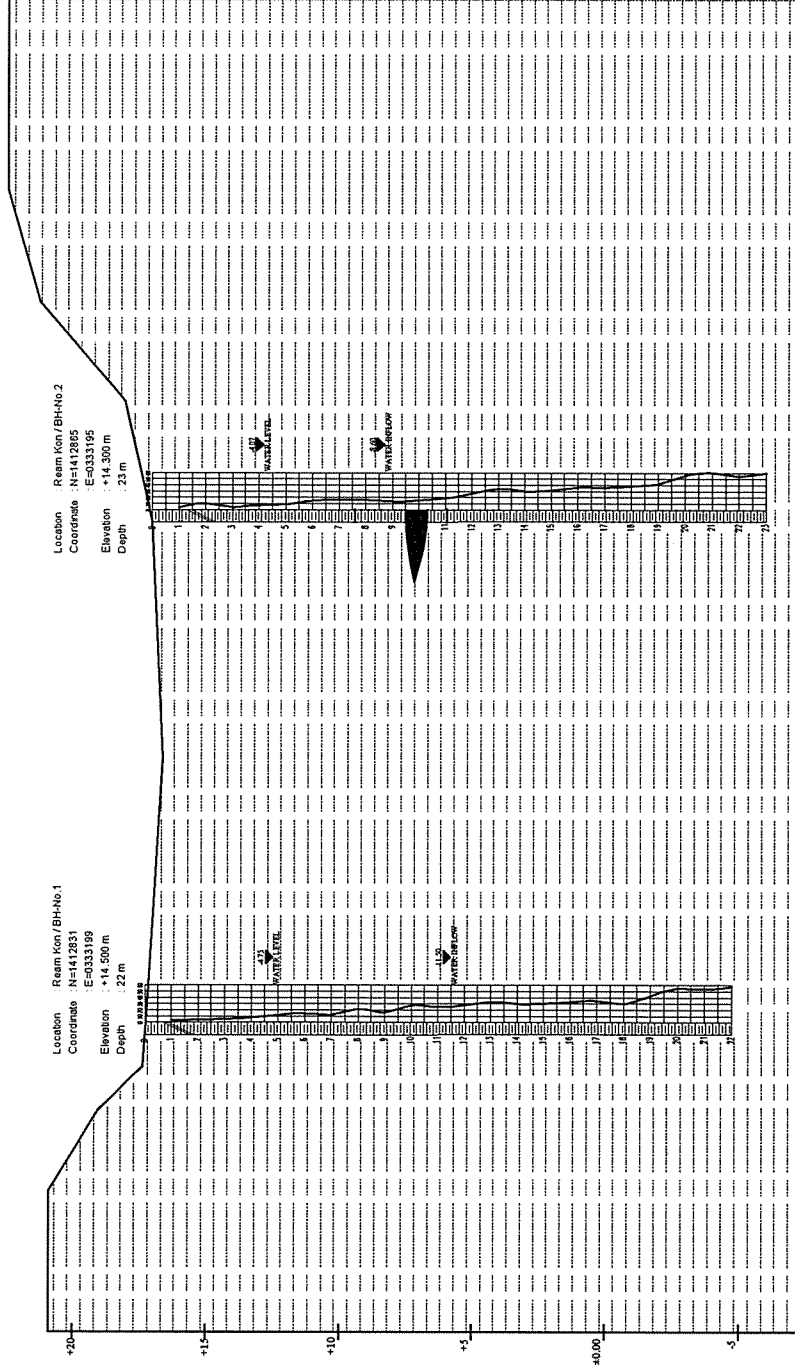
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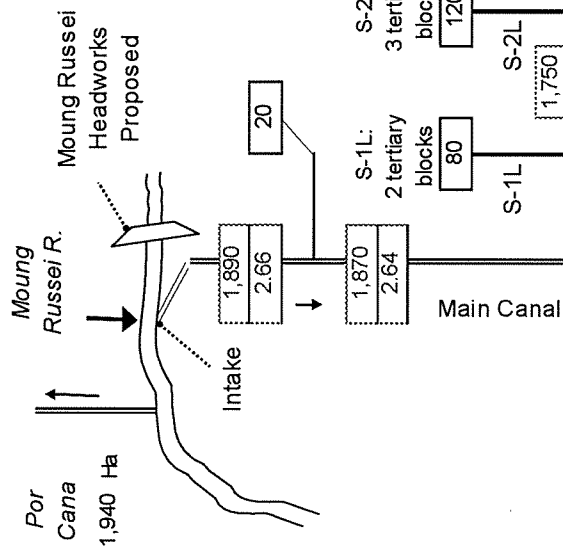
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	B - 06
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Intake of MOUNG Russei Headworks

GEOLOGICAL PROFILE OF MOUNG RUSSEI HEADWORKS

Scale 1:200



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No.	B - 07
		Drawing Title	Geological Profile of MOUNG RUSSEI Headworks



Construction Length of Canals in kilometer

Main Canal:	9.9
Secondary/Sub-secondary Canals (S/SS)	
Secondary Canal	
S-1L:	0.7
S-2L:	0.9
S-3L:	1.5
S-4L:	2.0
S-5L:	3.0
S-3R:	1.4
S-4R:	1.4
S-5R:	1.4
Sub-secondary Canal	
S-1R:	0.6
S-2R:	0.6
SS-5L:	2.6
Total of Secondary/Sub-secondary Canals:	17.5
Number of tertiary blocks:	45

Unit irr. Req.= 1.41 lit/sec/ha

Main canal

Secondary(S)

Sub-secondary canals (SS)

Tertiary canal(s)

Secondary or tertiary blocks branch from main canal, Irrigation area in Ha

(**) means pump irrigation area in Ha

Irrigation area in Ha

Design discharge of canal in m³/sec

1,890
(130)

1,890
1.89

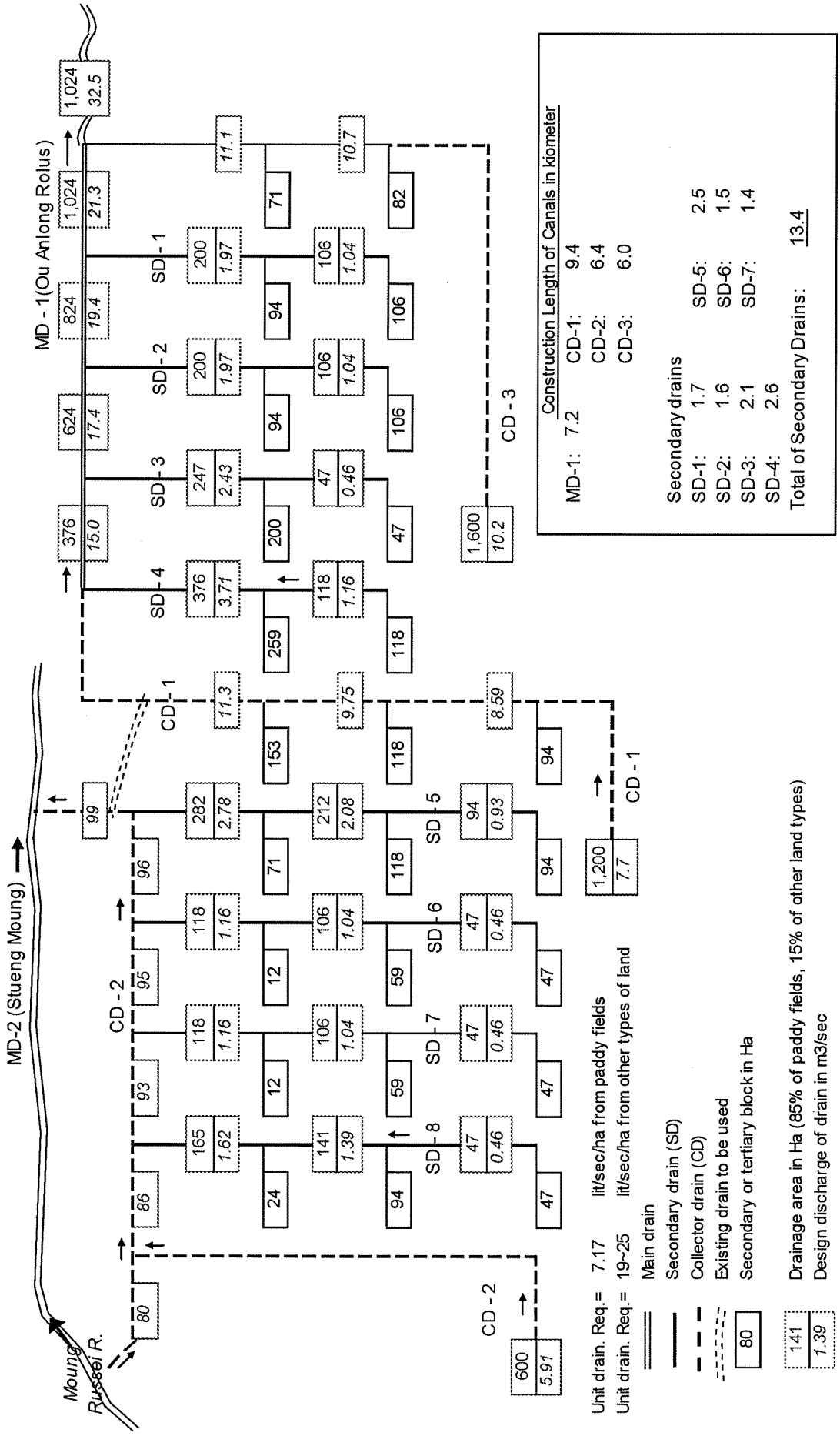
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT

B - 08

Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Irrigation Diagram of Ream Kon Sub-Project



Construction Length of Canals in Kilometer	
MD-1:	7.2
CD-1:	9.4
CD-2:	6.4
CD-3:	6.0

Secondary drains	
SD-1:	1.7
SD-2:	1.6
SD-3:	2.1
SD-4:	2.6
SD-5:	2.5
SD-6:	1.5
SD-7:	1.4
SD-8:	2.6

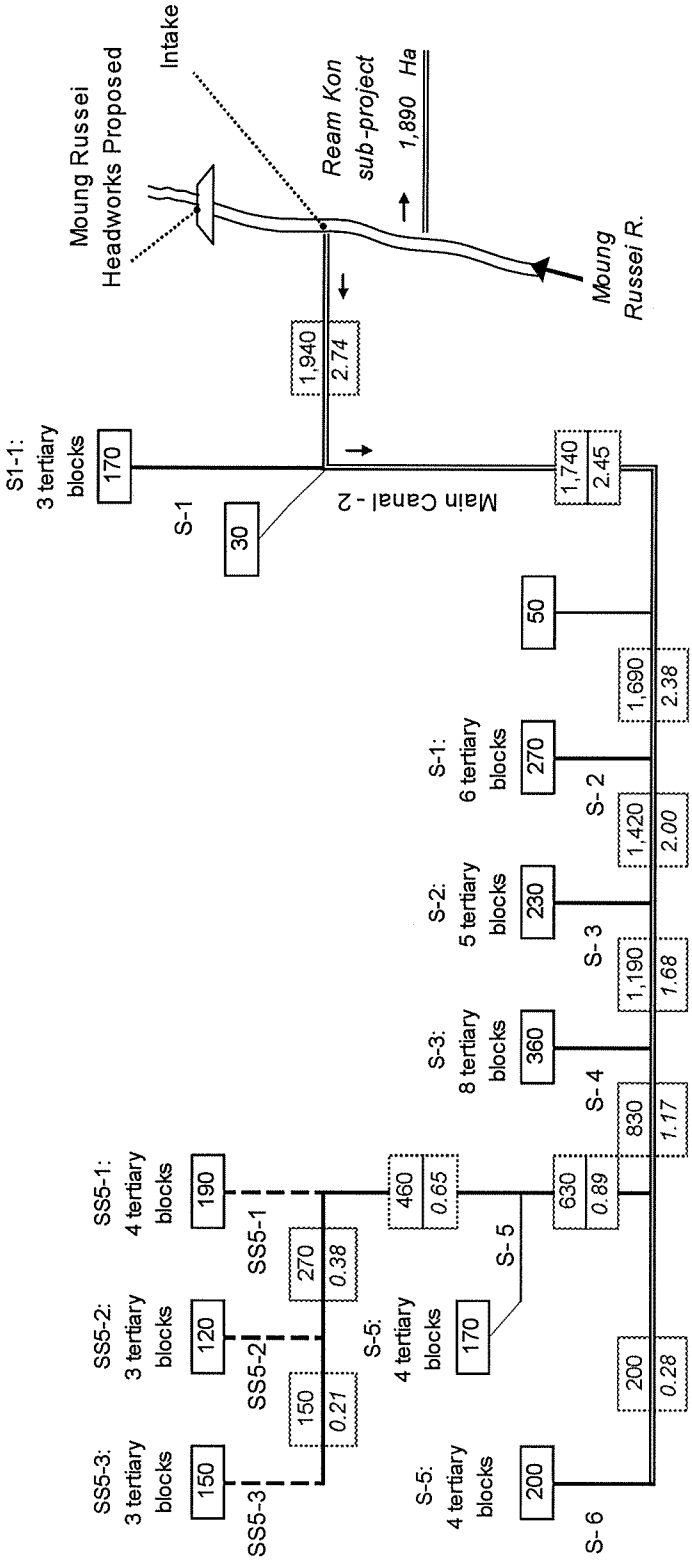
Total of Secondary Drains: 13.4

Unit drain. Req. = 7.17 lit/sec/ha from paddy fields
 Unit drain. Req. = 19-25 lit/sec/ha from other types of land

Main drain
 Secondary drain (SD)
 Collector drain (CD)
 Existing drain to be used
 Secondary or tertiary block in Ha

Drainage area in Ha (85% of paddy fields, 15% of other land types)
 Design discharge of drain in m³/sec

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	B - 09
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Drainage Diagram of Ream Kon Sub-Project



Construction Length of Canals in kilometer

Main Canal: 6.8

Secondary Canals	Sub-Secondary Canals
S-1: 1.7	S-5 3.8
S-2: 2.4	SS4-1 1.6
S-3: 2.0	SS4-2 1.7
S-4: 2.9	SS4-3 1.5

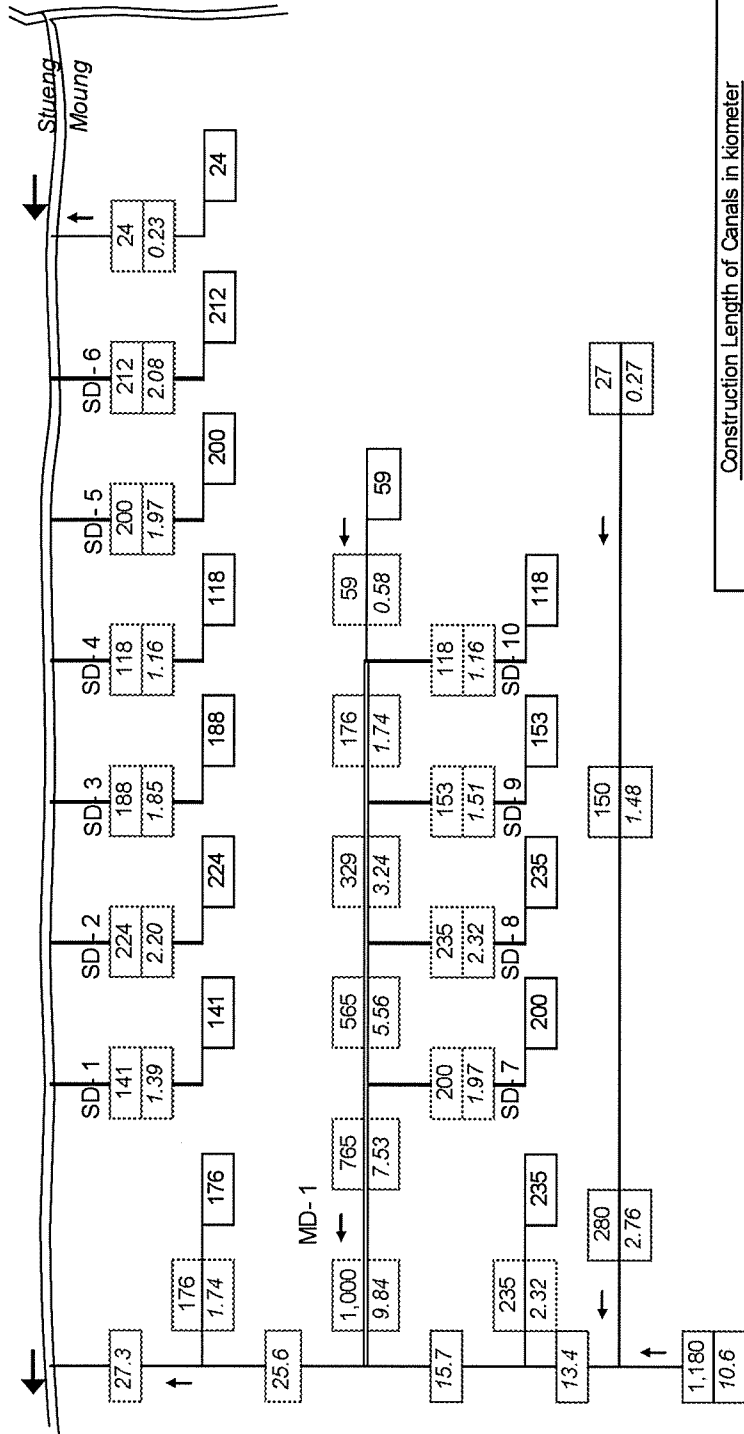
Total of Secondary/Sub-secondary Canals : 19.1

Number of tertiary blocks: 42

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. B - 11

Drawing Title Irrigation Diagram of Por Canal Sub-Project



Unit drain. Req.= 7.17 lit/sec/ha from paddy fields
 Unit drain. Req.= 19-25 lit/sec/ha from other types of land
 Main drain
 Secondary drain (SD)
 Through Existing side ditch
 Secondary or tertiary block in Ha
 80
 235
 2.32

Drainage area in Ha (85% of paddy fields, 15% of other land types)

Design discharge of drain in m³/sec

Construction Length of Canals in kilometer

MD-1: 5.6

Secondary drains

SD-1: 1.7
 SD-2: 1.8
 SD-3: 1.9
 SD-4: 1.1
 SD-5: 1.2
 SD-6: 1.8
 SD-7: 1.5
 SD-8: 1.5
 SD-9: 1.4
 SD-10: 0.9

Total of Secondary Drains: 14.8

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT

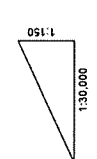
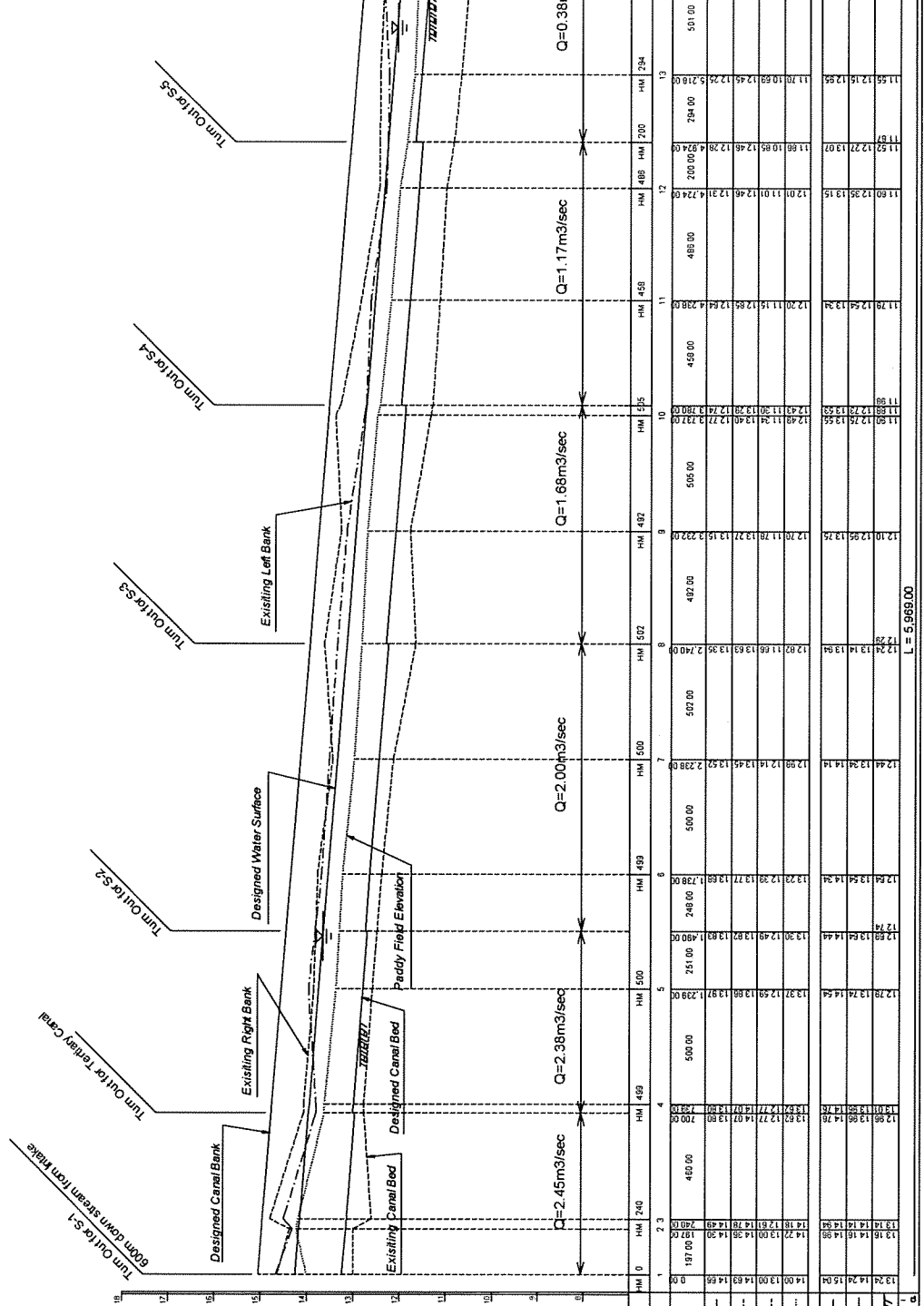
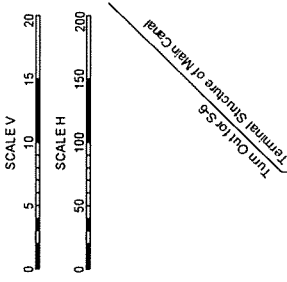
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

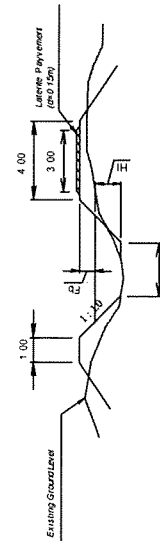
B - 12

Drawing Title

Drainage Diagram of Por Canal Sub-Project



PROFILE NUMBER	HM 0	HM 240	HM 489	HM 499	HM 500	HM 502	HM 492	HM 495	HM 458	HM 488	HM 200	HM 294	HM 501	HM 240
ACCUMULATED DISTANCE	0.00	197.00	480.00	700.00	920.00	1140.00	1360.00	1580.00	1800.00	2020.00	2240.00	2460.00	2680.00	2900.00
EXISTING LEFT BANK LEVEL	13.24	13.14	13.12	13.10	13.08	13.06	13.04	13.02	13.00	12.98	12.96	12.94	12.92	12.90
EXISTING RIGHT BANK LEVEL	14.18	14.08	14.06	14.04	14.02	14.00	13.98	13.96	13.94	13.92	13.90	13.88	13.86	13.84
EXISTING CANAL BED LEVEL	14.22	14.12	14.10	14.08	14.06	14.04	14.02	14.00	13.98	13.96	13.94	13.92	13.90	13.88
EXISTING CANAL BED LEVEL	14.00	13.90	13.88	13.86	13.84	13.82	13.80	13.78	13.76	13.74	13.72	13.70	13.68	13.66
GROUND LEVEL IN CENTER LINE	14.00	13.90	13.88	13.86	13.84	13.82	13.80	13.78	13.76	13.74	13.72	13.70	13.68	13.66
BANK LEVEL	13.24	13.14	13.12	13.10	13.08	13.06	13.04	13.02	13.00	12.98	12.96	12.94	12.92	12.90
DESIGN WATER LEVEL	13.24	13.14	13.12	13.10	13.08	13.06	13.04	13.02	13.00	12.98	12.96	12.94	12.92	12.90
BED LEVEL	13.24	13.14	13.12	13.10	13.08	13.06	13.04	13.02	13.00	12.98	12.96	12.94	12.92	12.90
ALIGNMENT	13.24	13.14	13.12	13.10	13.08	13.06	13.04	13.02	13.00	12.98	12.96	12.94	12.92	12.90
L = 5,969.00														



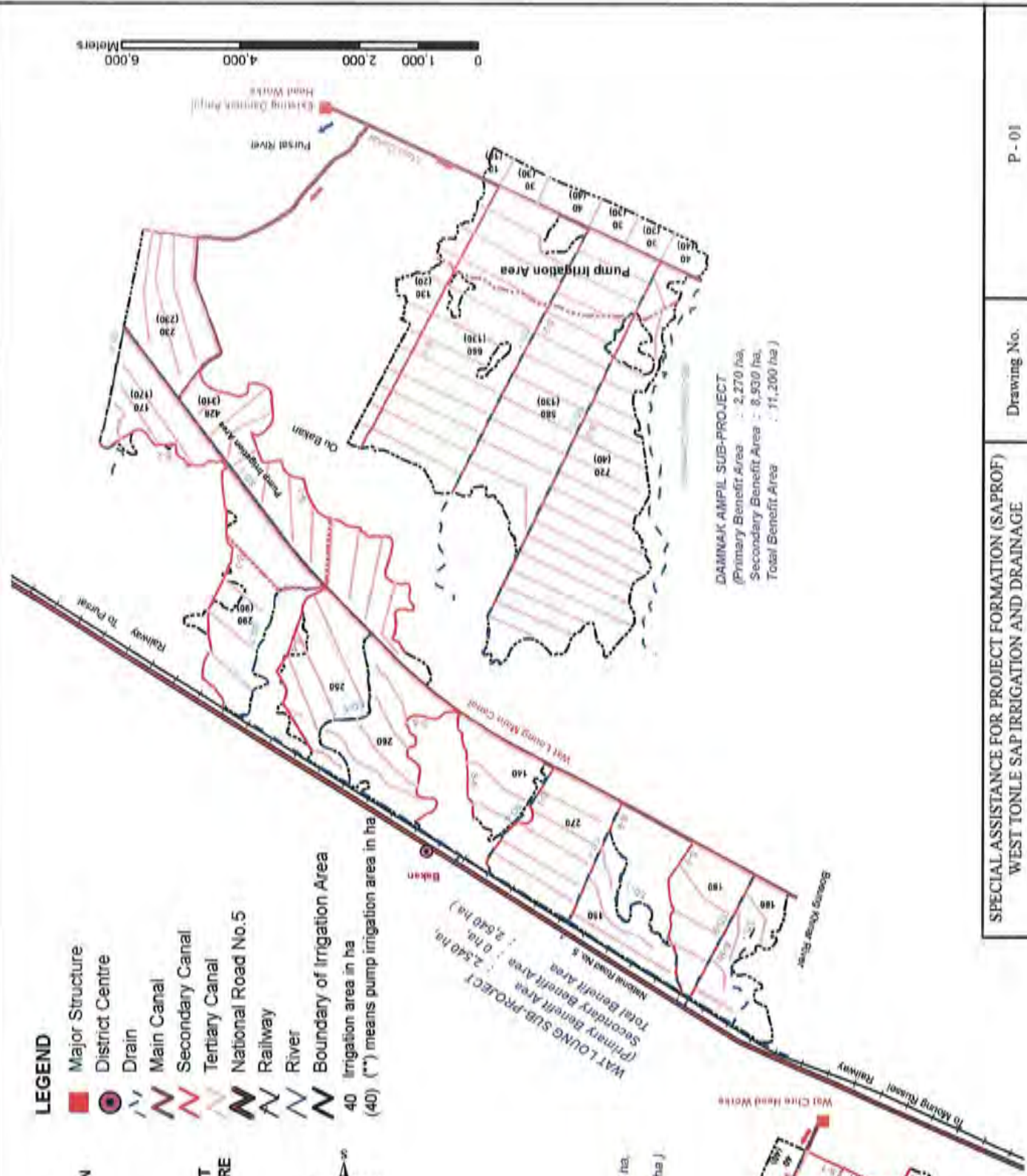
SPECIAL ASSISTANCE FOR PROJECT FORMATION FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT IN THE KINGDOM OF CAMBODIA UNDER JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) IRRIGATION AND DRAINAGE CANAL LAYOUT OF DAMNAK AMPIL, WAT LOUNG AND WAT CHRE REHABILITATION SUB-PROJECT

COORDINATE SYSTEM
 Projection: UTM
 Zone: 48
 Horizontal datum: Indian 1960
 Vertical datum: MSL at Ha Tien z
 Spheroid: Everest
 Grid line: 2 Km



LEGEND

- Major Structure
- District Centre
- Drain
- Main Canal
- Secondary Canal
- Tertiary Canal
- National Road No.5
- Railway
- River
- Boundary of Irrigation Area
- Irrigation area in ha
- (40) (**) means pump irrigation area in ha



DAMNAK AMPIL SUB-PROJECT
 (Primary Benefit Area : 2,270 ha,
 Secondary Benefit Area : 8,930 ha,
 Total Benefit Area : 11,200 ha)

WAT LOUNG SUB-PROJECT
 (Primary Benefit Area : 2,540 ha,
 Secondary Benefit Area : 0 ha,
 Total Benefit Area : 2,540 ha)

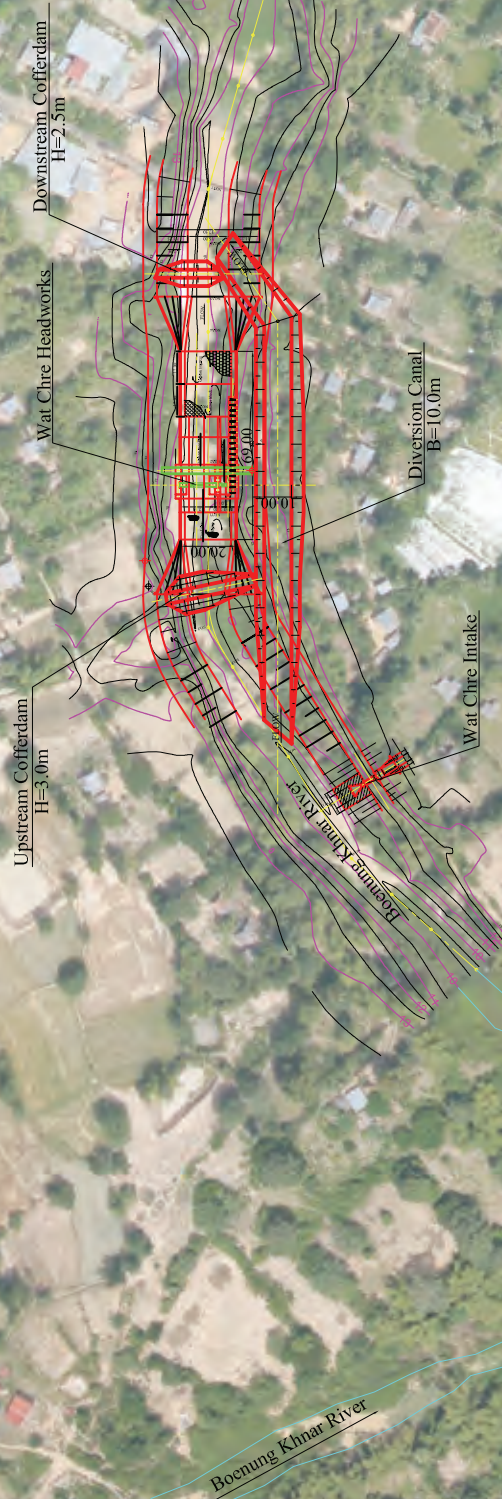
WAT CHRE SUB-PROJECT
 (Primary Benefit Area : 1,020 ha,
 Secondary Benefit Area : 0 ha,
 Total Benefit Area : 1,020 ha)



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)		Drawing No.	P - 01
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT			
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	General layout of Damnak Ampil Wat Loung and Wat Chre Sub-Projects

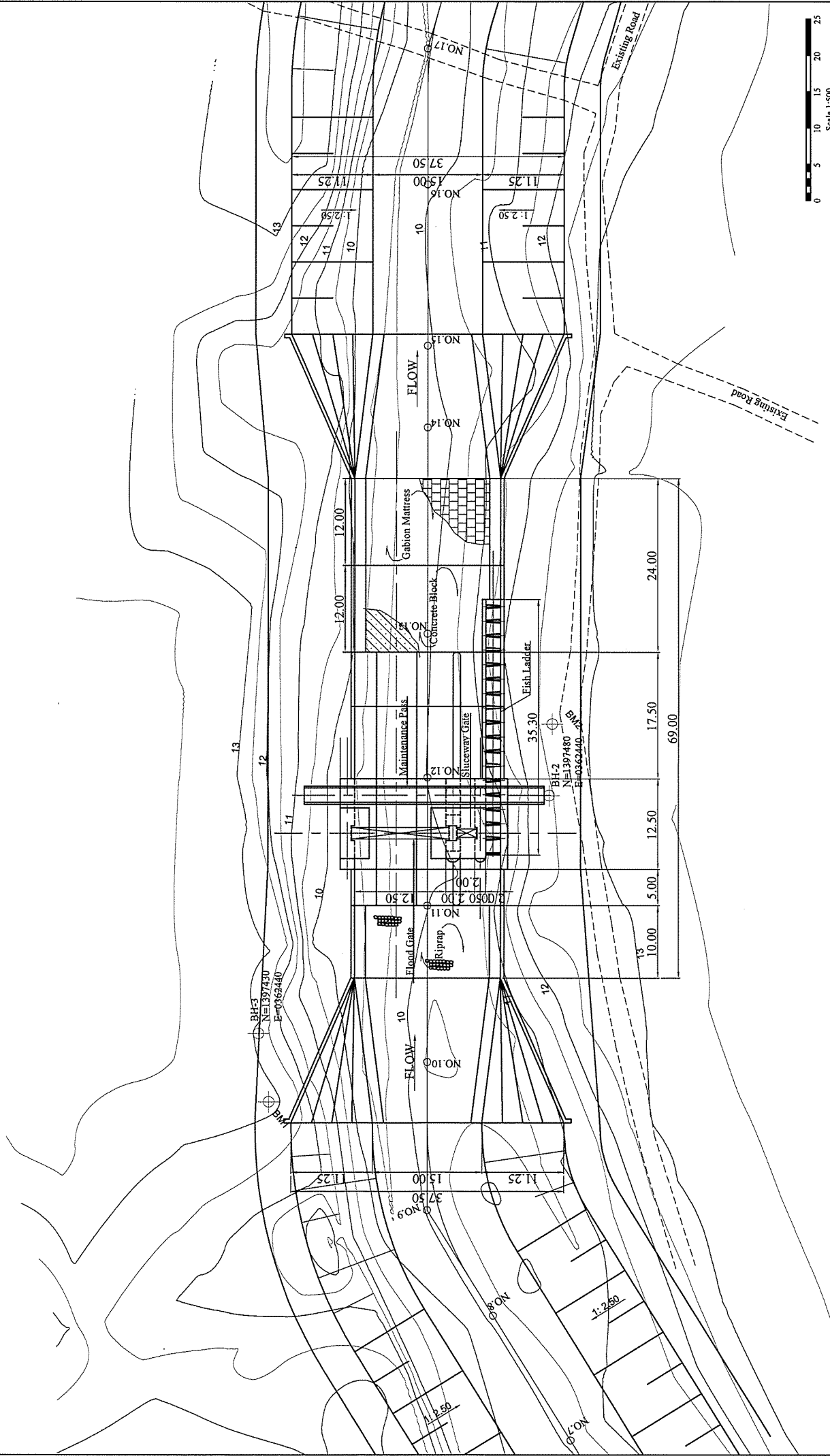
OVERVIEW OF WAT CHRE HEADWORKS SITE

Scale 1:2000



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	P - 02 - 01
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Overview of Wat Chre Headworks Site

LAYOUT OF WAT CHRE HEADWORKS



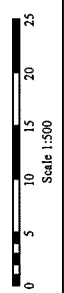
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

Drawing Title

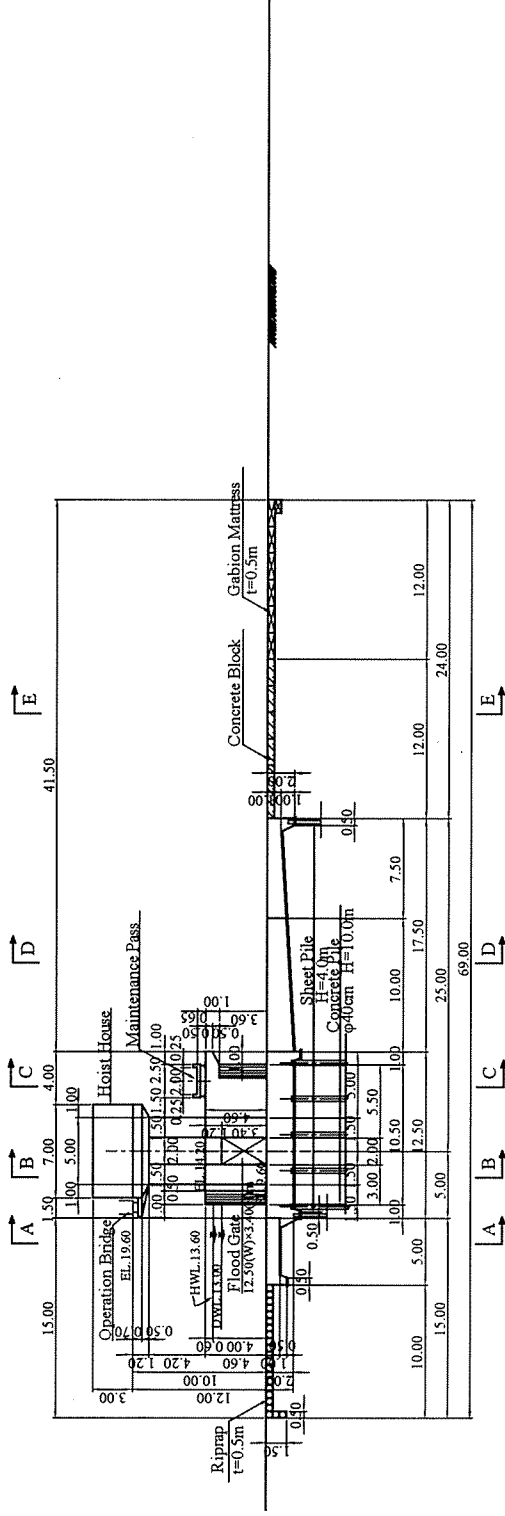
P - 02 - 02

Layout of Wat Chre Headworks

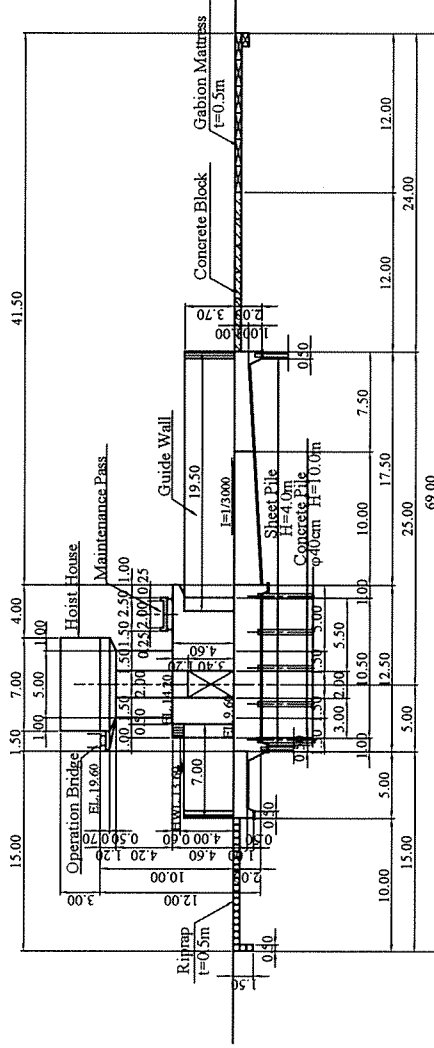


PROFILE OF WAT CHRE HEADWORKS

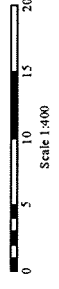
Scale 1:400



FLOOD GATE SECTION



SLUICWAY GATE SECTION



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

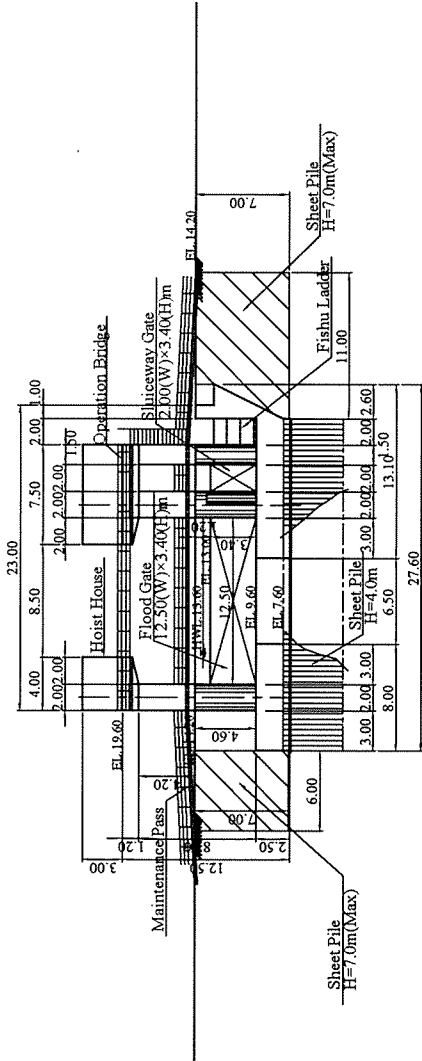
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. P-03

Drawing Title Profile of Wat Chre Headworks

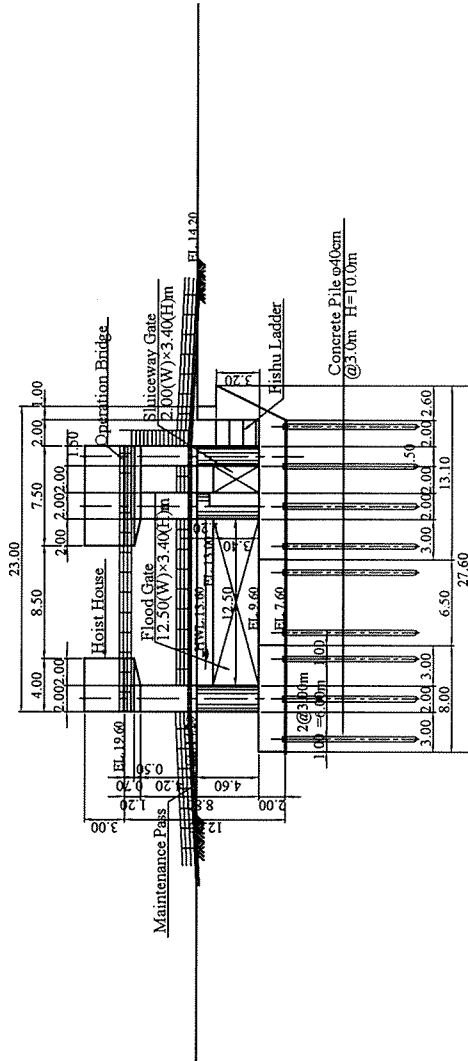
SECTION

Scale 1:400

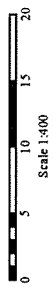


SECTION A-A

(P1) (P2) (P3)



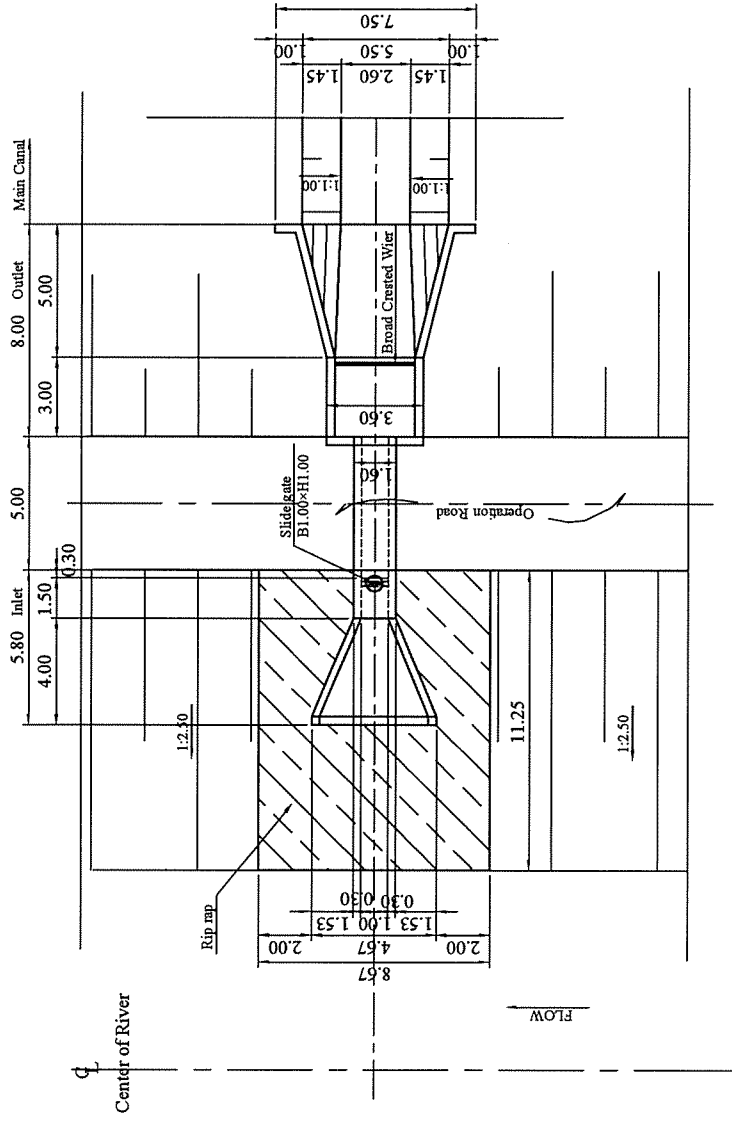
SECTION B-B



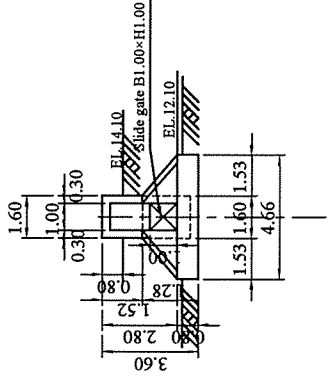
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No. P - 04
Drawing Title Section of Wat Chre Headworks (1/2)		

INTAKE OF WAT CHRE HEADWORKS

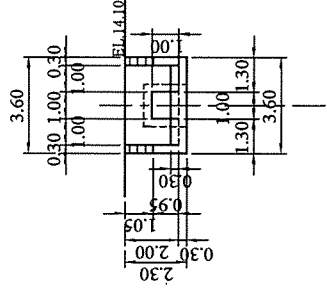
Scale 1:200



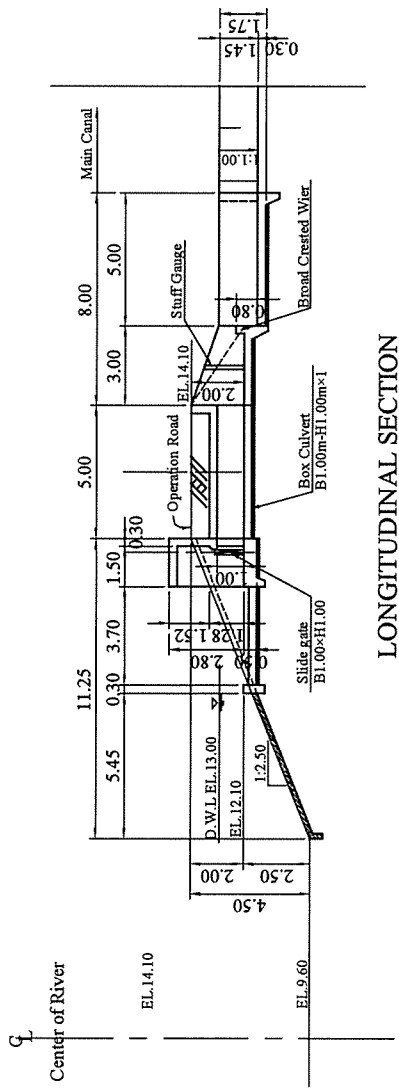
PLAN



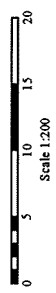
ELEVATION of INLET



ELEVATION of OUTLET



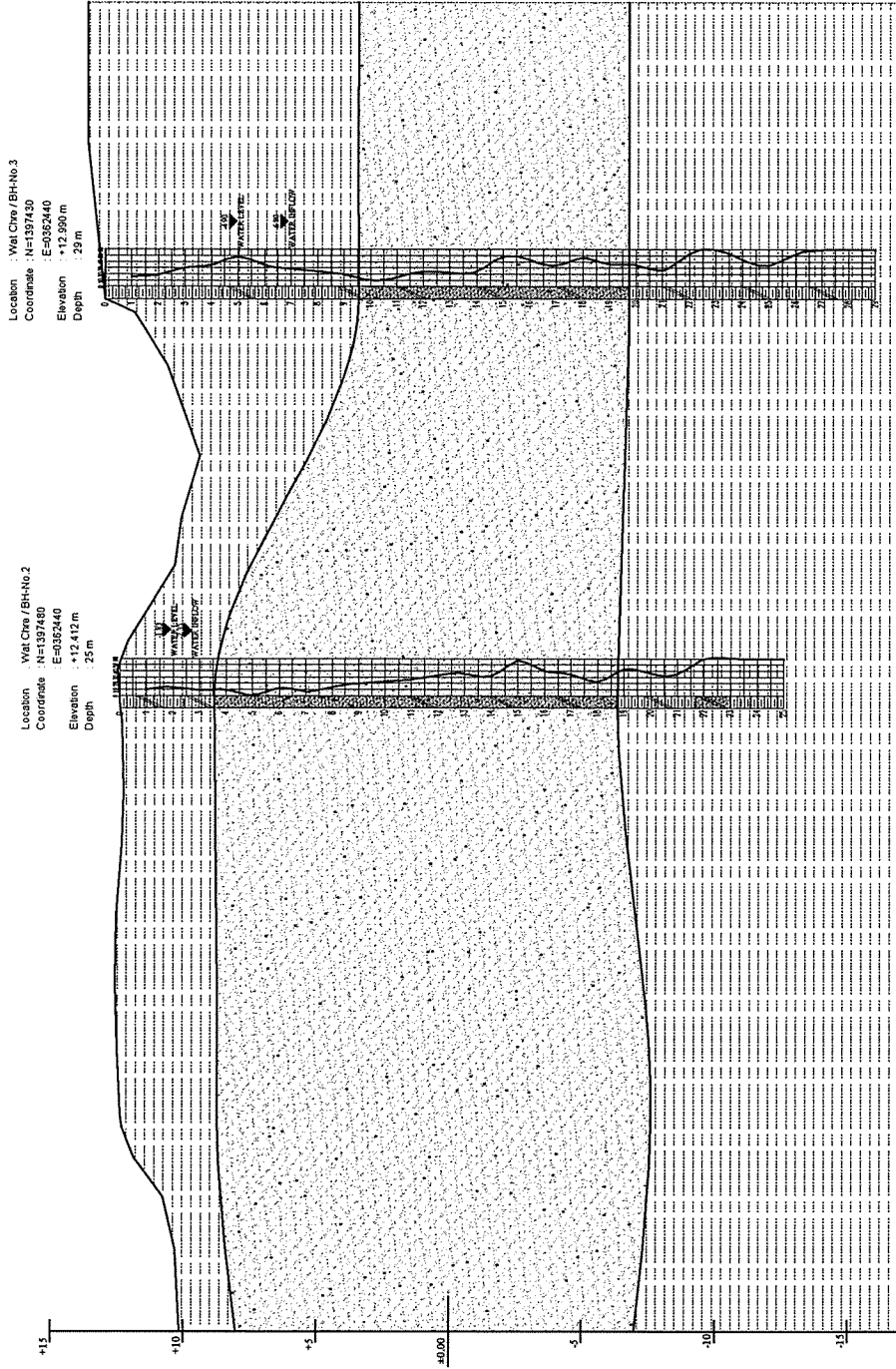
LONGITUDINAL SECTION



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No.	P - 06
		Drawing Title	Intake of Wat Chre Headworks

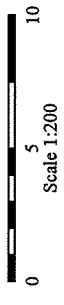
GEOLOGICAL PROFILE OF WAT CHRE HEADWORKS

Scale 1:200



Location : Wat Chre / BH-No.3
 Coordinate : N=1397430
 E=0382440
 Elevation : +12.980m
 Depth : 29m

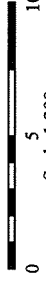
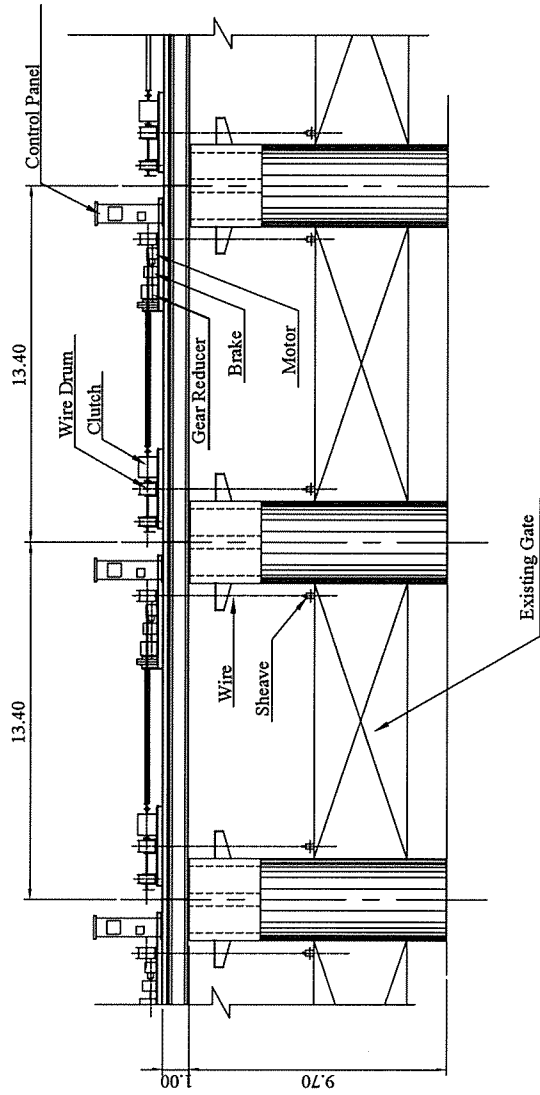
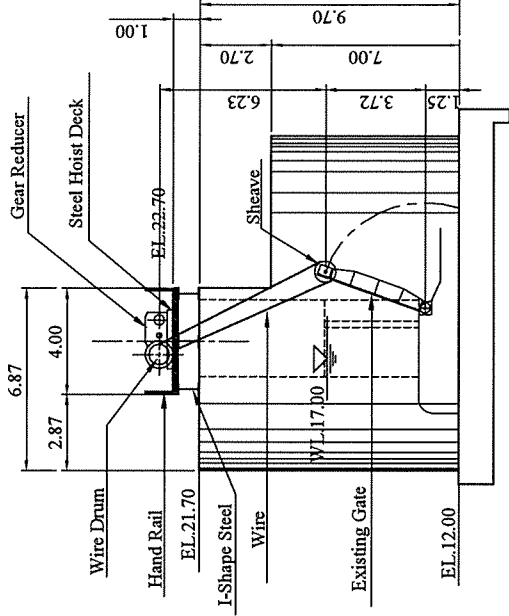
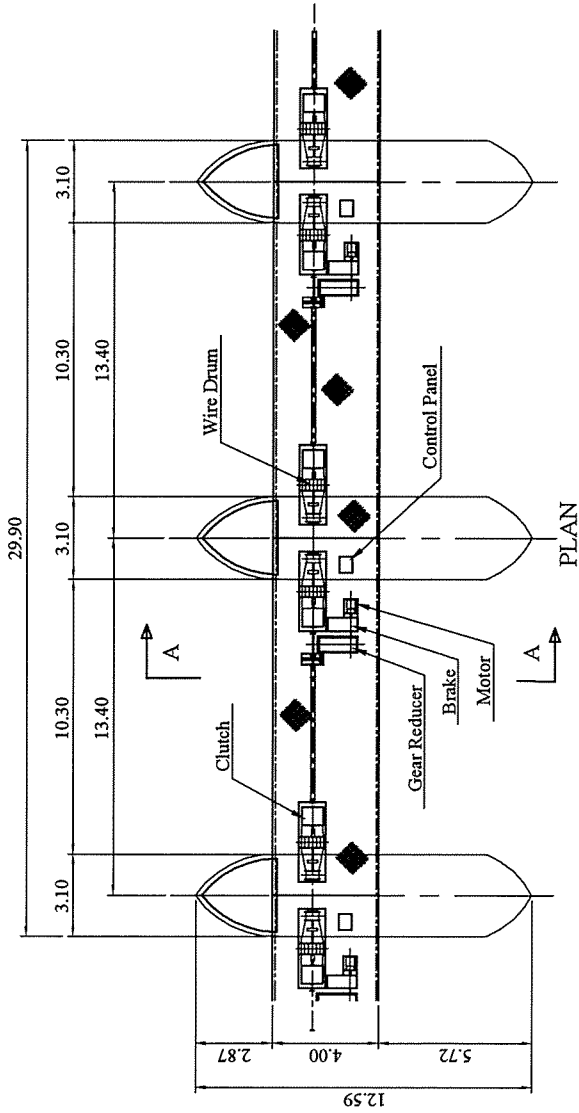
Location : Wat Chre / BH-No.2
 Coordinate : N=1397480
 E=0382440
 Elevation : +12.412 m
 Depth : 25 m



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No. P - 07
		Drawing Title Geological Profile of Wat Chre Headworks

HOISTING SYSTEM FOR FOOLD GATE

Scale 1:200



Total Number of Gate : 7

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. P - 08

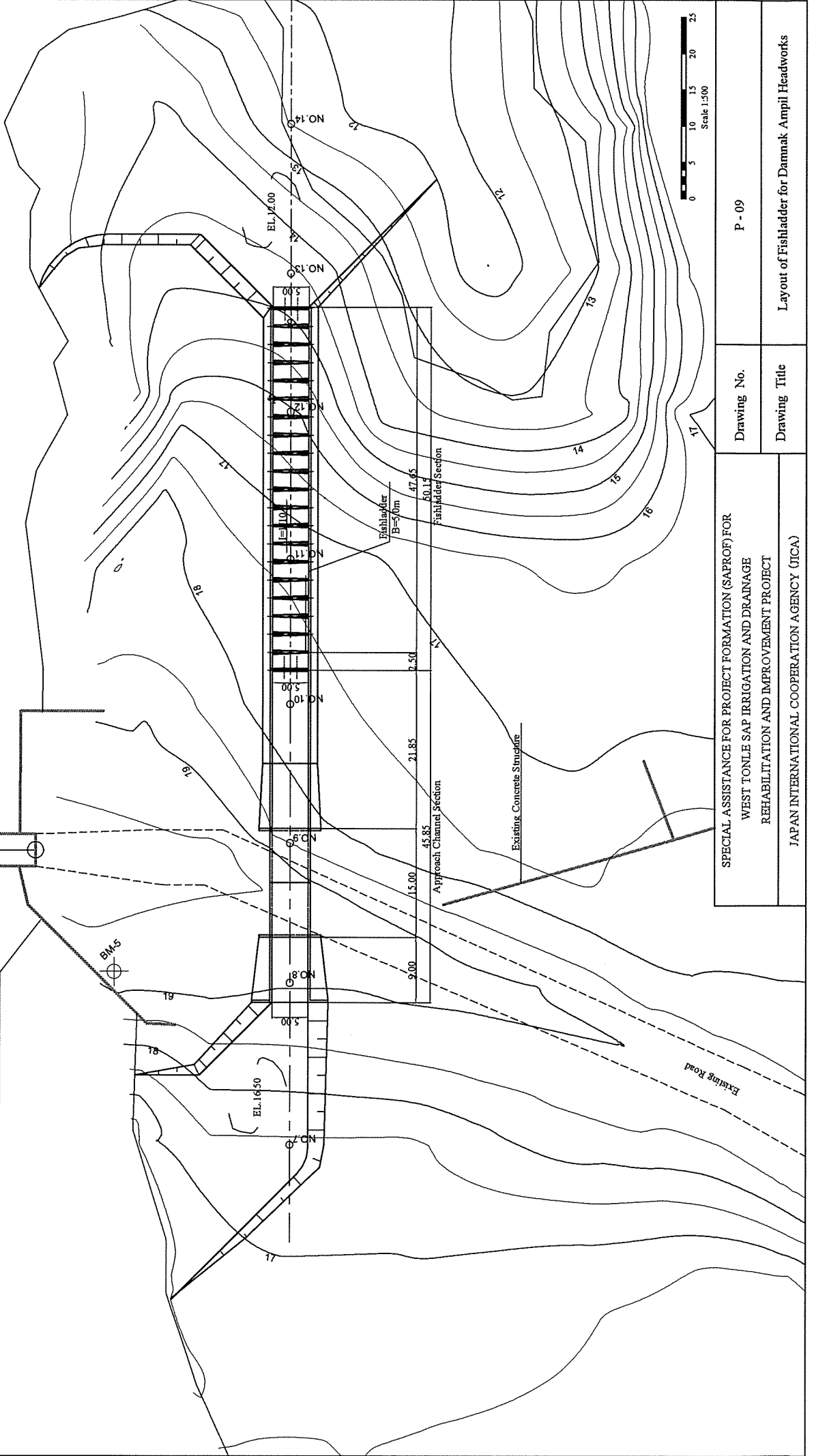
Drawing Title Hoisting System for Flood Gate (Electric Type)

LAYOUTPLAN OF FISHLADDER FOR DAMNAK AMPIL HEADWORKS

Scale 1:500

Existing Damnak Ampil Headworks

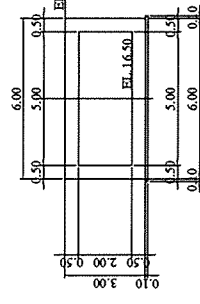
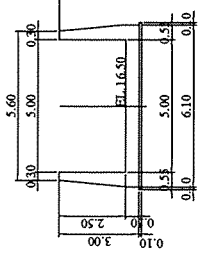
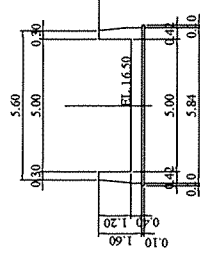
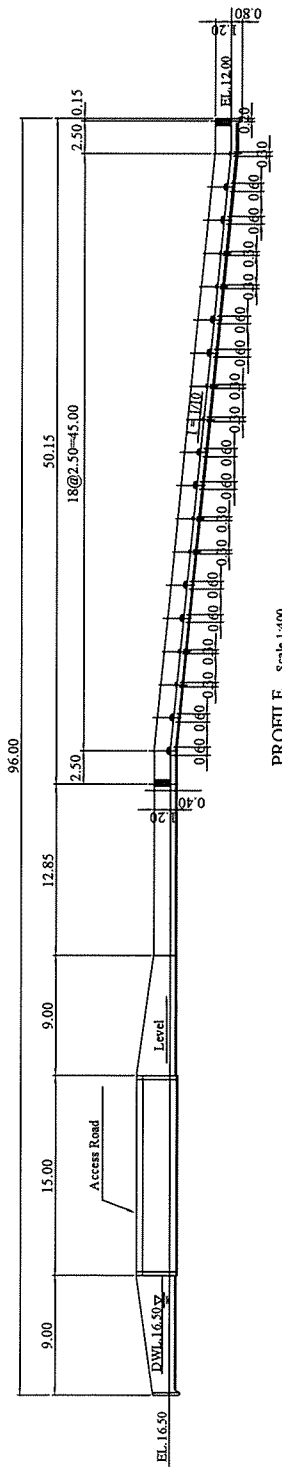
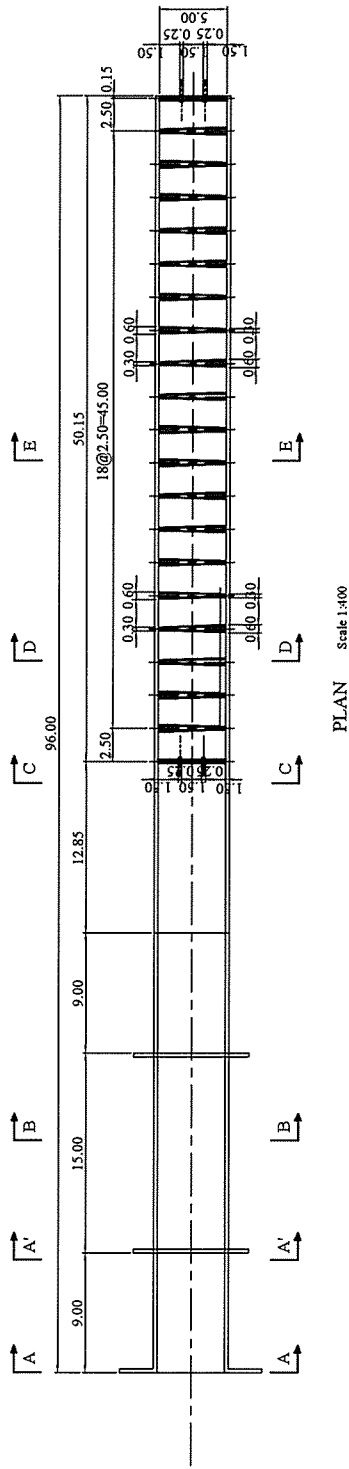
Existing Concrete Structure



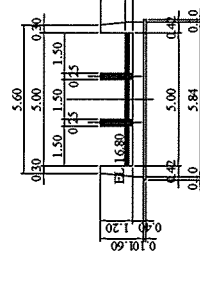
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. P-09
 Drawing Title Layout of Fishladder for Damnak Ampil Headworks

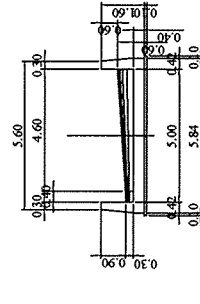
SECTION OF FISHLADDER FOR DAMNAK AMPIL



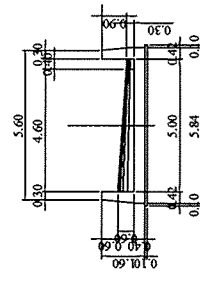
SECTION B-B Scale 1:200



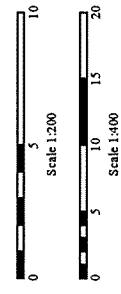
SECTION C-C Scale 1:200



SECTION D-D Scale 1:200

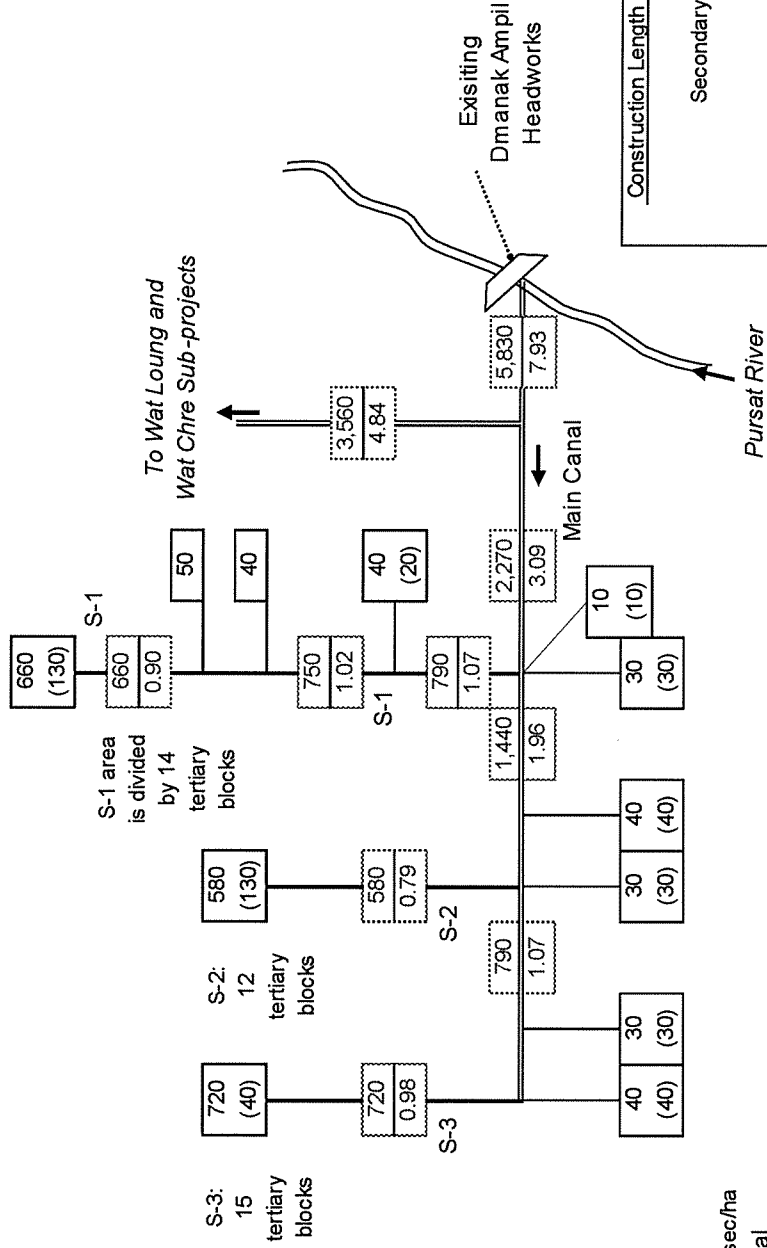


SECTION E-E Scale 1:200



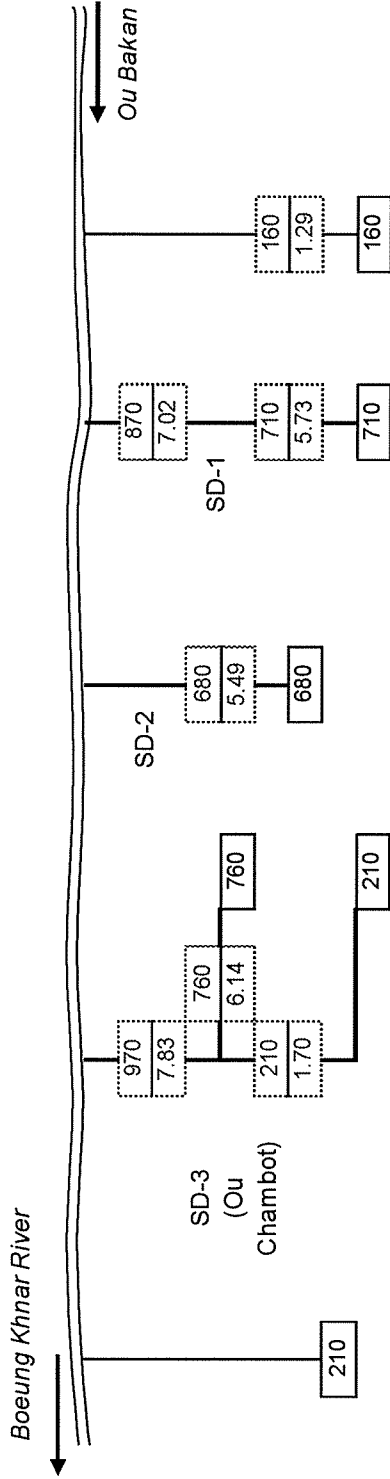
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.	P - 10	
Drawing Title	Section of Fishladder for Damnak Ampil Headworks	



Unit irr. Req.= 1.36 lit/sec/ha
 Main canal
 Secondary/sub-secondary canals (S / SS)
 Tertiary canal(s)
 Secondary or tertiary blocks branch from main canal, Irrigation area in Ha
 (***) means pump irrigation area in Ha
 Irrigation area in Ha
 Design discharge of canal in m³/sec

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	P - 11
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Irrigation Diagram of Dammak Ampil Sub-Project



Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
 Unit drain. Req.= 18~25 lit/sec/ha from other types of land

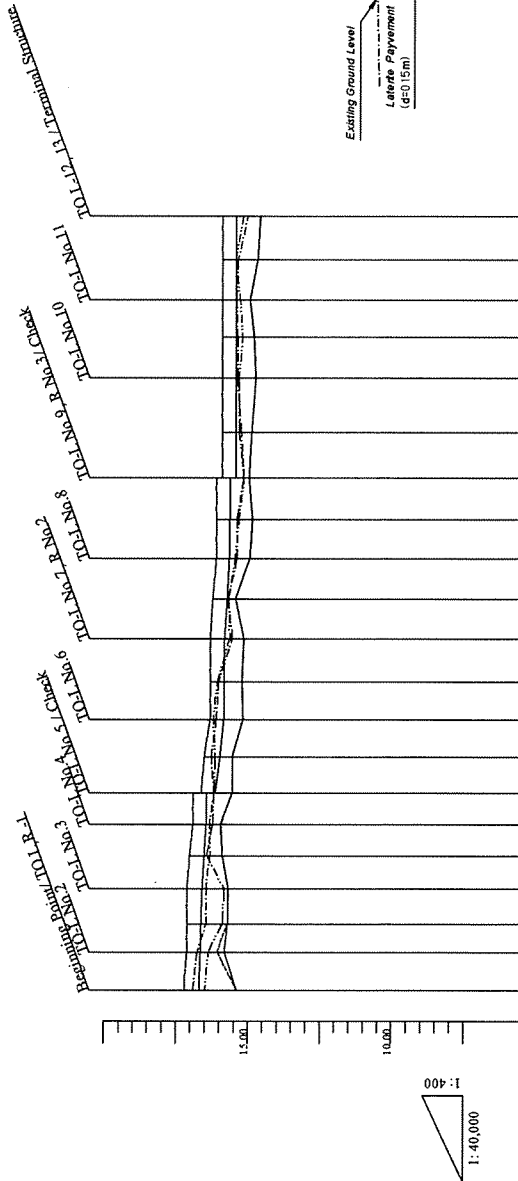
- ==== Main drain
- ==== Secondary drain
- Through Existing side ditch
- 80 Secondary or tertiary block in Ha

1,060
 9.55
 Drainage area in Ha (85% of paddy fields, 15% of other land types)
 Design discharge of drain in m³/sec

Construction Length of Canals in kilometer
 Secondary Drains

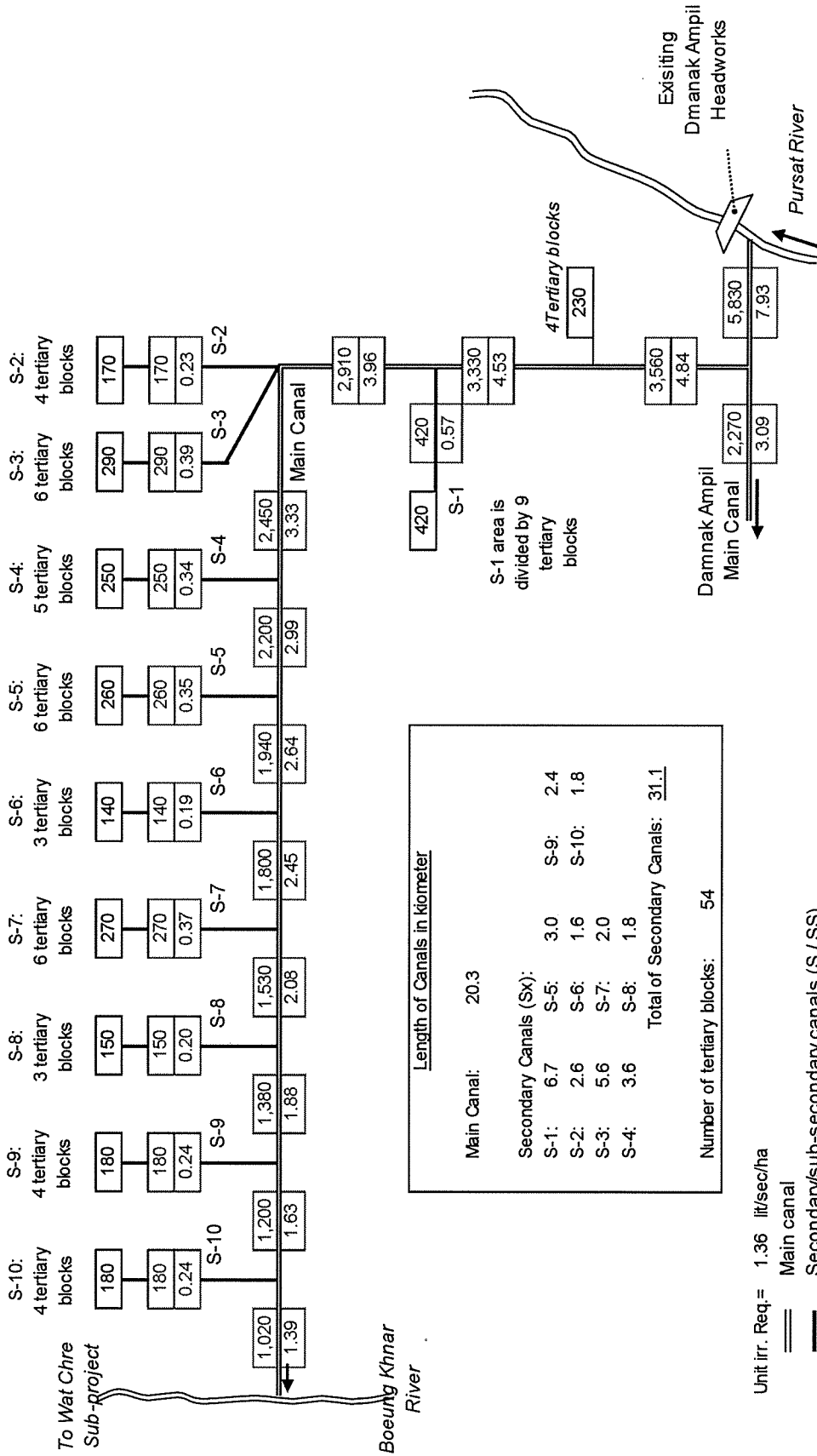
SD-1: 6.8
 SD-2: 7.8
 SD-3: 7.2
 Total of Secondary Drains: 21.8

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	P - 12
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Drainage Diagram of Damnak Ampil Sub-Project



Station No.	Distance (m)	Accumulated Distance (m)	Existing					Design						
			Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)	Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)		
BP/No.1	0.00	0.00	15.38	16.89	16.47	15.38	16.68	17.20	17.10	17.10	16.64	15.80	16.64	17.10
No.2	267.50	267.50	16.05	16.75	16.35	15.80	16.64	17.10	17.10	16.61	15.70	16.61	17.10	17.10
No.3	464.00	464.00	15.70	16.42	15.88	15.70	16.61	17.10	17.10	16.57	15.67	16.57	17.10	17.10
No.4	707.93	707.93	15.67	16.44	15.81	15.67	16.57	17.10	17.10	16.49	15.88	16.49	17.00	17.00
No.5	938.57	938.57	15.88	16.30	16.41	15.88	16.49	17.00	17.00	16.21	15.93	16.21	16.90	16.90
No.6	1155.01	1155.01	15.93	16.31	16.21	15.93	16.43	16.90	16.90	16.42	15.53	16.42	16.90	16.90
No.7	1377.50	1377.50	15.53	16.16	16.16	15.53	16.42	16.90	16.90	16.42	15.54	16.42	16.90	16.90
No.8	1625.62	1625.62	15.54	16.26	16.12	15.54	15.96	16.50	16.50	16.12	15.54	15.96	16.50	16.50
No.9	1884.04	1884.04	15.16	16.09	16.19	15.16	15.83	16.30	16.30	16.19	15.16	15.83	16.30	16.30
No.10	2151.48	2151.48	15.19	16.01	16.05	15.19	15.82	16.30	16.30	16.05	15.19	15.82	16.30	16.30
No.11	2450.60	2450.60	15.13	15.53	15.63	15.13	15.80	16.30	16.30	15.63	15.13	15.80	16.30	16.30
No.12	2726.35	2726.35	15.42	15.68	15.66	15.42	15.72	16.20	16.20	15.66	15.42	15.72	16.20	16.20
No.13	3010.12	3010.12	14.93	15.37	15.44	14.93	15.64	16.10	16.10	15.44	14.93	15.64	16.10	16.10
No.14	3282.91	3282.91	14.84	15.37	15.30	14.84	14.93	16.10	16.10	14.84	15.37	14.84	16.10	16.10
No.15	3572.16	3572.16	14.96	15.14	15.12	14.96	14.96	16.10	16.10	15.12	14.96	14.96	16.10	16.10
No.16	3892.34	3892.34	14.87	15.23	15.20	14.87	15.43	15.90	15.90	15.20	14.87	15.43	15.90	15.90
No.17	4272.93	4272.93	14.73	15.35	15.30	14.73	15.43	15.90	15.90	15.30	14.73	15.43	15.90	15.90
No.18	4557.08	4557.08	14.79	15.36	15.18	14.79	15.43	15.90	15.90	15.18	14.79	15.43	15.90	15.90
No.19	4817.41	4817.41	14.92	15.39	15.26	14.92	14.92	15.90	15.90	15.26	14.92	14.92	15.90	15.90
No.20	5099.02	5099.02	14.67	15.33	15.43	14.67	14.67	15.90	15.90	15.43	14.67	14.67	15.90	15.90
No.21	5402.72	5402.72	14.57	15.15	15.15	14.57	14.57	15.90	15.90	15.15	14.57	14.57	15.90	15.90

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



Length of Canals in kilometer	
Main Canal:	20.3
Secondary Canals (Sx):	
S-1:	6.7
S-2:	2.6
S-3:	5.6
S-4:	3.6
S-5:	3.0
S-6:	1.6
S-7:	2.0
S-8:	1.8
S-9:	2.4
S-10:	1.8
Total of Secondary Canals: 31.1	
Number of tertiary blocks: 54	

Unit irr. Req.= 1.36 lit/sec/ha

== Main canal

— Secondary/sub-secondary canals (S / SS)

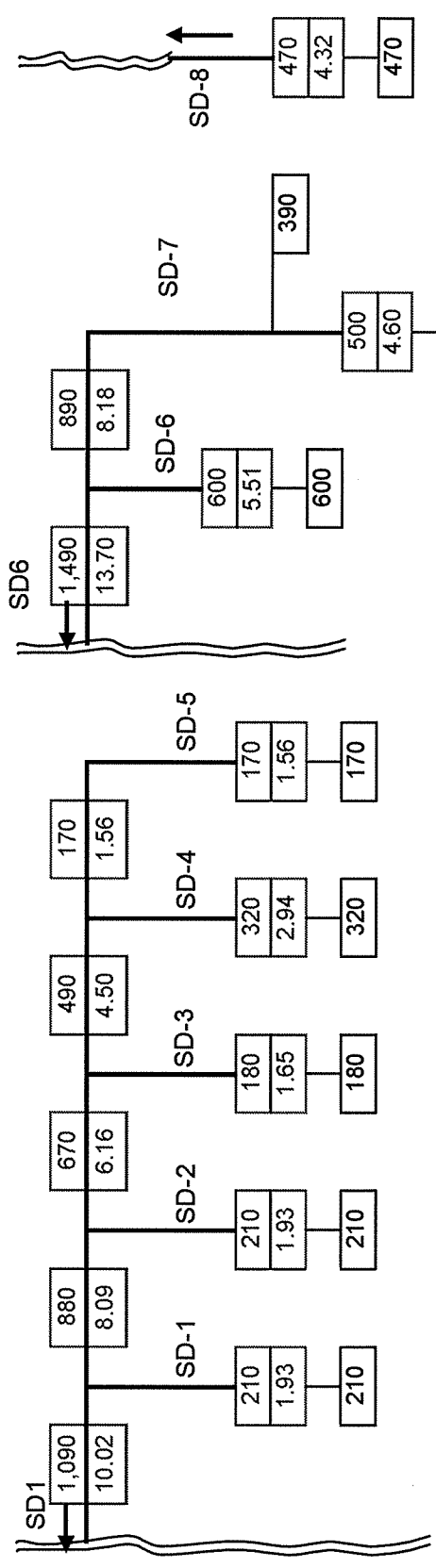
— Tertiary canal(s)

130 Secondary or tertiary blocks branch from main canal, Irrigation area in Ha

170 Irrigation area in Ha

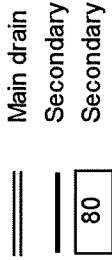
0.23 Design discharge of canal in m3/sec

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	P - 14
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Irrigation Diagram of Wat Loung Sub-Project



Boeung Khnar River

Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
 Unit drain. Req.= 18-25 lit/sec/ha from other types of land



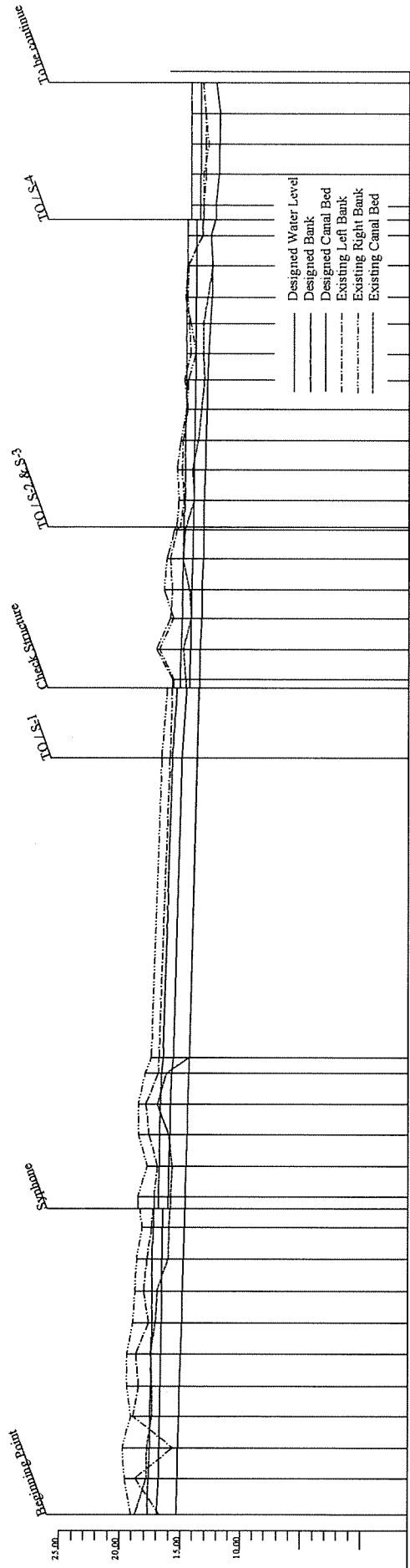
Drainage area in Ha (85% of paddy fields, 15% of other land types)
 Design discharge of drain in m³/sec



Construction Length of Canals in kilometer

Secondary drains	SD-1:	SD-2:	SD-3:	SD-4:	SD-5:	SD-6:	SD-7:	SD-8:
	2.7	3.3	4.2	4.5	3.7	6.1	9.5	3.7
Total of Secondary Drains:	37.7							

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT	Drawing No.	P - 15
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Drawing Title	Drainage Diagram of Wat Loung Sub-Project

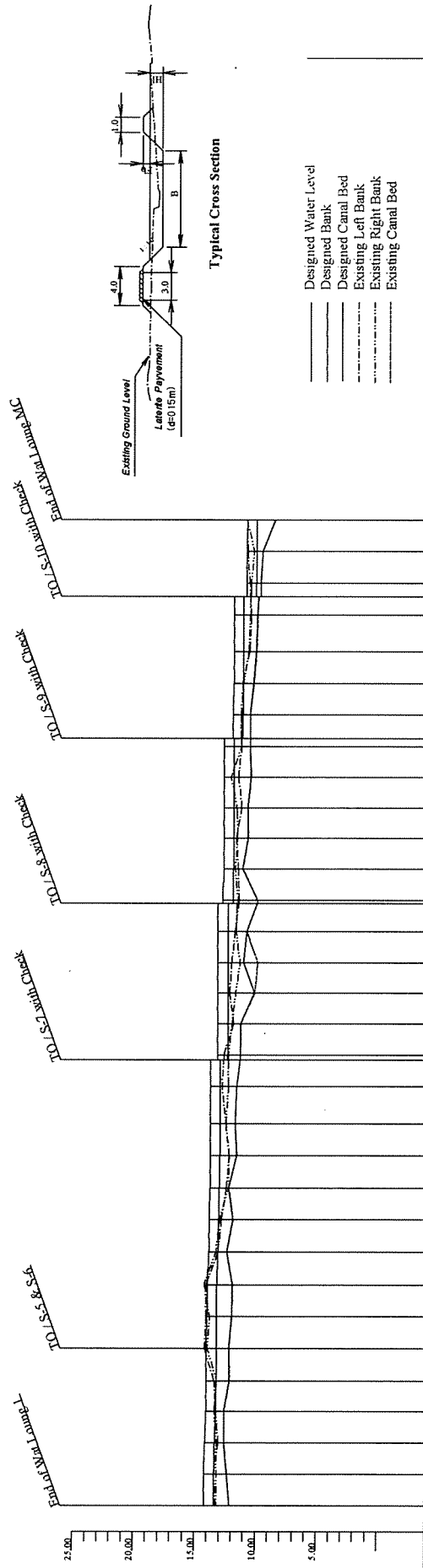


Station No.	Distance (m)	Accumulated Distance (m)	Existing					Design				
			Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)	Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)
BP/No.1	0.00	0.00	18.70	16.69	19.01	15.33	16.92	17.70	15.33	16.76	17.60	17.70
No.2	301.63	301.63	17.79	18.68	19.56	15.24	16.76	17.60	15.17	16.71	17.50	17.50
No.3	254.28	555.91	17.74	18.57	19.75	15.17	16.71	17.50	16.66	15.09	16.66	17.50
No.4	262.40	818.31	17.33	18.85	19.03	15.09	16.66	17.50	16.62	15.02	16.62	17.40
No.5	252.23	1070.64	17.34	18.39	19.37	15.02	16.62	17.40	16.57	14.94	16.57	17.30
No.6	267.97	1338.61	17.44	18.63	19.36	14.94	16.57	17.30	16.53	14.87	16.53	17.30
No.7	258.62	1597.23	17.03	17.60	18.87	14.87	16.53	17.30	16.46	14.79	16.46	17.30
No.8	267.57	1864.80	16.88	18.00	18.70	14.79	16.46	17.30	16.40	14.72	16.40	17.30
No.9	268.46	2133.26	15.98	17.73	18.56	14.72	16.40	17.30	16.36	14.64	16.36	17.20
No.10	261.41	2394.67	15.93	17.35	18.14	14.64	16.40	17.20	16.32	14.60	16.32	17.20
No.11	97.67	2492.34	15.80	17.15	18.49	14.57	16.32	17.20	16.28	14.57	16.28	17.20
No.12	257.98	2750.32	15.67	16.86	17.71	14.49	16.28	17.20	16.24	14.49	16.24	17.20
No.13	260.57	3010.89	15.95	17.58	18.43	14.42	16.24	17.20	16.20	14.42	16.20	17.20
No.14	253.68	3264.57	16.87	17.84	18.45	14.35	16.20	17.20	16.16	14.35	16.16	17.20
No.15	259.86	3524.43	16.13	16.80	17.90	14.27	16.16	17.20	16.12	14.27	16.12	17.20
No.16	130.50	3654.93	14.24	16.76	17.39	14.24	16.12	17.20	16.08	14.24	16.08	17.20
No.17	2121.00	6224.15	13.61	15.89	16.55	13.61	14.89	15.70	15.30	14.89	15.30	15.70
No.18	1590.00	6984.15	13.46	15.71	16.09	13.46	14.89	15.70	15.30	14.89	15.30	15.70
No.19	250.20	7234.35	14.82	17.00	16.75	13.38	14.89	15.70	15.30	14.89	15.30	15.70
No.20	258.64	7492.99	14.14	15.87	15.63	13.26	14.89	15.70	15.30	14.89	15.30	15.70
No.21	240.08	7733.07	14.31	15.73	16.40	13.25	14.89	15.70	15.30	14.89	15.30	15.70
No.22	260.00	7993.07	14.87	15.90	16.16	13.13	14.89	15.70	15.30	14.89	15.30	15.70
No.23	240.60	8233.67	14.66	15.74	15.56	13.13	14.89	15.70	15.30	14.89	15.30	15.70
No.24	224.20	8457.87	13.89	14.79	15.20	13.07	14.89	15.70	15.30	14.89	15.30	15.70
No.25	255.72	8713.59	14.06	14.93	15.34	13.00	14.89	15.70	15.30	14.89	15.30	15.70
No.26	243.43	8957.02	13.56	14.87	15.05	12.94	14.89	15.70	15.30	14.89	15.30	15.70
No.27	262.24	9219.26	13.31	14.45	14.57	12.86	14.89	15.70	15.30	14.89	15.30	15.70
No.28	246.61	9465.87	13.07	14.76	14.40	12.81	14.89	15.70	15.30	14.89	15.30	15.70
No.29	216.00	9681.87	13.16	14.20	13.77	12.70	14.89	15.70	15.30	14.89	15.30	15.70
No.30	252.72	9934.59	12.80	14.48	14.70	12.46	14.89	15.70	15.30	14.89	15.30	15.70
No.31	217.18	10151.77	12.46	14.39	14.48	12.39	14.89	15.70	15.30	14.89	15.30	15.70
No.32	263.83	10415.60	12.39	14.39	14.48	12.39	14.89	15.70	15.30	14.89	15.30	15.70
No.33	251.91	10667.51	12.54	13.26	13.21	12.54	14.89	15.70	15.30	14.89	15.30	15.70
No.34	133.14	10800.65	12.15	13.22	13.18	12.15	14.89	15.70	15.30	14.89	15.30	15.70
No.35	258.09	10962.72	11.88	12.95	13.14	12.12	14.89	15.70	15.30	14.89	15.30	15.70
No.36	251.96	11214.68	11.83	13.00	12.73	11.83	14.89	15.70	15.30	14.89	15.30	15.70
No.37	255.80	11470.48	11.75	12.97	12.99	11.75	14.89	15.70	15.30	14.89	15.30	15.70
No.38	258.14	11728.62	11.70	12.99	12.99	11.70	14.89	15.70	15.30	14.89	15.30	15.70

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.
Drawing Title

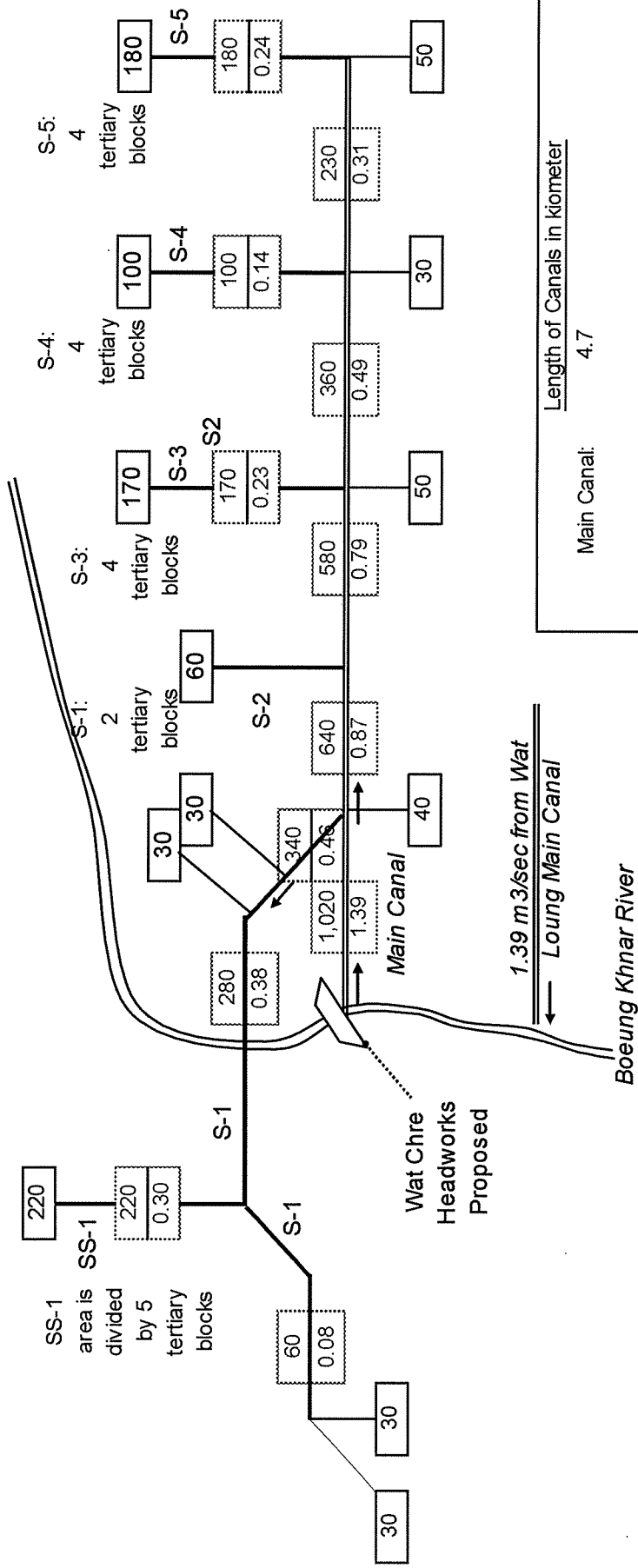
P - 16
Profile of Main Canal, Wat Loung Sub-Project (1/2)



Station No.	Existing		Rehabilitation Section												Accumulated Distance (m)	Distance (m)	Station No.																																																																																																																																																																																																																																																																																																																
	Canal Bed Elevation (m)	Left Bank Elevation (m)	Q=1.39m ³ /sec	Q=1.65m ³ /sec	Q=1.88m ³ /sec	Q=2.08m ³ /sec	Q=2.45m ³ /sec	Q=2.80m ³ /sec	Q=3.19m ³ /sec	Q=3.59m ³ /sec	Q=3.99m ³ /sec	Q=4.39m ³ /sec	Q=4.79m ³ /sec	Q=5.19m ³ /sec																																																																																																																																																																																																																																																																																																																			
N438	12.09	13.20	13.16	12.09	12.29	13.14	12.29	13.15	12.53	13.28	14.10	14.20	13.36	12.29	13.14	12.29	13.36	N439	263.47	11992.09	12.29	13.36	N440	257.54	12496.63	12.53	13.00	13.18	13.18	14.00	14.00	N441	258.59	12508.22	12.52	13.18	13.33	13.20	14.00	14.00	N442	249.99	12758.21	12.09	13.35	13.11	12.09	13.18	14.00	14.00	N443	269.65	13027.86	12.12	14.13	13.90	12.12	13.16	14.00	14.00	N444	263.84	13291.70	11.90	14.04	13.71	11.90	13.14	13.90	13.90	N445	261.84	13553.54	11.85	14.03	14.17	11.85	13.12	13.90	13.90	N446	270.43	13823.97	12.32	13.02	13.22	12.32	13.04	13.80	13.80	N447	270.21	14094.18	11.80	12.75	12.89	11.80	12.98	13.80	13.80	N448	261.12	14353.30	12.16	12.34	12.19	12.16	12.16	12.94	13.70	13.70	N449	267.03	14622.33	11.50	12.13	12.14	11.50	12.91	13.70	13.70	N450	262.25	14884.58	11.64	12.39	12.40	11.64	12.90	13.70	13.70	N451	311.95	15196.53	11.52	12.72	12.20	11.52	12.89	13.70	13.70	N452	213.52	15413.86	11.53	12.93	12.38	11.53	12.88	13.70	13.70	N453	215.22	15613.88	11.52	12.92	12.37	11.52	12.87	13.70	13.70	N454	253.00	15967.62	10.05	12.13	11.62	10.05	12.27	13.10	13.10	N455	253.08	16220.70	9.82	11.95	11.26	9.82	12.26	13.10	13.10	N456	257.21	16477.91	10.71	11.66	11.59	10.71	12.26	13.10	13.10	N457	253.79	16738.05	9.85	11.35	11.45	9.85	11.86	12.70	12.70	N458	261.16	16999.21	11.04	11.42	11.67	11.04	11.84	12.60	12.60	N459	254.37	17253.58	10.61	11.58	11.47	10.61	11.82	12.60	12.60	N460	251.07	17504.65	10.67	11.13	11.54	10.67	11.81	12.60	12.60	N461	257.18	17761.83	10.37	11.40	12.03	10.37	11.81	12.60	12.60	N462	252.55	18014.38	10.47	11.16	11.16	10.47	11.88	12.69	12.69	N463	256.88	18281.26	10.47	11.17	11.20	10.47	11.88	12.69	12.69	N464	256.38	18537.73	10.19	11.10	11.01	10.19	11.05	11.80	11.80	N465	266.52	18804.27	9.96	10.50	10.61	9.96	11.04	11.80	11.80	N466	304.05	19108.23	9.88	10.41	10.49	9.88	11.03	11.80	11.80	N467	112.73	19370.99	9.60	10.52	10.41	9.60	10.00	10.80	10.80	N468	263.75	19634.74	9.45	10.71	10.16	9.45	9.99	10.80	10.80	N469	261.52	19896.26	8.42	10.73	10.76	8.42	9.92	10.70	10.70

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



Length of Canals in kilometer	
Main Canal:	4.7
Secondary canals:	
S-1:	3.0
S-2:	1.2
S-3:	2.9
Sub-secondary canal:	
SS1-1:	4.4
Total of Secondary/Sub-secondary Canals:	14.7
Number of tertiary blocks: 27	

Unit irr. Req.= 1.36 lit/sec/ha

== Main canal

— Secondary/sub-secondary canals (S / SS)

— Tertiary canal(s)

130 Secondary or tertiary blocks branch from main canal, Irrigation area in Ha

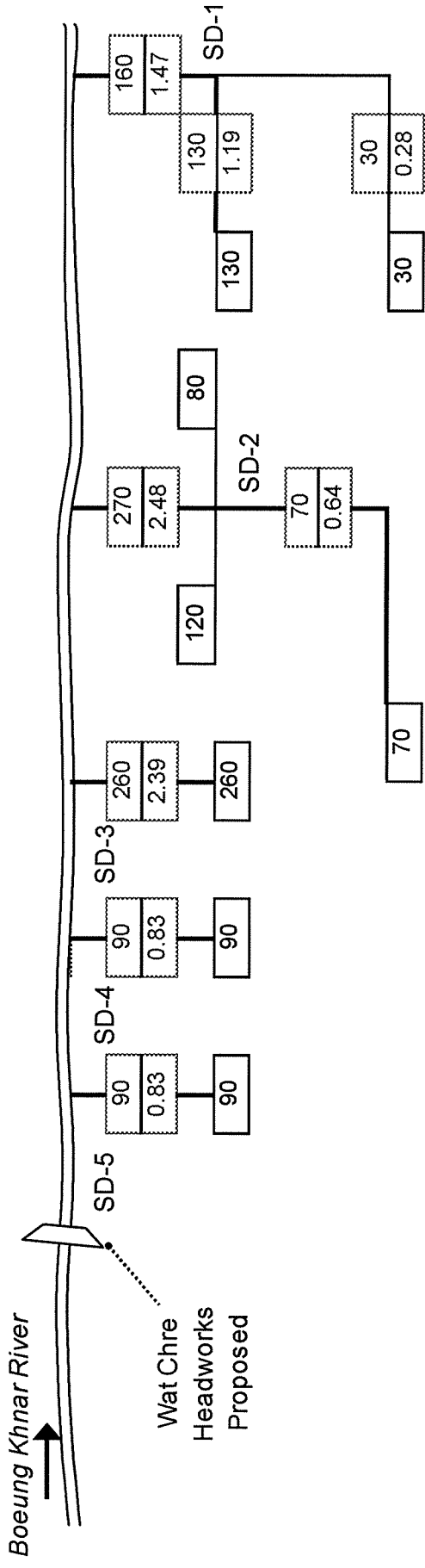
1,020 Irrigation area in Ha

1.39 Design discharge of canal in m³/sec

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. P - 18

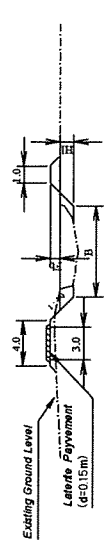
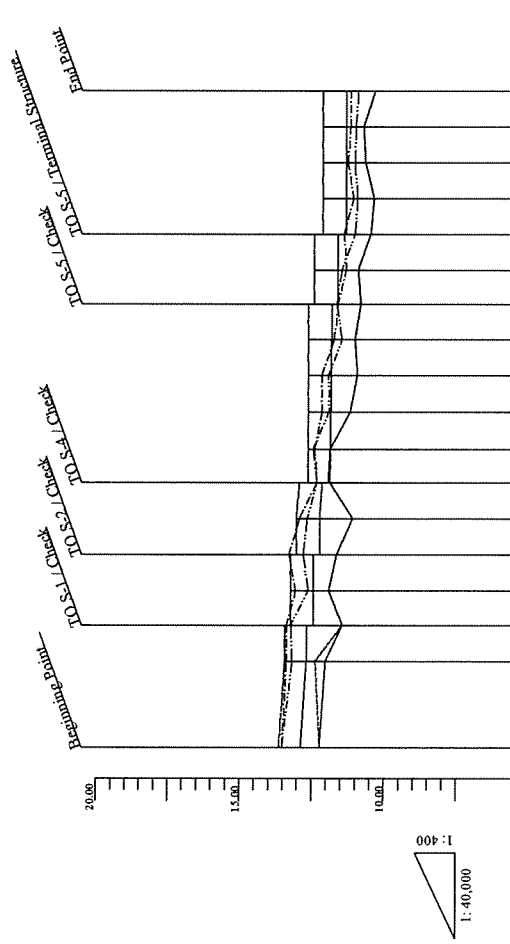
Drawing Title Irrigation Diagram of Wat Chre Sub-Project



Construction Length of Canals in kilometer	
Secondary drains:	
SD-1:	2.2
SD-2:	2.2
SD-3:	3.5
SD-4:	2.1
SD-5:	1.5
Total of Secondary Drains: 11.5	

Unit drain. Req.= 6.32 lit/sec/ha from paddy fields
 Unit drain. Req.= 18~25 lit/sec/ha from other types of land
 Secondary drain
 Existing side ditch
 Secondary or tertiary block in Ha
 Drainage area in Ha (85% of paddy fields, 15% of other land types)
 Design discharge of drain in m³/sec

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	P - 19
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Drainage Diagram of Wat Chre Sub-Project

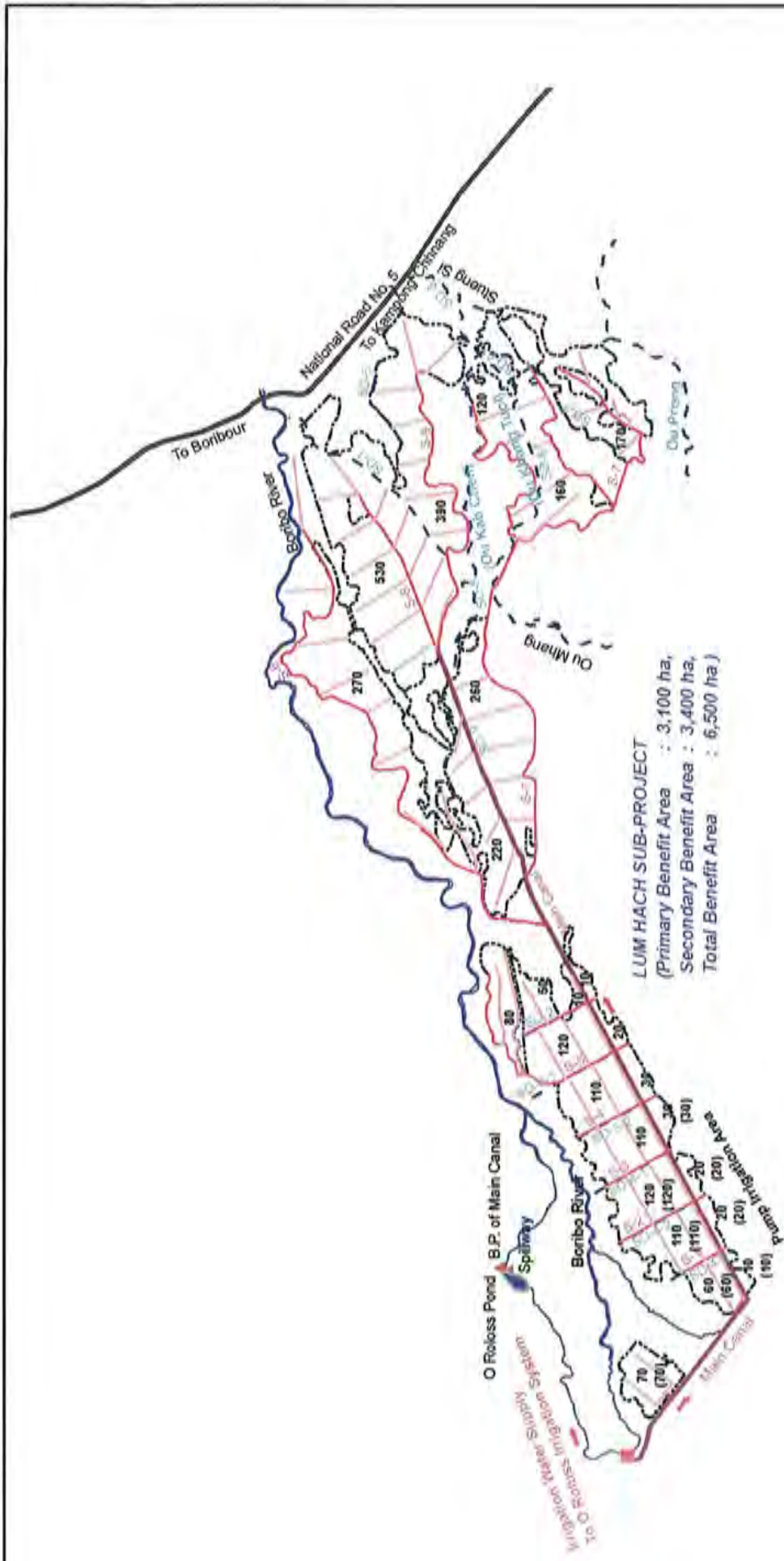


Typical Cross Section

- Designed Water Level
- Designed Bank
- Designed Canal Bed
- - - Existing Left Bank
- - - Existing Right Bank
- - - Existing Canal Bed

Station No.	Distance (m)	Accumulated Distance (m)	Existing					Design						
			Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)	Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)		
BP	0.00	600.00	12.20	13.50	13.50	12.85	13.60	13.40	13.40	13.40	13.60	13.60	13.60	13.60
No.1	600.00	600.00	12.35	13.34	13.34	12.64	13.40	13.40	13.40	13.40	13.40	13.40	13.40	13.40
No.2	852.76	852.76	11.42	13.34	13.19	11.42	12.63	13.40	13.40	13.40	13.40	13.40	13.40	13.40
No.3	1092.53	1092.53	11.89	13.02	12.59	11.89	12.47	13.20	13.20	13.20	13.20	13.20	13.20	13.20
No.4	1342.98	1342.98	11.62	13.25	12.76	11.62	12.40	13.20	13.20	13.20	13.20	13.20	13.20	13.20
No.5	1593.51	1593.51	11.06	12.89	12.62	11.06	12.20	13.00	13.00	13.00	13.00	13.00	13.00	13.00
No.6	1846.28	1846.28	11.86	12.29	12.29	11.86	12.11	12.90	12.90	12.90	12.90	12.90	12.90	12.90
No.7	2080.42	2080.42	11.83	12.37	12.42	11.83	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60
No.8	2337.65	2337.65	11.15	12.12	11.88	11.15	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60
No.9	2593.93	2593.93	10.91	12.13	11.90	10.91	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60
No.10	2843.41	2843.41	10.98	11.70	11.43	10.98	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60
No.11	3091.36	3091.36	10.79	11.57	11.62	10.79	12.60	12.60	12.60	12.60	12.60	12.60	12.60	12.60
No.12	3329.06	3329.06	10.88	11.30	11.44	10.88	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
No.13	3579.06	3579.06	10.45	11.36	10.98	10.45	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
No.14	3829.06	3829.06	10.34	11.04	10.90	10.34	12.10	12.10	12.10	12.10	12.10	12.10	12.10	12.10
No.15	4079.06	4079.06	10.64	11.23	11.00	10.64	12.10	12.10	12.10	12.10	12.10	12.10	12.10	12.10
No.16	4329.06	4329.06	10.70	11.16	10.96	10.70	12.10	12.10	12.10	12.10	12.10	12.10	12.10	12.10
No.17	4579.06	4579.06	10.30	11.14	10.88	10.30	12.10	12.10	12.10	12.10	12.10	12.10	12.10	12.10

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



LEGEND

- 20 Irrigation area in ha
- Boundary of Irrigation Area (20) (**) means pump irrigation area in ha
- Main Canal
- Secondary Canals
- Tertiary Canals
- Drain
- River
- Major Structure
- National Road No. 5

COORDINATE SYSTEM

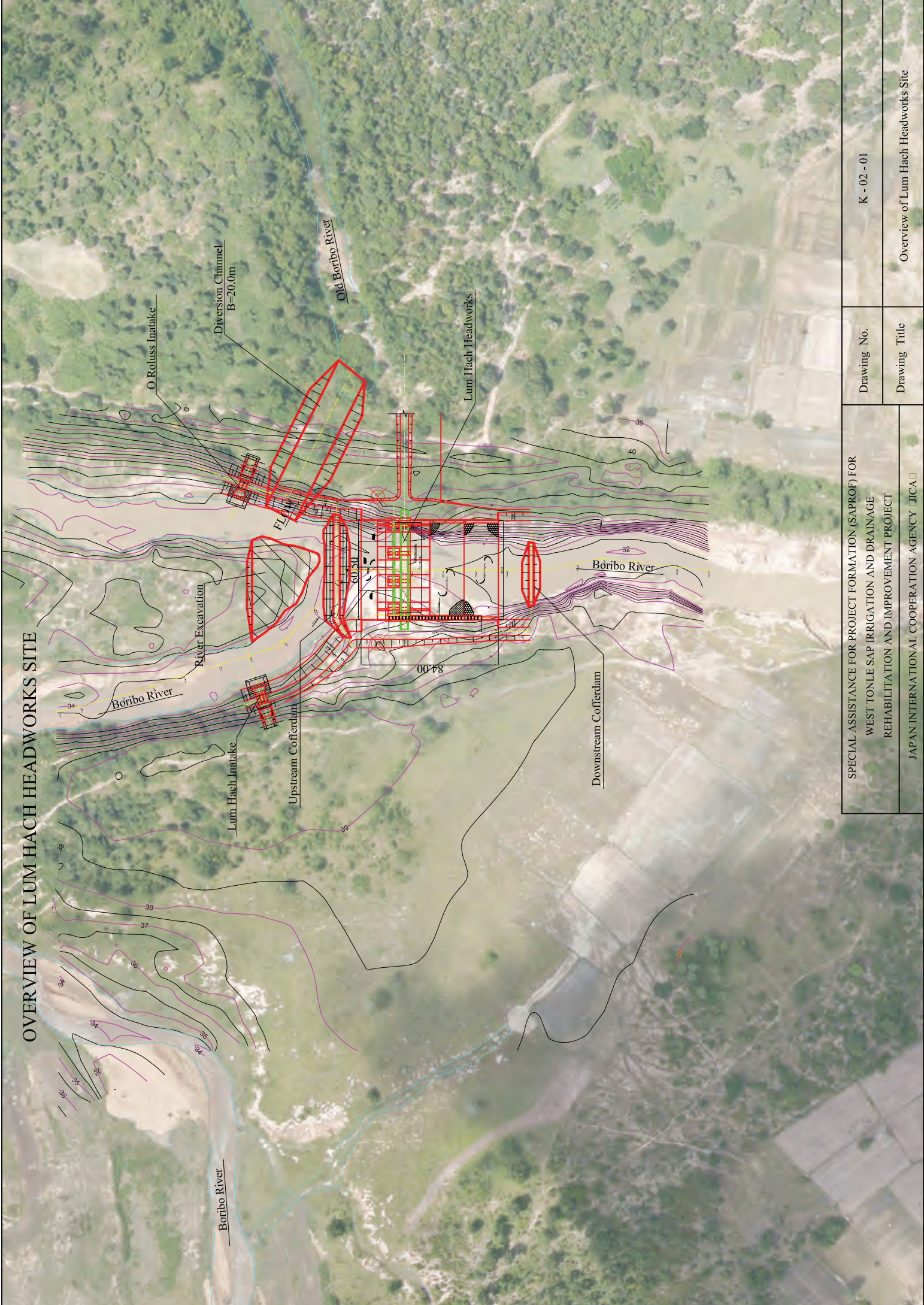
Projection: UTM
 Zone: 48
 Horizontal datum: Indian 1960
 Vertical datum: MSL at Ha Tien
 Spheroid: Everest
 Grid line: 2 Km

0 1,000 2,000 4,000 5,000 Meters

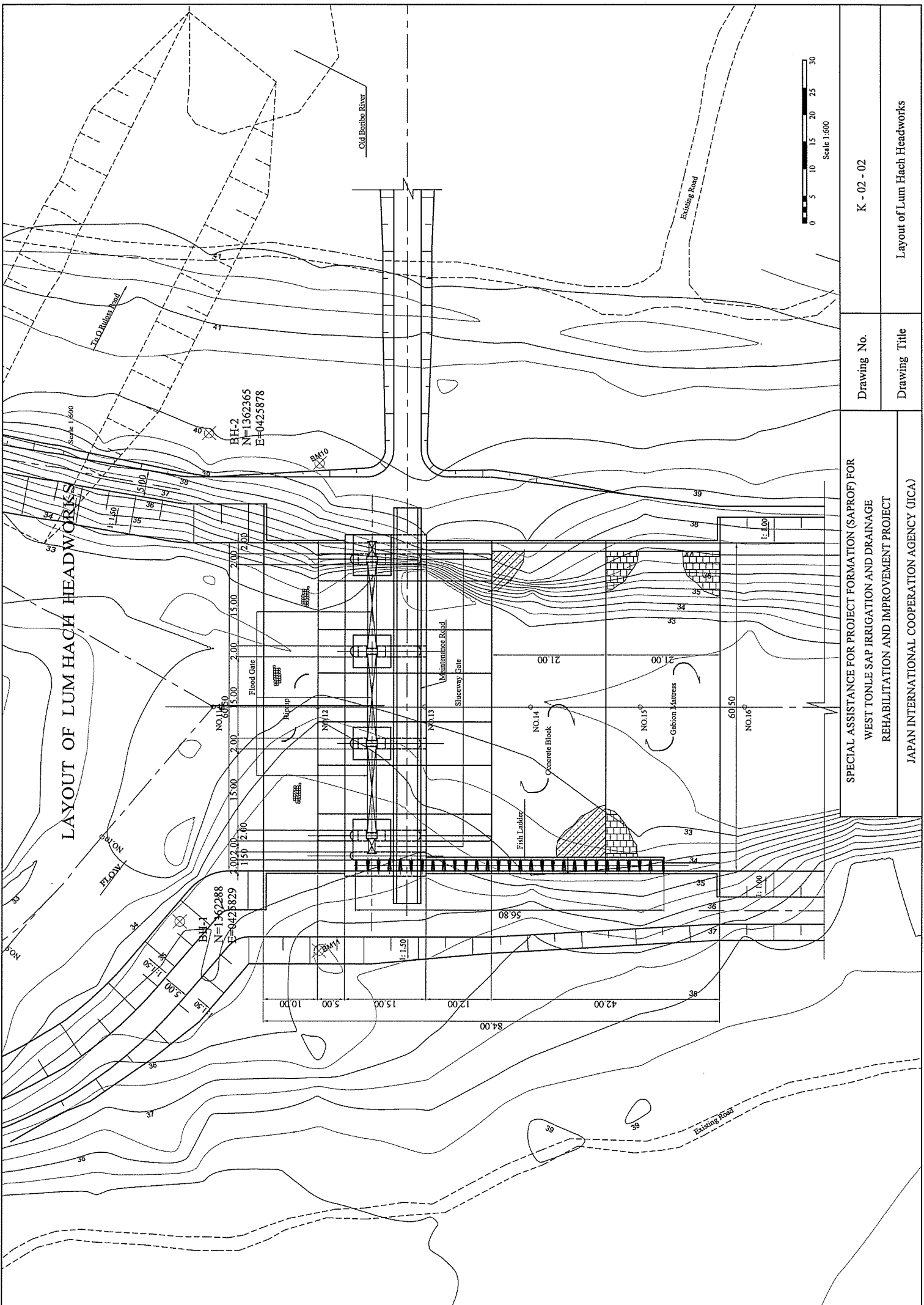
SPECIAL ASSISTANCE FOR PROJECT FORMATION FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT IN THE KINGDOM OF CAMBODIA UNDER JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
Drawing No.	K - 01
Drawing Title	General layout of Lum Hach Sub-Project

OVERVIEW OF LUM HACH HEADWORKS SITE



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) □		Drawing No.	K - 02 - 01
		Drawing Title	Overview of Lum Hach Headworks Site



LAYOUT OF LUMHACH HEADWORKS

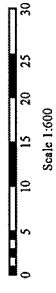
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

K - 02 - 02

Drawing Title

Layout of Lumhach Headworks



B.H.2
 N=1362365
 E=0425878

B.H.1
 N=1362288
 E=0425829

B.M.10

84.00

56.80

42.00

12.00

15.00

5.00

10.00

NO.11

NO.12

NO.13

NO.14

NO.15

NO.16

Flood Gate

Maintenance Road

Sluiceway Gate

Fish Ladder

Concrete Block

Gabion Mattress

FLOOD FLOW

To Okhass Road

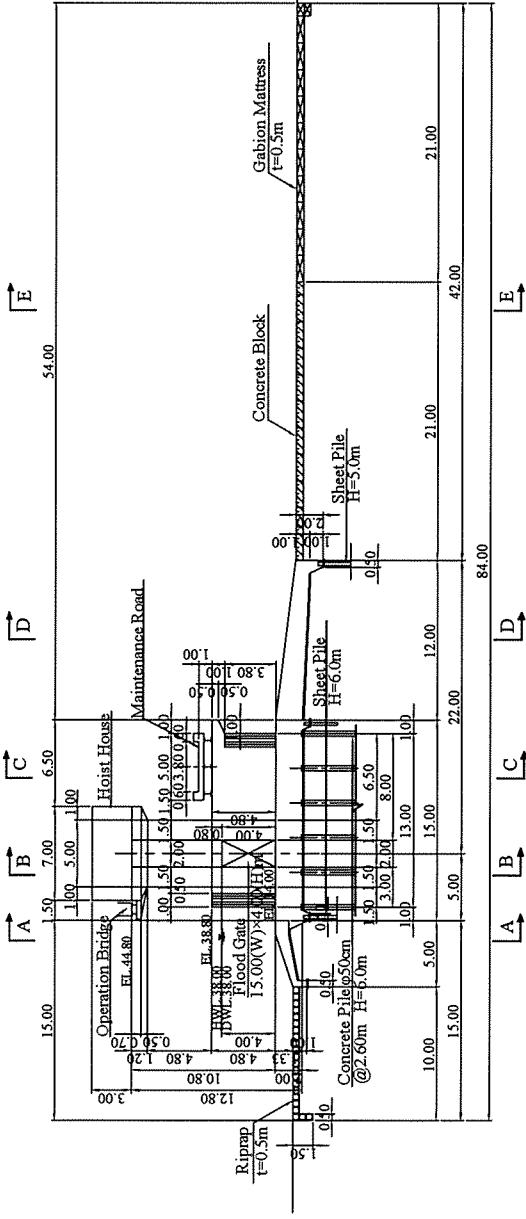
Existing Road

Old Bonibo River

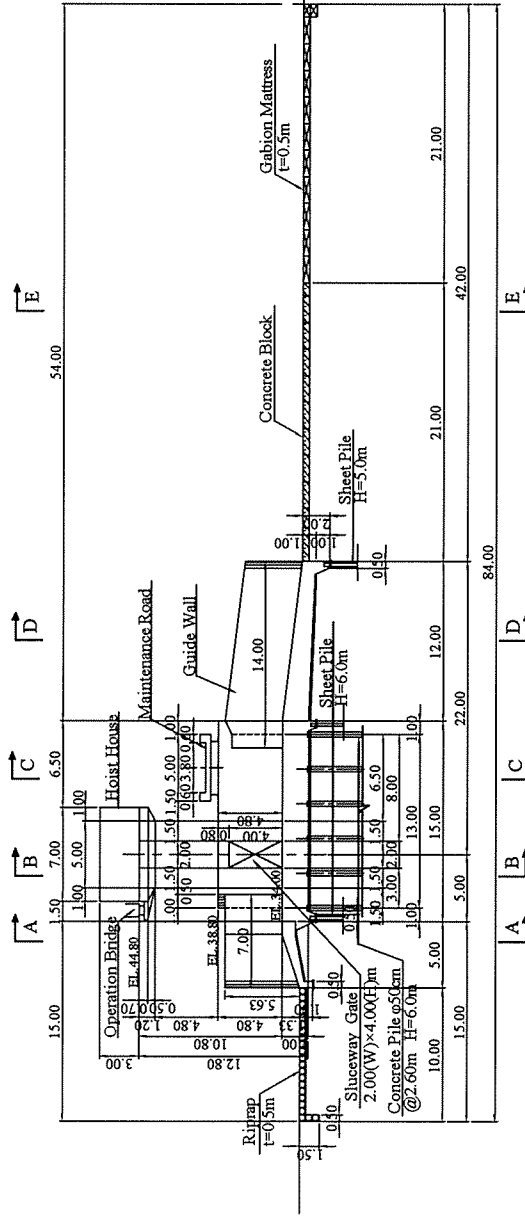
Scale 1:600

Scale 1:600

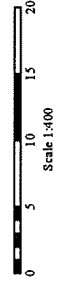
PROFILE OF LUM HACH HEADWORKS Scale 1:400



FLOOD GATE SECTION



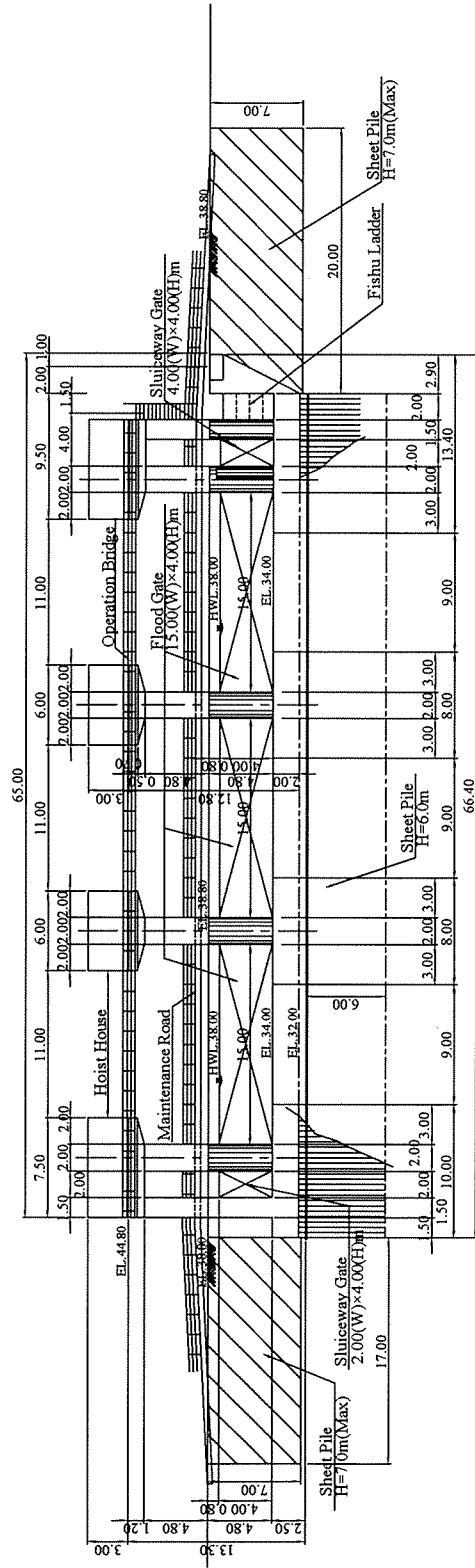
SLUICEWAY GATE SECTION



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	K - 03
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Profile of Lum Hach Headworks

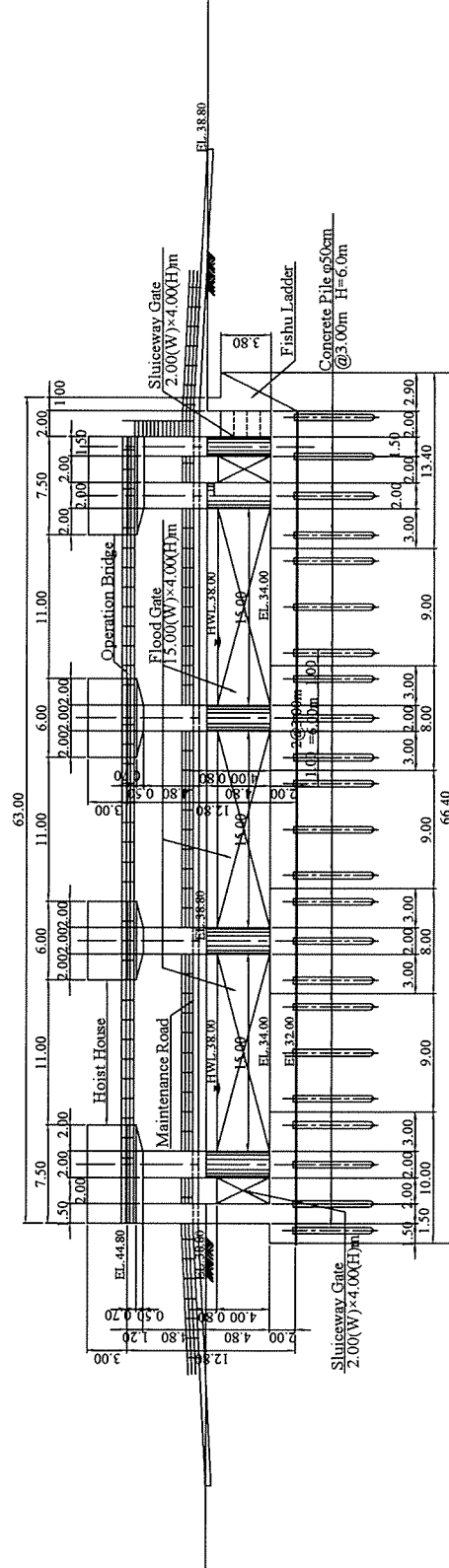
SECTION

Scale 1:400

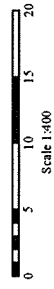


SECTION A-A

(P1) (P2) (P3) (P4) (P5) (P6)



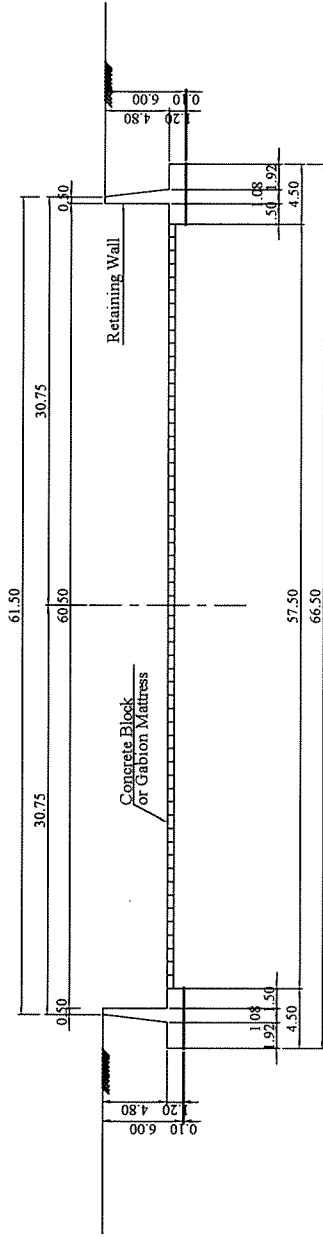
SECTION B-B



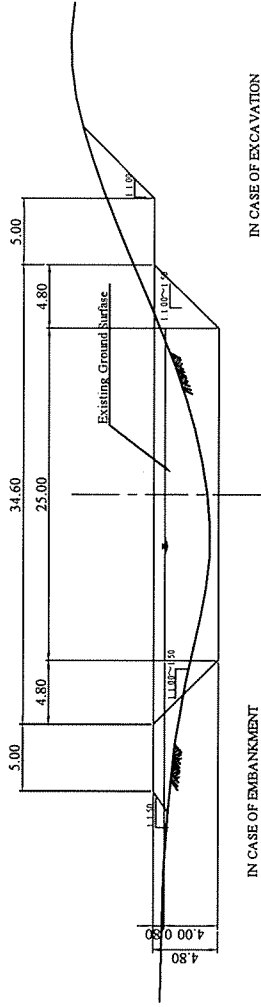
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	K - 04
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Section of Lum Hach Headworks (1/3)

SECTION

Scale 1:400



SECTION E-E



RIVER SECTION

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

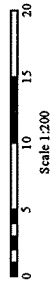
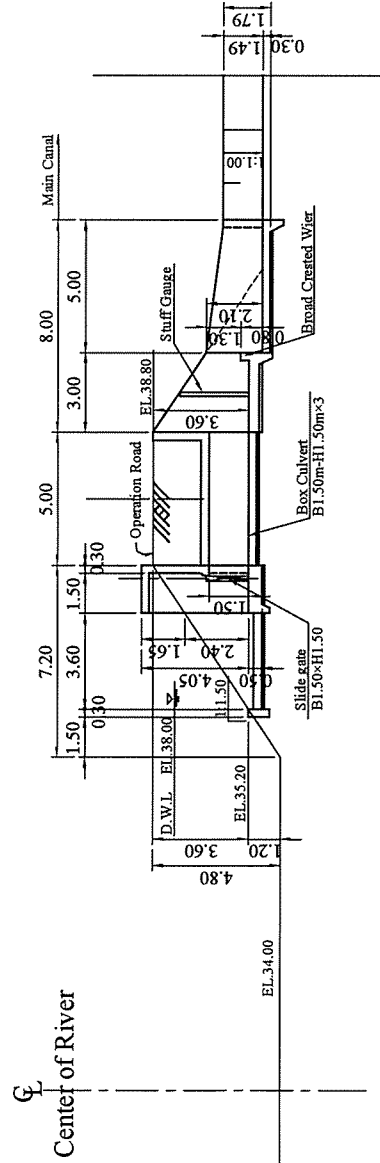
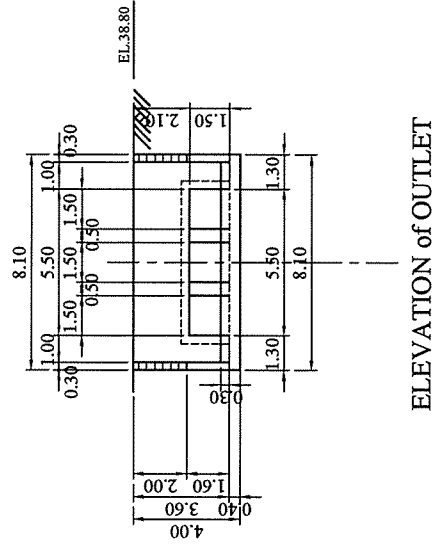
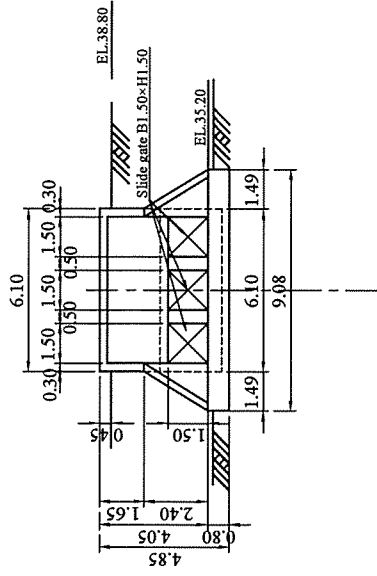
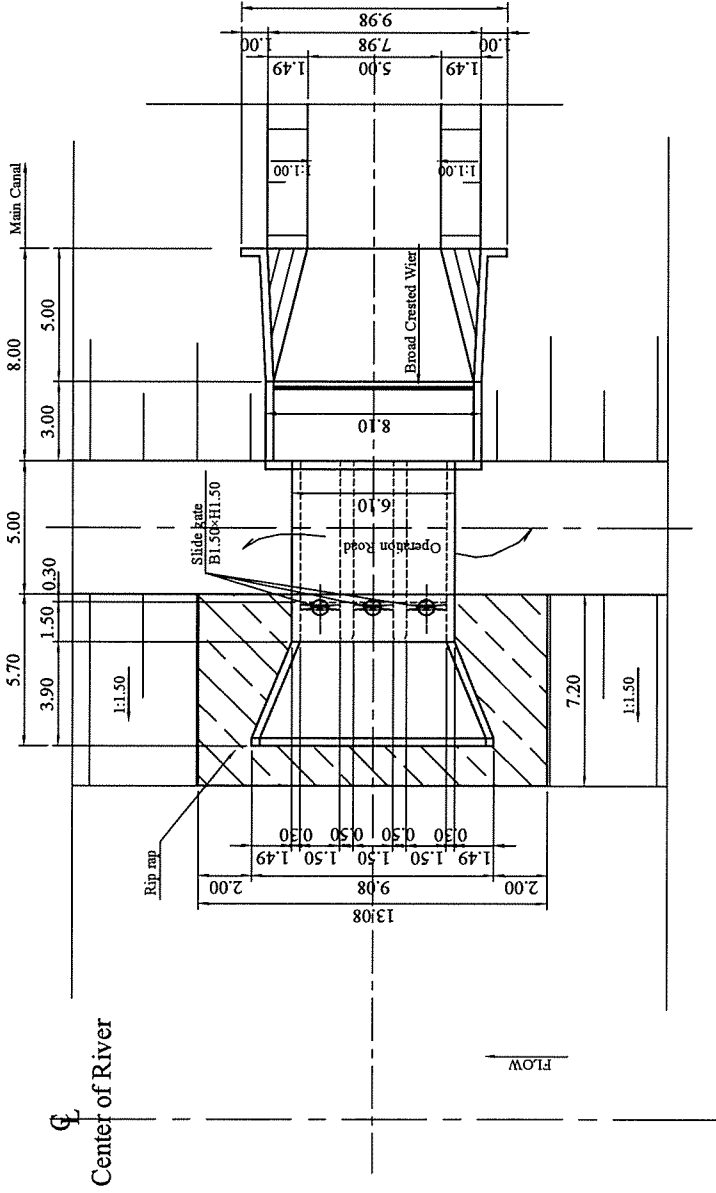
K - 06

Drawing Title

Section of Lum Hach Headworks (3/3)

INTAKE OF LUM HACH HEADWORKS

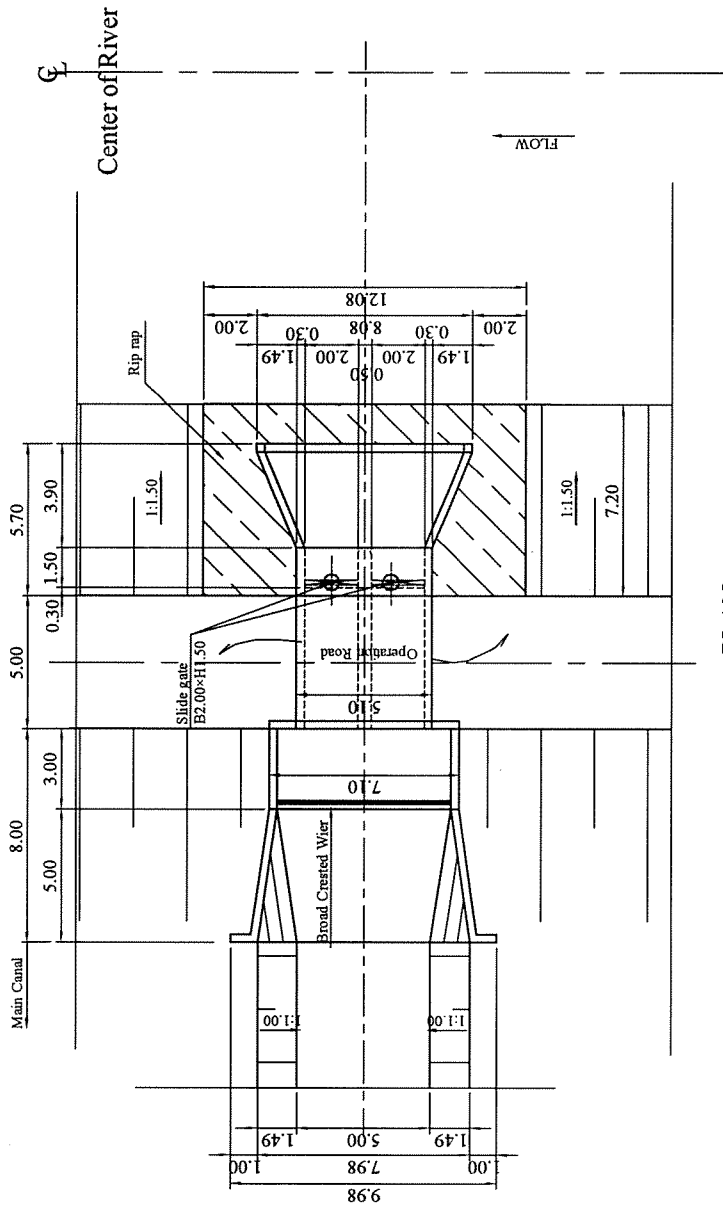
Scale 1:200



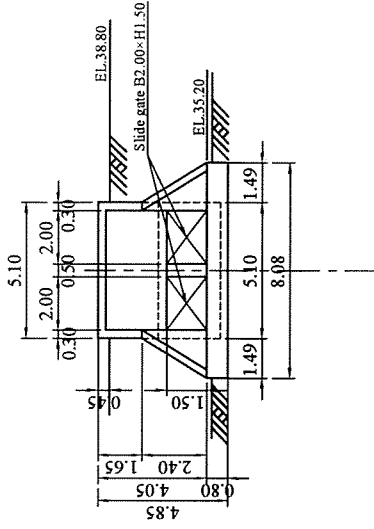
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No.	K - 07
		Drawing Title	Intake of Lum Hach Headworks

INTAKE OF O ROLUSS INTAKE

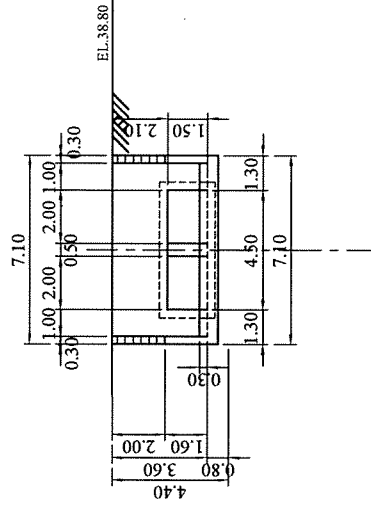
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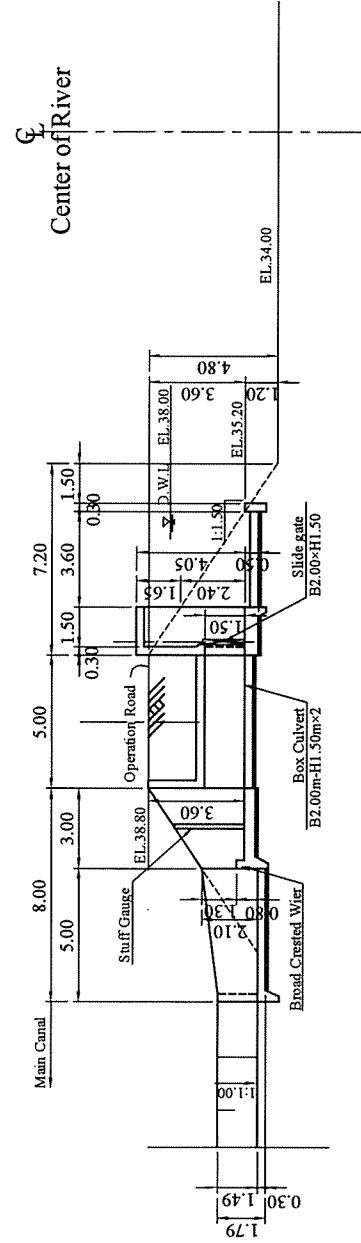
PLAN



ELEVATION of INLET



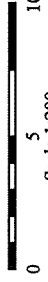
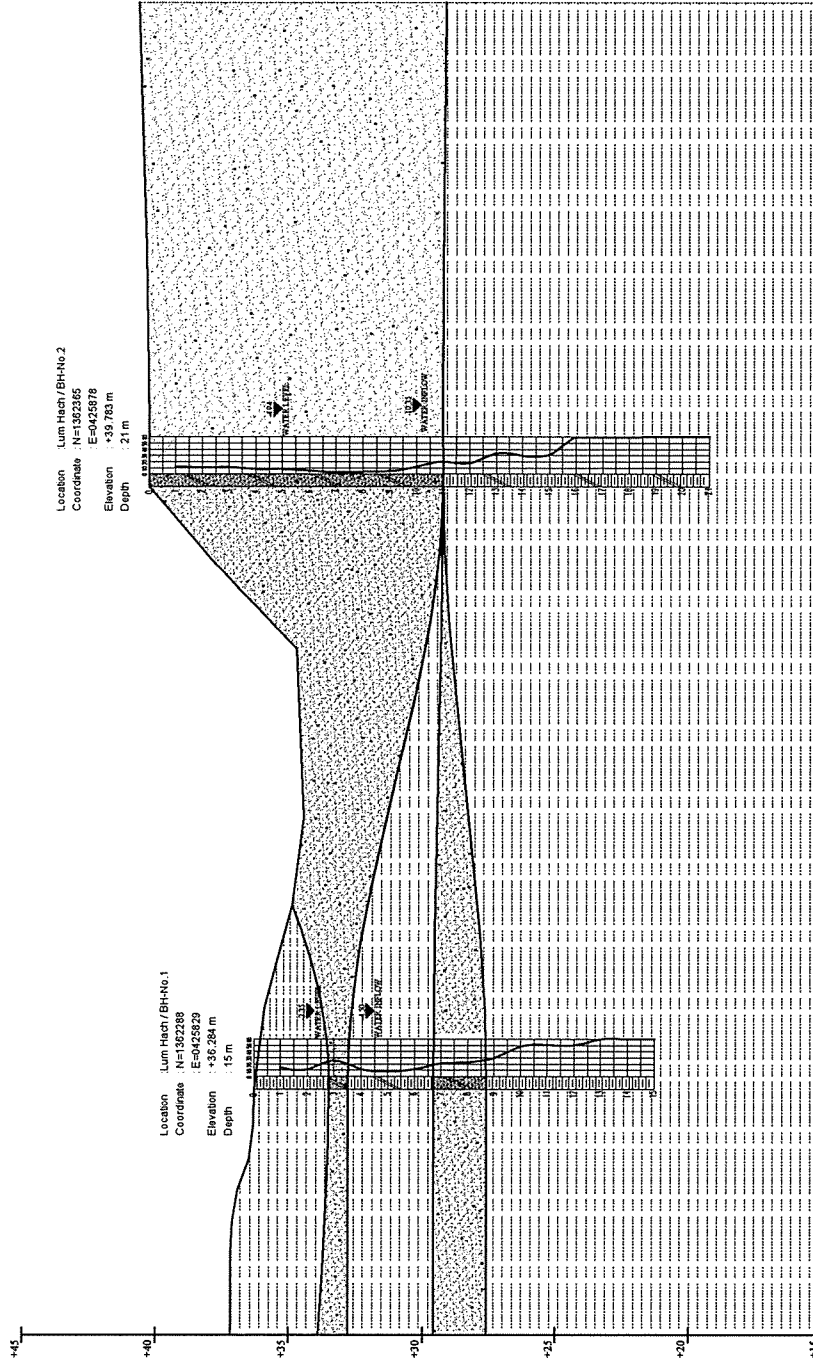
ELEVATION of OUTLET



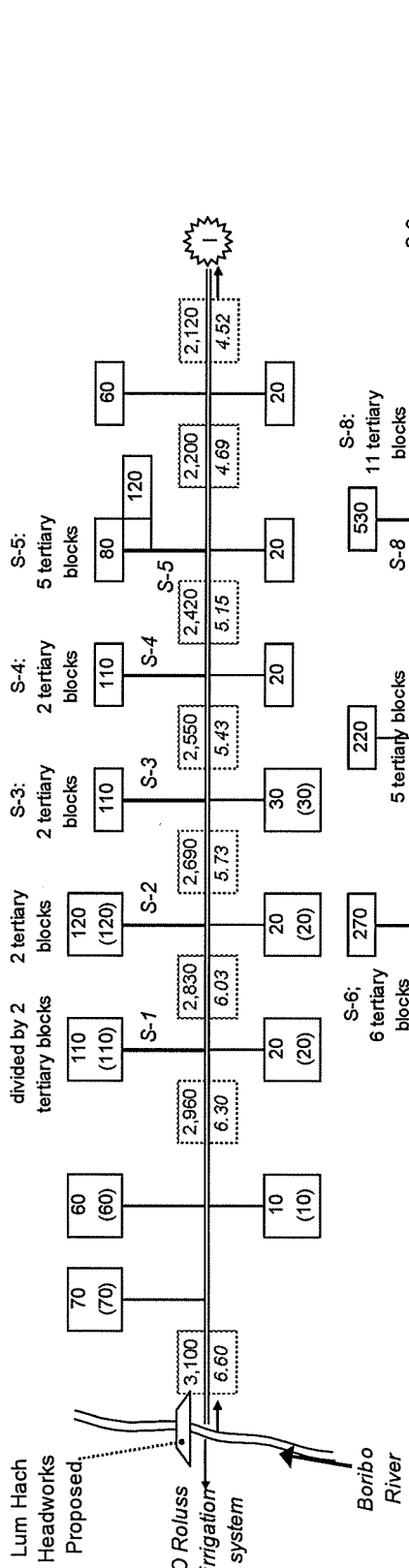
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	K - 08
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Intake of O Roluss Irrigation System

GEOLOGICAL PROFILE OF LUM HACH HEADWORKS

Scale 1:200



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing No. K - 09
Drawing Title	Geological Profile of Lum Hach Headworks	



Unit irr. Req = 2.13 lit/sec/ha

Main canal

Secondary/sub-secondary canals (S/SS)

Tertiary Canals

Secondary or tertiary blocks branch from main canal, Irrigation area in Ha

(**) means pump irrigation area in Ha

Irrigation area in Ha

Design discharge of canal in m³/sec

130 (130)

3,100

6.60

Construction Length of Canals in kilometer

Main Canal: 16.4

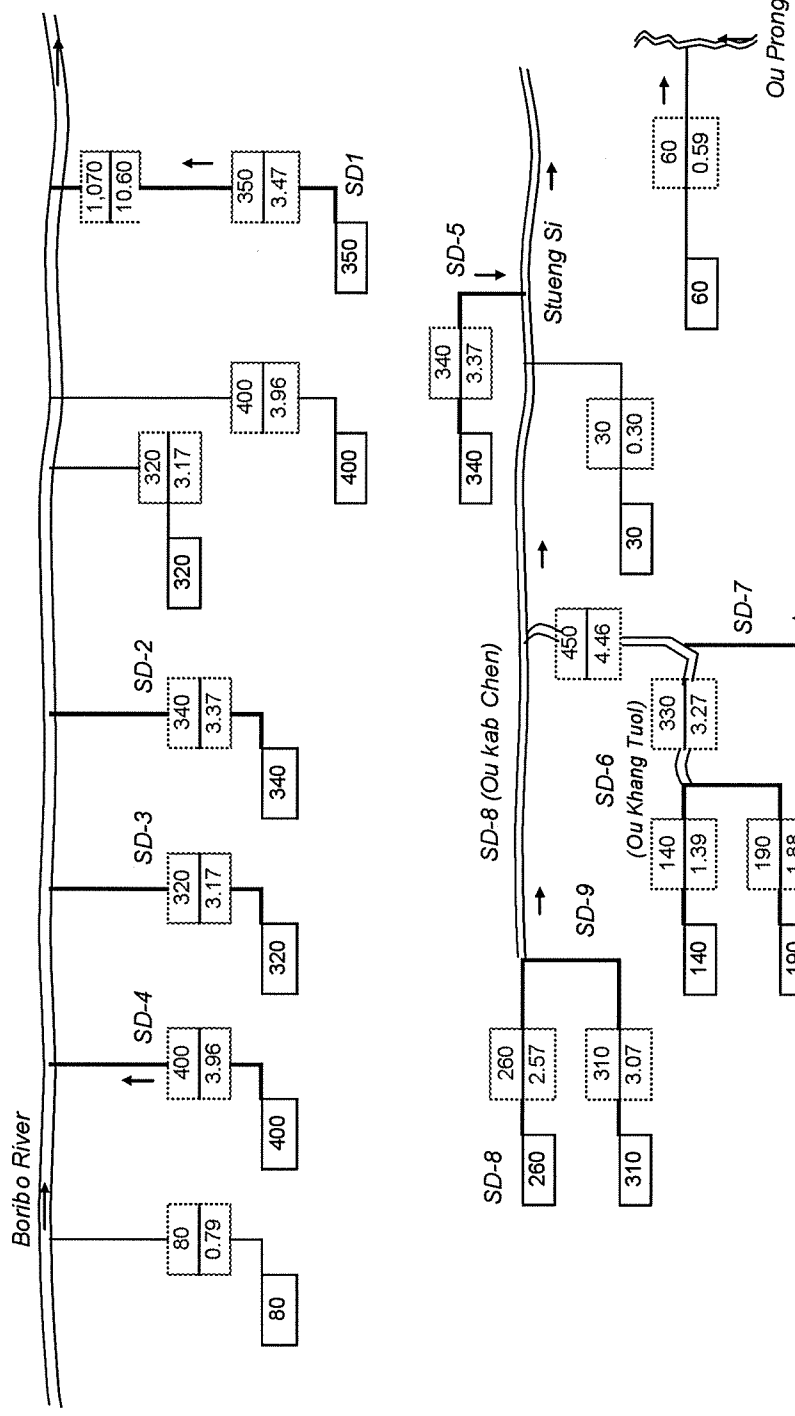
Secondary canals		Sub-secondary canals (SS)	
S-1:	0.5	S-6:	11.3
S-2:	1.0	S-7:	11.8
S-3:	0.8	S-8:	2.4
S-4:	0.9	S-9:	5.6
S-5:	2.0		
Total of Secondary/Sub-secondary canals: 42.4			

Number of tertiary blocks: 69

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT

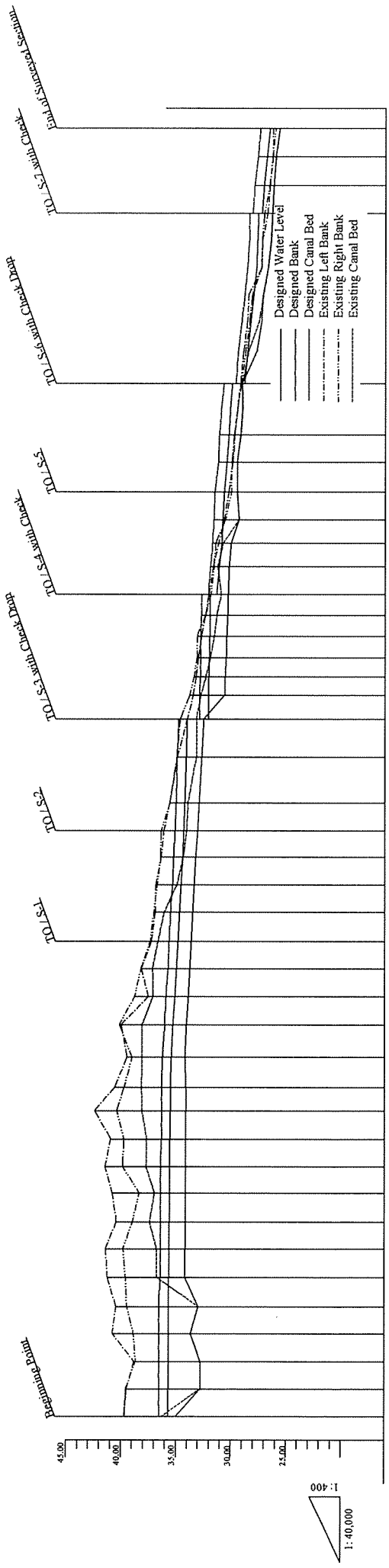
Drawing No. K - 10

Drawing Title Irrigation Diagram of Lum Hach Sub-Project

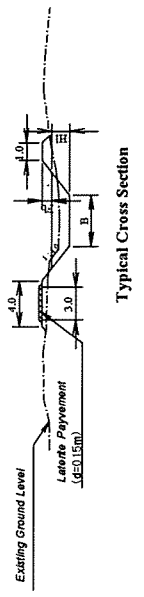


SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF)
 WEST TONLE SAP IRRIGATION AND DRAINAGE
 REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. K - 11
 Drawing Title Drainage Diagram of Lum Hach Sub-Project



Station No.	Distance (m)	Accumulated Distance (m)	Existing					Design				
			Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)	Canal Bed Elevation (m)	Left Bank Elevation (m)	Right Bank Elevation (m)	Water Surface (m)	Canal Bank Elevation (m)
B/P/No.1	0.00	0.00	36.30	39.70	39.63	35.69	36.50	39.63	39.70	39.63	35.69	
No.2	252.69	252.69	32.75	39.45	38.78	35.65	36.50	35.65	32.95	35.65	36.50	
No.3	249.01	501.70	32.74	38.78	38.64	35.65	36.50	35.65	32.95	35.65	36.50	
No.4	256.02	757.72	33.63	40.76	38.82	35.65	36.50	35.65	32.95	35.65	36.50	
No.5	247.24	1004.96	32.95	40.42	39.56	35.63	36.50	35.63	32.95	35.63	36.50	
No.6	267.93	1272.89	36.73	41.21	39.56	34.17	36.50	34.17	32.95	35.63	36.50	
No.7	260.05	1532.94	36.73	41.39	39.78	34.16	36.40	34.16	35.61	35.61	36.40	
No.8	246.63	1779.57	37.37	40.39	38.93	34.15	36.40	34.15	35.59	35.59	36.40	
No.9	264.61	2044.18	36.92	40.77	38.30	34.14	36.40	34.14	35.57	35.57	36.40	
No.10	239.89	2284.07	37.70	41.42	39.84	34.13	36.40	34.13	35.55	35.55	36.40	
No.11	252.80	2536.87	37.65	40.92	39.69	34.12	36.30	34.12	35.53	35.53	36.30	
No.12	259.42	2796.29	38.06	42.39	40.36	34.11	36.30	34.11	35.50	35.50	36.30	
No.13	213.35	3009.64	38.11	40.53	39.67	34.10	36.30	34.10	35.49	35.49	36.30	
No.14	275.76	3285.40	38.08	39.43	38.97	34.20	36.20	34.20	35.41	35.41	36.20	
No.15	298.48	3583.88	38.07	39.96	40.13	34.03	36.00	34.03	35.24	35.24	36.00	
No.16	256.63	3840.51	37.09	37.49	38.74	33.89	35.90	33.89	35.09	35.09	35.90	
No.17	255.81	4096.32	37.12	38.14	38.17	33.75	35.70	33.75	34.94	34.94	35.70	
No.18	250.02	4346.34	36.62	37.22	37.34	33.61	35.60	33.61	34.81	34.81	35.60	
No.19	267.94	4614.28	36.07	36.88	37.02	33.46	35.50	33.46	34.66	34.66	35.50	
No.20	253.60	4867.88	34.92	36.84	36.68	33.32	35.30	33.32	34.53	34.53	35.30	
No.21	252.72	5120.60	34.35	36.32	36.41	33.18	35.20	33.18	34.41	34.41	35.20	
No.22	241.94	5362.54	34.07	36.10	36.33	33.04	35.10	33.04	34.30	34.30	35.10	
No.23	254.95	5617.49	33.95	35.58	35.56	32.90	35.00	32.90	34.21	34.21	35.00	
No.24	423.99	6041.48	33.16	34.88	34.94	32.67	34.90	32.67	34.08	34.08	34.90	
No.25	348.60	6390.08	33.17	34.00	34.65	32.47	34.80	32.47	34.00	34.00	34.80	
No.26	217.68	6607.76	32.75	33.45	33.06	32.06	32.90	32.06	32.06	32.06	32.90	
No.27	168.60	6776.36	32.31	33.22	33.40	32.03	32.80	32.03	31.99	31.99	32.80	
No.28	178.13	6954.49	31.90	32.97	33.09	31.99	32.80	31.99	31.96	31.96	32.80	
No.29	194.59	7149.08	31.54	32.69	33.12	31.91	32.80	31.91	31.96	31.96	32.80	
No.30	195.06	7344.14	31.31	32.35	32.94	31.93	32.70	31.93	31.93	31.93	32.70	
No.31	190.66	7534.80	30.92	32.03	31.84	31.90	32.70	31.90	31.90	31.90	32.70	
No.32	255.89	7790.69	31.25	31.64	31.57	31.90	31.90	31.11	31.90	31.11	31.90	
No.33	216.00	8006.69	30.74	31.15	31.42	31.90	31.70	30.87	31.90	30.87	31.70	
No.34	211.53	8218.22	29.31	30.66	30.54	29.31	31.60	30.76	31.60	30.76	31.60	
No.35	255.88	8474.10	29.47	30.25	30.02	29.47	31.50	30.66	31.50	30.66	31.50	
No.36	273.96	8748.06	29.49	29.88	29.99	29.49	31.20	30.44	31.20	30.44	31.20	
No.37	251.96	9000.02	29.15	29.71	29.74	29.15	31.10	30.26	31.10	30.26	31.10	
No.38	250.60	9250.62	28.99	29.44	29.44	28.99	30.90	30.13	30.90	30.13	30.90	
No.39	216.69	9467.31	29.02	29.19	29.10	29.02	30.70	29.93	30.70	29.93	30.70	
No.40	300.85	9768.16	28.46	28.90	28.71	27.70	29.40	28.55	27.70	28.55	29.40	
No.41	261.18	10030.34	27.52	28.57	28.39	27.30	28.27	28.27	27.30	28.27	28.27	
No.42	242.89	10273.23	27.14	28.48	28.15	27.14	28.80	27.99	27.14	27.99	28.80	
No.43	252.68	10525.91	26.71	27.31	27.27	26.71	28.60	27.76	26.71	27.76	28.60	
No.44	248.85	10774.76	26.43	26.74	27.23	26.43	28.40	27.64	26.43	27.64	28.40	
No.45	250.69	11025.45	26.32	26.32	27.02	26.32	28.40	27.56	26.32	27.56	28.40	
No.46	255.83	11281.28	26.19	26.53	26.57	26.19	27.90	27.08	26.19	27.08	27.90	
No.47	265.41	11546.69	25.98	26.26	26.29	25.98	27.60	26.80	25.98	26.80	27.60	
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K - 12

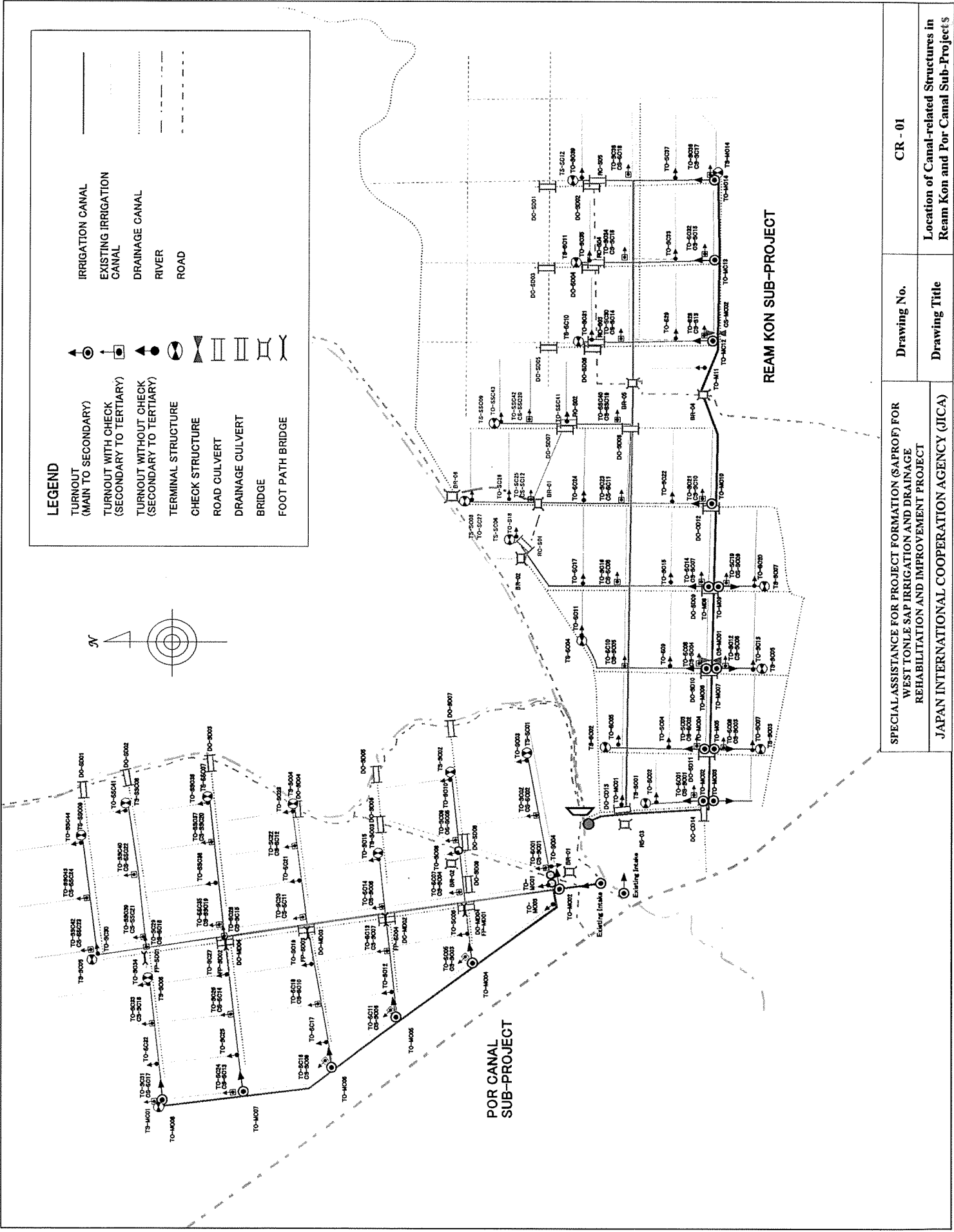
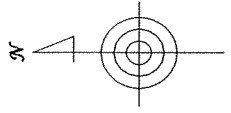
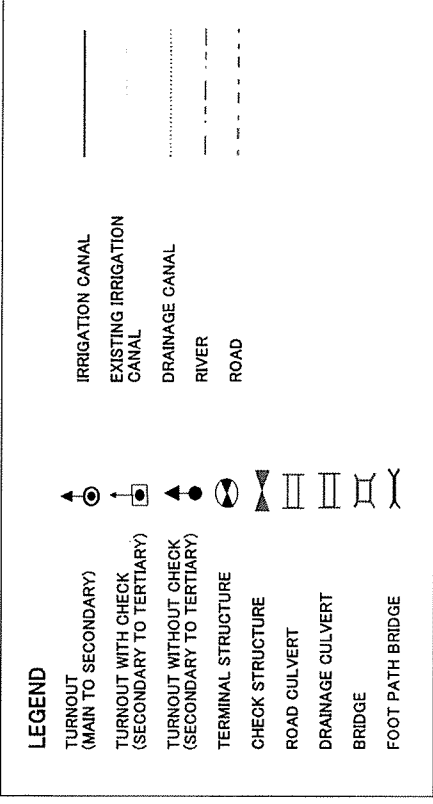
Drawing No.

Drawing Title

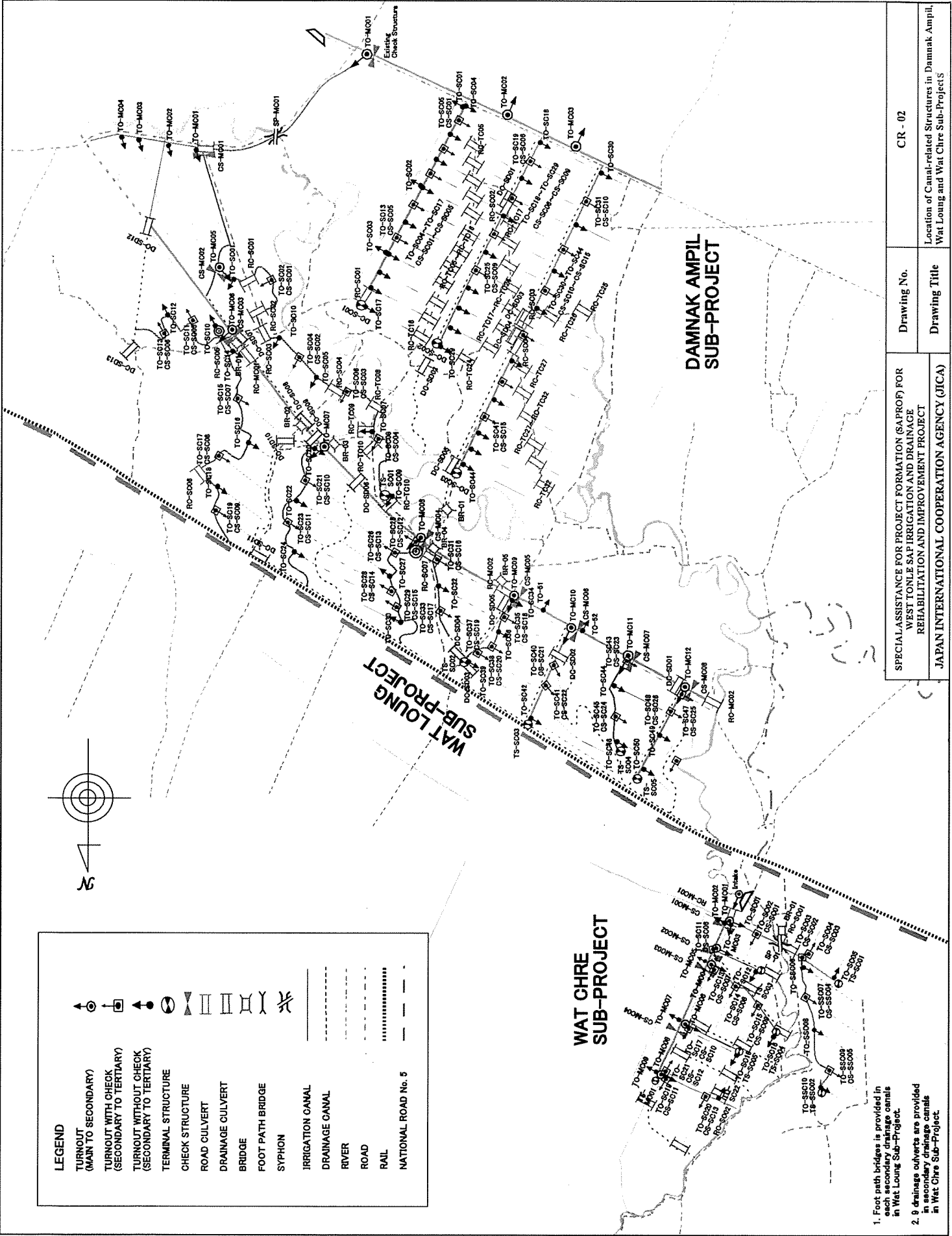
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Profile of Main Canal, Lum Haeh Sub-Project



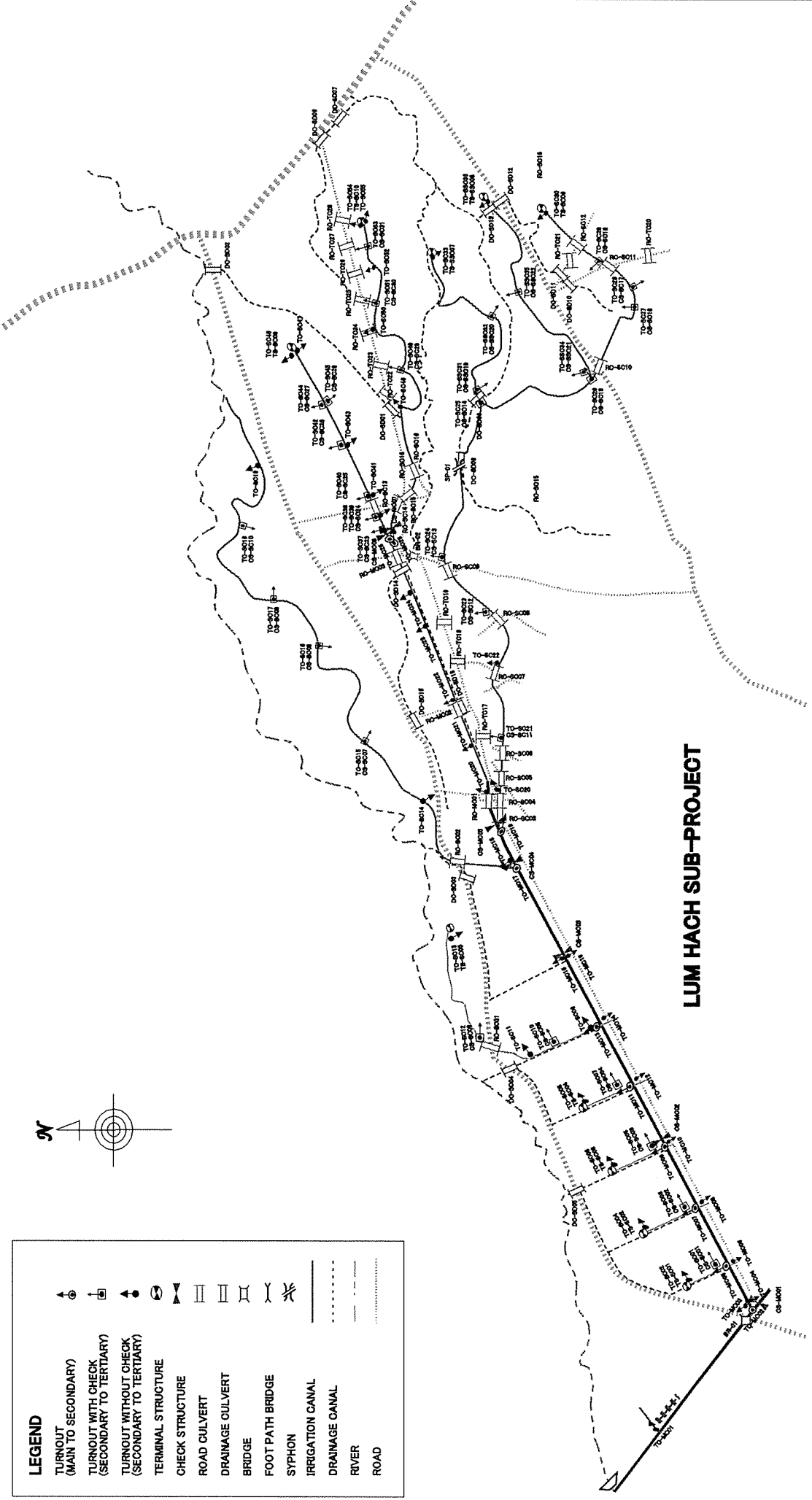
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		CR - 01
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Location of Canal-related Structures in Ream Kon and Por Canal Sub-Project's
DRAWING TITLE		DRAWING NO.



LEGEND	
	TURNOUT (MAIN TO SECONDARY)
	TURNOUT WITH CHECK (SECONDARY TO TERTIARY)
	TURNOUT WITHOUT CHECK (SECONDARY TO TERTIARY)
	TERMINAL STRUCTURE
	CHECK STRUCTURE
	ROAD CULVERT
	DRAINAGE CULVERT
	BRIDGE
	FOOT PATH BRIDGE
	SYPHON
	IRRIGATION CANAL
	DRAINAGE CANAL
	RIVER
	ROAD
	RAIL
	NATIONAL ROAD No. 5

1. Foot path bridges are provided in each secondary drainage canals in Wat Loung Sub-Project.
2. 8 drainage culverts are provided in secondary drainage canals in Wat Chre Sub-Project.

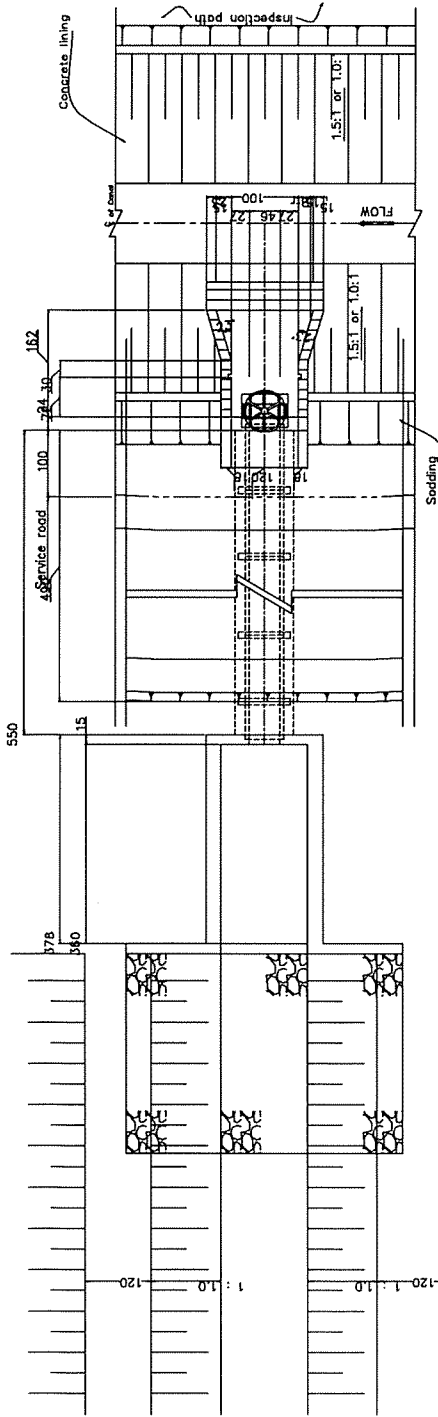
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		CR - 02
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Location of Canal-related Structures in Damnak Ampil, Wat Loung and Wat Chre Sub-Projects
Drawing No.		Drawing Title



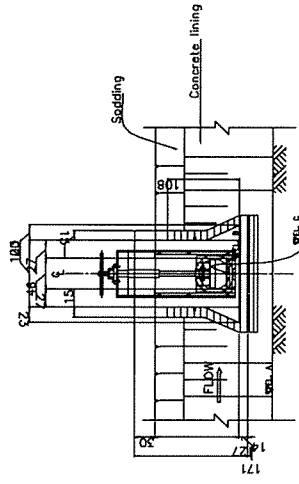
LEGEND	
	TURNOUT (MAIN TO SECONDARY)
	TURNOUT WITH CHECK (SECONDARY TO TERTIARY)
	TURNOUT WITHOUT CHECK (SECONDARY TO TERTIARY)
	TERMINAL STRUCTURE
	CHECK STRUCTURE
	ROAD CULVERT
	DRAINAGE CULVERT
	BRIDGE
	FOOT PATH BRIDGE
	SYPHON
	IRRIGATION CANAL
	DRAINAGE CANAL
	RIVER
	ROAD

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT		Drawing No.	CR - 03
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		Drawing Title	Location of Canal-related Structures in Lum Hach Sub-Project

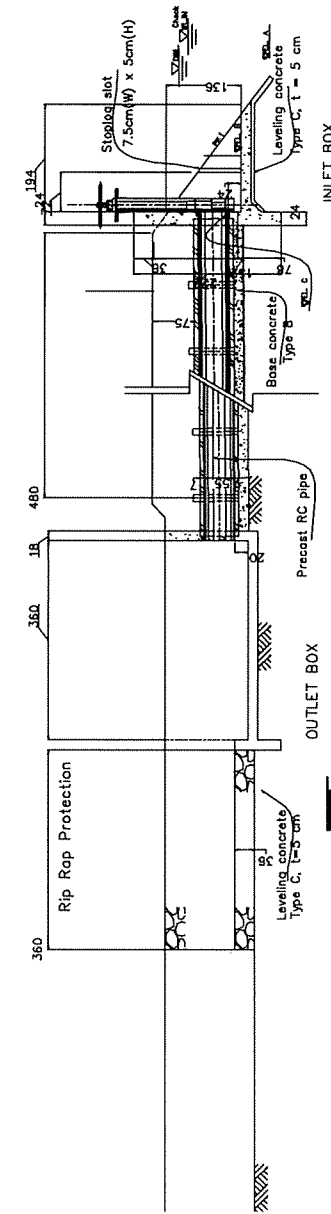
80 nos. of foot path bridges are provided every 100m along the both side of main road. (120 nos in total)



PLAN (INTAKE SILL IS HIGHER THAN CANAL BED)



SECTION II-II
INLET BOX TYPE B



PROFILE (SECTION A-A)

SCHALE 1 : 100

Type	Design Q (ml/sec)	Ream Kon		Per Canal		Dampak Ampil		Via Louq		Via Chre		Lumfish							
		MC	SD23C Total	MC	SD23C Total	MC	SD23C Total	MC	SD23C Total	MC	SD23C Total	MC	SD23C Total						
T0.01	0.06	1	14	15	1	6	7	1	3	4	0	6	6	1	8	9	8	5	13
T0.02	0.15	6	29	35	1	35	36	1	41	42	4	44	48	5	53	58	8	48	56
T0.03	0.28	5	0	5	2	3	5	2	5	7	2	2	1	3	4	1	5	0	1
T0.04	0.40	1	0	1	2	0	2	2	0	2	0	2	0	0	1	1	0	0	1
T0.05	0.60	1	0	1	1	0	1	2	0	2	1	0	1	0	1	2	0	2	0
T0.06	0.80	1	0	1	1	0	1	1	0	1	0	1	0	0	1	2	0	2	0
T0.07	1.20	1	0	1	1	0	1	1	0	1	0	1	0	0	1	2	0	2	0
T0.11	5.40	1	0	1	1	0	1	1	0	1	0	1	0	0	1	1	0	1	0
T0.12	6.00	1	0	1	1	0	1	1	0	1	0	1	0	0	1	1	0	1	0
Total		14	43	57	8	44	52	3	41	47	12	52	64	9	23	31	26	55	81

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

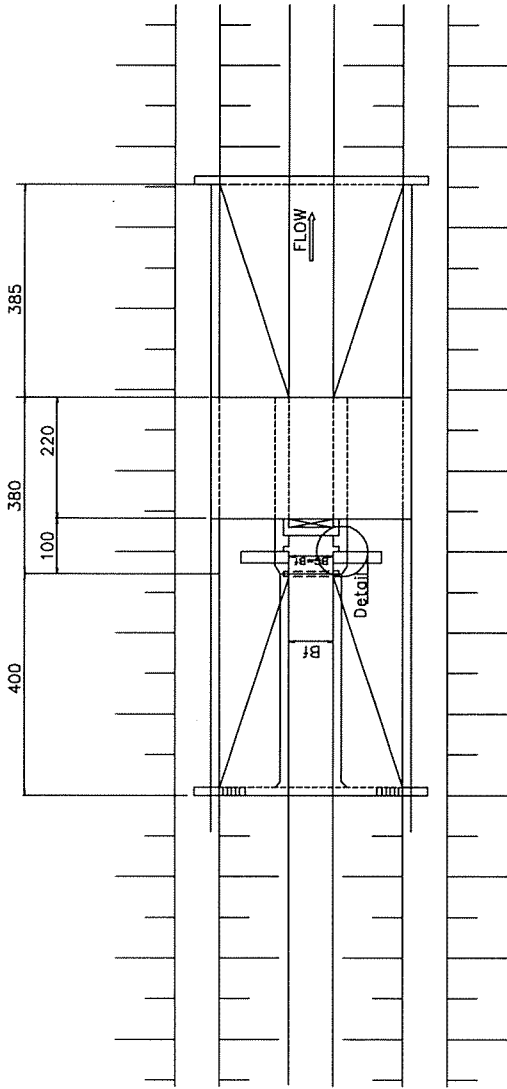
Drawing No.

CR -04

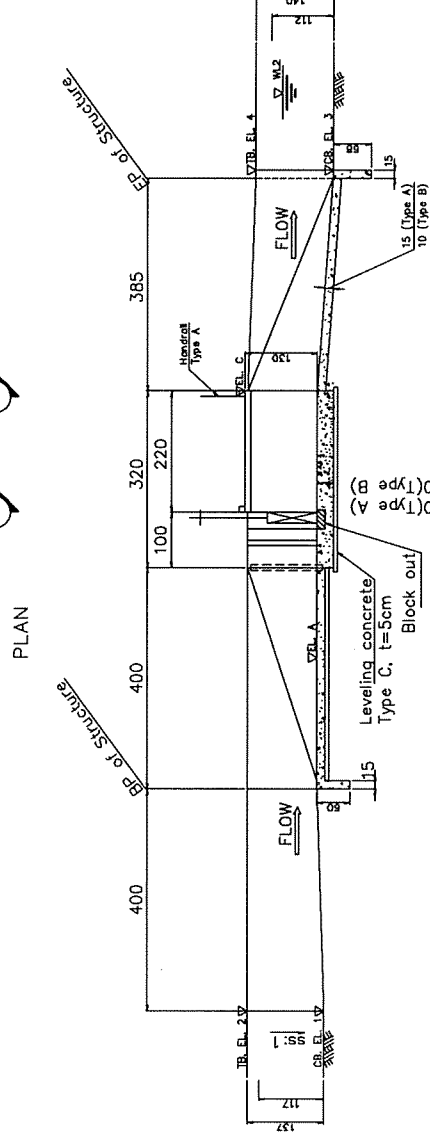
Drawing Title

Canal-related Structures for Six Sub-projects
Turnout

(TYPE A)

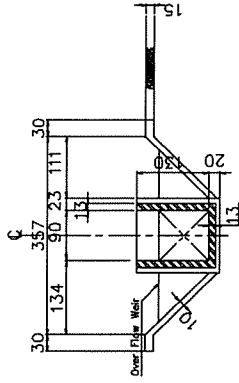


(TYPE B)

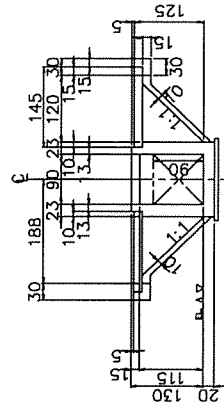


PROFILE

SCHALE 1 : 100



(TYPE B)
SECTION A-A



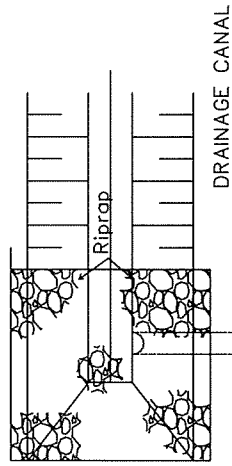
(TYPE B)
SECTION B-B

Type	Length Q (m/ft)	Room Km		Per Canal		Damask Ampel		Weir Long		Weir Chre		Lum Rich				
		MC	SP/200	TRIM	MC	SP/200	TRIM	MC	SP/200	TRIM	MC	SP/200	TRIM	MC	SP/200	TRIM
Check Structure	0.13	0	13	13	0	10	10	0	14	14	0	0	0	0	0	0
CS01	0.18	0	4	4	0	4	4	0	3	3	0	4	4	0	3	3
CS03	0.22	0	3	3	0	3	3	0	2	2	0	4	4	0	3	3
CS04	0.34	0	2	2	0	3	3	0	2	2	0	4	4	0	1	1
CS05	0.40	0	1	1	0	1	1	0	3	3	0	1	1	0	4	4
CS06	0.45	0	1	1	0	1	1	0	1	1	0	1	1	0	2	2
CS07	0.45	0	1	1	0	1	1	0	4	4	0	2	2	1	3	3
CS08	0.99	0	2	2	0	2	2	0	4	4	0	2	2	1	3	3
CS10	1.97	0	4	4	0	4	4	0	0	0	0	0	0	0	3	3
CS11	3.50	0	7	7	0	7	7	0	1	1	0	0	0	1	0	1
CS13	3.75	0	7	7	0	7	7	0	0	0	0	1	1	0	0	1
CS14	5.00	0	5	5	0	5	5	0	3	3	0	2	2	0	2	2
CS15	6.30	0	6	6	0	6	6	0	0	0	0	2	2	0	2	2
Check Structure with Deep	1.0	1	0	1	0	0	0	0	0	0	0	2	2	0	0	2
CD 09	0.48	1	0	1	0	0	0	0	0	0	0	1	1	0	0	1
CD 10	0.48	1	0	1	0	0	0	0	0	0	0	1	1	0	0	1
CD 12	2.70	1	0	1	0	0	0	0	0	0	0	5	5	0	4	4
Total		2	20	22	0	24	24	0	15	15	0	13	17	7	31	31

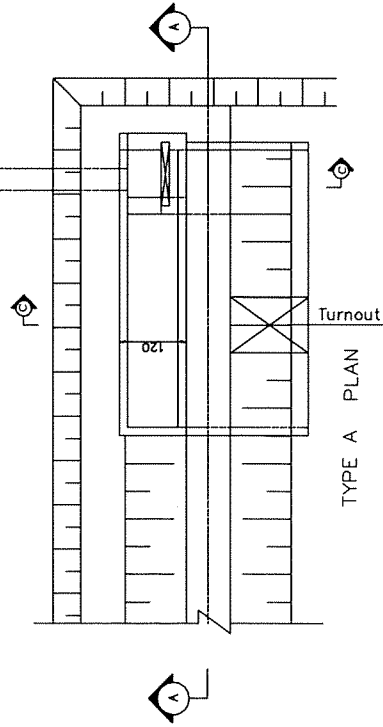
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. CR - 05

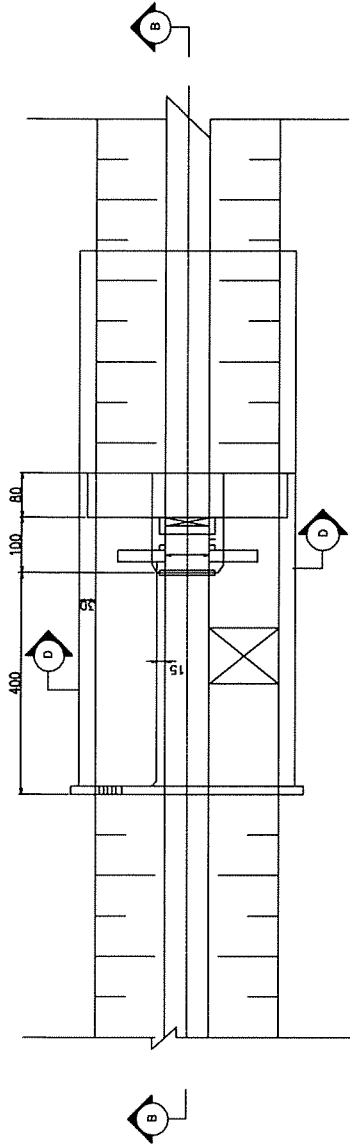
Drawing Title
Canal-related Structures for Six Sub-projects
Check Structure



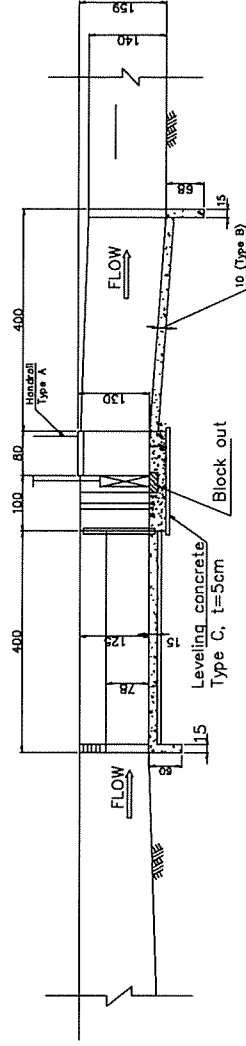
DRAINAGE CANAL



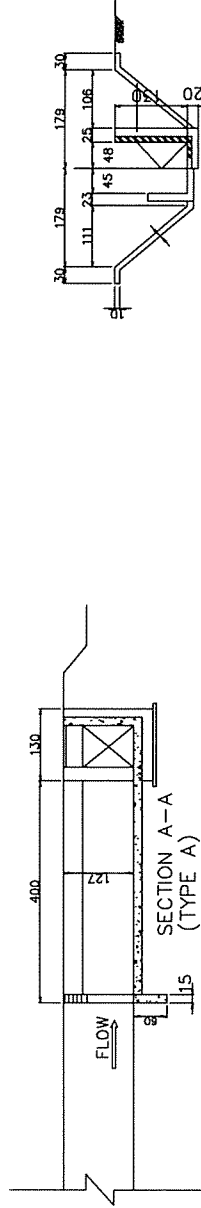
TYPE A PLAN



(TYPE B) PLAN

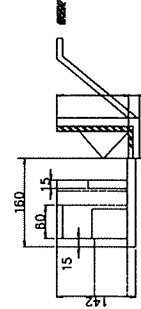


SECTION B-B
(TYPE B)



SECTION A-A
(TYPE A)

(TYPE B)
SECTION D-D



SECTION C-C
(TYPE A)

Type	Design Q (m ³ /sec)	Rum.Kon		Per Canal		Damak Amp'li		Wet Loss		Wet Chk		Lam Hash	
		MC	SDSBC Total	MC	SDSBC Total	MC	SDSBC Total	MC	SDSBC Total	MC	SDSBC Total	MC	SDSBC Total
Terminal Structure													
CS 01	0.13	0	12	0	8	0	3	0	5	1	5	6	8
CS 02	0.18	1	0	0	1	0	1	0	1	0	0	2	2
CS 03	0.22	1	0	1	0	1	0	1	0	1	0	2	2
CS 04	0.34	1	12	13	9	10	0	3	0	5	1	5	6
Total													

SCHALE 1 : 100

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE
REHABILITATION AND IMPROVEMENT PROJECT

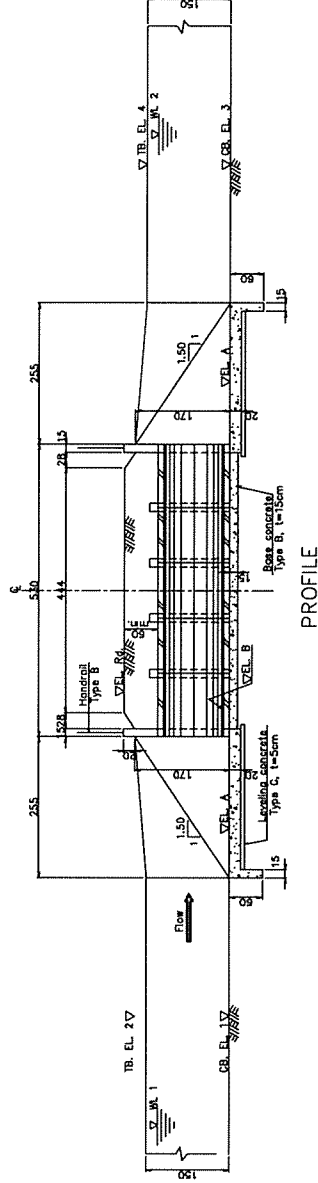
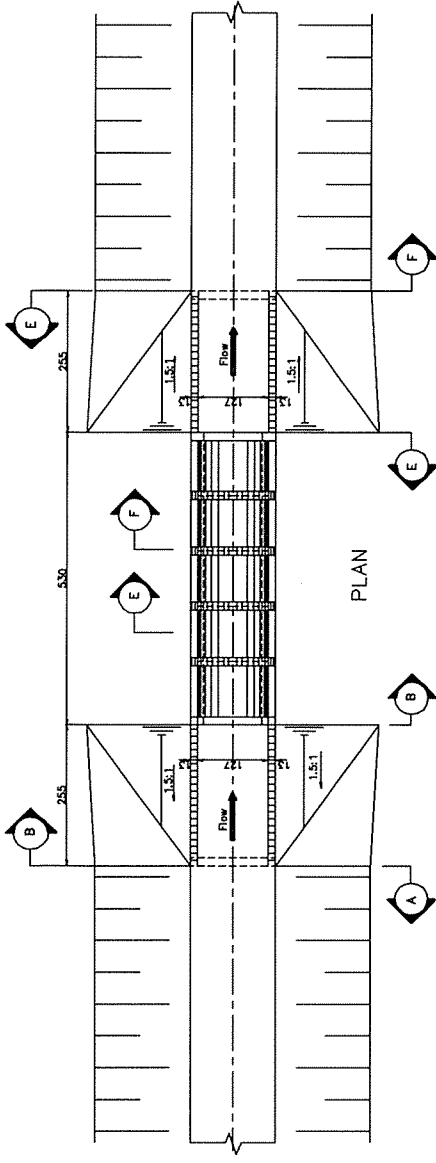
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

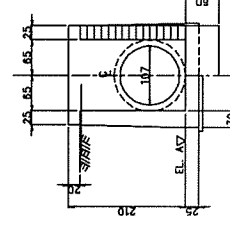
CR - 06

Drawing Title

Canal-related Structures for Six Sub-projects
Terminal Structure



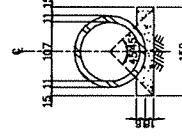
PROFILE



(TYPE B)

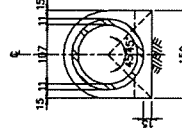
SECTION B-B

SCHALE 1 : 100



(TYPE B)

SECTION C-C



(TYPE B)

SECTION D-D

Type	Design Q (m ³ /sec)	Ream Km		For Canal		Dampak Ampil		Wai Long		Wai Chre		Lum Hach	
		MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total	MC	SC/SSC	Total
Road Culvert		0	4	4	0	28	28	0	4	4	0	1	1
RC 701	0.13											0	12
RC 702	0.18											0	1
RC 703	0.22											0	2
RC 704	0.34											0	2
RC 705	0.40											0	1
RC 706	0.51											0	1
RC 707	0.65											0	1
RC 708	0.99											0	3
RC 709	1.30											0	4
RC 710	1.68											0	4
RC 712	2.70											1	0
RC 1014	4.00											1	0
RC 2504	0.34	0	1	1								2	0
Length=20m													2
DRC1001	5.00											1	0
Total		0	5	5	0	0	32	32	2	11	13	1	2
												3	28
												3	28

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No.

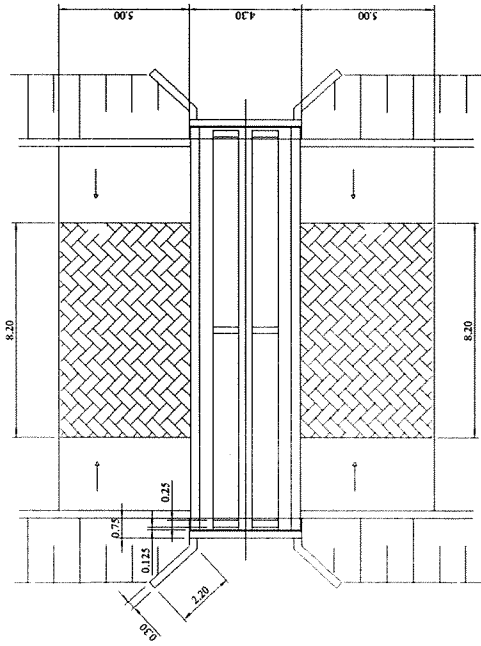
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CR - 07

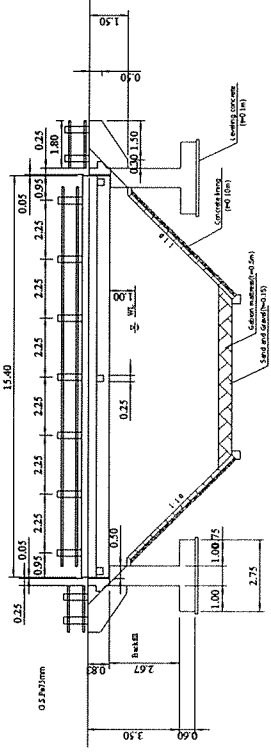
Canal-related Structures for Six Sub-projects
Road Culvert

CONCRETE BRIDGE

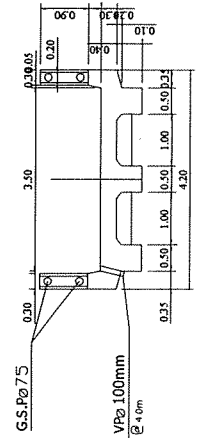
SCALE 1:200



PLAN

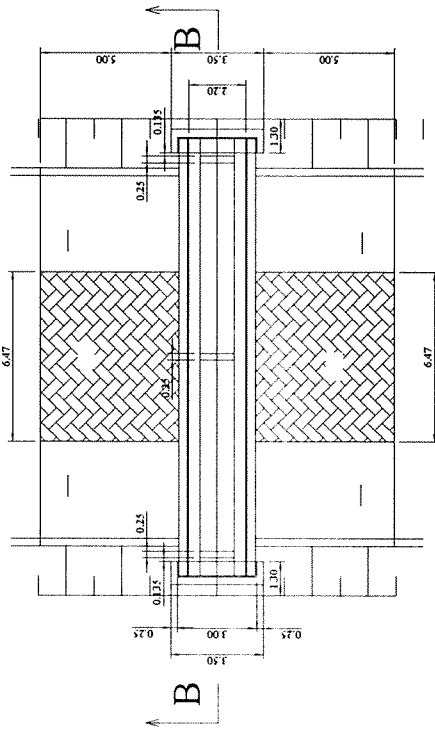


SECTION A-A

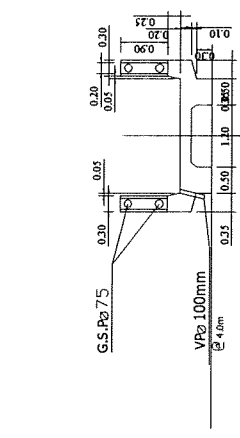


FOOT PATH

SCALE 1:200



SECTION B-B



FOOT PATH

Type	Design Q (unit/Sec)	Beam Kon		For Canal		Damask Amp. I		Vid. Long		Vid. Chre		Lum. Fish	
		MD	SECD	Total	MD	SECD	Total	MD	SECD	Total	MD	SECD	Total
Bridge	BR 2035	1	2	3	0	2	1	0	1	0	1	0	1
	BR 2045	1	2	3	0	2	1	0	1	0	1	0	1
	BR 2045	1	2	3	0	2	1	0	1	0	1	0	1
Total		3	6	9	0	6	3	0	3	0	3	0	3
Foot Path Bridge		1	5	6	0	2	1	0	1	0	1	1	2
FB 1020		1	3	4	0	1	1	0	1	0	1	1	2
FB 1200		1	3	4	0	1	1	0	1	0	1	1	2
Total		6	23	29	0	10	6	0	6	0	6	2	6

Foot path bridges of Vid. Long (300-Projet are provided in each secondary drainage canal
Foot path bridges of Lum. Fish (300-Projet are provided every 100m along the main road)

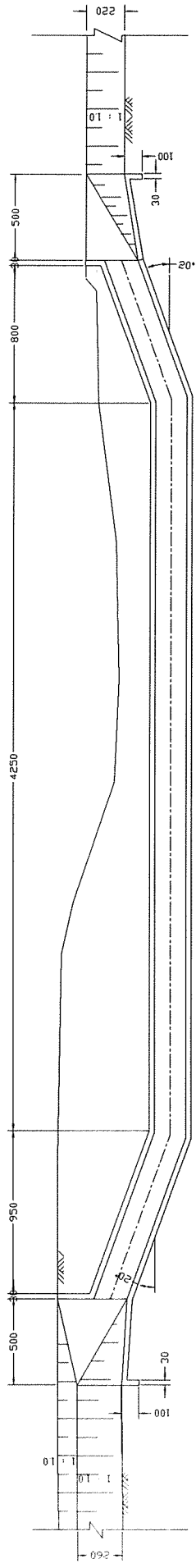
PLAN

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

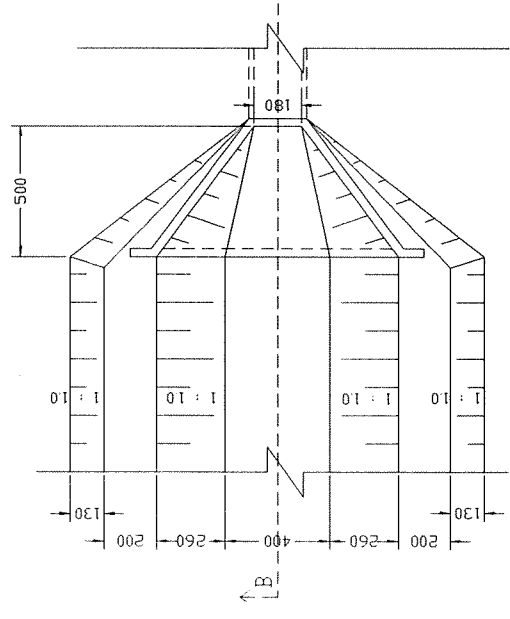
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. CR - 08

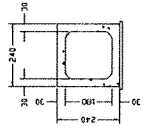
Drawing Title Canal-related Structures for Six Sub-projects Concrete Bridge and Footpath Bridge



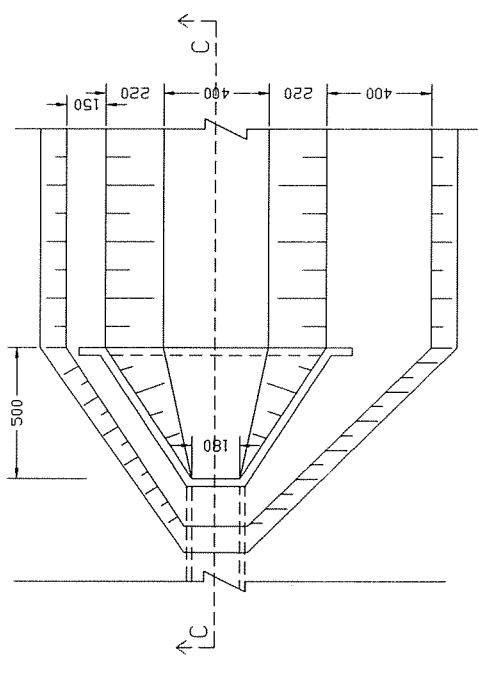
SECTION OF CONDUIT
SCALE 1 : 250



INLET TRANSITION
SCHALE 1 : 200



SECTION OF CONDUIT
SCALE 1 : 200



OUTLET TRANSITION
SCHALE 1 : 200

Type	Design Q (m ³ /sec)	Reman Kon		Per Canal		Dampak Ampil		Wak Loung		Wak Chre		Lum Hach	
		MC	SO/SSC	MC	SO/SSC	MC	SO/SSC	MC	SO/SSC	MC	SO/SSC	MC	SO/SSC
SY 01	4.84							1	0	1	0	1	1
SY 02	0.38												
SY 03	0.96												
Total		0	0	0	0	0	0	1	0	1	0	1	1

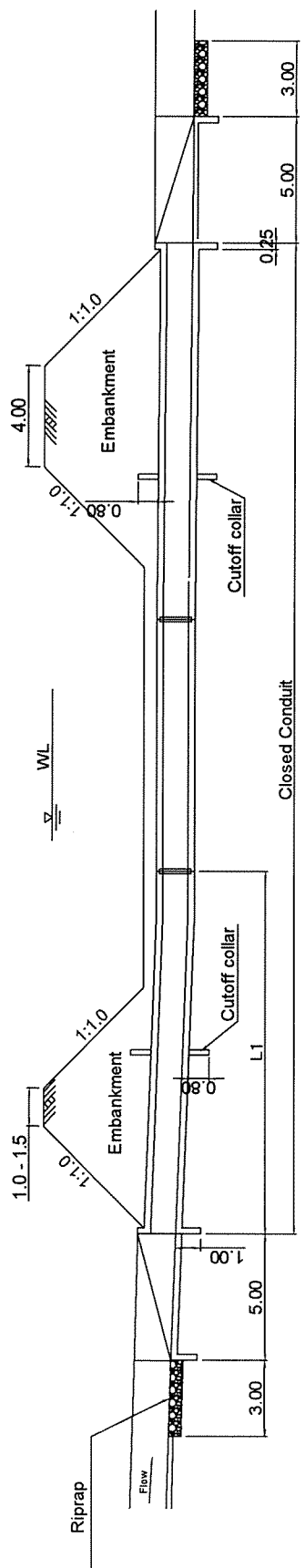
SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

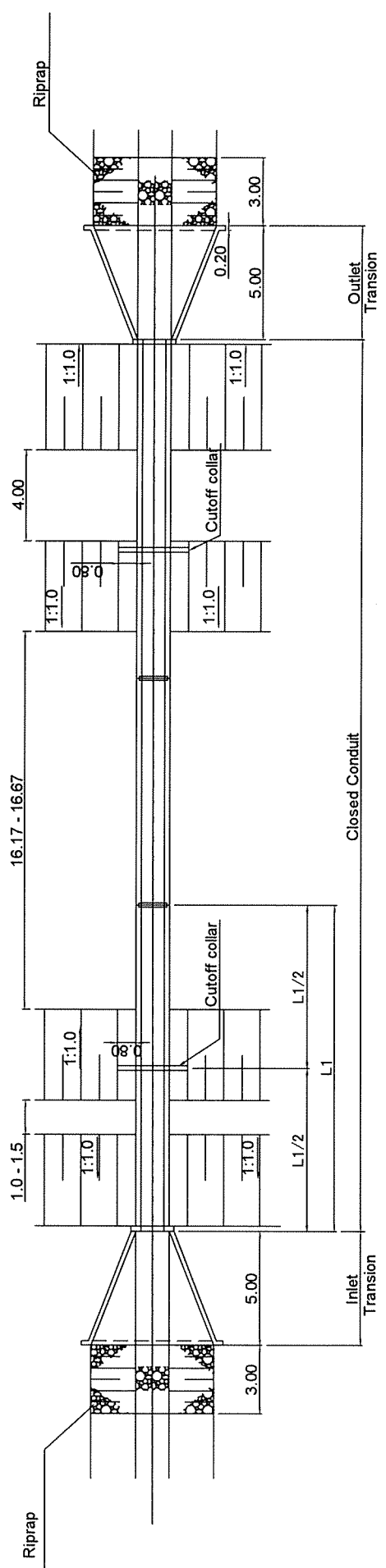
Drawing No. CR - 09

Drawing Title

Canal-related Structures for Six Sub-projects Syphon

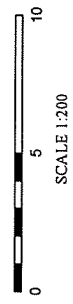


PROFILE



PLAN

Type	Drain Q (m³/sec)	Branch No	Prc. Cnst		Draink. Amplif		Vol. Leng.		Vol. Cnst		Lam. Hts.	
			MD	SD/CD Total	MD	SD/CD Total	MD	SD/CD Total	MD	SD/CD Total	MD	SD/CD Total
DC 104	0.34		0	0	0	0	0	0	0	0	0	0
DC 105	0.45		0	0	0	0	0	0	0	0	0	0
DC 108	0.44		0	0	0	0	0	0	0	0	0	0
DC 109	1.33		0	0	0	0	0	0	0	0	0	0
DC 111	1.67		0	0	0	0	0	0	0	0	0	0
DC 112	1.68		0	0	0	0	0	0	0	0	0	0
DC 113	2.19		0	0	0	0	0	0	0	0	0	0
DC 113	2.00		0	0	0	0	0	0	0	0	0	0
DC 200	5.00		0	0	0	0	0	0	0	0	0	0
DC 202	3.30		0	0	0	0	0	0	0	0	0	0
Total			0	14	4	9	13	0	5	0	13	18



SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND IMPROVEMENT PROJECT
 JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Drawing No. CR - 10
 Drawing Title Canal-related Structures for Six Sub-projects Drainage Culvert (Cross Drainage)

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

B3. COST ESTIMATE

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
IMPROVEMENT PROJECT

IN
THE KINGDOM OF CAMBODIA

FINAL REPORT
APPENDIX B-3 COST ESTIMATE

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Table B3.1 Initial Investment Cost for the Project

No.	Item	Total (US\$)	FC (JPY)	LC (Riels.)	Remarks
1	Construction	31,693,000	1,921,480,000	48,722,102,000	
1-1	Ream Kon Sub-Project	6,674,000	417,982,000	9,692,584,000	
1-2	Por Canal Sub-Project	2,215,000	129,034,000	3,628,548,000	
1-3	Damnak Ampil Sub-Project	4,008,000	190,309,000	8,400,788,000	
1-4	Wat Loung Sub-Project	4,811,000	294,853,000	7,261,210,000	
1-5	Wat Chre Sub-Project	3,276,000	193,310,000	5,261,806,000	
1-6	Lum Hach Sub-Project	10,709,000	695,992,000	14,477,166,000	
2	Procurement Cost	464,000	35,000,000	427,856,000	
3	Price Escalation	2,984,000	228,154,000	2,580,724,000	FC: 2.6%/year, LC: 1.2%/year
4	Physical Contingency	1,756,000	109,232,000	2,586,534,000	4 = (1+2+3) x 5%
<u>5</u>	<u>Sub-Total (=1 to 4)</u>	<u>36,897,000</u>	<u>2,293,866,000</u>	<u>54,317,216,000</u>	<u>5 = SUM (1 to 4)</u>
6	Consulting Services	5,485,000	304,280,000	9,621,252,000	
6-1	Detail Design (D/D)	2,464,000	133,430,000	4,459,838,000	
6-2	Construction Supervision (C/S)	3,021,000	170,850,000	5,161,414,000	
7	Price Escalation	357,000	25,742,000	371,510,000	FC: 2.6%/year, LC: 1.2%/year
8	Physical Contingency	293,000	16,501,000	499,639,000	8 = (6+7) x 5%
<u>9</u>	<u>Sub-Total (=6 to 8)</u>	<u>6,135,000</u>	<u>346,523,000</u>	<u>10,492,401,000</u>	<u>9 = SUM (6 to 8)</u>
10	Soft Component Activities	2,227,000	119,330,000	4,074,214,000	
10-1	FWUC Establishment and Strengthening Program	621,000	32,390,000	1,180,080,000	
10-2	Agriculture Support Services	443,000	26,460,000	691,545,000	
10-3	Meteo-hydrological Observation Strengthening Program	417,000	18,240,000	936,330,000	
10-4	Capacity Development of MOWRAM and PDOWRAM Staff	113,000	8,670,000	92,149,000	
10-5	Project Formulation Study	633,000	33,570,000	1,174,110,000	
11	Price Escalation	181,000	13,103,000	190,794,000	FC: 2.6%/year, LC: 1.2%/year
12	Physical Contingency	119,000	6,622,000	213,251,000	12 = (10+11) x 5%
<u>13</u>	<u>Sub-Total (=10 to 12)</u>	<u>2,527,000</u>	<u>139,055,000</u>	<u>4,478,259,000</u>	<u>13 = SUM (10 to 12)</u>
14	Land Acquisition	665,000	0	2,735,810,000	
15	Price Escalation	24,000	0	99,676,000	FC: 2.6%/year, LC: 1.2%/year
16	Physical Contingency	34,000	0	141,774,000	16 = (14+15) x 5%
<u>17</u>	<u>Sub-Total (=14 to 16)</u>	<u>723,000</u>	<u>0</u>	<u>2,977,260,000</u>	<u>17 = SUM (14 to 16)</u>
<u>18</u>	<u>Project Administration</u>	<u>1,107,000</u>	<u>0</u>	<u>4,554,198,000</u>	<u>18 = 3.0 % of (Total5)</u>
<u>19</u>	<u>Tax & Duty</u>	<u>1,684,000</u>	<u>0</u>	<u>6,927,976,000</u>	<u>19 = 10 % of (5+9+13)</u>
<u>20</u>	<u>Interest During Construction</u>	<u>18,000</u>	<u>1,010,000</u>	<u>25,023,000</u>	<u>0.01%/year</u>
<u>21</u>	<u>Total</u>	<u>49,091,000</u>	<u>2,780,454,000</u>	<u>83,772,333,000</u>	

Table B3.2 Construction Cost for Ream Kon Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
1)	Main Diversion Weir	2,894,000	
2)	Intake for Ream Kon	44,000	
3)	Operation and Maintenance Office	30,000	
4)	Collector Drain-2 (CD-2)	134,000	
5)	Closure Dike for Collector Drain-2 (CD-2)	326,000	
6)	Excavation of River	246,000	
	<u>Sub-total</u>	<u>3,674,000</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	474,000	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	650,000	
3)	Earthwork for Drainage Canal	921,000	
4)	Canal Related Structure Works	401,000	
5)	Metal Works	68,000	
	<u>Sub-total</u>	<u>2,514,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	446,000	
	<u>Sub-total</u>	<u>446,000</u>	
1-4	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculter Support Program	10,000	
	<u>Sub-total</u>	<u>40,000</u>	
<u>Grand Total</u>		<u>6,674,000</u>	

Table B3.3 Construction Cost for Por Canal Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
1)	Intake for Por Canal	56,000	
	<u>Sub-total</u>	<u>56,000</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	384,000	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	715,000	
3)	Earthwork for Drainage Canal	321,000	
4)	Canal Related Structure Works	229,000	
5)	Metal Works	75,000	
	<u>Sub-total</u>	<u>1,724,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	390,000	
	<u>Sub-total</u>	<u>390,000</u>	
1-4	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculter Support Program	15,000	
	<u>Sub-total</u>	<u>45,000</u>	
<u>Grand Total</u>		<u>2,215,000</u>	

Table B3.4 Construction Cost for Damnak Ampil Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
1)	Main Diversion Weir (mainly for Fish Ladder)	197,000	
2)	Gate Improvement for Damnak Ampil Weir	2,000,000	
	<u>Sub-total</u>	<u>2,197,000</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	0	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	493,000	
3)	Earthwork for Drainage Canal	405,000	
4)	Canal Related Structure Works	269,000	
5)	Metal Works	65,000	
	<u>Sub-total</u>	<u>1,232,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	536,000	
	<u>Sub-total</u>	<u>536,000</u>	
1-4	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculter Support Program	13,000	
	<u>Sub-total</u>	<u>43,000</u>	
<u>Grand Total</u>		<u>4,008,000</u>	

Table B3.5 Construction Cost for Wat Loung Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
	<u>Sub-total</u>	<u>0</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	1,415,000	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	1,080,000	
3)	Earthwork for Drainage Canal	950,000	
4)	Canal Related Structure Works	600,000	
5)	Metal Works	124,000	
	<u>Sub-total</u>	<u>4,169,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	599,000	
	<u>Sub-total</u>	<u>599,000</u>	
1-4	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculter Support Program	13,000	
	<u>Sub-total</u>	<u>43,000</u>	
<u>Grand Total</u>		<u>4,811,000</u>	

Table B3.6 Construction Cost for Wat Chre Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
1)	Wat Chre Diversion Weir	1,527,000	
2)	Intake for Wat Chre	16,000	
3)	Operation and Maintenance Office	30,000	
4)	Excavation of River	365,000	
	<u>Sub-total</u>	<u>1,938,000</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	256,000	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	485,000	
3)	Earthwork for Drainage Canal	138,000	
4)	Canal Related Structure Works	145,000	
5)	Metal Works	32,000	
	<u>Sub-total</u>	<u>1,056,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	241,000	
	<u>Sub-total</u>	<u>241,000</u>	
1-4	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculturer Support Program	11,000	
	<u>Sub-total</u>	<u>41,000</u>	
	<u>Grand Total</u>	<u>3,276,000</u>	

Table B3.7 Construction Cost for Lum Hach Sub-project

No.	Description	Amount (US\$)	Remarks
1-1	Headworks and Major Related Structures		
1)	Lum Hach Diversion Weir	4,579,000	
2)	Intake for Lum Hach and O Rollus	432,000	
3)	Operation and Maintenance Office	30,000	
4)	Approach Canal	75,000	
5)	Closure Dike for 7th January Canal	1,000	
6)	Excavation of River	28,000	
7)	Access Road to Headworks	75,000	
	<u>Sub-total</u>	<u>5,220,000</u>	
1-2	Main and Secondary Canal Systems		
1)	Earthwork for Main Irrigation Canal	1,156,000	
2)	Earthwork for Secondary and Sub-secondary Irrigation Canal	1,522,000	
3)	Earthwork for Drainage Canal	613,000	
4)	Canal Related Structure Works	1,195,000	
5)	Metal Works	187,000	
	<u>Sub-total</u>	<u>4,673,000</u>	
1-3	Tertiary Development		
1)	Tertiary Irrigation Canal System	732,000	
	<u>Sub-total</u>	<u>732,000</u>	
1-4	PIU Office	36,000	
1-5	Facilities for Soft Component Activities		
1)	Construction of FWUC Office	30,000	
2)	Facilities for Agriculturer Support Program	18,000	
	<u>Sub-total</u>	<u>48,000</u>	
	<u>Grand Total</u>	<u>10,709,000</u>	

Table B3.8 Procurement Cost

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Procurement Cost							
(a) Procurement of Vehicles	nos	10	3,500,000	35,000,000			360,000
(b) Procurement of Motorcycles	nos	24			4,114,000	98,736,000	24,000
(c) Procurement of Office Equipment and Furniture	LS	1			329,120,000	329,120,000	80,000
Total				35,000,000		427,856,000	464,000

Table B3.9 Consulting Services Cost for Detailed Design (D/D)

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	47	2,300,000	108,100,000			1,117,000
(b) Professional (B) Experts	MM	102			12,342,000	1,258,884,000	306,000
Sub-total				108,100,000		1,258,884,000	1,423,000
(2) Direct Cost							
(a) International travel cost	trips	9	450,000	4,050,000			42,000
(b) Perdiem and accommodation cost (Pro.A)	MM	47	440,000	20,680,000			214,000
(c) Perdiem and accommodation cost (Pro.B)	MM	102			3,291,000	335,682,000	82,000
(d) CAD Operators	MM	47			4,114,000	193,358,000	47,000
(e) Office Staffs	MM	96			2,057,000	197,472,000	48,000
(f) Duty trip expences (allowances)	trips	100			411,000	41,100,000	10,000
(g) Office rental cost	month	12			4,114,000	49,368,000	12,000
(h) Office running cost	month	12			4,114,000	49,368,000	12,000
(i) International communication cost	month	12	50,000	600,000			6,000
(j) Local communication cost	month	12			2,057,000	24,684,000	6,000
(k) Vehicle rental cost	car-M	18			10,285,000	185,130,000	45,000
(l) Motorcycle rental cost	car-M	24			288,000	6,912,000	2,000
(m) Vehicle operation	car-M	36			1,234,000	44,424,000	11,000
(n) Report printing cost	L.S.	1			8,228,000	8,228,000	2,000
(o) Workshop, etc.	L.S.	1			8,228,000	8,228,000	2,000
(p) Survey and Investigation Cost	L.S.	1			2,057,000,000	2,057,000,000	500,000
Sub-total				25,330,000		3,200,954,000	1,041,000
Total				133,430,000		4,459,838,000	2,464,000

Table B3.10 Consulting Services Cost for Construction Supervision (C/S)

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	60	2,300,000	138,000,000			1,426,000
(b) Professional (B) Experts	MM	172			12,342,000	2,122,824,000	516,000
Sub-total (round)				138,000,000		2,122,824,000	1,942,000
(2) Direct Cost							
(a) International travel cost	trips	9	450,000	4,050,000			42,000
(b) Perdiem and accommodation cost (Pro.A)	MM	60	440,000	26,400,000			273,000
(c) Perdiem and accommodation cost (Pro.B)	MM	172			3,291,000	566,052,000	138,000
(d) CAD Operators	MM	60			4,114,000	246,840,000	60,000
(e) Office Staffs	MM	378			2,057,000	777,546,000	189,000
(f) Duty trip expences (allowances)	trips	300			411,000	123,300,000	30,000
(g) Office rental cost	month	48			4,114,000	197,472,000	48,000
(h) Office running cost	month	48			4,114,000	197,472,000	48,000
(i) International communication cost	month	48	50,000	2,400,000			25,000
(j) Local communication cost	month	48			2,057,000	98,736,000	24,000
(k) Vehicle rental cost	car-M	48			10,285,000	493,680,000	120,000
(l) Vehicle operation	car-M	144			1,234,000	177,696,000	43,000
(m) Motorcycle operation	car-M	576			206,000	118,656,000	29,000
(n) Report printing cost	L.S.	1			20,570,000	20,570,000	5,000
(o) Workshop, etc.	L.S.	1			20,570,000	20,570,000	5,000
Sub-total (round)				32,850,000		3,038,590,000	1,079,000
Total				170,850,000		5,161,414,000	3,021,000

Table B3.11 Soft Component Activities Cost for FWUC Establishment and Strengthening Program

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	11	2,300,000	25,300,000			261,000
(b) Professional (B) Experts	MM	62			12,342,000	765,204,000	186,000
Sub-total				25,300,000		765,204,000	447,000
(2) Direct Cost							
(a) International travel cost	trips	5	450,000	2,250,000			23,000
(b) Perdiem and accommodation cost (Pro.A)	MM	11	440,000	4,840,000			50,000
(c) Perdiem and accommodation cost (Pro.B)	MM	62			3,291,000	204,042,000	50,000
(d) Duty trip expenses (allowances)	trips	40			411,000	16,440,000	4,000
(e) Vehicle rental cost	car-M	16			10,285,000	164,560,000	40,000
(f) Motorcycle rental cost	car-M	25			206,000	5,150,000	1,000
(g) Report printing cost	L.S.	1			4,114,000	4,114,000	1,000
(h) Workshop, etc.	L.S.	1			20,570,000	20,570,000	5,000
Sub-total				7,090,000		414,876,000	174,000
Total				32,390,000		1,180,080,000	621,000

Table B3.12 Soft Component Activities Cost for Agriculture Support Services

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	9	2,300,000	20,700,000			214,000
(b) Professional (B) Experts	MM	32			12,342,000	394,944,000	96,000
Sub-total				20,700,000		394,944,000	310,000
(2) Direct Cost							
(a) International travel cost	trips	4	450,000	1,800,000			19,000
(b) Perdiem and accommodation cost (Pro.A)	MM	9	440,000	3,960,000			41,000
(c) Perdiem and accommodation cost (Pro.B)	MM	32			3,291,000	105,312,000	26,000
(d) Duty trip expenses (allowances)	trips	30			411,000	12,330,000	3,000
(e) Vehicle rental cost	car-M	15			10,285,000	154,275,000	38,000
(f) Report printing cost	L.S.	1			4,114,000	4,114,000	1,000
(g) Workshop, etc.	L.S.	1			20,570,000	20,570,000	5,000
Sub-total				5,760,000		296,601,000	133,000
Total				26,460,000		691,545,000	443,000

Table B3.13 Soft Component Activities Cost for Meteo-hydrological Observation Strengthening Program

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	6	2,300,000	13,800,000			143,000
(b) Professional (B) Experts	MM	22			12,342,000	271,524,000	66,000
Sub-total				13,800,000		271,524,000	209,000
(2) Direct Cost							
(a) International travel cost	trips	4	450,000	1,800,000			19,000
(b) Perdiem and accommodation cost (Pro.A)	MM	6	440,000	2,640,000			27,000
(c) Perdiem and accommodation cost (Pro.B)	MM	22			3,291,000	72,402,000	18,000
(d) Duty trip expenses (allowances)	trips	30			411,000	12,330,000	3,000
(e) Procurement of equipment and furniture	L.S.	1			411,400,000	411,400,000	100,000
(f) Vehicle rental cost	car-M	14			10,285,000	143,990,000	35,000
(g) Report printing cost	L.S.	1			4,114,000	4,114,000	1,000
(h) Workshop, etc.	L.S.	1			20,570,000	20,570,000	5,000
Sub-total				4,440,000		664,806,000	208,000
Total				18,240,000		936,330,000	417,000

Table B3.14 Soft Component Activities Cost for Capacity Development of MOWRAM and PDOWRAM staff

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	3	2,300,000	6,900,000			71,000
(b) Professional (B) Experts	MM	3			12,342,000	37,026,000	9,000
<u>Sub-total</u>				<u>6,900,000</u>		<u>37,026,000</u>	<u>80,000</u>
(2) Direct Cost							
(a) International travel cost	trips	1	450,000	450,000			5,000
(b) Perdiem and accommodation cost (Pro.A)	MM	3	440,000	1,320,000			14,000
(c) Perdiem and accommodation cost (Pro.B)	MM	3			3,291,000	9,873,000	2,000
(d) Duty trip expences (allowances)	trips	10			411,000	4,110,000	1,000
(e) Vehicle rental cost	car-M	3			10,285,000	30,855,000	8,000
(f) Report printing cost	L.S.	1			2,057,000	2,057,000	1,000
(g) Workshop, etc.	L.S.	1			8,228,000	8,228,000	2,000
<u>Sub-total</u>				<u>1,770,000</u>		<u>55,123,000</u>	<u>33,000</u>
<u>Total</u>				<u>8,670,000</u>		<u>92,149,000</u>	<u>113,000</u>

Table B3.15 Soft Component Activities Cost for Project Formulation Study

Items	Unit	Qty.	FC (JPY)		LC (Riels)		Total (US\$)
			Unit Rate	Amount	Unit Rate	Amount	
(1) Remuneration and Salary							
(a) Professional (A) Experts	MM	12	2,300,000	27,600,000			285,000
(b) Professional (B) Experts	MM	58			12,342,000	715,836,000	174,000
<u>Sub-total (round)</u>				<u>27,600,000</u>		<u>715,836,000</u>	<u>459,000</u>
(2) Direct Cost							
(a) International travel cost	trips	1	450,000	450,000			5,000
(b) Perdiem and accommodation cost (Pro.A)	MM	12	440,000	5,280,000			55,000
(c) Perdiem and accommodation cost (Pro.B)	MM	58			3,291,000	190,878,000	46,000
(d) CAD Operators	MM	12			4,114,000	49,368,000	12,000
(e) Duty trip expences (allowances)	trips	50			411,000	20,550,000	5,000
(f) Office rental cost	month	12			1,646,000	19,752,000	5,000
(g) Office running cost	month	12			2,057,000	24,684,000	6,000
(h) International communication cost	month	12	20,000	240,000			2,000
(i) Local communication cost	month	12			1,234,000	14,808,000	4,000
(j) Vehicle rental cost	car-M	12			10,285,000	123,420,000	30,000
(k) Motorcycle rental cost	car-M	12			206,000	2,472,000	1,000
(l) Report printing cost	L.S.	1			8,228,000	8,228,000	2,000
(m) Workshop, etc.	L.S.	1			4,114,000	4,114,000	1,000
<u>Sub-total (round)</u>				<u>5,970,000</u>		<u>458,274,000</u>	<u>174,000</u>
<u>Total</u>				<u>33,570,000</u>		<u>1,174,110,000</u>	<u>633,000</u>

Table B3.16 Annual Disbursement Schedule for the Project

No.	Item	2010			2011			2012			2013			2014			2015			2016		
		FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)	FC (JPY)	LC (Riels)	Total (US\$)
1	Construction	0	0	0	0	0	0	0	0	1,245,344,000	33,269,341,000	20,952,000	676,136,000	15,452,761,000	10,741,000	0	0	0				
	1-1 Ream Kon Sub-Project	0	0	0	0	0	0	0	0	355,285,000	8,238,696,000	5,673,000	62,697,000	1,453,888,000	1,001,000	0	0	0				
	1-2 Por Canal Sub-Project	0	0	0	0	0	0	0	0	86,453,000	2,431,127,000	1,484,000	42,581,000	1,197,421,000	731,000	0	0	0				
	1-3 Damnak Ampil Sub-Project	0	0	0	0	0	0	0	0	180,794,000	7,980,749,000	3,808,000	9,515,000	420,039,000	200,000	0	0	0				
	1-4 Wat Loung Sub-Project	0	0	0	0	0	0	0	0	159,221,000	3,921,053,000	2,598,000	135,632,000	3,340,157,000	2,213,000	0	0	0				
	1-5 Wat Chre Sub-Project	0	0	0	0	0	0	0	0	164,314,000	4,472,535,000	2,784,000	28,996,000	789,271,000	492,000	0	0	0				
	1-6 Lum Hach Sub-Project	0	0	0	0	0	0	0	0	299,277,000	6,225,181,000	4,605,000	396,715,000	8,251,985,000	6,104,000	0	0	0				
2	Procurement Cost	35,000,000	427,856,000	464,000								0			0			0				
3	Price Escalation	910,000	5,134,000	10,000	0	0	0	0	0	134,655,000	1,625,904,000	1,786,000	92,589,000	949,686,000	1,188,000	0	0	0				
4	Physical Contingency	1,796,000	21,650,000	23,000	0	0	0	0	0	69,000,000	1,744,762,000	1,137,000	38,436,000	820,122,000	596,000	0	0	0				
5	Sub-Total (=1 to 4)	37,706,000	454,640,000	497,000	0	0	0	0	0	1,448,999,000	36,640,007,000	23,875,000	807,161,000	17,222,569,000	12,525,000	0	0	0				
6	Consulting Services	15,198,000	1,123,122,000	430,000	124,330,000	3,464,250,000	2,128,000	31,557,000	777,546,000	515,000	87,215,000	2,043,002,000	1,399,000	36,590,000	1,600,346,000	767,000	581,000	427,856,000	110,000	8,809,000	185,130,000	136,000
	6-1 Detail Design (D/D)	15,198,000	1,123,122,000	430,000	118,232,000	3,336,716,000	2,034,000	0	0	0	0	0	0	0	0	0	0	0	0			
	6-2 Construction Supervision (C/S)	0	0	0	6,098,000	127,534,000	94,000	31,557,000	777,546,000	515,000	87,215,000	2,043,002,000	1,399,000	36,590,000	1,600,346,000	767,000	581,000	427,856,000	110,000	8,809,000	185,130,000	136,000
7	Price Escalation	395,000	13,477,000	7,000	6,549,000	83,641,000	88,000	2,526,000	28,329,000	33,000	9,430,000	99,843,000	122,000	5,011,000	98,353,000	76,000	97,000	31,745,000	9,000	1,734,000	16,122,000	22,000
8	Physical Contingency	780,000	56,830,000	22,000	6,544,000	177,395,000	111,000	1,704,000	40,294,000	28,000	4,832,000	107,142,000	76,000	2,080,000	84,935,000	43,000	34,000	22,980,000	6,000	527,000	10,063,000	7,000
9	Sub-Total (=6 to 8)	16,373,000	1,193,429,000	459,000	137,423,000	3,725,286,000	2,327,000	35,787,000	846,169,000	576,000	101,477,000	2,249,987,000	1,597,000	43,681,000	1,783,634,000	886,000	712,000	482,581,000	125,000	11,070,000	211,315,000	165,000
10	Soft Component Activities	0	0	0	17,811,000	798,095,000	380,000	20,424,000	917,815,000	435,000	32,118,000	1,032,614,000	583,000	37,134,000	955,430,000	616,000	11,843,000	259,182,000	186,000	0	111,078,000	27,000
	10-1 FWUC Establishment and Strengthening Program	0	0	0	484,000	12,342,000	8,000	8,615,000	584,188,000	231,000	2,807,000	102,850,000	54,000	14,482,000	287,342,000	219,000	6,002,000	143,990,000	97,000	0	49,368,000	12,000
	10-2 Agriculture Support Services	0	0	0	0	0	0	8,615,000	226,663,000	145,000	6,002,000	156,332,000	100,000	6,002,000	131,648,000	94,000	5,841,000	115,192,000	89,000	0	61,710,000	15,000
	10-3 Meteo-hydrological Observation Strengthening Program	0	0	0	8,657,000	693,604,000	259,000	3,194,000	106,964,000	59,000	6,389,000	135,762,000	99,000	0	0	0	0	0	0	0	0	0
	10-4 Capacity Development of MOWRAM and PDOWRAM Staffs	0	0	0	8,670,000	92,149,000	113,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10-5 Project Formulation Study	0	0	0	0	0	0	0	0	16,920,000	637,670,000	330,000	16,650,000	536,440,000	303,000	0	0	0	0	0	0	0
11	Price Escalation	0	0	0	938,000	19,269,000	15,000	1,635,000	33,439,000	25,000	3,473,000	50,465,000	48,000	5,085,000	58,718,000	66,000	1,972,000	19,230,000	25,000	0	9,673,000	2,000
12	Physical Contingency	0	0	0	937,000	40,868,000	20,000	1,103,000	47,563,000	23,000	1,780,000	54,154,000	31,000	2,111,000	50,707,000	34,000	691,000	13,921,000	10,000	0	6,038,000	1,000
13	Sub-Total (=10 to 12)	0	0	0	19,686,000	858,232,000	415,000	23,162,000	998,817,000	483,000	37,371,000	1,137,233,000	662,000	44,330,000	1,064,855,000	716,000	14,506,000	292,333,000	221,000	0	126,789,000	30,000
14	Land Acquisition	0	0	0	0	0	0	2,735,810,000	665,000	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Price Escalation	0	0	0	0	0	0	99,676,000	24,000	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Physical Contingency	0	0	0	0	0	0	141,774,000	34,000	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Sub-Total (=14 to 16)	0	0	0	0	0	0	2,977,260,000	723,000	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Project Administration		98,736,000	24,000		242,726,000	59,000		135,762,000	33,000		2,653,530,000	645,000		1,394,646,000	339,000		12,342,000	3,000		16,456,000	4,000
19	Tax & Duty		164,807,000	40,000		458,352,000	112,000		184,499,000	45,000		4,002,723,000	973,000		2,007,106,000	488,000		76,679,000	18,000		33,810,000	8,000
20	Interest During Construction	5,000	165,000	0	19,000	537,000	0	23,000	622,000	0	178,000	4,511,000	3,000	263,000	6,412,000	5,000	263,000	6,460,000	5,000	259,000	6,316,000	5,000
21	Total	54,084,000	1,911,777,000	1,020,000	157,128,000	5,285,133,000	2,913,000	58,972,000	5,143,129,000	1,860,000	1,588,025,000	46,687,991,000	27,755,000	895,435,000	23,479,222,000	14,959,000	15,481,000	870,395,000	372,000	11,329,000	394,686,000	212,000

Table B3.17 Breakdown of Construction Cost for Headworks and Major related Structures (1/3)
(Ream Kon Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Main Diversion Weir				
1.1	Earth works				
1.1.1	Excavation of foundation	m ³	16,817.00	2.30	38,679.10
1.1.2	Embankment	m ³	5,665.00	2.50	14,162.50
1.1.3	Soil back filling and compaction	m ³	3,201.00	5.00	16,005.00
1.2	Removal of existing concrete				
1.2.1	Foundation of structure	m ³	600.00	40.00	24,000.00
1.2.2	Side wall of a structure	m ³	200.00	38.00	7,600.00
1.3	Foundation Pile				
1.3.1	Sheet pile L= 600 cm	m2	553.00	180.00	99,540.00
1.3.2	Concrete Pile 40 x 40 x 900 cm	Pcs	108.00	480.00	51,840.00
1.4	Lean Concrete				
1.4.1	Lean Concrete class D	m ³	242.60	75.00	18,195.00
1.5	Reinforce Concrete				
1.5.1	Concrete for weir body	m ³	2,190.00	195.00	427,050.00
1.5.2	Concrete for bridge	m ³	308.50	195.00	60,157.50
1.5.3	Concrete for upstream apron	m ³	187.30	195.00	36,523.50
1.5.4	Concrete for dawonstream apron	m ³	265.30	195.00	51,733.50
1.5.5	Concrete for Fish Ladder	m ³	2,050.90	195.00	399,925.50
1.5.6	Concrete for transition	m ³	460.20	195.00	89,739.00
1.6	Installation of gate				
1.6.1	Installation mechanic width size 3.00m x 2.00m	Set	1.00	36,000.00	36,000.00
1.6.2	Installation Roller gate width size 11.50m x height 4.20m, with Hoist System & Deck	Set	2.00	424,000.00	848,000.00
1.6.3	Counter weight from metal width size 1.40m x 0.90m x 0.25m	Pcs	28.00	2,500.00	70,000.00
1.6.4	Concrete wall	m ³	17.40	69.00	1,200.60
1.6.5	Steel hand rail	m	67.00	30.00	2,010.00
1.7	Stone pitching				
1.7.1	Gaion box downstream and both side slope with side (1.00m x 0.50m x 0.75m)	Pcs	780.00	35.00	27,300.00
1.7.2	Concrete Block	m ³	310.00	69.00	21,390.00
1.7.3	Riprap rock protection with side (20cm x 30cm)	m ³	160.00	35.00	5,600.00
1.7.4	Rock filter with side (4cm x 6cm)	m ³	390.00	28.00	10,920.00
1.7.5	Fine sand filter	m ³	90.00	13.33	1,199.70
1.7.6	Geotextile	m2	1,189.50	2.80	3,330.60
1.8	Temporary Works				
1.8.1	Diversion Channel				
	Excavation	m ³	4,200.00	2.30	9,660.00
1.8.2	Cofferdam				
	Excavation	m ³	4,050.00	2.30	9,315.00
	Embankment	m ³	3,900.00	2.50	9,750.00
	Riprap	m ³	600.00	35.00	21,000.00
	Sub Total 1				2,411,826.50
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		482,365.00
	Total of Item 1				2,894,191.50
					2,894,000.00
2	Intake for Ream Kon				
2.1	Earth works				
2.1.1	Excavation of foundation	m ³	20.00	2.30	46.00
2.1.2	Soil back filling and compaction	m ³	20.00	5.00	100.00
2.2	Removal of existing concrete				
2.2.1	Foundation of structure	m ³	27.00	40.00	1,080.00
2.2.2	Side wall of a structure	m ³	18.00	38.00	684.00
2.3	Foundation Pile				
2.3.1	Concrete Pile 20 x 20 x 400 cm	Psc	6.00	90.00	540.00

Table B3.17 Breakdown of Construction Cost for Headworks and Major related Structures (2/3)
(Ream Kon Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
2.4	Lean Concrete				
2.4.1	Lean Concrete class D	m ³	4.00	75.00	300.00
2.5	Reinforce Concrete				
2.5.1	Concrete for Intake Structure	m ³	45.00	195.00	8,775.00
2.5.2	Concrete for endsil	m ³	1.00	195.00	195.00
2.5.3	Concrete for bridge	m ³	12.00	195.00	2,340.00
2.6	Steel works				
2.6.1	Installation mechanic width size 1.00m x 1.20m	Set	2.00	7,200.00	14,400.00
2.6.2	Steel hand rail	m	14.00	26.00	364.00
2.7	Stone pitching				
2.7.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	220.00	35.00	7,700.00
2.7.2	Rock filter with side (4cm x 6cm)	m ³	4.00	28.00	112.00
2.7.3	Fine sand filter	m ³	2.00	13.33	26.66
2.7.4	Geotextile	m ³	26.00	2.80	72.80
	Sub total 2				36,735.46
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		7,347.00
	Total of Item 2				44,082.46
					44,000.00
3.	Operation and Maintenance office				
3.1	Earth works				
3.1.1	Excavation of foundation	m ³	27.00	2.30	62.10
3.1.2	Soil back filling and compaction	m ³	51.00	5.00	255.00
3.2	Foundation works				
3.2.1	Concrete Pile with size (20 x 20 x 400 cm)	Psc	36.00	90.00	3,240.00
3.2.2	Compaction with stone	m ³	18.00	18.00	324.00
3.3	Lean Concrete				
3.3.1	Lean Concrete class D	m ³	9.00	75.00	675.00
3.4	Reinforce Concrete				
3.4.1	Concrete for foundation	m ³	10.00	195.00	1,950.00
3.4.2	Concrete for pier and column	m ³	28.00	195.00	5,460.00
3.5	Wall brick works				
3.5.1	Preparation of brick wall	m ³	126.00	74.00	9,324.00
3.5.2	Floor tile works	m ³	40.00	12.50	500.00
3.6	Installation of door and window				
3.6.1	Door with size (3200mm x 2400mm)	Set	1.00	320.00	320.00
3.6.2	Window with size (1600mm x 1400mm)	Set	5.00	72.00	360.00
3.7	Roof works				
3.7.1	Roof works	m ²	67.00	25.00	1,675.00
3.8	Radio communication equipment				
3.8.1	Radio communication equipment	Set	3.00	235.00	705.00
3.9	Decoration works				
3.9.1	Decoration of out view	m	42.00	12.00	504.00
3.9.2	Painting external and internal surface wall and ceiling	m ²	166.00	2.00	332.00
	Sub Total 3				25,686.10
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		3,853.00
	Total of Item 3				29,539.10
					30,000.00

Table B3.17 Breakdown of Construction Cost for Headworks and Major related Structures (3/3)
(Ream Kon Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
4.	Collector Drain-2 (CD-2)				
4.1	Earth works				
4.1.1	Clearing site	m ²	19,950.00	0.50	9,975.00
4.1.2	Soil excavation	m ³	44,100.00	2.30	101,430.00
	Sub Total 4				111,405.00
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		22,281.00
	Total of Item 4				133,686.00
					134,000.00
5.	Closure Dike for Collector Drain-2 (CD-2)				
5.1	Earth works				
5.1.1	Soil excavation	m ³	428.00	2.30	984.40
5.1.2	Back filling with compaction (excavated material)	m ³	39.00	3.00	117.00
5.2	Lean Concrete				
5.2.1	Lean Concrete class D	m ³	214.00	75.00	16,050.00
5.3	Foundation works				
5.3.1	Concrete Pile with size (20 x 20 x 400 cm)	Psc	24.00	90.00	2,160.00
5.4	Concrete				
5.4.1	Concrete wall	m ³	1,023.00	75.00	76,725.00
5.4.2	Foundation Concrete	m ³	428.00	195.00	83,460.00
5.4.3	Concrete Pier and Operation bridge	m ³	17.00	195.00	3,315.00
5.5	Steel works				
5.5.1	Installation mechanic width size 3.50m x 1.20m	Set	5.00	12,600.00	63,000.00
5.5.2	Steel hand rail	m	80.00	26.00	2,080.00
5.5.3	Steel hand rail (Ladder step)	m	16.00	7.00	112.00
5.6	Stone pitching				
5.6.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	660.00	35.00	23,100.00
5.6.2	Rock filter with side (4cm x 6cm)	m ³	13.00	28.00	364.00
5.6.3	Fine sand filter	m ³	5.00	13.33	66.65
5.6.4	Geotextile	m ³	80.00	2.80	224.00
	Sub Total 5				271,758.05
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		54,352.00
	Total of Item 5				326,110.05
					326,000.00
6	Excavation of River				
6.1	Earth works				
6.1.1	Soil excavation	m ³	29,501.00	2.30	67,852.30
6.1.2	Embankment with compaction	m ³	52,517.00	2.50	131,292.50
6.1.3	Laterite Paavement (t=15cm)	m ³	253.35	23.00	5,827.05
	Sub Total 7				204,971.85
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		40,994.00
	Total of Item 7				245,965.85
					246,000.00
	Total all structures				3,674,000.00

**Table B3.18 Breakdown of Construction Cost for Canal Systems
(Ream Kon Sub-project)**

(unit: US \$)

Work Item		Quantity	Unit	Unit Price	Cost
1 Canal Earthwork					
1-1	Main Irrigation Canal				
1-1-1	Excavation (Common Soil)	16,500.00	m3	2.30	37,950.00
	Excavation (Soft Rock)	2,900.00	m3	8.00	23,200.00
1-1-2	Embankment (Excavated Material)	82,100.00	m3	2.50	205,250.00
1-1-3	Bush & Grass Clearing, Stripping	269,700.00	m2	0.22	59,334.00
1-1-4	Grass Sodding	53,200.00	m2	0.70	37,240.00
1-1-5	Laterite Pavement	4,800.00	m3	23.00	110,400.00
1-2 Secondary and Sub-secondary Irrigation Canal					
1-2-1	Excavation (Common Soil)	1,200.00	m3	2.30	2,760.00
1-2-2	Embankment (Excavated Material)	129,100.00	m3	2.50	322,750.00
1-2-3	Bush & Grass Clearing, Stripping	248,100.00	m2	0.22	54,582.00
1-2-4	Grass Sodding	66,400.00	m2	0.70	46,480.00
1-2-5	Laterite Pavement	9,700.00	m3	23.00	223,100.00
1-3 Drainage Canal					
1-3-1	Excavation (Common Soil)	394,900.00	m3	2.30	908,270.00
1-3-2	Bush & Grass Clearing, Stripping	60,500.00	m2	0.22	13,310.00
Sub-Total of Work Item 1					2,044,626.00
					Round 2,045,000.00
2 Canal Related Structure Work					
2-1 Earthwork					
2-1-1	Excavation (Common Soil)	4,400.00	m3	2.30	10,120.00
2-1-2	Disposal of Excavated Material	2,300.00	m3	2.20	5,060.00
2-1-3	Backfilling	3,900.00	m3	3.00	11,700.00
2-2 Structure Work					
2-2-1	Concrete (21N/mm2) including Form and Bar	1,566.87	m3	195.00	305,539.88
2-2-2	Concrete (18N/mm2) including Form and Bar	172.88	m3	75.00	12,966.30
2-2-3	Concrete Pipe D=1200	132.00	m	160.00	21,120.00
2-2-4	Concrete Pipe D=1000	135.00	m	115.00	15,525.00
2-2-5	Concrete Pipe D=800	30.00	m	85.00	2,550.00
2-2-6	Concrete Pipe D=600	60.00	m	55.00	3,300.00
2-2-7	Concrete Pipe D=500	273.00	m	40.00	10,920.00
2-2-8	Concrete Pipe D=300	105.00	m	22.00	2,310.00
Sub-Total of Work Item 2					401,111.00
					Round 401,000.00
3 Metal Work					
3-1	Turnout Gate	27.56	m2	2,400.00	66,144.00
3-2	Miscellaneous Works		set		1,984.32
Sub-Total of Work Item 3					68,128.32
					Round 68,000.00
4 Tertiary Development					
4-1	Tertiary Irrigation Canal System	1,890.00	ha	236.00	446,040.00
Sub-Total of Work Item 4					446,040.00
					Round 446,000.00
Total of Work Item 1 + 2 + 3 + 4					2,960,000.00

**Table B3.19 Breakdown of Construction Cost for Headworks and Major related Structures
(Por Canal Sub-project)**

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1	Intake for Por Canal				
1.1	Earth works				
1.1.1	Excavation of foundation	m ³	20.00	2.30	46.00
1.1.2	Soil back filling and compaction	m ³	20.00	5.00	100.00
1.2	Removal of existing concrete				
1.2.1	Foundation of structure	m ³	27.00	40.00	1,080.00
1.2.2	Side wall of a structure	m ³	18.00	38.00	684.00
1.3	Foundation Pile				
1.3.1	Concrete Pile 20 x 20 x 400 cm	Psc	6.00	90.00	540.00
1.4	Lean Concrete				
1.4.1	Lean Concrete class D	m ³	4.00	75.00	300.00
1.5	Reinforce Concrete				
1.5.1	Concrete for Intake Structure	m ³	45.00	195.00	8,775.00
1.5.2	Concrete for endsil	m ³	1.00	195.00	195.00
1.5.3	Concrete for bridge	m ³	12.00	195.00	2,340.00
1.6	Steel works				
1.6.1	Installation mechanic width size 2.00m x 1.00m	Set	2.00	12,000.00	24,000.00
1.6.2	Steel hand rail	m	14.00	26.00	364.00
1.7	Stone pitching				
1.7.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	220.00	35.00	7,700.00
1.7.2	Rock filter with side (4cm x 6cm)	m ³	4.00	28.00	112.00
1.7.3	Fine sand filter	m ³	2.00	13.33	26.66
1.7.4	Geotextile	m ³	26.00	2.80	72.80
	Sub total 1				46,335.46
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		9,267.00
	Total of Item 1				55,602.46
					56,000.00

**Table B3.20 Breakdown of Construction Cost for Canal Systems
(Por Canal Sub-project)**

(unit: US \$)

Work Item		Quantity	Unit	Unit Price	Cost
1 Canal Earthwork					
1-1	Main Irrigation Canal				
1-1-1	Excavation (Common Soil)	34,100.00	m3	2.30	78,430.00
	Excavation (Soft Rock)	6,000.00	m3	8.00	48,000.00
1-1-2	Embankment (Excavated Material)	48,700.00	m3	2.50	121,750.00
1-1-3	Bush & Grass Clearing, Stripping	193,000.00	m2	0.22	42,460.00
1-1-4	Grass Sodding	32,300.00	m2	0.70	22,610.00
1-1-5	Laterite Pavement	3,100.00	m3	23.00	71,300.00
1-2	Secondary Irrigation Canal				
1-2-1	Excavation (Common Soil)	4,400.00	m3	2.30	10,120.00
1-2-2	Embankment (Excavated Material)	151,700.00	m3	2.50	379,250.00
1-2-3	Bush & Grass Clearing, Stripping	286,800.00	m2	0.22	63,096.00
1-2-4	Grass Sodding	65,800.00	m2	0.70	46,060.00
1-2-5	Laterite Pavement	9,400.00	m3	23.00	216,200.00
1-3	Drainage Canal				
1-3-1	Excavation (Common Soil)	136,800.00	m3	2.30	314,640.00
1-3-2	Bush & Grass Clearing, Stripping	28,800.00	m2	0.22	6,336.00
Sub-Total of Work Item 1					1,420,252.00
				Round	1,420,000.00
2 Canal Related Structure Work					
2-1	Earthwork				
2-1-1	Excavation (Common Soil)	3,500.00	m3	2.30	8,050.00
2-1-2	Disposal of Excavated Material	3,300.00	m3	2.20	7,260.00
2-1-3	Backfilling	2,200.00	m3	3.00	6,600.00
2-2	Structure Work				
2-2-1	Concrete (21N/mm2) including Form and Bar	777.31	m3	195.00	151,576.35
2-2-2	Concrete (18N/mm2) including Form and Bar	95.59	m3	75.00	7,169.33
2-2-3	Concrete Pipe D=1200	105.00	m	160.00	16,800.00
2-2-4	Concrete Pipe D=1000	141.00	m	115.00	16,215.00
2-2-5	Concrete Pipe D=800	14.00	m	85.00	1,190.00
2-2-6	Concrete Pipe D=600	50.00	m	55.00	2,750.00
2-2-7	Concrete Pipe D=500	252.00	m	40.00	10,080.00
2-2-8	Concrete Pipe D=300	49.00	m	22.00	1,078.00
Sub-Total of Work Item 2					228,769.00
				Round	229,000.00
3 Metal Work					
3-1	Turnout Gate	30.42	m2	2,400.00	73,008.00
3-2	Miscellaneous Works		set		2,190.24
Sub-Total of Work Item 3					75,198.24
				Round	75,000.00
4 Tertiary Development					
4-1	Tertiary Irrigation Canal System	1,652.00	ha	236.00	389,872.00
Sub-Total of Work Item 4					389,872.00
				Round	390,000.00
Total of Work Item 1 + 2 + 3 + 4					2,114,000.00

**Table B3.21 Breakdown of Construction Cost for Headworks and Major related Structures
(Damnak Ampil Sub-project)**

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Main Diversion Weir (for Fish Ladder only)				
1.1	Earth works				
1.1.1	Excavation of foundation for Fish Ladder	m ³	4,450.00	8.00	35,600.00
1.1.2	Embankment	m ³	1,823.00	2.50	4,557.50
1.1.3	Soil back filling and compaction	m ³	507.00	5.00	2,535.00
1.2	Lean Concrete (for Fish Ladder only)				
1.2.1	Lean Concrete class D	m ³	70.00	75.00	5,250.00
1.3	Reinforce Concrete (for Fish Ladder only)				
1.3.1	Concrete for Fish Ladder	m ³	169.30	195.00	33,013.50
1.3.2	Concrete for transition	m ³	235.30	195.00	45,883.50
1.4	Installation of gate				
1.4.1	Steel hand rail	m	172.00	26.00	4,472.00
1.5	Stone pitching				
1.5.1	Gaion box downstream and both side slope with side (1.00m x 0.50m x 0.75m)	Pcs	489.33	35.00	17,126.67
1.6	Temporary Works				
1.6.1	Excavation	Set	3,500.00	2.30	8,050.00
1.6.2	Embankment	Set	3,000.00	2.50	7,500.00
	Sub total 1				164,000.00
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		32,800.00
	Total of Item 1				196,800.00
					197,000.00
2	Gate Improvement for Damnak Ampil Weir	set	1.00	2,000,000.00	2,000,000.00
	Total all structures				2,197,000.00

**Table B3.22 Breakdown of Construction Cost for Canal Systems
(Dannak Ampil Sub-project)**

(unit: US \$)

Work Item	Quantity	Unit	Unit Price	Cost
1 Canal Earthwork				
1-1 Secondary Irrigation Canal				
1-1-1 Excavation (Common Soil)	3,800.00	m3	2.30	8,740.00
1-1-2 Embankment (Excavated Material)	110,000.00	m3	2.50	275,000.00
1-1-3 Bush & Grass Clearing, Stripping	248,700.00	m2	0.22	54,714.00
1-1-4 Grass Sodding	34,500.00	m2	0.70	24,150.00
1-1-5 Laterite Pavement	5,670.00	m3	23.00	130,410.00
1-2 Drainage Canal				
1-2-1 Excavation (Common Soil)	173,000.00	m3	2.30	397,900.00
1-2-2 Bush & Grass Clearing, Stripping	33,600.00	m2	0.22	7,392.00
Sub-Total of Work Item 1				898,306.00
			Round	898,000.00
2 Canal Related Structure Work				
2-1 Earthwork				
2-1-1 Excavation (Common Soil)	6,200.00	m3	2.30	14,260.00
2-1-2 Disposal of Excavated Material	3,000.00	m3	2.20	6,600.00
2-1-3 Backfilling	3,600.00	m3	3.00	10,800.00
2-2 Structure Work				
2-2-1 Concrete (21N/mm2) including Form and Bar	975.00	m3	195.00	190,124.38
2-2-2 Concrete (18N/mm2) including Form and Bar	205.68	m3	75.00	15,426.22
2-2-3 Concrete Pipe D=1200	60.00	m	160.00	9,600.00
2-2-4 Concrete Pipe D=800	21.00	m	85.00	1,785.00
2-2-5 Concrete Pipe D=500	497.00	m	40.00	19,880.00
2-2-6 Concrete Pipe D=300	28.00	m	22.00	616.00
Sub-Total of Work Item 2				269,092.00
			Round	269,000.00
3 Metal Work				
3-1 Turnout Gate	26.20	m2	2,400.00	62,880.00
3-2 Miscellaneous Works		set		1,886.40
Sub-Total of Work Item 3				64,766.40
			Round	65,000.00
4 Tertiary Development				
4-1 Tertiary Irrigation Canal System	2,270.00	ha	236.00	535,720.00
Sub-Total of Work Item 4				535,720.00
			Round	536,000.00
Total of Work Item 1 + 2 + 3 + 4				1,768,000.00

**Table B3.23 Breakdown of Construction Cost for Canal Systems
(Wat Loung Sub-project)**

(unit: US \$)

Work Item		Quantity	Unit	Unit Price	Cost
1 Canal Earthwork					
1-1	Main Irrigation Canal				
1-1-1	Excavation (Common Soil)	148,800.00	m3	2.30	342,240.00
	Excavation (Soft Rock)	26,300.00	m3	8.00	210,400.00
1-1-2	Embankment (Excavated Material)	205,900.00	m3	2.50	514,750.00
1-1-3	Bush & Grass Clearing, Stripping	387,000.00	m2	0.22	85,140.00
1-1-4	Grass Sodding	75,900.00	m2	0.70	53,130.00
1-1-5	Laterite Pavement	9,100.00	m3	23.00	209,300.00
1-2	Secondary Irrigation Canal				
1-2-1	Excavation (Common Soil)	4,100.00	m3	2.30	9,430.00
1-2-2	Embankment (Excavated Material)	217,500.00	m3	2.50	543,750.00
1-2-3	Bush & Grass Clearing, Stripping	316,100.00	m2	0.22	69,542.00
1-2-4	Grass Sodding	121,700.00	m2	0.70	85,190.00
1-2-5	Laterite Pavement	16,200.00	m3	23.00	372,600.00
1-3	Drainage Canal				
1-3-1	Excavation (Common Soil)	406,400.00	m3	2.30	934,720.00
1-3-2	Bush & Grass Clearing, Stripping	68,600.00	m2	0.22	15,092.00
Sub-Total of Work Item 1					3,445,284.00
				Round	3,445,000.00
2 Canal Related Structure Work					
2-1	Earthwork				
2-1-1	Excavation (Common Soil)	8,800.00	m3	2.30	20,240.00
2-1-2	Disposal of Excavated Material	3,500.00	m3	2.20	7,700.00
2-1-3	Backfilling	6,600.00	m3	3.00	19,800.00
2-2	Structure Work				
2-2-1	Concrete (21N/mm2) including Form and Bar	2,458.67	m3	195.00	479,441.27
2-2-2	Concrete (18N/mm2) including Form and Bar	275.53	m3	75.00	20,664.68
2-2-3	Concrete Pipe D=1200	82.00	m	160.00	13,120.00
2-2-4	Concrete Pipe D=1000	148.00	m	115.00	17,020.00
2-2-5	Concrete Pipe D=800	42.00	m	85.00	3,570.00
2-2-6	Concrete Pipe D=600	42.00	m	55.00	2,310.00
2-2-7	Concrete Pipe D=500	378.00	m	40.00	15,120.00
2-2-8	Concrete Pipe D=300	42.00	m	22.00	924.00
Sub-Total of Work Item 2					599,910.00
				Round	600,000.00
3 Metal Work					
3-1	Turnout Gate	50.10	m2	2,400.00	120,240.00
3-2	Miscellaneous Works		set		3,607.20
Sub-Total of Work Item 3					123,847.20
				Round	124,000.00
4 Tertiary Development					
4-1	Tertiary Irrigation Canal System	2,540.00	ha	236.00	599,440.00
Sub-Total of Work Item 4					599,440.00
				Round	599,000.00
Total of Work Item 1 + 2 + 3 + 4					4,768,000.00

Table B3.24 Breakdown of Construction Cost for Headworks and Major related Structures (1/2)
(Wat Chre Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Wat Chre Diversion Weir				
1.1	Earth works				
1.1.1	Excavation of foundation	m ³	4,682.00	2.30	10,768.60
1.1.2	Embankment	m ³	5,372.00	2.50	13,430.00
1.1.3	Soil back filling and compaction	m ³	569.00	5.00	2,845.00
1.3	Foundation Pile				
1.3.1	Sheet pile L= 600 cm	m2	319.00	180.00	57,420.00
1.3.2	Concrete Pile 40 x 40 x 1000 cm	Pcs	73.00	533.00	38,909.00
1.4	Lean Concrete				
1.4.1	Lean Concrete class D	m ³	142.10	75.00	10,657.50
1.5	Reinforce Concrete				
1.5.1	Concrete for weir body	m ³	1,204.00	195.00	234,780.00
1.5.2	Concrete for bridge	m ³	40.00	195.00	7,800.00
1.5.3	Concrete for upstream apron	m ³	165.70	195.00	32,311.50
1.5.4	Concrete for dawonstream apron	m ³	1,107.90	195.00	216,040.50
1.5.5	Concrete for Fish Ladder	m ³	247.90	195.00	48,340.50
1.5.6	Concrete for transition	m ³	374.60	195.00	73,047.00
1.6	Installation of gate				
1.6.1	Installation mechanic width size 2.00m x 2.00m	Set	1.00	24,000.00	24,000.00
1.6.2	Installation Roller gate width size 12.50m x height 3.40m, with Hoist System & Deck	Set	1.00	379,000.00	379,000.00
1.6.3	Counter weight from metal width size 1.40m x 0.90m x 0.25m	Pcs	14.00	2,500.00	35,000.00
1.6.4	Steel hand rail	m	100.00	26.00	2,600.00
1.7	Stone pitching				
1.7.1	Gaion box downstream and both side slope with side (1.00m x 0.50m x 0.75m)	Pcs	280.00	35.00	9,800.00
1.7.2	Concrete Block	m ³	110.00	69.00	7,590.00
1.7.3	Riprap rock protection with side (20cm x 30cm)	m ³	90.00	35.00	3,150.00
1.7.4	Rock filter with side (4cm x 6cm)	m ³	390.00	28.00	10,920.00
1.7.5	Fine sand filter	m ³	40.00	13.33	533.20
1.7.6	Geotextile	m2	408.00	2.80	1,142.40
1.8	Temporary Works				
1.8.1	Diversion Channel Excavation	m ³	8,000.00	2.30	18,400.00
1.8.2	Cofferdam Excavation	m ³	3,500.00	2.30	8,050.00
	Embankment	m ³	3,400.00	2.50	8,500.00
	Riprap	m ³	500.00	35.00	17,500.00
	Sub Total 1				1,272,535.20
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		254,507.00
	Total of Item 1				1,527,042.20
					1,527,000.00
2.	Intake for Wat Chre				
2.1	Earth works				
2.1.1	Excavation of foundation	m ³	177.00	2.30	407.10
2.1.2	Soil back filling and compaction	m ³	91.00	5.00	455.00
2.2	Foundation Pile				
2.2.1	Concrete Pile 20 x 20 x 400 cm	Psc	6.00	90.00	540.00
2.3	Lean Concrete				
2.3.1	Lean Concrete class D	m ³	3.60	75.00	270.00
2.4	Reinforce Concrete				
2.4.1	Concrete for Intake structure	m ³	16.00	195.00	3,120.00
2.4.2	Concrete for endsil	m ³	3.00	195.00	585.00
2.4.3	Concrete for bridge	m ³	5.00	195.00	975.00
2.5	Steel works				
2.5.1	Installation mechanic width size 1.00m x 1.00m	Set	1.00	3,000.00	3,000.00
2.5.2	Steel hand rail	m	8.00	26.00	208.00

Table B3.24 Breakdown of Construction Cost for Headworks and Major related Structures (2/2)
(Wat Chre Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
2.6	Stone pitching				
2.6.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	110.00	35.00	3,850.00
2.6.2	Rock filter with side (4cm x 6cm)	m ³	2.00	28.00	56.00
2.6.3	Fine sand filter	m ³	1.00	13.33	13.33
2.6.4	Geotextile	m ³	13.00	2.80	36.40
	Sub Total 2				13,515.83
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		2,703.00
	Total of Item 2				16,218.83
					16,000.00
3.	Operation and Maintenance office				
3.1	Earth works				
3.1.1	Excavation of foundation	m ³	27.00	2.30	62.10
3.1.2	Soil back filling and compaction	m ³	51.00	5.00	255.00
3.2	Foundation works				
3.2.1	Concrete Pile with size (20 x 20 x 400 cm)	Psc	36.00	90.00	3,240.00
3.2.2	Compaction with stone	m ³	18.00	18.00	324.00
3.3	Lean Concrete				
3.3.1	Lean Concrete class D	m ³	9.00	75.00	675.00
3.4	Reinforce Concrete				
3.4.1	Concrete for foundation	m ³	10.00	195.00	1,950.00
3.4.2	Concrete for pier and column	m ³	28.00	195.00	5,460.00
3.5	Wall brick works				
3.5.1	Preparation of brick wall	m ³	126.00	74.00	9,324.00
3.5.2	Floor tile works	m ³	40.00	12.50	500.00
3.6	Installation of door and window				
3.6.1	Door with size (3200mm x 2400mm)	Set	1.00	320.00	320.00
3.6.2	Window with size (1600mm x 1400mm)	Set	5.00	72.00	360.00
3.7	Roof works				
3.7.1	Roof works	m ²	67.00	25.00	1,675.00
3.8	Radio communication equipment				
3.8.1	Radio communication equipment	Set	3.00	235.00	705.00
3.9	Decoration works				
3.9.1	Decoration of out view	m	42.00	12.00	504.00
3.9.2	Painting external and internal surface wall and ceiling	m ²	166.00	2.00	332.00
	Sub Total 3				25,686.10
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		3,853.00
	Total of Item 3				29,539.10
					30,000.00
4.	Excavation of River				
4.1	Earth works				
4.1.1	Soil excavation	m ³	16,212.00	2.30	37,287.60
4.1.2	Embankment with compaction	m ³	103,676.00	2.50	259,190.00
4.1.3	Laterite Paavement (t=15cm)	m ³	330.45	23.00	7,600.35
	Sub Total 4				304,077.95
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		60,816.00
	Total of Item 4				364,893.95
					365,000.00
	Total of all structures				1,938,000.00

**Table B3.25 Breakdown of Construction Cost for Canal Systems
(Wat Chre Sub-project)**

(unit: US \$)

Work Item		Quantity	Unit	Unit Price	Cost
1 Canal Earthwork					
1-1	Main Irrigation Canal				
1-1-1	Excavation (Common Soil)	5,100.00	m3	2.30	11,730.00
	Excavation (Soft Rock)	900.00	m3	8.00	7,200.00
1-1-2	Embankment (Excavated Material)	59,200.00	m3	2.50	148,000.00
1-1-3	Bush & Grass Clearing, Stripping	94,500.00	m2	0.22	20,790.00
1-1-4	Grass Sodding	28,500.00	m2	0.70	19,950.00
1-1-5	Laterite Pavement	2,100.00	m3	23.00	48,300.00
1-2	Secondary Irrigation Canal				
1-2-1	Excavation (Common Soil)	400.00	m3	2.30	920.00
1-2-2	Embankment (Excavated Material)	104,100.00	m3	2.50	260,250.00
1-2-3	Bush & Grass Clearing, Stripping	143,600.00	m2	0.22	31,592.00
1-2-4	Grass Sodding	58,100.00	m2	0.70	40,670.00
1-2-5	Laterite Pavement	6,600.00	m3	23.00	151,800.00
1-3	Drainage Canal				
1-3-1	Excavation (Common Soil)	58,600.00	m3	2.30	134,780.00
1-3-2	Bush & Grass Clearing, Stripping	14,300.00	m2	0.22	3,146.00
Sub-Total of Work Item 1				Round	879,128.00 879,000.00
2 Canal Related Structure Work					
2-1	Earthwork				
2-1-1	Excavation (Common Soil)	2,800.00	m3	2.30	6,440.00
2-1-2	Disposal of Excavated Material	1,900.00	m3	2.20	4,180.00
2-1-3	Backfilling	2,100.00	m3	3.00	6,300.00
2-2	Structure Work				
2-2-1	Concrete (21N/mm2) including Form and Bar	447.75	m3	195.00	87,312.13
2-2-2	Concrete (18N/mm2) including Form and Bar	76.12	m3	75.00	5,708.93
2-2-3	Concrete Pipe D=1200	75.00	m	160.00	12,000.00
2-2-4	Concrete Pipe D=1000	66.00	m	115.00	7,590.00
2-2-5	Concrete Pipe D=800	59.00	m	85.00	5,015.00
2-2-6	Concrete Pipe D=600	69.00	m	55.00	3,795.00
2-2-7	Concrete Pipe D=500	154.00	m	40.00	6,160.00
2-2-8	Concrete Pipe D=300	42.00	m	22.00	924.00
Sub-Total of Work Item 2				Round	145,425.00 145,000.00
3 Metal Work					
3-1	Turnout Gate	13.10	m2	2,400.00	31,440.00
3-2	Miscellaneous Works		set		943.20
Sub-Total of Work Item 3				Round	32,383.20 32,000.00
4 Tertiary Development					
4-1	Tertiary Irrigation Canal System	1,020.00	ha	236.00	240,720.00
Sub-Total of Work Item 4				Round	240,720.00 241,000.00
Total of Work Item 1 + 2 + 3 + 4					1,297,000.00

Table B3.26 Breakdown of Construction Cost for Headworks and Major related Structures (1/3)
(Lum Hach Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Lum Hach Diversion Weir				
1.1	Earth works				
1.1.1	Excavation of foundation (Soil)	m ³	14,663.00	2.30	33,724.90
1.1.3	Embankment	m ³	3,151.00	2.50	7,877.50
1.1.4	Soil back filling and compaction	m ³	2,093.00	5.00	10,465.00
1.2	Foundation Pile				
1.2.1	Sheet pile L= 600 cm	m2	1,338.50	180.00	240,930.00
1.2.2	Concrete Pile 50 x 50 x 600 cm	Pcs	139.00	500.00	69,500.00
1.3	Lean Concrete				
1.3.1	Lean Concrete class D	m ³	300.40	75.00	22,530.00
1.4	Reinforce Concrete				
1.4.1	Concrete for weir body	m ³	3,242.70	195.00	632,326.50
1.4.2	Concrete for bridge	m ³	280.00	195.00	54,600.00
1.4.3	Concrete for upstream apron	m ³	379.40	195.00	73,983.00
1.4.4	Concrete for dawnstream apron	m ³	1,996.50	195.00	389,317.50
1.4.5	Concrete for Fish Ladder	m ³	351.20	195.00	68,484.00
1.4.6	Concrete for transition	m ³	35.30	195.00	6,883.50
1.5	Installation of gate				
1.5.1	Installation mechanic width size 3.00m x 2.00m	Set	2.00	36,000.00	72,000.00
1.5.2	Installation Roller gate width size 15.0m x height 4.0m, with Hoist System & Deck	Set	3.00	606,000.00	1,818,000.00
1.5.3	Counter weight from metal width size 1.40m x 0.90m x 0.25m	Pcs	42.00	2,500.00	105,000.00
1.5.4	Concrete wall	m ³	28.00	69.00	1,932.00
1.5.5	Steel hand rail	m	120.00	26.00	3,120.00
1.6	Stone pitching				
1.6.1	Gaion box downstream and both side slope with side (1.00m x 0.50m x 0.75m)	Pcs	1,610.00	35.00	56,350.00
1.6.2	Concrete Block	m ³	610.00	69.00	42,090.00
1.6.3	Riprap rock protection with side (20cm x 30cm)	m ³	290.00	35.00	10,150.00
1.6.4	Rock filter with side (4cm x 6cm)	m ³	765.00	28.00	21,420.00
1.6.5	Fine sand filter	m ³	190.00	13.33	2,532.70
1.6.6	Geotextile	m2	2,415.00	2.80	6,762.00
1.7	Temporary Works				
1.7.1	Diversion Channel Excavation	m ³	4,800.00	2.30	11,040.00
1.7.2	Cofferdam Excavation	m ³	5,650.00	2.30	12,995.00
	Embankment	m ³	5,500.00	2.50	13,750.00
	Riprap	m ³	800.00	35.00	28,000.00
	Sub Total 1				3,815,763.60
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		763,153.00
	Total of Item 1				4,578,916.60
					4,579,000.00
2A.	Intake for Lum Hach				
2A.1	Earth works				
2A.1.1	Excavation of foundation	m ³	3,465.00	2.30	7,969.50
2A.1.2	Soil back filling and compaction	m ³	1,736.00	5.00	8,680.00
2A.2	Foundation Pile				
2A.2.1	Concrete Pile 20 x 20 x 400 cm	Psc	35.00	90.00	3,150.00
2A.3	Lean Concrete				
2A.3.1	Lean Concrete class D	m ³	36.00	75.00	2,700.00
2A.4	Reinforce Concrete				
2A.4.1	Concrete for cut-off wall	m ³	32.00	195.00	6,240.00
2A.4.2	Concrete for foundation structure	m ³	144.00	195.00	28,080.00
2A.4.3	Concrete for wing wall and side wall	m ³	133.00	195.00	25,935.00
2A.4.4	Concrete for endsil	m ³	7.00	195.00	1,365.00
2A.4.5	Concrete for pier and column	m ³	39.00	195.00	7,605.00
2A.4.6	Concrete for bridge	m ³	25.00	195.00	4,875.00

Table B3.26 Breakdown of Construction Cost for Headworks and Major related Structures (2/3)
(Lum Hach Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
2A.5	Steel works				
2A.5.1	Installation mechanic width size 1.50m x 1.00m	Set	3.00	9,000.00	27,000.00
2A.5.2	Steel hand rail	m	20.00	26.00	520.00
2A.6	Stone pitching				
2A.6.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	2,200.00	35.00	77,000.00
2A.6.2	Rock filter with side (4cm x 6cm)	m ³	42.00	28.00	1,176.00
2A.6.3	Fine sand filter	m ³	15.00	13.33	199.95
2A.6.4	Geotextile	m ³	264.00	2.80	739.20
	Total Cost for 2A				203,234.65
2B.	Intake for O Rollus				
2B.1	Earth works				
2B.1.1	Excavation of foundation	m ³	2,772.00	2.30	6,375.60
2B.1.2	Soil back filling and compaction	m ³	1,389.00	5.00	6,945.00
2B.2	Foundation Pile				
2B.2.1	Concrete Pile 20 x 20 x 400 cm	Psc	26.00	90.00	2,340.00
2B.3	Lean Concrete				
2B.3.1	Lean Concrete class D	m ³	27.00	75.00	2,025.00
2B.4	Reinforce Concrete				
2B.4.1	Concrete for cut-off wall	m ³	24.00	195.00	4,680.00
2B.4.2	Concrete for foundation structure	m ³	108.00	195.00	21,060.00
2B.4.3	Concrete for wing wall and side wall	m ³	100.00	195.00	19,500.00
2B.4.4	Concrete for endsil	m ³	5.00	195.00	975.00
2B.4.5	Concrete for pier and column	m ³	29.00	195.00	5,655.00
2B.4.6	Concrete for bridge	m ³	19.00	195.00	3,705.00
2B.5	Steel works				
2B.5.1	Installation mechanic width size 2.00m x 1.00m	Set	2.00	12,000.00	24,000.00
2B.5.2	Steel hand rail	m	16.00	26.00	416.00
2B.6	Stone pitching				
2B.6.1	Gaion box downstream and upstream with side (1.00m x 0.50m x 0.75m)	Psc	1,650.00	35.00	57,750.00
2B.6.2	Rock filter with side (4cm x 6cm)	m ³	32.00	28.00	896.00
2B.6.3	Fine sand filter	m ³	11.00	13.33	146.63
2B.6.4	Geotextile	m ³	198.00	2.80	554.40
	Total Cost for Item 2B				157,023.63
	Sub total for Item 2				360,258.28
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		72,052.00
	Total of Item 2				432,310.28
					432,000.00
3.	Operation and Maintenance office				
3.1	Earth works				
3.1.1	Excavation of foundation	m ³	27.00	2.30	62.10
3.1.2	Soil back filling and compaction	m ³	51.00	5.00	255.00
3.2	Foundation works				
3.2.1	Concrete Pile with size (20 x 20 x 400 cm)	Psc	36.00	90.00	3,240.00
3.2.2	Compaction with stone	m ³	18.00	18.00	324.00
3.3	Lean Concrete				
3.3.1	Lean Concrete class D	m ³	9.00	75.00	675.00
3.4	Reinforce Concrete				
3.4.1	Concrete for foundation	m ³	10.00	195.00	1,950.00
3.4.2	Concrete for pier and column	m ³	28.00	195.00	5,460.00
3.5	Wall brick works				
3.5.1	Preparation of brick wall	m ³	126.00	74.00	9,324.00
3.5.2	Floor tile works	m ³	40.00	12.50	500.00
3.6	Installation of door and window				
3.6.1	Door with size (3200mm x 2400mm)	Set	1.00	320.00	320.00
3.6.2	Window with size (1600mm x 1400mm)	Set	5.00	72.00	360.00
3.7	Roof works				
3.7.1	Roof works	m ²	67.00	25.00	1,675.00

Table B3.26 Breakdown of Construction Cost for Headworks and Major related Structures (3/3)
(Lum Hach Sub-project)

(unit: US \$)

No.	Description	Unit	Quantity	Unit Cost	Total Cost
3.8	Radio communication equipment				
3.8.1	Radio communication equipment	Set	3.00	235.00	705.00
3.9	Decoration works				
3.9.1	Decoration of out view	m	42.00	12.00	504.00
3.9.2	Painting external and internal surface wall and ceiling	m ²	166.00	2.00	332.00
	Sub Total 3				25,686.10
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		3,853.00
	Total of Item 3				29,539.10
					30,000.00
4.	Approach Canal				
4.1	Earth works				
4.1.1	Cleaning side	m ²	13,500.00	0.50	6,750.00
4.1.2	Soil excavation	m ³	14,400.00	2.30	33,120.00
4.1.4	Filling laterite with thickness 15 cm	m ³	900.00	23.00	20,700.00
4.2	Graasing works				
4.2.1	Graasing on both side slope of dike	m ³	2,683.00	0.70	1,878.10
	Sub Total 4				62,448.10
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		12,490.00
	Total of Item 4				74,938.10
					75,000.00
5.	Closure Dike for 7th January Canal				
5.1	Earth works				
5.1.1	Soil excavation	m ³	196.00	2.30	450.80
5.1.2	Back filling with compaction	m ³	40.00	2.50	100.00
	Sub Total 5				550.80
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		110.00
	Total of Item 5				660.80
					1,000.00
6.	Excavation of River				
6.1	Earth works				
6.1.1	Soil excavation	m ³	2,790.00	2.30	6,417.00
6.1.2	Embankment with compaction	m ³	6,536.00	2.50	16,340.00
6.1.3	Laterite Paavement (t=15cm)	m ³	23.00	23.00	529.00
	Sub Total 6				23,286.00
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		4,657.00
	Total of Item 6				27,943.00
					28,000.00
7.	Access Road to Headworks				
7.1	Earth works				
7.1.1	Soil excavation	m ³	540.00	2.30	1,242.00
7.1.2	Embankment with compaction	m ³	4,770.00	2.50	11,925.00
7.1.3	Laterite Paavement (t=15cm)	m ³	1,800.00	23.00	41,400.00
7.2	Culvert				
7.2.1	Soil excavation	m ³	713.00	2.30	1,639.90
7.2.2	Embankment with compaction	m ³	482.00	2.50	1,205.00
7.2.3	Concrete for culvert	m ³	25.10	195.00	4,894.50
	Sub Total 7				62,306.40
	General items (temporary access roads, diversion works, contractor's facilities, insurance, laboratory tests, etc.), O/H, etc.	L.S.	1.00		12,461.00
	Total of Item 7				74,767.40
					75,000.00
	Total all structures				5,220,000.00

**Table B3.27 Breakdown of Construction Cost for Canal Systems
(Lum Hach Sub-project)**

(unit: US \$)

Work Item		Quantity	Unit	Unit Price	Cost
1 Canal Earthwork					
1-1	Main Irrigation Canal				
1-1-1	Excavation (Common Soil)	220,300.00	m3	2.30	506,690.00
1-1-2	Excavation (Soft Rock)	38,900.00	m3	8.00	311,200.00
1-1-3	Embankment (Excavated Material)	60,100.00	m3	2.50	150,250.00
1-1-4	Bush & Grass Clearing, Stripping	145,000.00	m2	0.22	31,900.00
1-1-5	Grass Sodding	40,200.00	m2	0.70	28,140.00
1-1-6	Laterite Pavement	5,600.00	m3	23.00	128,800.00
1-2 Secondary Irrigation Canal					
1-2-1	Excavation (Common Soil)	11,000.00	m3	2.30	25,300.00
1-2-2	Embankment (Excavated Material)	342,200.00	m3	2.50	855,500.00
1-2-3	Bush & Grass Clearing, Stripping	452,800.00	m2	0.22	99,616.00
1-2-4	Grass Sodding	175,200.00	m2	0.70	122,640.00
1-2-5	Laterite Pavement	18,200.00	m3	23.00	418,600.00
1-3 Drainage Canal					
1-3-1	Excavation (Common Soil)	261,200.00	m3	2.30	600,760.00
1-3-2	Bush & Grass Clearing, Stripping	54,500.00	m2	0.22	11,990.00
Sub-Total of Work Item 1					3,291,386.00
					Round 3,291,000.00
2 Canal Related Structure Work					
2-1 Earthwork					
2-1-1	Excavation (Common Soil)	13,900.00	m3	2.30	31,970.00
2-1-2	Disposal of Excavated Material	5,700.00	m3	2.20	12,540.00
2-1-3	Backfilling	10,300.00	m3	3.00	30,900.00
2-2 Structure Work					
2-2-1	Concrete (21N/mm2) including Form and Bar	5,178.55	m3	195.00	1,009,818.00
2-2-2	Concrete (18N/mm2) including Form and Bar	491.34	m3	75.00	36,850.00
2-2-3	Concrete Pipe D=1200	176.00	m	160.00	28,160.00
2-2-4	Concrete Pipe D=1000	164.00	m	115.00	18,860.00
2-2-5	Concrete Pipe D=800	14.00	m	85.00	1,190.00
2-2-6	Concrete Pipe D=600	56.00	m	55.00	3,080.00
2-2-7	Concrete Pipe D=500	483.00	m	40.00	19,320.00
2-2-8	Concrete Pipe D=300	98.00	m	22.00	2,156.00
Sub-Total of Work Item 2					1,194,844.00
					Round 1,195,000.00
3 Metal Work					
3-1	Turnout Gate	75.70	m2	2,400.00	181,680.00
3-2	Miscellaneous Works		set		5,450.40
Sub-Total of Work Item 3					187,130.40
					Round 187,000.00
4 Tertiary Development					
4-1	Tertiary Irrigation Canal System	3,100.00	ha	236.00	731,600.00
Sub-Total of Work Item 4					731,600.00
					Round 732,000.00
Total of Work Item 1 + 2 + 3 + 4					5,405,000.00

*JICA Special Assistance for Project Formation (SAPROF) for West Tonle Sap
Irrigation and Drainage Rehabilitation and Improvement Project*

Final Report

B4. TERMS OF REFERENCE FOR CONSULTING SERVICES

**TENTATIVE TERMS OF REFERENCE
FOR
CONSULTING SERVICES
ON
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
IMPROVEMENT PROJECT**

1.1. Objective of the Consulting Services

The main objective of the consulting services is to assist Project Management Unit Japan Support Fund (PMU) under the Ministry of Water Resources and Meteorology (MOWRAM) for successful implementation of the West Tonle Sap Irrigation and Drainage Rehabilitation and Improvement Project and thereby to achieve the project objective and target.

The Project consists of 6 sub-projects scattered in three Provinces in the western region of Tonle Sap Lake. The list of the sub-projects and main scope of works are summarized hereunder.

1. Total target area	12,760 ha	25,610 ha in total consisting of primary benefit area (12,760 ha) and secondary benefit area (12,850 ha), in Battambang, Pursat and Kampong Chhnang Provinces
2. Scope of Works in 6 Sub-projects		
2-1 Hardware Component		
- Weir and intake	3 no.	Moung Russei, Wat Chre and Lum Hach
- Main canals	58 km	
- Secondary canals	138 km	
- Tertiary canal	371 km	
- Main drain	13 km	
- Secondary drain	135 km	
- Collector drain	22 km	
2-2 Software Component		
- FWUC Establishment and Strengthening		
- Agriculture Support Services		
2-3 Software Component		
- Meteo-hydrological Observation Strengthening		
- Capacity Development of MOWRAM Staff		
- Capacity Development of PDOWRAM Staff		
2-4 Project Formulation Study for Other Potential Areas		



1.2. Scope of Consulting Services (the Services)

To achieve the project objective and target, the consultant will execute the works classified into the following categories.

- i) Overall project management,
- ii) Check, review and modification of existing plan and design of sub-projects,
- iii) Construction supervision of sub-projects,
- iv) Socio-economic baseline study of all sub-projects,
- v) FWUCs establishment and strengthening
- vi) Agricultural support services
- vii) Meteo-hydrological observation strengthening
- viii) Capacity development of MOWRAM and Provincial Department of Water Resources and Meteorology (PDOWRAM) staff, and
- ix) Project formulation study for other potential areas.

Each of the above work will be carried out under the task concept and assistance concept as presented hereunder.

1.2.1 Overall project management

Task Concept

- T.1 To execute overall project management, monitoring and coordination among MOWRAM, PDOWRAM, Japan International Cooperation Agency (JICA), and other agencies concerned for the purpose of smooth implementation of the project,
- T.2 To monitor, evaluate and individually authorize tender process, contracts, physical and financial progress, and to prepare a regular progress report, and
- T.3 To monitor and individually authorize the disbursement of fund and collate those data.

Assistant Concept

- A.1 To assist project director at PMU and project manager at Project Implementation Unit (PIU) of each Province in preparation of implementation schedule of sub-projects and annual budget arrangement, and
- A.2 To assist PMU in preparation of implementation schedule of sub-projects and annual budget arrangement.

1.2.2 Check, Review and Modification of Existing Plan and Design of Sub-Projects

Task Concept

- T.4 To check and review existing plan, prepare detailed design and drawings of the sub-projects in collaboration with project offices concerned.

The Consultant's check and modification will be stressed on the following items:

- T.4.1 To check availability of irrigation water, flood discharge at weir site, drainage condition of some sub-projects,
- T.4.2 To check and, if necessary, modify location, layout plan and design of large or important structures including rehabilitation works such as diversion weirs, intakes, main and secondary irrigation canals, and main drains,
- T.4.3 To review and evaluate the existing data, plan and design and to prepare the

additional investigation and survey plan for each sub-project such as:

- i) Geo-technical and soil mechanical investigation,
 - ii) Topographic surveys and mapping,
 - iii) Canal route survey,
 - iv) Inventory survey of the existing facilities,
 - v) Construction material surveys,
 - vi) Detailed design of irrigation and drainage facilities including preparation of detailed design drawings,
 - vii) Existing environmental study review, and
 - viii) Preparation of bill of quantities and cost estimate, and
- T.4.4 To carry out the additional investigation and survey works, for a preparation, modification or finalization of the design of the main systems,
- T.4.5 To make cost estimate, and
- T.4.6 To examine the present constraints of O&M and water management of the irrigation sub-projects which are currently supplying irrigation for incorporating such results into the design review.
- T.5 To prepare pre-qualification and tender documents based on the detailed design taking into account of procurement procedure of JICA, and
- T.6 To prepare pre-qualification and tender evaluation report.

Assistant Concept

- A.3 To assist and advise PMU and PIUs in holding public consultation meeting for project implementation and O&M,
- A.4 To assist and advise PMU in pre-qualification of construction firms, and
- A.5 To assist and advise PMU in tendering of construction firms.

1.2.3 Construction Supervision of Sub-Projects

Task Concept

- T.7 To carry out construction supervision of civil works of the irrigation sub-projects for the following items to the extent of such powers that will be delegated to the Consultant by the project director of PMU:
- T.7.1 To prepare the quality control manuals for earth works, concrete works, stone works and other important construction works and to apply such manual for quality control in the field,
 - T.7.2 To check and approve construction drawings and shop drawings to be prepared by the contractor,
 - T.7.3 To check and approve the setting-out lines and levels, and control points established by the contractor,
 - T.7.4 To check and approve the construction statement proposed by the contractor which includes construction materials, equipment, construction method and other related matters required for the works,
 - T.7.5 To supervise field tests, sampling and laboratory tests to be carried out by the contractor,

- T.7.6 To inspect the construction method, equipment use, workmanship at the site, and to attend shop inspection and manufacturing test in accordance with the technical specifications,
- T.7.7 To issue a site instruction or other instruction to the contractor, as the necessity arises, on the way of clarification of construction drawings and technical specifications, and the construction supervision,
- T.7.8 To attend the regular meetings to check and confirm the construction method, work performance, work progress, status of equipment and materials, work schedule, and problems to be solved,
- T.7.9 To survey and measure the work output performed by the contractor,
- T.7.10 To check and certify the advance payment and progress payment claimed by the contractor for approval of the project manager of sub-project,
- T.7.11 To keep proper records necessary for preparation of the project completion report,
- T.7.12 To check as-built drawings prepared by the contractor, and
- T.7.13 To perform the final inspection of the works together with the sub-project office and recommend to issue the completion certificate, and
- T.8 To prepare O&M manual for each sub project.

Assistant Concept

- A.6 To assist and advise in modifying original tender designs, technical specifications and drawings, related calculation and cost estimate as the necessity arises in accordance with the actual site condition,
- A.7 To assist and advise in issuing variation order, and
- A.8 To assist and advise in settlement of the contractor's claim and disputes on the basis of the analysis of the Consultant hereof in accordance with the civil work contract.

1.2.4 Socio-economic Baseline Study of All Sub-Projects

Assistant Concept

- T.9 To collect such data and information from National Institute of Statistics, Ministry of Planning and other agencies as national and provincial socio-economic data related to sub-projects,
- T.10 To set up operation and effect indicators to be used in the future evaluation of the Project by JICA, and to collect general information of those indicators,
- T.11 To carry out baseline survey of current situation of each sub-project at the initial stage of the Project, and
- T.12 To carry out a socio-economy/rural development baseline study of each sub-project.

1.2.5 FWUC Establishment and Strengthening

Task Concept

- T.13 To conduct general program of the institutional survey and investigation,
- T.14 To carry out sub-project specific FWUCs establishment and strengthening program surveys, design and formulate development activities for preparation of detailed FWUCs strengthening work plan,

T.15 To conduct periodic reviews and monitoring assessments of FWUCs establishment and strengthening implementation progress to identify and recommend any needed program improvements to Field Units under PIUs,

T.16 To provide feedback from reviews and assessments for Project progress reporting.

Assistant Concept

A.9 To advise and assist in the overall implementation of the FWUCs establishment and strengthening program, the development of training activities and workshops,

A.10 To provide guidance, support and assistance on a needs basis to sub-project FWUC establishment and strengthening field unit under PIUs for implementation program components, and

A.11 To associate with and support MOWRAM/PDOWRAM for carrying out sub-project FWUC establishment and strengthening activities.

1.2.6 Agricultural Support Services

Task Concept

T.17 To prepare of manuals, materials and guidelines for new and appropriate agriculture technologies,

T.18 To process those materials for broadcast media and development of TV and radio programs for agricultural information, preparation of materials in various written forms,

T.19 To monitor and evaluate the publications' effectiveness and modify if necessary.

Assistant Concept

A.12 To assist and advise the execution of the overall implementation of the program,

A.13 To assist in the planning of the program including inventory survey, needs assessment and problem identification at the selected sub-project,

A.14 To support in the establishment of the organization on agricultural support coordination,

A.15 To assist in development, preparation and operation of demonstration farm and related facilities,

A.16 To assist in the organization of in-class discussion & lectures, study tour, workshop and installation and operation of equipment for TV and radio program to disseminate agricultural technologies, and

A.17 To assist in updating and amending programs and publications in the light of new information or feedback from the field.

1.2.7 Meteo-hydrological Observation Strengthening

Task Concept

T.20 To procure and install meteo-hydrological equipment at designated sites.

Assistant Concept

A.18 To assist and advise the execution of the overall implementation of the program, and

A.19 To assist in the organization of lectures, study tour and workshop related to meteo-hydrological observation, and

A.20 To assist in updating and amending programs and publications in the light of new information or feedback from the field.

1.2.8 Capacity Development of MOWRAM and PDOWRAM Staff

Task Concept

- T.21 To prepare manual for construction supervision (C/S)
Assistant Concept
- A.21 To assist in the organization of lectures, study tour and workshop related to C/S.

1.2.9 Project Formulation Study for Other Potential Areas

Task Concept

- T.22 To collect the information, data and documents on each regional and the national irrigation and water resources development policy and strategy including the development plan, the development priority and the O&M policy,
- T.23 To set up the future project formulation concept based on the regional and the national development policy and strategy in collaboration with PMU,
- T.24 To collect the existing data and information such as the sub-project plan, study and design of the candidate sub-projects in each region or province,
- T.25 To review the collected data and information collected on the candidate sub-projects including the site reconnaissance,
- T.26 To evaluate sub-projects from economic and financial points of view, and
- T.27 To formulate the integrated implementation plan and the action plan of the candidate sub-project for its realization.

1.3. Reports

The Consultant shall prepare and submit to MOWRAM the following reports in English during the Services.

- (1) Inception Report (10 sets)

Inception Report, to be submitted 3 months after the commencement of the Services, contains overall work schedule, work plan, administrative arrangement, results of review of existing designs during the inception period, and so on.

- (2) Monthly Progress Report and Quarterly Progress Report (10 sets)

Monthly Progress Report or Quarterly Progress Report, to be prepared at the end of every month or every quarter, shall contain detailed information of physical and financial progress of sub-projects, issues and problems, Consultant's input and activities, and work schedule of works for the next period.

- (3) Design Review/Modification Reports of Irrigation Sub-projects (10 sets)

Design Review/Modification Reports are prepared and submitted at the completion of design review works. In the reports, such several items are presented as results of additional investigations and analyses, and result of design review.

- (4) PQ Documents and Tender Documents of Each Sub-project (10 sets)

PQ documents and Tender documents, to be prepared after the completion of design review/modification of each sub-project.

- (5) Operation and Maintenance Manuals of Each Sub-project (10 sets)

The O&M report is prepared after the completion of construction works of each sub-

project. The report contains manual and procedure for O&M of all sub-project facilities to achieve the most effective use of water resources and to keep the sub-project facilities functional within its designated lifetime. The report shall be written in English.

(6) Socio-economy/Rural Development Baseline Study (10 sets)

The report, to be used in future evaluation of the Project, contains various indicators in socio-economy and rural development point of view of each sub-projects.

(7) Project Completion Report (Executive Summary) (10 sets)

Based on the record of the construction works of each sub-project, the Consultant shall prepare and submit the project completion report which covers the results of all sub-projects.

(8) Special Study Report on Future Irrigation Development Program (10 sets)

Based on the results of the special study and formulation of the future irrigation and water resources development program, the Consultant shall prepare and submit the special study report.

(9) Technical Reports (10 sets)

Technical Reports, as required, should be prepared on the specific technical issues with the aim to enhance and upgrade technical understandings and skill of the executing agencies and managing agency concerned for the project implementation.

CHAPTER 2

PROJECT ORGANIZATION

2.1. Project Executing Agency

MOWRAM is the executing agency of the Project. The PMU will assume the direct administrative responsibility for the Project. The Project Director at the central level is appointed in MOWRAM, who will be responsible for implementation of the Project under MOWRAM.

At each sub-project level, the PIU is established under the PDOWRAM. The chives under PIUs monitor and control the physical progress of the sub-projects. Pre-qualification, tendering will be carried out by PMU at the central level while the control of contractor of each sub-project is conducted jointly by PMU and PIUs at the provincial level and approved at the central level.

2.2. Consultant's Organization

The Consultant shall establish a central office in Phnom Penh. Further, the Consultant shall set a provincial office at each province.

The Consultant is represented by Team Leader and is responsible for executing the consulting services as a whole. The Consultant's central office executes project management, and progress and quality control as a whole. The Consultant's central office shall supervise and advise provincial offices.

Under the Team Leader, Engineers are assigned for the daily management and supervision of the implementation of the sub-projects. They will be stationed in Phnom Penh and regularly make the site inspection of the sub-projects for instruction and guidance of the Consultant's sub-project teams and the Contractors together with coordinating with and advising to the sub-project offices.

The provincial offices shall be stationed at each province, and are under supervision of the central office. A consultant provincial office is represented by a provincial Leader. A provincial office is, in general, responsible for execution of daily construction supervision of a sub-project in collaboration with relevant government project office.

2.3. Experts Required

The total required expertise staff man-month (M/M) for the Services shall not exceed 599 M/M consisting of 148 M/M of Professional A experts, and 451 M/M of Professional B experts.

Assistant engineers and sub professionals such as draftsmen, auto CAD operators and surveyors are also required.

Further, office supporting staff will be required in main office, sub-project site offices. The Consultant should make provision in his financial proposal for such costs.

CHAPTER 3 GENERAL REMARKS

3.1. Location of Offices

The Consultant would have one central office in Phnom Penh and provincial offices at each province.

Although the Consultant is assumed to be located in MOWRAM office space, or provincial site office, the Consultant should make provision in his financial proposal for the renting of suitable office space in the MOWRAM and provinces for the case MOWRAM would be unable to provide such facilities.

3.2. Language and Weight & Measures

The Consultant will be responsible for the provision of translators as necessary. The metric system will be used for weight and measures and the language employed for the documents/correspondence will be as follows:

- a) Proposal : in English
- b) Contract for the consulting services: in English
- c) Day-to-day correspondence with MOWRAM: in English
- d) Correspondence to local government: in English
- e) Reports: as specified in the reporting requirement of the Terms of Reference

3.3. Equipment and Facilities to be provided to the Consultant

The Consultant is entitled to use facilities and equipment to be purchased or rented under the contract exclusively for the purpose of carrying out the services, and shall hand them over to the client upon completion of the services.

3.4. Association of the Consultant

The leading consulting firm is encouraged to associate with the Cambodian consulting firm(s), of which the Services should be under the overall technical supervision of the leading consulting firm.

3.5. Close Contact

The Services should be provided in close contact and good cooperation with MOWRAM.

CHAPTER 4

GOODS AND FACILITIES TO BE PROVIDED BY THE GOVERNMENT

4.1. Report and Data

Existing reports and data related to the project will be provided by MOWRAM in accordance with the needs of the project.

4.2. Accommodation and Office Space

The Consultant's personnel will make all necessary arrangement to organize their own accommodation. Detailed requirements of housing and the costs involved should be stated clearly in the proposal taking the existing conditions in Phnom Penh and the provinces concerned in to account.

The Consultant's requirement for office space in Phnom Penh and provincial offices including necessary equipment and utilities, should be stated clearly in the proposal with the cost for renting such office space for the case that MOWRAM would be unable to provide such facilities. The office will be equipped with electricity, communication facilities, water supply and necessary furniture.

4.3. Appointment of Officials

MOWRAM will appoint officials, agents and representative as may be necessary for effective implementation of the consulting services.

4.4. Visas and Permits

MOWRAM will assist the Consultant's personnel in obtaining necessary entry and exit visa, residence and work permits and travel documents required for their stay in Cambodia.

4.5. Experts Status

Foreign personnel for the Consultant assigned to carry out the services, will be given the status of experts performing the services for MOWRAM during their stay in Cambodia. The Consultant shall ensure, however, that their personnel abide by all applicable laws and regulations of the Government and its authorities.

4.6. Taxes and Duties

The Consultant shall comply with the current Government regulations on taxes and duties which are in effect on the date of signing of the contract.

4.7. Cooperation and Counterpart Staff

MOWRAM will issue to its officials, agent and representative concerned, all such instructions as may be necessary or appropriate for effective implementation of the services.

4.8. Regulation for Use of Foreign Personnel

In accordance with the Government regulations, the Consultant shall submit an application to employ expatriates in Cambodia, prior to the arrival of such personnel, for approval by the Government authority concerned.

Such approval will subsequently be needed to obtain works permits and other immigration

documents.

MOWRAM will issue a sponsor letter to request and facilitate the prompt clearance of those formalities.

4.9. Ownership of Equipment and Data

Equipment and data supplied by MOWRAM or purchased by the Consultant on behalf of MOWRAM shall remain at all times the property of MOWRAM.

The procedure for inventory and handing over to MOWRAM will be determined by MOWRAM representative in accordance with the established Government regulation.

4.10. Reports and Other Records

MOWRAM or its representative will determine the procedure for recording, indexing, circulation and storage of reports and other records.

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APPENDIX-C ENVIRONMENTAL EVALUATION

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
WEST TONLE SAP IRRIGATION AND DRAINAGE REHABILITATION AND
IMPROVEMENT PROJECT

IN
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Table C.1 Environment Related Laws and Regulations (1/3)

Title	Issued in	Provisions
Basic Law		
Law on Environmental Protection and Natural Resource Management (LEPNRM)	1996	<ul style="list-style-type: none"> • It is the supreme legal instrument under the Constitution controlling environmental protection and natural resource management of the country. Following subjects are included in the Law: <ul style="list-style-type: none"> ➢ To protect and promote environmental quality and public health through prevention, reduction, and control of point sources and non-point source of pollution (Environmental Protection), ➢ To assess the environmental impact of all proposed projects prior to the issuance of the decision by the Government (Environmental Impact Assessment), ➢ To encourage and enable the public to participate in environmental protection, and natural resource management (Public Participation and Information Disclosure), and ➢ To suppress any acts that cause harm to the environment (Management and Penalty). • LEPNRM consists of 11 chapters, 6 of which are the keys to environmental protection, an important part of sustainable development in environmental friendly manner. Those chapters cover: (i) national environmental action planning and regional environmental planning, (ii) protected area management, (iii) environmental impact assessment, (iv) pollution control, (v) an environmental endowment fund, and (vi) penalties for violation of the law.
Environmental Management Institution		
Sub-Decree on the Organization and Functions of the Ministry of Environment	1997	<ul style="list-style-type: none"> • Structures of MOE and its functions including tasks of six line departments are defined. • Provincial and/or Municipal Department of Environment are established in each Province and/or Municipality responsible for coordinating and implementing MOE activities at respective Provinces and/or Municipalities.
Environmental Impact Assessment		
Sub-Decree on Environmental Impact Assessment Process	1999	<ul style="list-style-type: none"> • Project Owners, including private or public, shall prepare Environmental Impact Assessment (EIA) or Initial Environmental Impact Assessment (IEIA) reports prior to the projects. • The sub-decree also fosters public participation in the environmental impact assessment process so as to empower communities in decision-making.
Declaration on Guidelines for Conducting Environmental Impact Assessment Report		<ul style="list-style-type: none"> • The declaration is the summary for Guideline of conducting Environmental Impact Assessment Report including: (i) subjects of proposal of projects by project owner and (ii) the function of Department of Environmental Impact Assessment Monitoring.
Guideline for Conducting Environmental Impact Assessment Report	2000	<ul style="list-style-type: none"> • The Guideline defines the format of EIA report consisting of: (i) Project Summary, (ii) Introduction, (iii) Purpose of the Project, (iv) Project Description, (v) Description of Environmental Resources, (vi) Public Participation, (vii) Environmental Impact Analysis, (viii) Environmental Impact Mitigation Measures, (ix) Economic Analysis and Environmental Value, (x) Environmental Management Plan, (xi) Institutional Capacity, (xii) Conclusion and Suggestion and (xiii) References.

Table C.1 Environment Related Laws and Regulations (2/3)

Title	Issued in	Provisions
Protected Areas Management		
Royal Decree on the Protection of Protected Areas	1993	<ul style="list-style-type: none"> The Decree consists of six chapters defining protected areas classified into four categories corresponding to international classifications as follows: (i) National Parks, (ii) Wildlife Sanctuaries, (iii) Protected Landscapes and (iv) Multiple Use Areas in the country.
Declaration No. 1033 on Protected Area	1994	<ul style="list-style-type: none"> It is the declaration dealing with activities prohibited within the protected areas such as hunting, deforestation, exploitation of minerals, and water pollution.
Royal Decree on the Establishment and Management of Tonle Sap Biosphere Reserve	2001	<ul style="list-style-type: none"> The Tonle Sap Biosphere Reserve shall fulfill three complementary functions: (i) a conservation function to contribute to the conservation of biological diversity, (ii) a development function to foster sustainable development of ecology, environment, society, and culture, and (iii) a logistic function to provide support for demonstration projects, environmental education and training. The Tonle Sap consists of three zones: (i) Core Zone, totaling 42,257 ha (Prek Toal: 21,342 ha, Boeng Tonle Chhmar: 14,560 ha and Stoeng Sen: 6,355 ha), (ii) Buffer Zone, totaling 541,482 ha and (iii) Transitional Zone amounting to 899,600 ha each of which are defined as follows: <ul style="list-style-type: none"> ➤ Core Zone: Defined likewise national park or wildlife sanctuary devoted to long term protection and conservation of natural resources and ecosystem ➤ Buffer Zone: Managed to be consistent to the protection and conservation plan of the core areas ➤ Transitional Zone: The integrated economic zone managed for the sustainable agriculture, human settlement and land uses without having adverse effects on the flooded forest, water quality and soils around the Tonle Sap Lake
Protected Area Law	2008	<ul style="list-style-type: none"> The law defines the framework of management, conservation and development of protected areas. The objectives of the law are to ensure the management, conservation of biodiversity, and sustainable use of natural resources in protected area.
Pollution Control		
Sub-Decree on Water Pollution Control	1999	<ul style="list-style-type: none"> Standard on effluent discharge and water quality is defined. Type of pollution sources are categorized which requires permission from MOE. MOE has responsibilities for monitoring the pollution sources and the situation of the water pollution in public water bodies.
Sub-Decree on Solid Waste Management	1999	<ul style="list-style-type: none"> This sub-decree is to regulate solid waste management in proper technical manner and safe way in order to ensure the protection of human health and the conservation of biodiversity. Types of the hazardous wastes are defined which may cause the danger to human health and animal or damage plants, public property and the environment. MOE shall establish guidelines on household waste management and hazardous waste management. The Provincial and/or Cities' Authorities shall establish the waste management plan and have the responsibilities for the collection, transport, storage, recycling, minimizing and dumping of waste.

Table C.1 Environment Related Laws and Regulations (3/3)

Title	Issued in	Provisions
Sub-Decree on Air Pollution and Noise Disturbance	2000	<ul style="list-style-type: none"> The sub-decree has a purpose to protect the environmental quality and public health from air pollutants and noise pollution through monitoring and curing activities.
Resource management		
Land Law	2001	<ul style="list-style-type: none"> There are some provisions including land ownership and property rights, land acquisition for public works, resettlement aspects and legal requirement for compensation for the loss of land.
National Water Resources Policy for The Kingdom of Cambodia	2007	<p>The National Water Resource Policy is:</p> <ul style="list-style-type: none"> ➤ To protect, manage and use water resources with effective, equitable and sustainable manner, ➤ To foresee and take measures to assist related institutions to settle the facing problems which might be occurred in water sector, ➤ To develop and implement the national strategy and formulate the national policy and sector policies on water resources management, ➤ To direct the water resources development, management and utilization in the Kingdom of Cambodia to all activities of institutions, private sector and public sector, and ➤ To improve and upgrade living conditions of the people to achieve the national policy on poverty reduction and sustainable national economic development.
Sub-Decree on Addressing Socio-Economic Impacts caused by Development Project	Draft	<ul style="list-style-type: none"> The sub-decree explains that procedures and institutional arrangements for acquisition of land or property, resolving claims of rights or interests to land property and resolving complaints regarding land or property valuations. The sub-decree defines seven categories of Rehabilitation Assistance: (i) Transportation allowance, (ii) Transitional subsistence or food allowance, (iii) Transitional loss of business profit allowance, (iv) Income and livelihood restoration assistance, (v) Business restoration assistance, (vi) Vulnerability assistance, and (vii) Special additional or follow up assistance.
Sub-Decree on Farmer Water User Community	2008	<ul style="list-style-type: none"> The sub-decree defines Farmer Water User Community (FWUC). The organization is the group of water users under an irrigation system as a legal autonomous entity to use irrigation system for their agriculture production as well as maintenance, development and modernization of the irrigation system. The sub-decree consists of 12 chapters: (i) General Provisions, (ii) Definitions, (iii) Basic Principles and Process of FWUC, (iv) Jurisdiction and Conditions to be a Member of FWUC, (v) Exercise of Rights, Power and Obligations of FWUC, (vi) Capacity Building of FWUC, (vii) Development of Statute and Internal Rules of FWUC, (viii) Financing for Operations and Management of Irrigation System, (ix) Support Services and Communications, (x) Beneficiary-participatory Irrigation System Management and Development and Transfer of Irrigation System and (xi) Litigations and Penalties and (xii) Final Provisions.

Source: JICA (2009), Basin-Wide Basic Irrigation and Drainage Master Plan Study in the Kingdom of Cambodia
 ASIAN DEVELOPMENT BANK (2003), Compendium on Environment Statistics 2003 Cambodia
 Sok Sphana and Sarin Denora, Laws & Regulations on Environment Biodiversity & Protected Areas

Table C.2 Environmental Checklist based on JBIC Guidelines on Confirmation of Environmental and Social Consideration (April 2002) (1/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1. Permits and Explanation	(1) EIA and Environmental Permits	<ul style="list-style-type: none"> ① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government? 	<ul style="list-style-type: none"> ① The Sub-Decree on Environmental Impact Assessment Process explains that irrigation development with more than 5,000 ha is required to carry out EIA or IEIA for approval from the Ministry of Environment (MOE) prior to the implementation. All the six sub-projects' areas are less than 5,000 ha, therefore, no EIA or IEIA is required. ② An Initial Environment Examination (IEE) was carried out in the previous Study (M/P) from the view point of: (i) social environment, (ii) natural environment and (iii) pollution. The IEE judged that the environmental impact from the Project is small. ③ Not applicable. ④ Not applicable.
	(2) Explanation to the Public	<ul style="list-style-type: none"> ① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities? 	<ul style="list-style-type: none"> ① In the previous study (M/P), workshop and public meeting were organized to confirm community member's opinions toward the sub-project as well as environmental management at the project site. ② The stable irrigation water supply is placed highest priority for the participants of Workshop. Therefore, necessity of irrigation rehabilitation was justified from the view point of public opinion.
2. Mitigation Measures	(1) Water Quality	<ul style="list-style-type: none"> ① Are considerations given to water pollution of the surrounding water bodies, such as rivers and groundwater by the effluents or leachates from irrigation ponds? Are adequate use/disposal standards for chemicals, such as fertilizers and agrochemicals established? Is a framework established to increase awareness of the standards among farmers? ② Do effluents and ambient water quality of the surrounding water bodies comply with the country's effluent standards and ambient water quality standards? 	<ul style="list-style-type: none"> ① Following activities will be proposed under the Project: (i) training of farmers for appropriate use of fertilizer and pesticide, (ii) awareness raising of farmers toward prohibited chemicals according to the regulation of MAFF ② No serious problems are reported at present, however, soil and water quality monitoring are to be carried out regularly during the construction and O&M period.

Table C.2 Environmental Checklist based on JBIC Guidelines on Confirmation of Environmental and Social Consideration (April 2002) (2/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2)Soil Contamination	<ol style="list-style-type: none"> ① Is there a possibility that impacts in irrigated lands, such as salinization of soils will result? ② Are adequate measures taken to prevent soil contamination of irrigated lands by agrochemicals, heavy metals and other hazardous substances? 	<ol style="list-style-type: none"> ① Not applicable. ② Trainings of farmers for appropriate application of chemicals and fertilizers are to be supported under agricultural support program.
	(3)Subsidence	<ol style="list-style-type: none"> ① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence? 	<ol style="list-style-type: none"> ① Not applicable since water source of the Project depend on the river run-off.
	(1)Protected Areas	<ol style="list-style-type: none"> ① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas? 	<ol style="list-style-type: none"> ① Not applicable.
3.Natural Environment	(2)Ecosystem	<ol style="list-style-type: none"> ① Does the project site encompass primeval forests, tropical rain forest, ecologically valuable habitats(e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's law or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection, measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? ⑤ Is there a possibility that installation of structures, such as intake weirs will block the movement of the migratory fish species (such as salmon, trout and eel that move between rivers and the sea for spawning)? Are adequate measures taken to reduce the impacts on these species? 	<ol style="list-style-type: none"> ① Not applicable. ② Not applicable. ③ It is proposed to carry out water quality monitoring in the operation period. ④ It is proposed to carry out water quality monitoring in the operation period. ⑤ It is proposed to construct the fish ladder to be equipped with the headworks to avoid disturbing fish sprawling.

Table C.2 Environmental Checklist based on JBIC Guidelines on Confirmation of Environmental and Social Consideration (April 2002) (3/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(1) Resettlement	<p>① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?</p> <p>② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement?</p> <p>③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?</p> <p>④ Does the resettlement plan pay particular attention to vulnerable groups or ethnic minorities, and indigenous peoples?</p> <p>⑤ Are agreements with the affected persons obtained prior to resettlement?</p> <p>⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?</p> <p>⑦ Is a plan developed to monitor the impacts of resettlement?</p>	<p>① Large scale involuntary resettlement is not generated under the Project since the Project aims to rehabilitate existing facilities and no large scale expansion works are included. However, land acquisition is required for the construction of main, secondary and tertiary canals. In addition, in the D/D phase, if involuntary resettlements will be identified, Resettlement Unit under MOWRAM is required to prepare resettlement plan through the cooperation of Inter-ministerial Resettlement Committee (IRC), and to carry out the appropriate land acquisition process.</p> <p>② All the affected person, including those without title to land, will be given adequate explanation on relocation and compensation for the construction of facilities.</p> <p>③~⑥ The Project owner, MOWRAM has the resettlement unit in charge of resettlement planning and coordination among relevant organizations including IRC.</p> <p>⑦ Land acquisition and compensation process at tertiary canal level is proposed in the Project. Monitoring will be necessary during implementation.</p>
	(2) Living and Livelihood	<p>① Is there a possibility the project will adversely affects the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?</p> <p>② Are proper allotments, such as water rights allotment in the project area made? Is there a possibility that the allotments will result in inequitable distribution or usurpation of water rights and available resources?</p> <p>③ In there a possibility that the amount of water used (surface water, groundwater) by the project will adversely the downstream fisheries and water uses?</p>	<p>① The main source of drinking water and domestic water among the communities in the project area is well and rain water, therefore the impact from the Project is not anticipated. Moreover, stable supply of irrigation water by the Project will greatly contributes to the farming activity.</p> <p>② No significant adverse impact will be expected. Water management measures in the Project are: (i) to establish and strengthen FWUC and (ii) to monitor appropriate water management by the Government.</p> <p>③ No significant impact will be expected since: (i) construction of fish</p>

Table C.2 Environmental Checklist based on JBIC Guidelines on Confirmation of Environmental and Social Consideration (April 2002) (4/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
		<p>④ Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? Is adequate consideration given to public health education, if necessary?</p>	<p>ladder is proposed to support fish migration and (ii) river maintenance water is considered in the Project.</p> <p>④ Because of the inflow of construction workers from outside, following negative impact is expected: (i) deterioration of sanitary condition and (ii) increase of infectious disease. Therefore, educational program for construction workers are proposed in the Project.</p>
	(3) Heritage	<p>① Is there a possibility that the project will damage the local archeological historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's law?</p>	<p>① Not applicable.</p>
	(4) Landscape	<p>① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?</p>	<p>① Not applicable.</p>
5 Others	<p>(1) Impacts during Construction</p>	<p>① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?</p> <p>② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?</p> <p>③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?</p>	<p>① Following measures are proposed to reduce impacts for the construction works: (i) noise and the vibration; limit construction time (e.g. at daytime only), (ii) turbid water; proper treatment before discharging, (iii) organization of education program for construction laborers and (iv) inclusion of the environmental consideration matters in the technical specification of the construction works.</p> <p>② To minimize the influence on fish sprawling by the headworks, fish ladder is proposed to be equipped with the headworks. And river maintenance flow will be ensured during construction works and O&M.</p> <p>③ Management measures proposed are: (i) to educate construction workers about environment impacts, (ii) to stipulate environmental consideration measures in the technical specification of the construction works, (iii) to limit construction time, (iv) to explain purpose and period of construction works to rural community and (v) to recycle material from construction works.</p>

Table C.2 Environmental Checklist based on JBIC Guidelines on Confirmation of Environmental and Social Consideration (April 2002) (5/5)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2)Monitoring	<p>① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?</p> <p>② Are the items, methods and frequencies included in the monitoring program judged to be appropriate?</p> <p>③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?</p> <p>④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?</p>	<p>④ The educational program for construction workers are to be organized by the Contractors.</p> <p>① Two plans are proposed for monitoring of the impact from the Project: (i) participatory land compensation for tertiary development and (ii) soil and water quality monitoring, both of which are relevant to all the six sub-projects.</p> <p>② The social environmental monitoring is properly carried out from design to operation phase of the Project. The natural environmental monitoring is executed during rainy and dry season. Overall, frequency of monitoring activities proposed in the plan are judged to be appropriate.</p> <p>③ Monitoring is proposed to be carried out by the responsibility of MOWRAM and PDOWRAM.</p> <p>④ At present, the format and the frequency of the report are not provided from regulatory authorities.</p>
6 Note	Reference to Checklist of Other Sectors	<p>① Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation).</p> <p>② For the projects including construction of large-scale weirs, reservoirs, and dams, where necessary, pertinent items described in the Dams and Reservoirs checklist should also be checked.</p>	<p>① Not applicable.</p> <p>② Not applicable.</p>
	Note on Using Environmental Checklist	<p>① If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).</p>	<p>① Not applicable.</p>

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APPENDIX-D PROJECT EVALUATION

SPECIAL ASSISTANCE FOR PROJECT FORMATION (SAPROF) FOR
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CHAPTER D.1 ECONOMIC EVALUATION

D 1.1 Evaluation Conditions

The economic project benefit and cost are estimated based on the following conditions;

- All the prices are expressed in constant prices as of September 2009, and the foreign currency exchange rate is fixed at USD 1.00 = Riel 4,114;
- The evaluation period is 30 years starting from 2010;-
- Economic farm gate prices of internationally traded agricultural inputs and outputs are calculated in the form of export and import parity prices as shown in Table D1-1, citing the World Bank Commodity Price Forecasts as of August 2009;
- A standard conversion factor (SCF) is determined at 0.977 based on the formula as mentioned below. Input data are referred to Cambodia Statistical Yearbook 2008 and IMF Country Report No. 09/48 Cambodia Statistical Appendix

$$SCF = (I + E) / [(I - I_s + I_t) + (E + E_s - E_t)]$$

Where, I = Total import value (CIF) to Cambodia,
E = Total export value (FOB) from Cambodia,
s = subsidy, and
t = tax;

- A shadow wage rate (SWR) is assumed to be 0.75 which is a rate with international consensus among officials concerned with Cambodia; and
- Transfer payments such as taxes, duties, subsidies, interest, land acquisition cost, administration cost, etc. are not included into economic cost.

D 1.2 Crop Budget

Financial crop budget of rice cultivation is prepared for different types of planting method and water sources in the six sub-project areas as shown in Table D2.1.

Considering the above conditions, farm gate prices of internationally traded goods are set up as shown in Table D1.1 for a farm output and Table D1.2 for farm inputs. A list comparing the both financial and economic farm gate prices is made as shown in Table D1.3. Citing these data, economic crop budget is calculated as presented in Table D1.4 for the present condition and Table D1.5 for the future condition.

D 1.3 Project Benefits

The economic benefit is defined as the incremental net benefit between the present “Without Project” condition and the future “With Project” condition.

The project benefit is assumed to be borne from the next year after the completion of construction works at the rate of 70% of predicted level and reach to the full target at the fourth year. Based on these assumptions, the irrigation benefit of each sub-project is firstly estimated and then combined for the whole project.

Through re-examination of the original design capacity of irrigation facilities and available irrigation water resources, additional irrigation areas can be expected to come from the outside of command areas of

Ream Kon, Por Canal, Damnak Ampil and Lum Hach Sub-projects. These areas have been quantified at 12,850 ha as the secondary benefit area in addition to 12,760 ha as the primary benefit area.

D 1.4 Economic Project Cost

The financial project cost covers civil works, engineering services including support programs, and O&M and major repairing works, which is estimated based on the price level in September 2009 and exchange rate at USD 1.00 = Riel 4,114.

The financial project cost is converted to the economic project cost by applying the standard conversion factor (SCF) of 1.0 to foreign currency portion of each cost item, 0.977 to the physical portion of civil works, engineering services and O&M estimated at local currency, and 0.75 to unskilled labor cost of the civil works. The financial construction cost is assumed to include unskilled labor cost in the local currency portion at a rate of 10% of intake facility cost, 25% of main and secondary canal cost and 50% of on-farm development cost.

From the engineering point of view, the initial investment costs of irrigation facilities commonly used for irrigation water intake purposes by the both benefit areas can be allocated according to the ratio of both command areas. In order to realize the secondary project benefit, it is prerequisite to invest in new development of required irrigation systems in the respective secondary benefit areas. Taking into account the above basic assumptions as well as the allocation concept of initial investment costs, the cash flow is projected for the respective sub-projects and then the entire proposed project as summarized below.

Cash Flow of Economic Cost and Benefit

Unit: Riel Million

Item	2010	2011	2012	2013	2014	2015	2016	2017	2018
- Financial investment cost	4,196	11,984	7,652	114,184	61,541	1,530	872	0	
- Economic investment cost	2,041	9,121	3,453	80,168	42,024	1,073	592	0	
- Economic annual O&M cost	0	0	0	0	272	410	410	410	410
- Economic benefit	0	0	0	0	6,083	16,063	18,978	21,893	22,840

Prepared by JICA SAPROF Study Team

D 1.5 Economic Evaluation

In conducting economic evaluation, the economic cost and benefit stream is prepared for the evaluation period of 30 years, comprising the project investment cost, annual O&M cost and major repairing cost of every 10 year for the cost stream as well as annual irrigation and drainage benefit in the build-up and full swing stages for the benefit stream.

Sensitivity analysis is made for such cases as cost 10% and 20% up, benefit 10% and 20% down, and combination of each case.

The results of economic evaluation and sensitivity analysis are expressed by the economic internal rate of return (EIRR), NPV at discount rate of 12% and benefit-cost ratio (B/C) as summarized as below, and the details are given in Tables D1.6.

Results of Economic Analysis

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

Prepared by JICA SAPROF Study Team

CHAPTER D.2 FINANCIAL EVALUATION

D 2.1 Financial Evaluation

Financial evaluation of the proposed project is undertaken in terms of financial viability from individual farmer's perspective, focusing on the beneficiary farmers' capacity to pay. Such pay is intended for shouldering partly annual O&M cost from their increments of net farm income from irrigated rice cultivation. The average annual farmer's net income in the project area is estimated to increase by Riel 1,284,000/ha from Riel 785,000/ha at present to Riel 2,069,000/ha in the future. As the annual O&M cost required is estimated at USD 10/ha or Riel 41,000/ha annually, an affordable portion of this cost can be covered with this increment of the net farm income.

In addition to the net farm income, farmers in the project area have earned non-farm income mainly from temporary works and/or daily labor. On the other hand, they have to spend cash for buying daily necessities. From such viewpoint, the actual capacity to pay is examined for beneficiary farmers in the respective sub-project area based on the average farm size and financial crop budget given in Tables D2.1 and D2.2. The result is as shown in Table D2.3.

CHAPTER D.3 OPERATION AND EFFECT INDICATOR

D 3.1 Operation Indicators

Operation indicators proposed for monitoring the sub-projects are listed as follows. The project benefit is to be borne from the next year after the completion of civil works and reach to the target yield in the fourth year. Details of operation indicators of each sub-project are as shown in Table D3.1. Collection ratio of water charge is targeted at 80% based on the experience of the Study on Comprehensive Agricultural Development of Prek Thnot River Basin (2008).

Operation Indicators

	Indicator	Unit	Without Project	With Project
1	Irrigated area	ha	760	12,760
2	Planted area of paddy	ha	14,260	16,800
3	Cropping intensity	%	104	132
4	Number of FWUGs	nos.	0	52
5	Collection ratio of water charge	%	0	80

Prepared by JICA SAPROF Study Team

D 3.2 Effect Indicators

Effect indicators proposed for monitoring the sub-projects are listed as follows. The project benefit is to be borne from the next year after the completion of civil works and reach to the target yield in the fourth year. Details of effect indicators of each sub-project are as shown in table D3.2 to D 3.8.

Effect Indicators

	Indicator	Unit	Without Project	With Project
1	Paddy production	ton	22,000	54,000
2	Paddy yield	ton/ha	1.5	3.2
3	Annual net farm income	Riel/ha	785,000	2,069,000

Prepared by JICA SAPROF Study Team

D 3.3 Procedures for Monitoring Operation and Effect Indicators

The operation and effect indicators above-mentioned will be collected by the project consultant. The consultant will carry out baseline survey and monitoring and evaluation activities (M&E). Based on the collected data, monthly, quarterly and annual report will be prepared by the project consultant. After finishing the Project, M&E activity will be handed over from the consultant to the MOWRAM.

Table D1.1 Economic Farm Gate Price of Internationally Traded Outputs

Item	Import Parity Price			Export Parity Price		
	Operation	Unit	Price	Operation	Unit	Price
I. Rice/Paddy						
1. Forcasted 2020 World Price (in 2007 price) /a		US\$/ton	354		US\$/ton	354
2. Quality Adjustment	x	%	90	x	%	90
3. CIF/FOB Price at Sihanouk Ville International Port /b	=	US\$/ton	319	=	US\$/ton	319
4. Port Charge, Handling and Warehousing	+	US\$/ton	14	-	US\$/ton	14
5. Price at Sihanouk Ville International Port	=	US\$/ton	333	=	Riel/kg	305
Equivalent in Riel / kg /c	=	Riel/kg	1,368	=	Riel/kg	1,253
6. Transportation Cost (Sihanouk Ville-Phnom Penh)	+	Riel/kg	33	-	Riel/kg	33
(Phnom Penh -Pursat)	+	Riel/kg	33	-	Riel/kg	33
7. Ex-Mill /Wholesale Price in Pursat	=	Riel/kg	1,434	=	Riel/kg	1,187
8. Milling Cost and Margin /d	-	Riel/kg	27	-	Riel/kg	27
9. Processing Ratio	x	%	64	x	%	64
10. By-Products through Processing /e	+	Riel/kg	121	+	Riel/kg	121
11. Millgate Paddy Price	=	Riel/kg	1,021	=	Riel/kg	863
12. Transport/Handling from Farmgate	-	Riel/kg	17	-	Riel/kg	17
13. Farmgate Price	=	Riel/kg	1,004	=	Riel/kg	846
			91%			9%
17. Weighted average economic farm gate price / f		Riel/kg	990			

Note : /a ; Nominal index based on 2008 real international market prices, Prosects for the Global Economy, the World Bank, 2009

Rice : Thai, milled, 5% broken, FOB Bangkok

/b ; Assumed at the same price at Bangkok port in Thailand

/c ; Exchange rate _____ US\$ = Riel _____ 4,114 (As of December 2008)

/d ; Milling cost : Riel 27 /kg of paddy

/e ; Rice bran : Riel 520 /kg of rice bran, 18% of paddy weight

Broken rice: Riel 550 /kg of broken rice, 5 % of paddy weight.

/f ; Average feom 2000 to 2007 estimated based on FAO export and import statistics

Table D1.2 Economic Farm Gate Price of Internationally Traded Inputs

Item	Import Parity Price		
	Operation	Unit	Price
III. Fertilizer			
(1) Urea			
1. Forecasted 2020 World Price (in 2008 price) /a		US\$/ton	180
2. International Shipping and Handling	+	US\$/ton	43
3. CIF/FOB Price at Sihanouk Ville International Port	=	US\$/ton	223
4. Port Charge, Handling and Warehousing	+	US\$/ton	14
5. Price at Sihanouk Ville International Port	=	US\$/ton	237
Equivalent in Riel / kg /b	=	Riel/kg	975
6. Transportation Cost /d (Sihanouk Ville-Pursat)	+	Riel/kg	66
7. Trade Price in Pursat	=	Riel/kg	1,041
8. Transport/Handling to Farmgate	+	Riel/kg	17
9. Farmgate Price	=	Riel/kg	1,058
Price of Nutrient (N) /c		Riel/kg	2,300
(2) DAP (Diammonium Phosphate)			
1. Forecasted 2020 World Price (in 2007 price) /a		US\$/ton	293
2. International Shipping and Handling	+	US\$/ton	49
3. CIF/FOB Price at Sihanouk Ville International Port	=	US\$/ton	342
4. Port Charge, Handling, Warehousing and Bagging	+	US\$/ton	14
5. Price at Sihanouk Ville International Port	=	US\$/ton	356
Equivalent in Riel / kg /b	=	Riel/kg	1,465
6. Transportation Cost /c (Sihanouk Ville-Pursat)	+	Riel/kg	66
7. Trade Price in Kampong Speu	=	Riel/kg	1,531
8. Transport/Handling to Farmgate	+	Riel/kg	17
9. Farmgate Price	=	Riel/kg	1,548
Price of Nutrient (P) /c		Riel/kg	3,365
(3) Potassium Chloride (KCl)			
1. Forecasted 2020 World Price (in 2007 price) /a		US\$/ton	161
2. International Shipping and Handling	+	US\$/ton	43
3. CIF/FOB Price at Sihanouk Ville International Port	=	US\$/ton	204
4. Port Charge, Handling, Warehousing and Bagging	+	US\$/ton	14
5. Price at Sihanouk Ville International Port	=	US\$/ton	218
Equivalent in Riel / kg /b	=	Riel/kg	897
6. Transportation Cost /c (Sihanouk Ville-Pursat)	+	Riel/kg	66
7. Trade Price in Takeo	=	Riel/kg	963
8. Transport/Handling to Farmgate	+	Riel/kg	17
9. Farmgate Price	=	Riel/kg	980
Price of Nutrient (K) /c		Riel/kg	1,633

Note : /a ; Nominal index based on 2007 real international market prices, Prosects for the Global Economy, the World Bank, 2008

Urea : Bagged, FOB Black Sea

DAP : Bulk, FOB US Gulf

KCl : Bulk, FOB Vancouver

/b ; Exchange rate : US\$ = Riel 4,114 (As of December 2008)

/c ; Nutrient content is 46%, 46%(18-46-0), and 60%, respectively for Urea, DAP and KCL.

Table D1.3 Summary of Financial and Economic Prices Applied

Particulars	Unit	Financial Price / a	Conversion	Economic Price
1 Farm Products				
Dry paddy (Wet season)	(Riel/kg)	1,100	b	990
Dry paddy (Early wet season)	(Riel/kg)	1,000	b	990
2 By-Products				
By-products of paddy		5% of gross return of paddy /c		
By-products of upland crops and vegetables		2% of gross return of upland crops /c		
3 Seeds				
Paddy (Present/Without)	(Riel/kg)	1,100	c	1,075
Paddy (Present/Without for EWS)	(Riel/kg)	1,000	c	977
Paddy (With)	(Riel/kg)	1,400	c	1,368
4 Fertilizer				
Urea	(Riel/kg)	3,500	b	1,058
DAP	(Riel/kg)	5,000	b	1,548
Compound (20-20-15)	(Riel/kg)	3,400	b	1,378
Manure	(Riel/ton)	50,000	e	40,338
5 Agro-chemicals				
Liquid chemicals (paddy) ^f	(Riel/litre)	20,000	c	19,541
Dust chemicals (paddy) ^g	(Riel/kg)	10,000	c	9,771
6 Labor				
Hired labor	(Riel/manday)	10,000	d	7,500
Family labor	(Riel/manday)	0	d	7,500
7 Land Preparation				
Direct sowing (Present/Without)	(Riel/ha)	200,000	e	161,353
Transplanting (Present/Without)	(Riel/ha)	250,000	e	201,691
Direct sowing (With for EWS/WS)	(Riel/ha)	250,000	e	201,691
Transplanting (With for EWS/WS)	(Riel/ha)	350,000	e	282,368
8 Pumping				
Early wet season (Present/Without)	(Riel/ha)	300,000	e	242,029
Wet season (With)	(Riel/ha)	200,000	e	161,353
Early wet season (With)	(Riel/ha)	400,000	e	322,706
9 Transportation				
Ox cart	(Riel/ton)	40,000	e	32,271
10 Miscellaneous				
5% of total of cost items 3 to 9	(Riel)			

Remarks:

/a ; August. 2008 prices

/b ; Economic price estimate based on the WB Commodity Markets Forecast

/c ; Financial prices are converted to economic value multiplying by SCF of 0.977

/d ; Multiplied by shadow wage rate and SCF 0.75

/e ; Average proportion of materials/equipment (25%) and manpower (75%) 0.81

/f ; Fungicide

/g ; Pesticide

Table D1.4 Economic Crop Budget / Without Project

Sub-project Cropping Season Water Source Planting Method Item	Unit	Ream Kon & Por Canal						Wet Season						Lum Hach														
		Early Wet Season			Supplemental Irrigation			Transplanting			Direct Sowing			Transplanting			Direct Sowing			Transplanting			Direct Sowing					
		Pump Irrigation			Transplanting			Direct Sowing			Transplanting			Direct Sowing			Transplanting			Direct Sowing			Transplanting			Direct Sowing		
		Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)
1. Gross Income			2,911			2,079			1,197			1,663			1,455			1,635			1,179			1,145			1,247	
Main products	kg	990	2,772	2,800	990	2,772	2,200	990	2,200	990	2,178	2,200	990	2,178	2,287	2,000	990	1,980	1,600	990	1,584	1,400	990	1,386	1,600	990	1,188	
By-product (straw)	kg		139								109																59	
2. Production Cost			1,557			1,102			1,301			1,035			1,197			1,035			1,179			1,145			1,145	
2.1 Inputs			344			228			235			203			202			202			203			203			203	
Seed	kg	140	977	137	80	1,075	86	120	1,075	129	86	120	1,075	129	86	120	1,075	129	80	1,075	86	80	1,075	86	80	1,075	86	
Manure (wet)	ton	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	0	0	40,338	
Fertilizer: Urea	kg	100	1,058	106	75	1,058	79	50	1,058	53	63	40	1,058	42	60	1,058	42	60	1,058	60	1,058	63	60	1,058	63	60	1,058	
DAP	kg	60	1,548	93	45	1,548	70	30	1,548	46	54	20	1,548	31	35	1,548	31	35	1,548	35	1,548	54	35	1,548	54	35	1,548	
Compound (20-20-)	kg	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	0	0	1,378	
Agro-chemicals: Liquid	liter	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	
Dust	kg	0.8	9,771	8	0	9,771	0	0	9,771	0	0	9,771	0	0	9,771	0	0	9,771	0	0	9,771	0	0	9,771	0	0	9,771	
2.2 Labor			578			548			675			631			533			615			615			600			600	
Hired labor	manday	15	7,500	113	18	7,500	135	15	7,500	113	128	14	7,500	105	105	14	7,500	105	8	7,500	60	8	7,500	60	8	7,500		
Family labor	manday	62	7,500	465	72	7,500	540	58	7,500	435	465	57	7,500	428	428	74	7,500	555	74	7,500	555	72	7,500	540	72	7,500		
2.3 Land preparation			161			161			202			161			161			161			161			202			202	
Draft animal/Tractor	ha	1	161,353	161	1	161,353	161	1	161,353	161	161	1	161,353	161	161	1	161,353	161	1	161,353	161	1	161,353	161	1	161,353		
2.4 Pumping			242			0			0			0			0			0			0			0			0	
Pumping	ha	1	242,029	242	0	242,029	0	0	242,029	0	0	0	242,029	0	0	0	242,029	0	0	242,029	0	0	242,029	0	0	242,029		
2.5 Transportation			90			65			71			65			65			65			65			52			39	
Ox-cart	ton	2.8	32,271	90	2.2	32,271	71	2.0	32,271	65	65	1.4	32,271	45	52	1.4	32,271	45	1.6	32,271	52	1.6	32,271	52	1.2	32,271		
2.6 Miscellaneous			142			100			118			109			94			107			107			101			101	
3. Net Return			1,354			977			986			466			420			484			484			101			103	

Note: *: Farmers use small manual pump in rainfed paddy field.

Table D1.5 (1/2) Economic Crop Budget / With Project

Sub-project	Ream Kon & Por Canal												Dannak Ampil/Wat Loung/Wat Chre		
	Early Wet Season						Wet Season						Early Wet Season		
	Gravity irrigation			Pump irrigation			Gravity irrigation			Pump irrigation			Gravity irrigation		
	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)
1. Gross Income															
Main products	3,000	990	2,970	3,000	990	3,267	3,300	990	3,267	3,300	990	3,267	3,000	990	2,970
By-product (straw)	149		149			163		163			163				149
2. Production Cost															
2.1 Inputs															
Seed	80	1,368	109	80	1,368	109	25	1,368	34	25	1,368	34	80	1,368	109
Manure (wet)	1	40,338	40	1	40,338	40	1	40,338	40	1	40,338	40	1	40,338	40
Fertilizer: Urea	80	1,058	85	80	1,058	85	80	1,058	85	80	1,058	85	80	1,058	85
DAP	0	1,548	0	0	1,548	0	0	1,548	0	0	1,548	0	0	1,548	0
Compound (20-20-20)	140	1,378	193	140	1,378	193	140	1,378	193	140	1,378	193	140	1,378	193
Agro-chemicals: Liqu	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0	0	19,541	0
Dust	1	9,771	10	1	9,771	10	0	9,771	0	0	9,771	0	1	9,771	10
2.2 Labor															
Hired labor	17	7,500	128	17	7,500	128	23	7,500	173	23	7,500	173	17	7,500	128
Family labor	69	7,500	518	69	7,500	518	92	7,500	690	92	7,500	690	69	7,500	518
2.3 Land preparation															
Draft animal/Tractor	1	201,691	202	1	201,691	202	1	282,368	282	1	282,368	282	1	201,691	202
2.4 Pumping															
Pumping	0	322,706	0	0	322,706	0	0	161,353	161	0	161,353	161	0	322,706	0
2.5 Transportation															
Ox-cart	3	32,271	100	3	32,271	113	2.8	32,271	113	2.8	32,271	113	3	32,271	100
2.6 Miscellaneous															
	69		69			77			77			89			69
3. Net Return															
			1,664			1,987			1,740			1,818			1,571

Note: *: Farmers use small moval pump in rainfed paddy field.

Table D1.5 (2/2) Economic Crop Budget / With Project

Sub-project	Lum Hach																
	Dannak Ampil/Wat Loung/Wat Chre						Wet Season										
	Early Wet Season		Wet Season		Pump irrigation		Gravity irrigation		Pump irrigation		Gravity irrigation						
Cropping Season	Water Source	Planting Method	Item	Unit	Pump irrigation		Transplanting		Pump irrigation		Transplanting		Pump irrigation		Gravity irrigation		
					Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty
1. Gross Income																	
Main products																	
By-product (straw)																	
2. Production Cost																	
2.1 Inputs																	
Seed																	
Manure (wet)																	
Fertilizer: Urea																	
DAP																	
Compound (20-20-20)																	
Agro-chemicals: Liqu																	
Dust																	
2.2 Labor																	
Hired labor																	
Family labor																	
2.3 Land preparation																	
Draft animal/Tractor																	
2.4 Pumping																	
Pumping																	
2.5 Transportation																	
Ox-cart																	
2.6 Miscellaneous																	
3. Net Return																	

Note: *: Farmers use small manual pump in rainfed paddy field.

Table D1.6 Economic Cost and Benefit Stream for Primary Benefit Areas with Allocated Cost

EIRR : 13.3%		Net Present Value (Riel Million)		Benefit	Cost	B/C Ratio	
		(12 % discount rate)		99,536	90,571	1.10	
							(Unit : Riel Million)
Year in Order	Year	Economic Cost				Economic Benefit	Net Cash Flow
		Initial Investment	Annual O&M	Major Repairing	Total		
1	2010	2,041			2,041	0	(2,041)
2	2011	9,121			9,121	0	(9,121)
3	2012	3,453			3,453	0	(3,453)
4	2013	80,168			80,168	0	(80,168)
5	2014	42,024	272		42,296	6,083	(36,213)
6	2015	1,073	410		1,483	16,063	14,579
7	2016	592	410		1,003	18,978	17,975
8	2017		410		410	21,893	21,482
9	2018		410		410	22,840	22,430
10	2019		410		410	22,840	22,430
11	2020		410		410	22,840	22,430
12	2021		410		410	22,840	22,430
13	2022		410		410	22,840	22,430
14	2023		410	3,648	4,058	22,840	18,782
15	2024		410	1,850	2,260	22,840	20,580
16	2025		410		410	22,840	22,430
17	2026		410		410	22,840	22,430
18	2027		410		410	22,840	22,430
19	2028		410		410	22,840	22,430
20	2029		410		410	22,840	22,430
21	2030		410		410	22,840	22,430
22	2031		410		410	22,840	22,430
23	2032		410		410	22,840	22,430
24	2033		410	3,648	4,058	22,840	18,782
25	2034		410	1,850	2,260	22,840	20,580
26	2035		410		410	22,840	22,430
27	2036		410		410	22,840	22,430
28	2037		410		410	22,840	22,430
29	2038		410		410	22,840	22,430
30	2039		410		410	22,840	22,430

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Table D2.1 Financial Crop Budget / Without Project

Sub-project Cropping Season Water Source	Wet Season										Rain-fed																			
	Early Wet Season					Ream Kon & Por Canal					Wet Season					Dannak Ampil/Wat Loung/Wat Chre					Lum Hach									
	Pump Irrigation					Supplemental Irrigation					Transplanting					Direct Sowing					Transplanting									
	Planting Method	Q'ty	Price (Riel)	Value ('000 Riel)	Unit	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)				
1. <i>Gross Income</i>			2,940	Riel			2,541	2,420	1,100	1,203	954	1,600	1,100	1,760	1,617	1,848	1,848	1,600	1,100	1,760	1,600	1,100	1,760	1,600	1,100	1,320				
Main products	2,800	1,000	2,800	kg			121			110				88		88				88			88			66				
By-product (straw)			140	Riel																										
2. <i>Production Cost</i>			1,703	Riel			576			457				473		473				473						931				
2.1 <i>Inputs</i>			798	Riel			88			132				132		88				88						88				
Seed	140	1,000	140	kg			0			0				0		50,000				50,000						0				
Manure (wet)	0	50,000	0	ton			0			0				0		50,000				50,000						0				
Fertilizer: Urea	100	3,500	350	kg			263			175				140		3,500				3,500						210				
DAP	60	5,000	300	kg			225			150				100		5,000				5,000						175				
Compound (20-20-)	0	3,400	0	kg			0			0				0		3,400				3,400						0				
Agro-chemicals: Liquid	0	20,000	0	liter			0			0				0		20,000				20,000						0				
Dust	0.8	10,000	8	kg			0			0				0		10,000				10,000						0				
2.2 <i>Labor</i>			150	Riel			180			150				140		170				140						80				
Hired labor	15	10,000	150	manday			180			150				140		170				140						80				
Family labor	62	0	0	manday			0			0				57		0				0						0				
2.3 <i>Land preparation</i>			200	Riel			250			200				200		250				200						250				
Draft animal/Tractor	1	200,000	200	ha			250			200				200		250				200						250				
2.4 <i>Pumping</i>			300	Riel			0			0				0		300,000				0						0				
Pumping	1	300,000	300	ha			0			0				0		300,000				0						0				
2.5 <i>Transportation</i>			100	Riel			88			60				40		88				60						48				
Ox-cart	2.5	40,000	100	ton			88			60				40		88				60						48				
2.6 <i>Miscellaneous</i>			155	Riel			109			87				75		96				75						80				
3. <i>Net Return</i>			1,237	Riel			1,338			1,356				791		791				791						455				

Note: *. Farmers use small metal pump in rainfed paddy field.

Table D2.2 (1/2) Financial Crop Budget / With Project

Sub-project	Ream Kon & Por Canal												Dannak Ampil/Wat Loung/Wat Chre						
	Early Wet Season				Wet Season				Pump irrigation				Early Wet Season						
	Gravity irrigation		Direct Sowing		Gravity Irrigation		Transplanting		Direct Sowing		Transplanting		Gravity irrigation						
Planting Method	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	
1. Gross Income																			
Main products	3,000	1,000	3,000	3,000	1,100	3,630	3,300	1,100	3,630	3,300	1,100	3,630	3,300	1,100	3,630	3,000	1,000	3,000	3,150
By-product (straw)			150			182			182			182			182				150
2. Production Cost			1,546			1,856			1,533			1,848			1,954				1,546
2.1 Inputs			928			841			928			841			928				928
Seed	80	1,400	112	80	1,400	112	25	1,400	35	80	1,400	112	25	1,400	35	80	1,400	112	80
Manure (wet)	1	50,000	50	1	50,000	50	1	50,000	50	1	50,000	50	1	50,000	50	1	50,000	50	1
Fertilizer: Urea	80	3,500	280	80	3,500	280	80	3,500	280	80	3,500	280	80	3,500	280	80	3,500	280	80
DAP	0	5,000	0	0	5,000	0	0	5,000	0	0	5,000	0	0	5,000	0	0	5,000	0	0
Compound (20-20-20)	140	3,400	476	140	3,400	476	140	3,400	476	140	3,400	476	140	3,400	476	140	3,400	476	140
Agro-chemicals: Liquid	0	20,000	0	0	20,000	0	0	20,000	0	0	20,000	0	0	20,000	0	0	20,000	0	0
Dust	1	10,000	10	1	10,000	10	0	10,000	10	1	10,000	10	0	10,000	10	1	10,000	10	1
2.2 Labor			170			170			170			170			170				170
Hired labor	17	10,000	170	17	10,000	170	23	10,000	230	17	10,000	170	23	10,000	230	17	10,000	170	17
Family labor	69	0	0	69	0	0	92	0	0	69	0	0	92	0	0	69	0	0	69
2.3 Land preparation			250			250			250			250			250				250
Draft animal/Tractor	1	250,000	250	1	250,000	250	1	350,000	350	1	250,000	250	1	350,000	350	1	250,000	250	1
2.4 Pumping			300			300			0			300			300				300
Pumping	0	300,000	0	0	300,000	0	0	300,000	0	0	300,000	0	0	300,000	0	0	300,000	0	0
2.5 Transportation			124			124			112			140			140				124
Ox-cart	3	40,000	120	3	40,000	120	3.5	40,000	140	2.8	40,000	112	3.5	40,000	140	3	40,000	120	3
2.6 Miscellaneous			88			88			73			78			93				74
3. Net Return			1,604			1,294			2,279			1,294			1,857				1,604

Note: *: Farmers use small moval pump in rainfed paddy field.

Table D2.2(2/2) Financial Crop Budget / With Project

Sub-project	Dannak Ampil/Wat Leung/Wat Chre						Lam Hach							
	Early Wet Season			Wet Season			Early Wet Season			Wet Season				
	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)		
Water Source	Pump irrigation			Pump irrigation			Pump irrigation			Pump irrigation				
Planting Method	Pump irrigation			Pump irrigation			Pump irrigation			Pump irrigation				
Item	Unit	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	Q'ty	Price (Riel)	Value ('000 Riel)	
1. Gross Income														
Main products	kg	3,000	1,000	3,000	3,300	1,100	3,630	3,812	3,300	1,100	3,630	3,300	1,100	3,630
By-product (straw)	Riel			150			182				182			182
2. Production Cost														
2.1 Inputs														
Seed	Riel			928			841				841			841
Manure (wet)	kg	80	1,400	112	25	1,400	35	35	25	1,400	35	25	1,400	35
Fertilizer: Urea	ton	1	50,000	50	1	50,000	50	50	1	50,000	50	1	50,000	50
DAP	kg	80	3,500	280	80	3,500	280	280	80	3,500	280	80	3,500	280
Compound (20-20-20)	kg	0	5,000	0	0	5,000	0	0	0	5,000	0	0	5,000	0
Agro-chemicals: Liq	kg	140	3,400	476	140	3,400	476	476	140	3,400	476	140	3,400	476
Dust	liter	0	20,000	0	0	20,000	0	0	0	20,000	0	0	20,000	0
Labor	kg	1	10,000	10	0	10,000	0	0	0	10,000	0	0	10,000	0
Hired labor	Riel			170			110				110			110
Family labor	manday	17	10,000	170	11	10,000	110	110	11	10,000	110	11	10,000	110
Land preparation	manday	69	0	0	102	0	0	0	100	0	0	100	0	0
Draft animal/Tractor	Riel			250			350				350			350
Pumping	ha	1	250,000	250	1	350,000	350	350	1	350,000	350	1	350,000	350
Pumping	Riel			300			300				300			300
Pumping	ha	1	300,000	300	0	300,000	0	0	1	300,000	0	0	300,000	0
Transportation	Riel			120			132				120			120
Ox-cart	ton	3	40,000	120	3.3	40,000	132	132	3	40,000	120	3	40,000	120
Miscellaneous	Riel			88			87				86			86
3. Net Return				1,294			1,992				1,343			2,004

Note: *: Farmers use small moval pump in rainfed paddy field.

Table D2.3 Result of Farm Budget Analysis

(unit: Riel '000)

Sub-project	Typical Farm ha/HH	Without Project					With Project					Increased Capacity to Pay			
		Net Farm Income	Net Farm Income (Riel '000/ha)	Non Farm Income	Expenditure	Net Surplus	Net Farm Income (Riel '000/ha)	Net Farm Income	Non Farm Income	Expenditure	Net Surplus	Riel '000	Riel '000/ha	USD/ha	times
		(Riel '000/ha)		(Riel '000/HH)											
1 Ream Kon	2.2	843	1,855	502	927	1,430	1,940	4,268	502	1,115	3,655	2,225	1,012	541	1.6
2 Por Canal	2.4	887	2,128	483	895	1,716	1,980	4,753	483	1,073	4,163	2,447	1,020	595	1.4
3 Damnak Ampil	1.2	899	1,078	467	829	716	2,188	2,626	467	995	2,098	1,381	1,151	336	1.9
4 Wat Loung	1.4	899	1,258	412	700	970	2,159	3,022	412	839	2,595	1,625	1,161	395	1.7
5 Wat Chre	1.6	899	1,438	424	600	1,262	2,133	3,412	424	717	3,119	1,857	1,161	451	1.5
6 Lum Hach	1.4	455	637	139	312	464	2,083	2,916	139	378	2,677	2,213	1,581	538	4.8
The Project	1.7	785	1,238	376	672	942	2,069	3,261	376	807	2,830	1,889	1,144	459	2.0

Table D 3.1 Details of Operation Indicators (With-Project Conditions)

Operation Indicator	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Total/Average
1 Irrigation Area							
Gravity	1,610	1,940	1,770	1,740	620	2,660	10,340
Pump	280	0	500	800	400	440	2,420
Sub-total	1,890	1,940	2,270	2,540	1,020	3,100	12,760
2 Cropping Season							
Early Wet	1,130	1,200	170	190	80	1,270	4,040
Wet	1,890	1,940	2,270	2,540	1,020	3,100	12,760
Sub-total	3,020	3,140	2,440	2,730	1,100	4,370	16,800
3 Cropping Intensity	160%	162%	107%	107%	108%	141%	132%
4 Number of FWUG	13	9	3	10	6	11	52

Prepared by JICA SAPROF Study Team

Table D 3.2 Details of Effect Indicators (With-Project Conditions)

Effect Indicator	Ream Kon	Por Canal	Damnak Ampil	Wat Loung	Wat Chre	Lum Hach	Total/Average
1 Yield (ton/ha)							
Early Wet	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Wet	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Average	3.2	3.2	3.3	3.3	3.3	3.2	3.2
2 Production (ton)							
Gravity	3,390	3,600	510	570	240	3,810	12,120
Pump	6,237	6,402	7,491	8,382	3,366	10,230	42,108
Sub-total	9,627	10,002	8,001	8,952	3,606	14,040	54,228
3 Annual Net Farm Income (Riel '000/ha)	1,940	1,980	2,188	2,159	2,133	2,083	2,069

Prepared by JICA SAPROF Study Team

Table D3.3 Net Farm Income for Ream Kon Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
Rice	2,220		1,872	3,020		5,858
Early Wet Season						
- Normal irrigation area				960	1,604	1,540
- Pump irrigation area				170	1,294	220
- Supplemental irrigation area						
- Pumping rainfed area	200	1,237	247			
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				960	2,172	2,085
- Pump irrigation area				170	1,857	316
- Supplemental irrigation area	25	1,338	34			
- Rainfed area	985	791	779			
Wet Season Direct Sowing						
- Normal irrigation area				650	2,279	1,481
- Pump irrigation area				110	1,964	216
- Supplemental irrigation area	25	1,356	34			
- Rainfed area	985	790	778			
Total	2,220		1,872	3,020		5,858
Net Farm Income (Riel '000/ha)			843			1,940

Prepared by JICA SAPROF Study Team

Table D3.4 Net Farm Income for Por Canal Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
Rice	2,480		2,199	3,140		6,218
Early Wet Season						
- Normal irrigation area				1,200	1,604	1,925
- Pump irrigation area						
- Supplemental irrigation area						
- Pumping rainfed area	410	1,237	507			
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				1,200	2,172	2,606
- Pump irrigation area						
- Supplemental irrigation area	50	1,338	67			
- Rainfed area	985	791	779			
Wet Season Direct Sowing						
- Normal irrigation area				740	2,279	1,687
- Pump irrigation area						
- Supplemental irrigation area	50	1,356	68			
- Rainfed area	985	790	778			
Total	2,480		2,199	3,140		6,218
Net Farm Income (Riel '000/ha)			887			1,980

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Table D3.5 Net Farm Income for Damnak Ampil Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
<u>Rice</u>	<u>2,430</u>		<u>2,185</u>	<u>2,440</u>		<u>5,339</u>
Early Wet Season						
- Normal irrigation area				130	1,604	209
- Pump irrigation area				40	1,294	52
- Supplemental irrigation area						
- Pumping rainfed area						
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				1,770	2,307	4,083
- Pump irrigation area				500	1,992	996
- Supplemental irrigation area						
- Rainfed area	2,430	899	2,185			
Total	2,430		2,185	2,440		5,339
Net Farm Income (Riel '000/ha)			899			2,188

Prepared by JICA SAPROF Study Team

Table D3.6 Net Farm Income for Wat Loung Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
<u>Rice</u>	<u>2,720</u>		<u>2,445</u>	<u>2,730</u>		<u>5,894</u>
Early Wet Season						
- Normal irrigation area				130	1,604	209
- Pump irrigation area				60	1,294	78
- Supplemental irrigation area						
- Pumping rainfed area						
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				1,740	2,307	4,014
- Pump irrigation area				800	1,992	1,594
- Supplemental irrigation area						
- Rainfed area	2,720	899	2,445			
Total	2,720		2,445	2,730		5,894
Net Farm Income (Riel '000/ha)			899			2,159

Prepared by JICA SAPROF Study Team

Table D3.7 Net Farm Income for Wat Chre Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
<u>Rice</u>	<u>1,090</u>		<u>980</u>	<u>1,100</u>		<u>2,346</u>
Early Wet Season						
- Normal irrigation area				50	1,604	80
- Pump irrigation area				30	1,294	39
- Supplemental irrigation area						
- Pumping rainfed area						
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				620	2,307	1,430
- Pump irrigation area				400	1,992	797
- Supplemental irrigation area						
- Rainfed area	1,090	899	980			
Total	1,090		980	1,100		2,346
Net Farm Income (Riel '000/ha)			899			2,133

Prepared by JICA SAPROF Study Team

Table D3.8 Net Farm Income for Lum Hach Sub-project

Crops	Present / Without Condition			With Project Condition		
	Planted	Net Production Value		Planted	Net Production Value	
	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)	Area (ha)	Per ha (Riel '000)	Total (Riel 'Million)
<u>Rice</u>	<u>3,320</u>		<u>1,511</u>	<u>4,370</u>		<u>9,101</u>
Early Wet Season						
- Normal irrigation area				1,090	1658	1,807
- Pump irrigation area				180	1343	242
- Supplemental irrigation area						
- Pumping rainfed area						
- Rainfed area						
Wet Season Transplanting						
- Normal irrigation area				2,660	2319	6,170
- Pump irrigation area				440	2004	882
- Supplemental irrigation area						
- Rainfed area	3,320	455	1,511			
Total	3,320		1,511	4,370		9,101
Net Farm Income (Riel '000/ha)			455			2,083

Prepared by JICA SAPROF Study Team