


Final Report

TA-9681 CAM: Integrated Water Resources Management Project (50266-001)

29 November 2024

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Project (50266-001)

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Document Details

This report describes the findings and outputs of the Integrated Water Resources Management (IWRM) Project. This project is commissioned by the Asian Development Bank (ADB) to a consortium led by NIRAS to support the Ministry of Water Resources and Meteorology (MOWRAM) in preparing a package of Water Resource Projects for Rapid Implementation. The IWRMP team works with the implementing agency in MOWRAM, under the Royal Government of Cambodia (RCG), and benefits from additional support provided by the Asian Infrastructure Investment Bank (AIIB) Project Preparation Special Fund (PPSF).

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Prepared by

NIRAS Consortium

Purpose

This document has been prepared as part of the project preparation and feasibility studies for the IWRM TRTA-9681 project under contract to the Asian Development Bank for the Ministry of Water Resources and Meteorology, Royal Government of Cambodia under the guidance of His Excellency Chann Sinath. NIRAS accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

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LIST OF ACRONYMS

ADB	Asian Development Bank
AFD	Agence Française de Développement
AEP	Annual exceedance probability
AIIB	Asian Infrastructure Investment Bank
AWD	Alternative Wet and Dry
AMSL	Above Mean Sea Level
AS	Apparent Specific Gravity
BC	Branch Canals
CAD	Computer Aided Design
CAISAR	Climate Adaptive Irrigation and Sustainable Agriculture for Resilience Project
CARDI	Cambodia Agriculture Research and Development Institute
CCCA	Cambodia Climate Change Alliance
CSU	Charles Sturt University
CVAA	Climate Vulnerability and Adaptation Assessment
DED	Detailed Engineering Design
DFAT	Department of Foreign Affairs and Trade (Australia)
DFR	Draft Final Report
DMF	Design and Monitoring Framework
DRR	Disaster Risk Reduction
EMP	Environmental Management Plan
FGD	Focus Group Discussion
FC	Field Capacity
FDRMMP	Flood and Drought Risk Management and Mitigation Project
FFEWS	Flood Forecasting And Early Warning System
FMA	Financial Management Assessment
FMR	Financial Management Risk
FMRA	Financial Management Risk Assessment
FWUC	Farmer water user community
GIS	Geographic Information System
GMC	General Main Canals
GWP	Global Water Partnership
IAIP	Irrigated Agriculture Improvement Project
ICID	International Committee on Irrigation and Drainage
IEE	Initial Environmental Examination
IOL	Inventory of Loss
IPCC	International Panel on Climate change
IS	Irrigation Scheme
ISWM	Irrigation and Social Water Management
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
JFPR	Japan fund for Prosperous and Resilient Asia and the Pacific
KR	Khmer Rouge/Pol Pot period 1975-1978
LC	Lateral canals
LIDAR	Light Detection and Ranging
MAFF	Ministry Of Agriculture, Forestry And Fisheries
MC	Main Canals
MCA	Multi-Criteria Analysis
MCM	Million Cubic Meters
MME	Ministry of Mines and Energy
MOE	Ministry of Environment

MOP	Ministry of Planning
MOWRAM	Ministry of Water Resources and Meteorology
MPWT	Ministry of Public Works and Transport
MRC	Mekong River Commission
NWISP	North-West Irrigation Sector Project
NWRDMC	National Water Resources Data Management Centre
PAM	Project Administration Manual
PDWRAMs	Provincial Department of Water Resources and Meteorology
PPRA	Project Procurement Risk Assessment
PPSF	Project Preparation Special Fund (AIIB)
PMU	Project Management Unit (MOWRAM)
PWP	Permanent Wilting Point
RBMC	River Basin Management Committee
RBG	River Basin Group
SC	Secondary Canal
TC	Tertiary Canal
TOR	Terms of Reference
TRTA	Transactional Technical Assistance
UIWRMSP	Upland Irrigation and Water Resources Management Project
USAID	United States Agency for International Development
USBR	United State Bureau of Reclamation
WAR	Water Allocation Rule
WRIS	Water Resource Information System
WRMSDP	Water Resources Management Sector Development Program
WAT4CAM	AFD/EU Supported Project in MOWRAM including adjacent blocks of Kanghot IS.

EXECUTIVE SUMMARY

1. The TRTA has completed technical, social and environmental studies to support preparation of a loan project to be implemented by the Asian Development Bank (ADB) and co-financed by the Asian Infrastructure Investment Bank (AIIB). The project will make Cambodia's water resource management more integrated, climate-adaptive, and sustainable in order to support social and economic growth and protect the overall ecosystem[1]. Its objectives are to:

(i) Strengthen planning, coordination, and climate change adaptation capacities of water resources management in the project area (Output 1);
(ii) Increase water supply capacity during the dry season (Output 2); and
(iii) Reduce flood risks during the wet season (Output 3).

2. The project focuses on the river basins of the Pursat, Svay Don Keo, Moung Russei and Sangker rivers located in Pursat and Battambang provinces to the southwest of the Tonle Sap Lake catchment. This river basin group was assessed by the ADB as one of the most vulnerable to climate change impacts. An integrated approach to water resource management (IWRM) takes in a holistic view of all water users including, for example fisheries and the environment as well as agriculture and the need of people and industry. Both excess/flood and water shortages are considered. The project proposes both construction work and soft measures in Pursat and Battambang Provinces to enable better management such as support to the work of River Basin Management Committees to a total estimated total cost of $198.18m to be financed from both grant and loan and Government contribution:

Fund Source	**Amount**	**%**
ADB Loan	83.69	42.2
ADB Grant	4.30	2.2
AIIB Loan	80.00	40.4
Government of Cambodia	30.19	15.2
Total	**198.18**	**100.0**

ADB = Asian Development Bank, AIIB = Asian Infrastructure Investment Bank

3. The works proposed include restoration of the Kbal Hong irrigation system, improvement of parts of the Kanghot Irrigation system, flood relief channel improvements for Svay Ath in Pursat and Ou Sralao in Battambang.

4. The schemes as a whole and indidually are found to be economically beneficial with strongly positive NPV at discount rate of 8% and EIRR between 11.3% and 51.4%.

5. The environment classification is confirmed as category B. An initial environmental examination (IEE) and accompanying environmental management plan (EMP) was produced for the entire project. Negative impacts mainly come from construction phase which is short term and localized with standard measures to control as specified in the EMP.

6. The project is classified as category A for involuntary resettlement (IR) impacts due to the requirement for land acquisition or resettlement where works are proposed along river banks and within the existing irrigation systems. The acquisition and resettlement is minimised in the feasibility level designs. Advanced works have a defined footprint and corridor of impact and therefore a basic resettlement plan (BRP) has been prepared for the impacts. There will be 24

[1] ADB (2022), Concept Paper for Proposed Loan and Grant and Administration of Loan Kingdom of Cambodia: Integrated Water Resources Management Project

affected households/ 169 affected persons will need to be physically relocated. The irrigation canal alignments for both IS subprojects are not identified and defined at the project preparation phase in accordance with the resettlement framework prepared.

7. A Gender Action Plan has been produced and the project monitoring framework (DMF) features performance indicators including gender. Within the two irrigation areas farmer water user groups will be created and capacity built to enable sustainable operation of the systems at tertiary level.

8. It is expected that the project will be implemented during the period 2025-2030 following ADB procedures and safeguards, monitoring and evaluation in close and open coordination with stakeholders.

9. The work of the TRTA is summarised in this final report with 30 supporting Appendices covering the work completed with ADB and AIIB support.

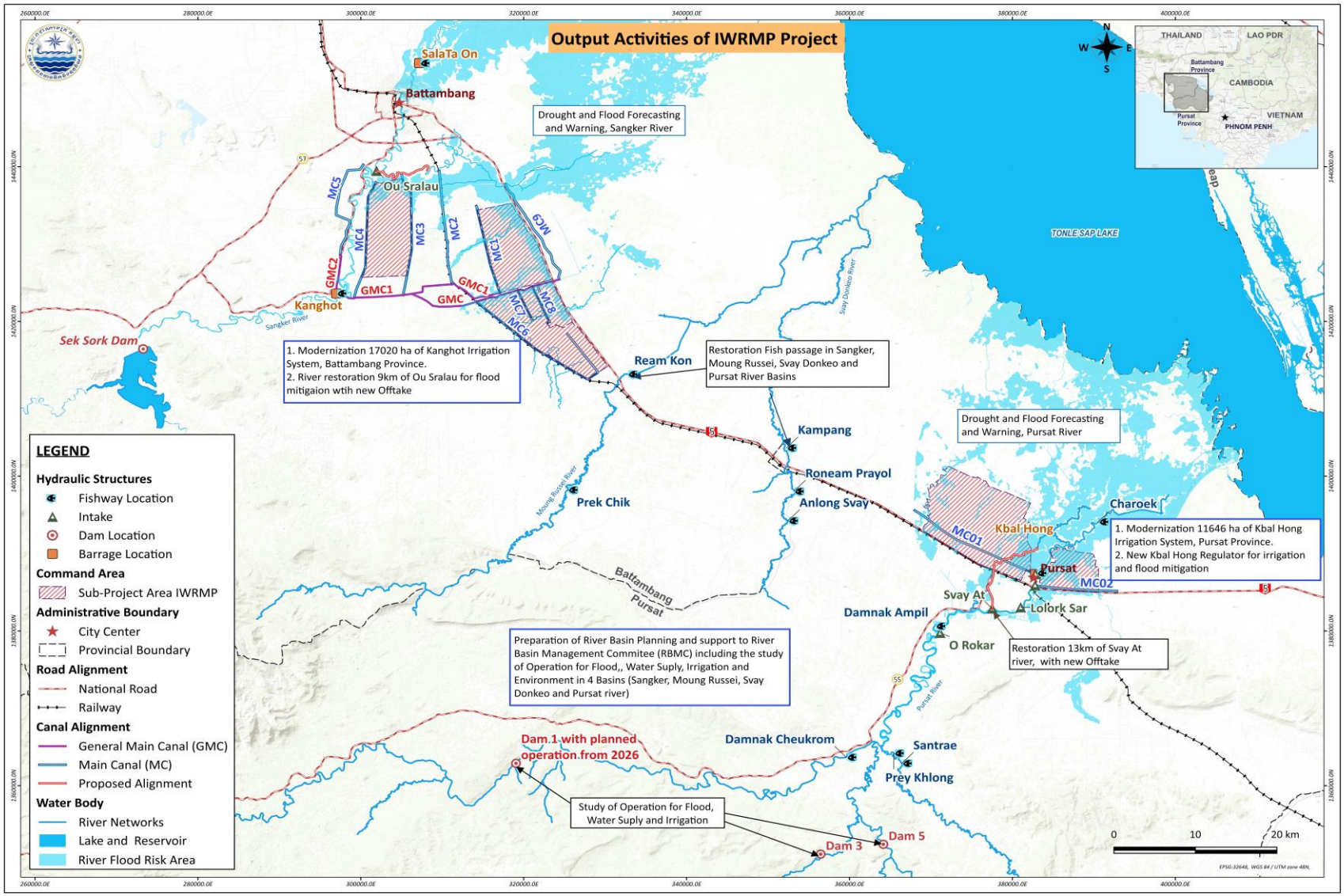


Figure 1 Summary of Output Activities of the IWRMP

I. INTRODUCTION

A. PROJECT OBJECTIVES AND DESCRIPTION

1. This transactional technical assistance (TRTA) commenced on 10 October 2022 to prepare a loan project for MOWRAM financed by the Asian Development Bank (ADB) with co-financing by the Asian Infrastructure Investment Bank (AIIB). The Integrated Water Resource Management Project (IWRM) will make Cambodia's water resource management more integrated, climate-adaptive and sustainable, support social and economic growth and protect the overall ecosystem[2]. Its objectives are to:

   (i) Strengthen planning, coordination, and climate change adaptation capacities of water resources management in the project area;
   (ii) Increase water supply capacity during the dry season; and
   (iii) Reduce flood risks during the wet season.

2. The Outcome of the project will be more climate and disaster resilient livelihoods in the target river basin group (Pursat and Battambang Provinces).

B. BACKGROUND

3. Cambodia's gross domestic product (GDP) grew at an average rate of 7.0% per year from 2000 to 2019. While the coronavirus disease (COVID-19) pandemic threatened the development gains achieved since 2000 with contracted economy by 3.1% in 2020 (footnote 2), it rebounded to 5.3% growth in 2022, 5.0% growth in 2023 and further growth of 5.8% in GDP projected for 2024, driven by industrial sector performance and tourism. The human development index for Cambodia improved from 0.42 in 2000 to 0.59 in 2019. However, many people remain vulnerable to poverty—about 17.8% of the population was living below the national poverty line in 2020.

4. Whilst Cambodia is urbanising rapidly, reaching 25% in 2022, rates are significantly below neighbouring countries such as Thailand which had the same urban proportion in 1980. The rural population have lower incomes and are more exposed to the extremes of climate including floods, drought and heatwaves.

5. The agriculture sector is still one of the engines of the country economy with the share of the sector in GDP of 23.7% in 2022 and 37.6% of the country's total employment in 2019. Agriculture is critical in recovery efforts, especially in rural areas and in response to deteriorating food security and nutrition faced by poor and vulnerable communities.

6. Cambodia's socioeconomic development is vulnerable to climate change. Cambodia is presently ranked 12th out of 181 countries in the Global Climate Risk Index in 2020. Cambodia is projected to experience warming of 3.1°C by the 2090s, against the baseline conditions over 1986–2005 under the highest emissions pathway. Increased incidence of extreme heat represents a major threat to human health in Cambodia, especially for outdoor laborers. Without action, the population exposed to an extreme river flood could grow by around 4 million by the 2040s. Climate change and human influences over the Mekong River's hydrological regime threaten to reduce the productivity of the Tonle Sap Lake and Cambodia's fisheries – a significant threat to the livelihoods and nourishment of many poor, rural communities. Projected climate change trends indicate more severe floods and droughts, which is expected to affect Cambodia's GDP by nearly 10% by 2050. Significant adaptation efforts are required to manage loss of yields due to the projected increases in the incidence of extreme heat during the growing season of staple crops.

[2] ADB (2022), Concept Paper for Proposed Loan and Grant and Administration of Loan Kingdom of Cambodia: Integrated Water Resources Management Project

7. Cambodia's updated nationally determined contribution (NDC) highlighted agriculture and water resources the most vulnerable to the climate change impacts. Under future climate conditions (2025 and 2050), most of Cambodia's agricultural areas will be exposed to higher risks of drought while losses in production were mainly due to flooding (about 62%) and drought (about 36%) in the past 20 years. Flooding due to (unseasonal) increases or decreases in water levels in the Mekong River and Tonle Sap Lake during wet season disrupts agricultural supply chains, both domestically and for international trade. Under the high emission scenario, wet season rice yield (rain-fed) is continuously expected to decrease until 2080 and could fall by up to 70% of current yield levels. Similarly, for the dry season, yields of irrigated rice planted in November and December could decrease by 40%. The negative impacts on agricultural production can lead to breakdown of food systems, and vulnerable groups risk further deterioration into food and nutrition crises if exposed to extreme climate events. The NDC also estimated the greenhouse gases (GHG) emissions in the country. In the business-as-usual scenario, overall GHG emissions in 2030 with the forestry and other land use are expected to increase to 155 million tCO2e/year, with the share of 17.5% and GHG emissions of 27.1 million tCO_2e in agriculture in 2030.

8. MOWRAM has the responsibility not only for irrigation but water resource management as a whole, including river flooding, and is also responsible for meteorology and forecasting.

9. The application of an integrated approach to water resources management, however, is still limited as although MOWRAM has a wide remit for water management, important aspects of IWRM (including climate change, disaster management, catchment and environmental protection, agriculture and fisheries, energy from hydropower, land use planning) are divided between different ministries which inevitably makes integration a challenge.

10. Whilst in the past, data availability and use has been poor in Cambodia, this is undergoing a sea change with the development of Information Systems to be deployed with the completion of the National Water Resources Data Centre in 2024.

C. WATER USE DEMAND AMONG WATER USERS

11. The use of water for domestic supplies and industry is increasing but still only a small fraction of the demand for irrigation and the environment. In a previous study of water resources[3], demand for potable water supply in the Pursat Basin was estimated as 7.5MCM/y whereas irrigation supply demands were 220MCM/y and the desirable environmental flow even higher. The total resource available from the Sangker Basin at Kanghot on average is around 1800MCM/y and the irrigation demand about 700MCM. Downstream irrigation, domestic supply and environmental `demands are estimated as 175MCM so there is excess flow per year. However, as flows typically follow the pattern of rainfall with 90% occurring in the wet season, without sufficient storage water runs to the lake and is not available for use in the basin.

12. A new storage in the upper basin of the Pursat at Veal Veng (Pursat 1) is being constructed for hydropower by a private operator under license due to begin operation in 2026. Releases from this large storage will change the flow regime in the Pursat river as the operator will prioritise dry season power generation thus increasing the amount available for use downstream. However even with this storage, there will be a need to efficiently use water to meet the high demands in the basin.

[3] FutureWater (2019), Rapid Assessment of the State of Water Resources for the Tonle Sap River Basin and Mekong Delta River Basin, Cambodia. Asian Development Bank TA-7610 CAM

13. In Battambang there is already a storage on the Sangker River at Sek Sork and there is a high priority improve irrigation efficiently as currently the low efficiency results in water shortages and limits the area of irrigation served.

14. Climate change simulations show clear impacts:

15. Water demand at field level depends highly on rainfall so when there are longer dry periods irrigation is essential to avoid crop losses.

16. Delayed onset of the rainy season requires more water at the beginning of the season if two wet season crops are planned.

17. Evaporative demands increase but only marginally

18. Flow in the river at critical times in dry season and early wet season are predicted to be lower.

D. FLOOD RISKS

19. Recent flood events in 2018, 2020, 2022 and 2023 have shown the two provinces have high flood risks. In the Pursat catchment in 2023 9200 people and 7200ha were affected. Within the lower Sangker floodplain of Battambang , it is estimated by the project that there are 224,000ha and 95,000 people at risk of flood at a 100 year return rising to 107,000 people by 2090 due to Climate Change. In Pursat there are similarly 65,000ha at risk of flood from the Pursat river. Details are in Appendix 17.

E. FINANCIAL AND TECHNICAL ASSISTANCE NEEDS AND MDB PARTNERSHIPS

20. The project investment loan modality is suitable as the project has a clear scope, tangible outputs, and cost estimates for works and services that are beneficial for stakeholders and national development in line with the agreed MOWRAM Strategic Plan and Road Map 2019-2033.

21. To sustain its rapid development and attain the government target of high middle income status by 2030 and high income by 2050, Cambodia needs to invest in its infrastructure and people. ADB supported Cambodia with $1.48b of loans and grants from 2021-23[4] and expects to provide increasing climate adaptation funding especially given the climate impacts already apparent.

F. STUDIES AND PROJECTS THAT INFORM THE TRTA

22. There are many projects of relevance for the Mekong and Tonle Sap System going back to the 1960s. Here we just highlight some of the main planning studies and then those that are local to the project area.

1. Regional Studies

23. Studies of note include the ADB KSTA 9634 Strengthening Integrated Flood Risk Management completed in 2022 which provides guidance in the probabilistic approach to flood risk management and was referred to in the economic analysis of this study. The Mekong River Commission produced a number of useful publications referred to ‘Guidance for Improving Irrigation Systems to Address Climate Change and Food Security’ 2022, TN18 Yield and Value of the Wild Fishery of Rice Fields in Battambang Province, Near the Tonle Sap Lake, Cambodia 2008, ‘Summary of the basin-wide assessments of climate change

[4] ADB Country Operations Plan 2021-2023

impacts on water and water related resources in the Lower Mekong Basin' 2017, Enhancement of Basin wide flood analysis under climate change for Impact Assessment and MASAP Preparation' 2019.

2. Tonle Sap and Mekong Basin

24. Many studies of Water Resources and specific projects are available, as well as relevant previous and ongoing studies. Some key examples are described below:

25. Irrigation Rehabilitation Study in Cambodia, Mekong Secretariat, Halcrow, June 1994 gives formulae for estimating flood and monthly flows in ungauged rivers.

26. Cambodia Water Resources Profile produced under ADB TA7610 (2014) gives comprehensive data for gauged and ungauged catchments.

27. Rapid Assessment of Water Resources and Hydroecology also produced under ADB TA7610 (2019) gives an assessment of water available and useable in the Tonle Sap and Mekong delta river basins.

28. GMS Flood and Drought Risk Management and Mitigation Project, funded by ADB strengthened disaster risk management at community level to raise the ability of vulnerable communities to cope with floods and droughts, and rehabilitated the Damnak Chheukrom irrigation system for supplementary irrigation to 16,000 hectares of net command area in Pursat province. The project also provided support to the development of a national flood forecast centre and pilot flood forecast system for Pursat. Unfortunately this has never functioned.

3. Water Resource Projects

29. Climate Adaptive Irrigation and Sustainable Agriculture for Resilience (CAISAR) funded by AIIB (ongoing) with IFAD and Green Climate Fund studies 3 Sub projects, one at Ou Tapoung will be restored and expanded to 13000ha. This study site connects with the Kbal Hong canal though supply is anticipated mainly through the Damnak Ampil system.

30. Climate-friendly Agribusiness Value Chains Sector Project (funded by ADB and due for completion in 2025) is being implemented in Kampong Cham, Kampot, Takeo and Tbuong Khmum provinces and includes some support for upgrading of irrigation systems as well as strengthening the capacity of the Farm Water User Communities (FWUCs) to manage the systems. There are ten irrigation subprojects that have been identified and are currently under survey and design whilst the plans for the formation of the FWUCs within these systems have been prepared and are under review.

31. Water Resources Management and Agricultural Transition for Cambodia (also referred to as Wat4Cam, funded by AFD/EU and due for completion in late 2023) includes support for rehabilitation and completion of parts of Kanghot close to the works of the IWRM project. The project also repaired many of the main structures and canals in Battambang which were overtopped and damaged by flood in 2020. The project also has a component for conveying weather information to farmers and to develop the water distribution plan for a Sangker RBC.

32. Project for Development of National Standard Design Documents for Irrigation and Drainage (funded by JICA to 2023-2026) will develop standard design documents for two types of facilities, namely headworks and open canals and related structures based on standard design criteria that are applied in Japan. This will have relevance to Output 2 of this TA. The standard design criteria and standard design manuals will be made for the general purpose of planning and designing work for small, medium and large scale irrigation systems.

These standard designs will be of direct relevance to the preparation of the DEDs for the proposed IWRM project.

33. Irrigated Agriculture Improvement Project (funded by ADB) that is now being implemented is designed to provide assistance to modernize and improve the climate and disaster resilience of four irrigation systems in Battambang, Kampong Cham, Kampong Thom and Takeo provinces to supply water to irrigate 43,500 ha, ensure the sustainability of these systems by strengthening the institutional and financial capacity of the government staff and the FWUCs in operation and maintenance, improve farming practices for increased agricultural productivity and crop diversification and establish the National Water Resources Data Management Centre (NWRDMC), a Water Resources Information System (WRIS), and an irrigation asset management system for better water resources management, planning, operation and investment that could potentially provide a source of additional real-time data to feed into river basin plans. This project has relevance to many of the tasks to be undertaken in this TA.

(i) CNMC/Hatfield 2013 Study Water Demand Analysis within the Pursat River Catchment Fostering Evidence-based IWRM in Stung Pursat Catchment. Applied models and analysis to study the potential effect of Pursat 1 dam and showed significantly increased water for irrigation in the dry season should be expected.
(ii) JICA 2016 Survey on Basic Information in Pursat River Basin Survey on Actual Condition of Facilities and Utilization of River Basin Water Resources and other feasibility studies around Pursat such as Wat Chre and Wat Luong.
(iii) JICA 2019 Preparatory survey for expansion of water supply systems in Pursat.
(iv) ADB 2021 Integrated Urban Environmental Management in the Tonle Sap Basin – Drainage and Wastewater treatment in Pursat and Battambang.
(v) Sino Hydro 2017 Pursat 1 Feasibility Study for Ministry of Energy and Mines[5]
(vi) IHE/ADB 2017 Water Accounting in Selected Asian River Basins: Pilot study in Cambodia–
(vii) People in Need Cambodia 2022 Flood Mitigation Recommendations for Battambang.

[5] Pursat-1 hydroelectric project feasibility study report. Ministry of Mines and Energy in 2017

II. PROJECT APPROACH AND METHODOLOGY

A. INTEGRATED WATER RESOURCES MANAGEMENT

1. Principles

34. The IWRM concept is wide ranging encompassing all aspects of the management of water, though the project focus of IWRM specifically relates to Agriculture and Natural Resources. The ADB support under TA-9681 encompasses river basin management in the Pursat and Sangker river basins, feasibility studies for support to agriculture through irrigation development in two subprojects at Kbal Hong and Kanghot and two further sub projects for flood management of Pursat and Sangker rivers basins. In addition, fish friendly measures such as fish ladders and improved dam operations will be implemented as well as measures for flood risk reduction. Under IWRM principles the development of irrigation and flood control will ensure that other water users including fisheries, the environment, potable water use, hydropower and water quality are considered in developments.

35. IWRM is based on the three principles:

(i) social equity,
(ii) economic efficiency and
(iii) environmental sustainability.

36. IWRM approaches involve applying knowledge from various disciplines with insights from diverse stakeholders to devise and implement efficient, equitable and sustainable solutions to water and development problems. As such, IWRM is a comprehensive, participatory planning and implementation tool for managing and developing water resources for all users. Balancing social and economic needs must ensure the protection of ecosystems.

2. Application of IWRM for the Project

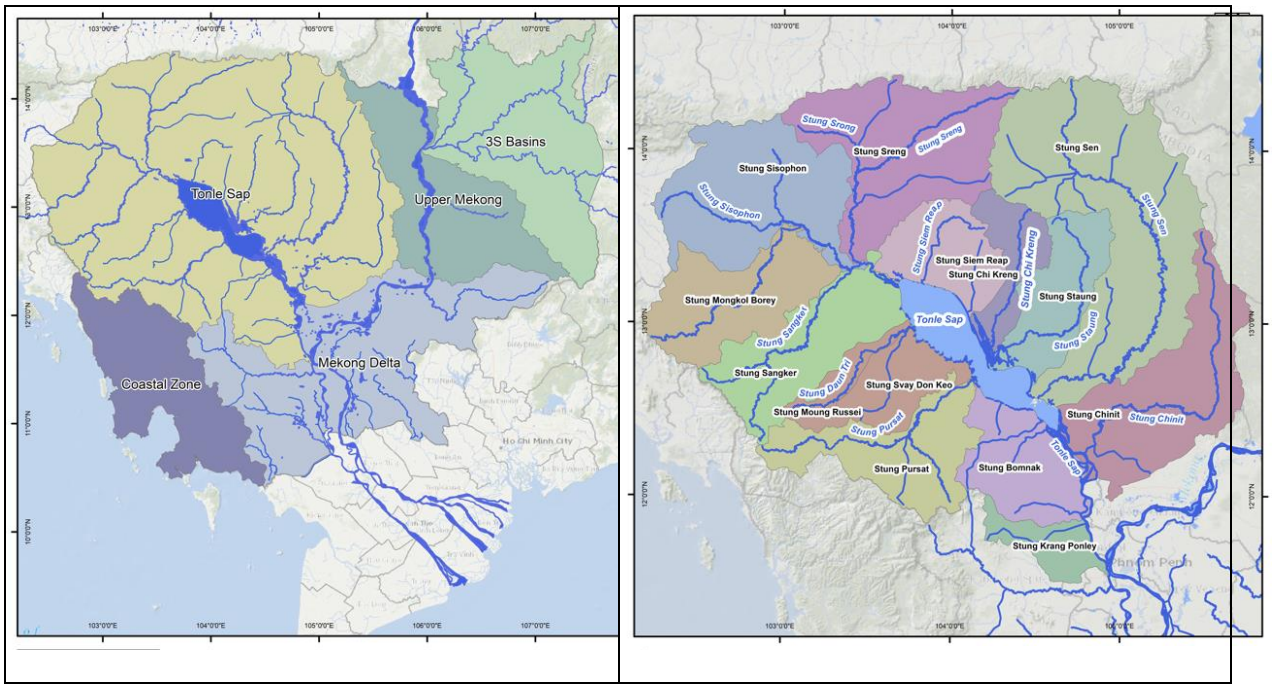
37. The approach adopted for the project formulation follows a logical progression of assessment of the issues and selection of potential subprojects in the priority support categories, collection of detailed data, feasibility level design and cost estimation, assessments and implementation arrangements.

38. In line with lessons learned from previous projects, this IWRM Project will target only two (2) Provinces, Battambang and Pursat but follow an integrated approach to ensure catchment based management principles and consideration of multiple uses is at the heart of the planning.

3. Water Resource of the Target Province Areas

39. MOWRAM divides Cambodia into five (5) River Basin Groups based on a physical grouping of catchments as show in Figure 2-1.

Figure II-1 5 River Basin Groups of Cambodia and River Catchments of Tonle Sap Group



40. About 90% of the land area of Cambodia lies in the catchment area of the Mekong, with an estimated average annual surface water volume of 473,000 million cubic meters (MCM) of which 134,000 MCM (about 30%) is from rainfall within Cambodia and the balance is inflows from upstream countries, namely Lao PDR, Thailand, Vietnam Highlands and China. The average annual outflow volume in the Mekong River to Viet Nam is estimated to be 437,000 MCM which represents 92% of the annual surface water volume. The annual water use in the country is estimated at 10,000 MCM which is only 2% of the annual surface water volume. However, about 90% of the annual rainfall in Cambodia occurs during the wet season, from May to November, and the dry season surface water use is 6,000 MCM and about 95% of this is used for agriculture.

41. Although Cambodia is well endowed with water resources, the availability of this water varies widely across the country and the Tonle Sap River Basin Group in particular is highly dependent on local rainfall. Availability of water in the river basin group during the dry season is very limited and severe water shortages are increasing in frequency. The Tonle Sap river basin group receives only 7% of the annual rainfall during the six-month dry season, which is the lowest of the five major river basin groups (RBGs). In the Tonle Sap River Basin Group dry season water demand is high with current water delivery meeting 30% and 70% of the agricultural and domestic annual demand respectively. The seasonal deficits scenarios are expected to become more severe and prolonged due to declining rainfall as well a projected increase in the number and severity of hotter days during the dry season that increase rates of crop evapotranspiration.

42. Water resource infrastructure for agriculture, domestic, and industrial uses, remains degraded and underdeveloped due to limited capital investment to upgrade the systems and inadequate funding for effective operation and maintenance. Most of the irrigation systems, constructed over 50 years ago, were poorly designed and are rice centric with no consideration for the rapid diversification of irrigated agriculture and the need for water control, or future climate change impact. These schemes operate inefficiently in terms of water distribution particularly during the dry season and the ability to manage water delivery in terms of timing and amounts.

43. With droughts occurring with increasing frequency and intensity, together with the inadequacy of water resource management it is foreseen that this situation will not only impact irrigation for agriculture but increasingly domestic water availability. This will result from increased difficulty in extracting water from rivers for water supply, water shortages in ponds and wells for rural water supplies and constraints on the migration of fish and other aquatic life. In contrast, the increasing intensity of storms during the wet season is resulting in flash flooding that is compounded by the lack of sufficient physical assets for flood risk management and limited flood protection capacity within reservoir systems, as well as the absence of effective early warning and preparedness systems.

44. Over the last decade significant flood events have occurred in most years affecting an estimated 0.5 million households and during the floods in 2020 an area of 330,000 ha of agricultural crops were damaged. Further impacts are being felt on the inland capture of fish and aquatic animals that for some households contribute up to 80% of their protein intake, whilst the Tonle Sap fisheries as whole provide for 60% of the protein intake of the entire population. An essential component of fisheries production in Cambodia is related to annual flood pulse of the Tonle Sap and any reduction in the volumes of water or measures that restrict access by aquatic life to flooded areas of tributaries could have a devastating impact on their life cycles of fish and their levels of productivity.

B. KEY RISKS IN PLANNING WATER RESOURCE DEVELOPMENTS

45. The context of irrigation and water resource development in Cambodia is unique based on the central role it has played in the history of the country and its people. Some of the risks associated with development of irrigation relate to this history.

46. The Khmer people have a very long history of water resource management and there is a legacy of previous development of reservoirs, canals, river diversions and floodplain storage spanning back over 1000 years to the Angkor period when water resource development was key to the success of that civilization. During the troubled period of the 1970s the emphasis in 1975-78 was to turn back from urbanization and to develop the productive capability of collective agriculture through extensive construction of irrigation systems.

47. With the advent of democratic government, rural people were assigned small plots of land and predominantly rainfed or flood recession agriculture recommenced where the canal systems were dysfunctional. However, yields were relatively low and the agricultural methods were labour intensive. In recent years the situation has been evolving rapidly towards higher input use with higher yields, development of irrigation and increasing mechanisation. Multiple cropping per year is increasing and in suitable locations crop diversification has increased although farmers find it difficult to compete with imports of vegetables and fruits from neighbouring countries which freely pass the borders.

48. Whilst Climate Change was previously viewed as something occurring in the future, farmers experiencing crop loss due to both flood and drought and even lack of flooding (for recession agriculture) see this as already occurring.

49. The rural system is thus carefully balanced and close to tipping point if crop loss occurs that a farmer may not be able to recover from.

50. There was a great loss of technical knowledge during the troubles of the 1970s so experienced personnel for planning or operating systems and the data available for planning such as good hydrological data is limited. Much of the existing irrigation is operated at village or commune level with limited input from the province once a scheme has been developed or rehabilitated. Advanced systems thus typically do not survive beyond the implementation of project.

1. Specific Risks and Approach to Their Management

Relevance and Ownership of the Project by Stakeholders

51. The social surveys and focus group discussion for baseline socioeconomic reporting and for the Land Inventory of Loss and Resettlement both indicated a strong need and support for the sub projects but also expressed strong views on the final layouts of canals that might be selected.

52. The approach to finalising layouts of channels is being set out in a open and consultative manner as set out in the Resettlement Framework already prepared while Basic and Detailed Resettlement plans cover all sub projects that will be prepared.

53. Final design layouts of canals will be closely consulted with landowners and stakeholders at detailed engineering design (DED) and implementation.

River Basin Committee and Improvements to Dam Operations

54. Active River Basin Committees are a necessary part of the management of water resources for all users and they should guide the Provincial Department of Water Resources and Meteorology (PDWRAM) in priorities and water management. One specific issue in both of the target river basins will be determining and agreeing reservoir operation procedures during floods. Clear information is to be provided by the project from studies carried out by the Project Management Implementation Consultant (PMIC). Continuing liaison with the Ministry of Energy will also be needed so that the private hydropower operator of Pursat 1 is also clear what is expected for the operation of spillway gates during a flood.

55. The operation of Sek Sork by PDWRAM in Battambang follows a guideline from the developer though it appears to result in overly cautious opening of the very large radial gates that can exacerbate floods rather than help attenuate them. This highlights the need to revise and update such rules following review and open access to records is required. Without development and acceptance of modified operating rules and potentially a new operating system, the flood risk reductions expected under Component 3 may not be realised.

Preparation of River Basin Plan and Agreement of Water Allocation and Sharing

56. There is an existing water allocation and basin plan for Pursat prepared under JICA in 2020 but this will need to be updated to account for changes in the Basin. This is planned under Component 1. There is a risk that developments in the Pursat basin are taking place very quickly (dams, upgrading irrigation systems under this and other projects) such that there is an urgency to update the plan. Data available is still limited so early and continuing support to the River Basin Management Committees (RBMCs) may be needed. For Sangker the preparation of a water distribution plan under the Wat4Cam project has taken time and there is a risk that this is not produced or is not agreed. The IWRM project may take a similar approach of making an early start on the process of preparing the Basin plan to reduce risks. Specifically including dam storage release and flood operation procedures, fish passage and response to climate change in the plan will distinguish from the earlier work.

Hydrometeorological Stations and Data

57. Previous automated hydrometeorological stations installed in Pursat have suffered problems of reliability and lack of ratings for flow measurement. The risks of this occurring again can be minimised by ensuring use of equipment that is proven to be reliable and possible for MOWRAM to maintain. Realistic budgets are set for equipment operation and maintenance and allowance for sufficient flow measurement to derive key ratings.

Operational Sustainability

58. The investment in water resource assets in Pursat and Battambang is high relative to the resource available in the PDWRAM to operate and maintain the system even with the FWUC managing the lower level system. The risks of the assets not yielding their full benefits will be addressed both in the Basin Plans and at the National Level within MOWRAM to provide more capacity building and systems to improve operations. The water monitoring, productivity and asset management systems being developed under the IAIP CS02 National Water Resources Data Centre (NWRDC) and Water resource information system (WRIS) play a key part in this.

Construction

59. During the construction period of the new regulator in the Pursat River partially constructed piers and aprons may be exposed to flooding. The proposed construction methods must adopt ways of working that ensure evacuation of the site where there are risks to personnel or plant. Risk may be mitigated through the use of a partial cofferdam and flood forecasting but the cofferdam may be below bank level to reduce impact on floods during construction. The filling of Pursat 1 dam could present an opportunity for working as flood flows may be utilised in the first filling of the reservoir storage and coordination with the Ministry of Energy and the operator should be continued.

60. Main canals exist and only minor works are needed in Kanghot, however the two main canals of Kbal Hong where they pass through informal settlements within the Pursat Urban area will experience changes in the flow regime as the canals readjust to their original function. This should not differ greatly to conditions prior to 2018 and water levels will be lower than during recent floods but good information provision will be needed.

61. Land and resettlement issues have been studied and consulted on supporting the Cambodia department of general resettlement (GDR) of the Ministry of Finance to produce a resettlement framework (RF) and Basic Resettlement Plan (for Advanced Works). These documents set out the mechanisms to be followed in accordance with the Government of Cambodia regulations which include grievance mechanisms and verification that may need to be taken account of when executing works.

New Secondary and Tertiary Canals

62. Tertiary canal construction and any access track included is for the benefit of the local farmers so a detailed consultation is needed to agree on alignments. The agreement may take time and if agreement is not reached then construction may not occur. This aspect is critical to the success of the project and formation of FWUC prior to this should be completed so that the FWUC may help the process and as part of the local stakeholder group arrive at suitable proposals. Consultations and analysis of sample areas of the two irrigation systems considering the outline design at feasibility, has highlighted how new secondary and tertiary canals will need to be adapted in consultation with stakeholders.

Farmer Water Groups

63. The formation of effective Farmer Water Groups is critical for the operation of the systems as proposed. Experience shows that an effective leader is a critical factor in the success of FWUC. There is clearly a risk that a suitable leader is not found and thus time must be allowed for the FWUC to establish and support provided for them to become effective and sustainable.

Agricultural Extension and adoption of Alternative Wet and Dry (AWD) techniques

64. To realise the full benefits of the improved water supply, as a primary constraint on agricultural production, agricultural development and extension is needed. Support for the introduction of alternative wet and dry (AWD) techniques will be provided for a pilot/demonstration area of 2,350ha supported by the Japan fund for prosperous and resilient Asia and the Pacific (JFPR) but also there is a need for agricultural support locally that is allowed for in the budget. At present the Ministry of Agriculture is not involved in the IWRM project (at their request) but clearly the extension work it would be hoped can be provided by the provincial department. The Inland Fisheries Department is already active working with MOWRAM on the fish pass issue.

Water Availability

65. It is key for the project that water estimated is available as planned. The risk that this does not occur is managed by completing comprehensive studies but there are still uncertainties from the data available. The monitoring proposed will thus be important to understand any shortage that does occur and together with the National Monitoring system deficiencies will need to be monitored and lessons learned for operating in the future.

66. A risk of low water supplies during the filling of Pursat 1 will require careful cooperation and monitoring.

Fisheries

67. The project is expected to have long term benefits for the wild fisheries by removing barriers to migration at a basin scale. Environmental impacts during construction such as silt disturbance and loss of bank habitat will be closely monitoring under the IEE. The removal of the existing Kbal Hong fishway will be scheduled to coincide with the operation of the new pass for the regulator as it is constructed.

Flood Forecasting and Warning Systems

68. The previous flood forecasting system developed as a pilot for the Pursat basin has not been operated since handover to MOWRAM flood centre. A more suitable system will be used and operated for 3 years so that MOWRAM or PDWRAM are fully capable to operate.

Flood Relief Channels

69. The development of offtakes and channels for relieving floods prevents a risk that floods move from one place to another and that if one part is completed (such as the offtake) before the conveyance channel then local flooding will be exacerbated. The risks of this will be minimised by scheduling when works are completed (or made operational) relative to completion of other parts.

Impact on Environment

70. As mentioned above the primary tool for reducing and managing risks of impact on the environment is use of an IEE and EMP as standard ADB safeguards. The selection of Sub Projects includes consideration of environmental impact so that risks are minimised.

Outside Influences including Operation of Upstream Dams and Flash flood or Drought Caused by Climate Change

71. The Basin planning for each catchment can ensure such risks are addressed and minimised.

C. INNOVATIVE APPROACHES

72. For this project we have carried out land, channel and social survey including using drone based data collection and Lidar. This extensive dataset has been used in modelling in 2D modelling of floods as well as reservoir operations modelling using well known software.

73. The existing land use in irrigation sub projects was studied closely and the existing cropping mapped in detail showing areas differentiating for example high and lower land that may be planted at different times, those areas where two or three crops are planted, and areas prone to flood which may be left fallow in some years.

74. The approach to flood risk analysis and economic analysis has followed the recommended approach of ADB KSTA 9634 and is the first applications of probability based risk calculation in Cambodia.

75. At the existing Sek Sork reservoir we obtained records of water levels and releases. We combined this data with a reservoir simulation model (HEC Ressim) and used the output to run a 2Dhydraulic model (HEC RAS 2D).

76. For minimising the impact of the main canal restoration on land acquisition and resettlement of informal houses along the canal we used survey and 1D models to assess low impact options of leaving the informal houses on stilts in place.

77. During the survey of fish passes we used drone based photogrammetry with the consultant whilst samples of fish passing existing structures were taken.

D. DATA GATHERING AND QUALITY CONTROL

78. The project was fortunate to have support from the AIIB PPSF fund for survey and specialist support. The implementation of the surveys was somewhat late in the TRTA program but extensive when finally available. The surveys carried out were:

(i) Socioeconomic Baseline and Gender
(ii) Rapid Topographic and Channel Survey
(iii) Full Lidar Survey of Irrigation Sub Projects
(iv) Inventory of Loss and resettlement (Under TRTA funding)

79. In addition three technical specialists were assigned to the project:

(i) Hydraulic Structures and Barrage Specialist (to complete an assessment of the regulator options
(ii) Fish Passage Specialist
(iii) Hydraulic Modelling Specialist

80. The TRTA team has been fully involved in providing Terms of Reference (ToR), supervising, working on site, and checking each deliverable of the company or sub consultant.

81. The TRTA team has also collected primary hydrological data for model set up and analysis and had several meetings with the provinces and other ministries to collect

information on current operations (Sek Sork dam in particular), and proposed infrastructure (Pursat 1 dam in particular).

E. METHODS AND MODELLING

82. The collection and analysis of data for the IWRM project has been extensive. These are described in the relevant Appendices attached. In particular state of the art 2D modelling techniques have been used to give a probabilistic approach and wide ranging analysis using GIS output to input to the economic and financial analysis.

F. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENTS

83. The main environmental impacts occur potentially on downstream areas due to changing water distribution, river levels or flood patterns. The Tonle Sap Lake in particular has sensitive areas and environmental designations. Sub projects should be chosen to minimise these potential effects and studies carried out to establish potential impacts following ADB guidelines for Environmental Examination and Management Planning.

G. SOCIAL, POVERTY AND GENDER

84. A social poverty and gender baseline survey has been carried out in the area of the sub projects in September 2023 and reported in October 2023 as attached in Appendix 25. A comprehensive survey of 600 households was carried out as well as focal group discussions and interviews with key informants.

85. Key highlights of the survey include high poverty rates in some locations and unstable incomes with shortages of food occurring one to three (1-3) months in the last three (3) years. Around 60% of Households in Battambang have experienced flood one to two (1-2) times in the last five (5) years and forty-four percent (44%) in Pursat. Similarly fifty-two percent (52%) in Battambang and thirty-eight percent (38%) in Pursat experienced severe water shortage. In Battambang women were more concerned about drinking supply in times of shortage whereas in Pursat they were most concerned about irrigation.

86. A summary poverty reduction and social strategy is attached in Appendix 4

H. TRTA PROJECT PREPARATION ACTIVITIES

87. To implement the TRTA and assist MOWRAM in preparing the design of the proposed project ADB engaged the services of a consortium led by NIRAS with Fraser Thomas, SCP and Maxima. The team mobilized in October 2022 and presented a draft Inception Report in December 2022, Draft Mid Term Report in May 2023, final Mid Term report in October 2023 and Draft Final Report in February 2024.

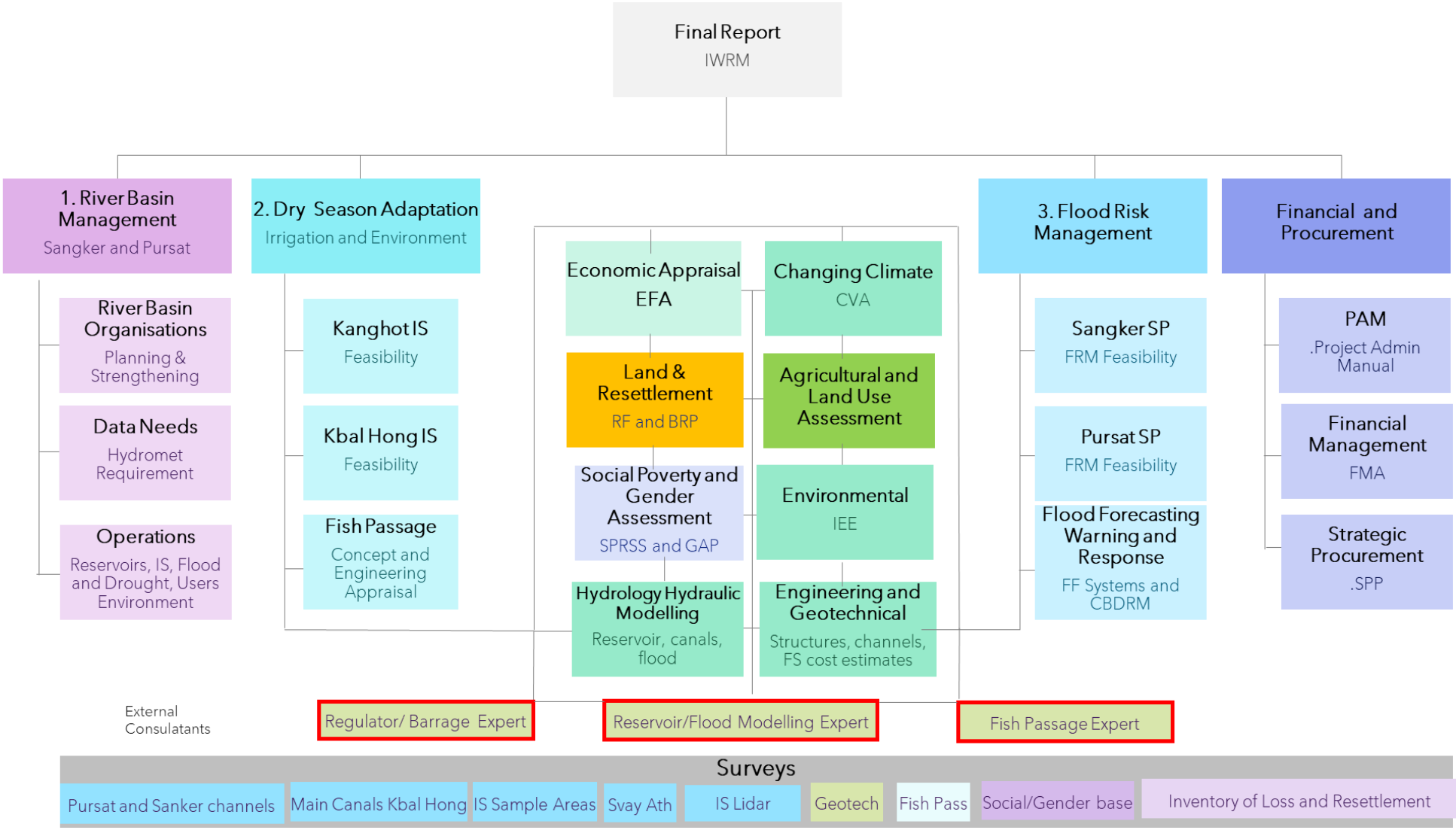
88. The project is supported by extensive surveys (topographic and bathymetric, social baseline, geotechnical and Inventory of Loss) together with three individual experts who support the sub project feasibility studies and project planning as summarised in Figure II-2.

89. The Surveys were commissioned later than originally anticipated due to delays in processing the PPSF funding and started at the end of June 2023 with completion in September or October 2023. This caused some delays in the formulation of feasibility studies especially for the flood component. The flood component makes use of extensive modelling and analysis that needed to wait for the survey data before modelling could begin. The appointment of three external experts for barrage design, hydrological and hydraulic modelling and fish passage conceptual design also began at a similar time as the surveys.

90. The first ADB Mission was held in January 2023 and the decision to choose specific sub projects for improvement of water supply (Component 2) at Kanghot (Battambang) and Kbal Hong (Pursat) was made and agreed with all parties. More information was needed to select the flood components although two possible sub projects (SP) were proposed by the PDWRAM. The approach to the siting of the Pursat regulator and initial recommendations made by the TRTA team had been raised as a concern by MOWRAM. The initial recommendation was reviewed and ADB appointed an independent expert to work with the NIRAS TRTA team on the issue intensively in June and July 2023 with initial reporting in September 2023.

91. The next review mission following the draft Mid Term Report was made 11-18 September 2023. The Sub Project selection for Component 3 flood risk reductions were discussed and agreed to focus on softer measures in Battambang and an assessment of Svay Ath diversion and alternatives in Pursat. Following field missions to Sangker and Pursat areas, the mission had concerns on land acquisition and resettlement both along the main canals in Pursat and for both sub projects concern on the impact of new secondary or tertiary canals that may be provided with farm tracks and thus require more land and potentially greater impact. Following discussion with the team and with the Cambodia Authority responsible for Land Acquisition and Resettlement, and a department of the Ministry of Finance (GDR) it was agreed that a Resettlement Framework would be prepared and a Basic Resettlement Plan covering the priority works at Pursat and a sample area of irrigation service area in both provinces. For these locations Inventory of Loss and Resettlement Survey was completed in November 2023 and reported in December 2023.

Figure II-3 Summary of TRTA Project Activities



III. PROJECT SCOPING

A. RATIONALE

92. The monsoonal climate of Cambodia gives it a relatively high annual rainfall (1500-1800mm typically per year) and is favoured with higher total water resource than most countries of the world. However, most of the rain falls in the wet season (90%) and tributary rivers such as those of the Tonle Sap may be in flood one month then with only small baseflows the next month if there is no further rain. The water of the Mekong and Tonle Sap Lake also follow a very strong flood pulse and dry season flows and, though still significant flow occurs in the mainstream Mekong sustained by the snowmelt of the Tibetan plateau and hydropower releases, water level is low level relative to the land of Cambodia throughout the dry season. The Tonle Sap Lake whose level closely follows that of the Mekong at Phnom Penh, contracts in the recession months of November – February and is difficult to access especially for the agricultural areas of the Tonle Sap basin. The changing climate has exacerbated the flood and drought characteristic and combined with temperature rise small holder rain fed agriculture is becoming more marginalised.

93. The ongoing construction of new storage for hydropower in the Pursat upper basin (Pursat 1) which is expected to be completed in 2026 gives an opportunity to increase the quantity and reliability of supply to famers in the Pursat basin where the irrigation infrastructure is in place. Similarly, in Battambang, the development of the Sek Sork storage and the main canals of a system for Kanghot if completed with secondary and tertiary canals and drainage offers an opportunity for improving supply to farmers and greater efficiency will allow more area to be supplied.

94. Cambodian society is still predominantly rural (75%) and the agricultural sector plays a key role in providing jobs, food security and the household income of smallholders. Of 2.6 million households in Cambodia it is estimated that 1.87m are still engaged in agriculture in some way.

95. Poverty rates have gone down with the development of the economy especially in urban parts around Phnom Penh such that the overall rate in Cambodia was estimated as 16.6% in 2022 but are relatively high in the rural areas where pockets of high poverty persist. The average poverty rate in project areas of Battambang and Pursat is twenty-six percent (26%) and twenty-eight percent (28%) respectively. In some rural villages rates as high as eighty-five to ninety percent (85-90%) occur.

B. OUTCOME

96. The project is aligned with the impact related to the well-being of the target beneficiaries.

97. The Outcome of the project is expected to be:

Project Outcome:

Livelihoods in the target river basin group (Pursat and Battambang Province) are made more climate and disaster resilient

98. Quantifiable performance indicators for assessing achievement of the outcome may be set in terms of farmer income, crop yields, irrigated crop/year as set out in the Design and Monitoring Framework (DMF) in Annex 2. Household income is expected to rise by at least

10% (Survey of Household incomes in 2023 was USD 3961/y in Battambang and USD 3317/y in Pursat. Indicators on crop yields and cropped area will also be included.

99. Focussing on this **Outcome**, the project addresses a number of operational priorities and Sustainable Development Goals as summarised:

Table III-1 Operational Priorities Related to Project

ADB Operational Priority	Description
OP1	Addressing remaining poverty and reducing inequalities
OP2	Accelerating progress in gender equality
OP3	Tackling Climate Change, building resilience and enhancing environmental sustainability
OP5	Promoting rural development and food security
OP6	Strengthening governance and institutional capacity
Sustainable Development Goal	1.5 (Poverty), 2.4 (Food Security), 5.5 (Gender), 6.5 (Water), 10.3 (Equity), 12.2 (Sustainable Consumption)

C. OUTPUTS

100. The outputs are of the project are divided into 3 Output Areas

Project Outputs

1) **Planning coordination and climate change adaptation capacity strengthened**
2) **Water Supply Capacity during dry periods increased**
3) **Flood Risks Reduced**

101. The first output concerns management of the river basin and for the project emphasis is being put on activities to improve the management of the Pursat and Battambang through development of the River Basin Committees that already are set up for each basin but do needs significant support and upgrading to meet the requirements of efficient management and adaptation to changing climate and development. The second and third outputs will be discussed in the next chapter.

102. For project the delivery of outputs a fourth category for management of the project is introduced.

D. ACTIVITIES

103. A list of activities related to the selected subprojects is given in the DMF. The project has elements of capacity building, community development and better governance balanced with physical engineering works for making water more available and managing floods. These works are described further in the next sections.

IV. SUBPROJECT IDENTIFICATION

A. IDENTIFICATION OF SUB PROJECTS COMPONENT 1 – RIVER BASIN MANAGEMENT

1. River Basin Plans and Support to River Basin Management Committees

104. The establishment of River Basin Management Committees (RBMCs) is considered to be an essential requirement to address the existing weaknesses in planning, coordination and climate change adaptation capacities. An important element of the TOR under Output 1 is to develop a strategy for establishing **effective river basin management committee**s, keeping in mind women's representation, and a mechanism that will enable them to develop and implement effective and climate-adaptive river basin management plans (RBMPs) that take account of identified climate change impacts, vulnerabilities and risks. Such plans should also include clear water allocation rules, procedures for multiple reservoir integrated operation and river flow management.

105. An RBMC was established in Pursat Province with JICA funding following the . It is reported by the Director of PDWRAM in Pursat that the RMBC is not operating effectively and needs support to strengthen the capacity of its members and its mode of operation. It was agreed during the inception mission that this should be the focus of this task of the TRTA.

106. In addition, the WAT4CAM Project (Component 3.2), funded by AFD/EU recently established an RBMC for the Sangker River Basin. The project completed in 2024 so it is timely for the IWRM project to build on the initial work.

107. The Svay Don Keo, which is primarily in Pursat Province is already included in the RBMC for Pursat prepared by the Japan International Cooperation Agency (JICA) and the TRTA would recommend similarly including the Moung Russei in the planning for Sangker River RBMC. Although River Plans should be catchment based, due to the local administrative arrangement of Provincial responsibilities it is more effective if the Basin Planning also respects provincial boundaries.

108. RBMCs are legitimized in Cambodia under Sub-Decree on River Basin Management (N°98-ank/bk), 24th July 2015. It was thus recommended that the term "implementation plan" should be used to describe the document that will be produced under Output 1 which will define the expected support to be provided. This can be included under the PMIC (recommended) or contracted to an external consultant or organisation. The issues are further discussed in Appendix 18.

2. Hydrometerological Upgrading and Flood Forecasting

109. The major issue with the hydromet equipment that has been installed in Pursat and Battambang catchments is that it has not been maintained and neither were the resources available to read the manual rain gauges and maintain records. As a consequence of six (6) automated weather stations installed by the Department of Meteorology zero were fully functional, similarly with the 17 manual rain gauges, none were fully working. The hydrology stations installed by the Department of Hydrology and river works covers 30 stations of which ten (10) are reported functioning. Only Bak Trakoun has a flow rating and that is 10 years old so needs a rerating. The status of different stations has recently improved and during the project implementation further investigation will be needed to finalise the list of requirements. It is clear that mostly the upgrading needed is for equipment at existing stations, operating budget and flow measurement for deriving rating curves.

110. The national centre for flood forecasting which will be based in MOWRAM's new data centre is the obvious place for flood forecasting on the Pursat and Sangker. The access to

real time data locally and simple warnings based on exceedance thresholds is required for the PDWRAM to better operate gates and flood channels and this is included in the proposed workd as further discussed in Appendix 16.

B. IDENTIFICATION OF SUB PROJECTS COMPONENT 2 IMPROVED AVAILABILITY OF WATER

111. Output 2 has the objective of enhancing agricultural productivity by improving the irrigation infrastructure and irrigation management practices in the project area. This must also consider social and environmental factors. Because of the importance of fisheries in and around Tonle Sap Lake, proposals for development must recognize “fish friendly irrigation” principles.

112. It was expected that “two or three investment packages with feasibility studies” should be prepared by the Consultant for Output 2. It was agreed during the inception phase that two sub-projects only will be the subject feasibility studies. Both will be irrigation development packages.

1. Selection of Irrigation Projects

113. For the irrigation investment packages, the process of selection will be as follows:

(i) Step 1: Submission of a “long list” of project sites with proposed interventions (MOWRAM with Battambang and Pursat provinces)
(ii) Step 2: Development of selection criteria (TRTA)
(iii) Step 3: Review, screening-out ineligible sub-projects and ranking possible eligible irrigation sub-projects, based on selection criteria (MOWRAM, AIIB, TRTA, ADB, Battambang and Pursat)
(iv) Step 4: Decision on the two projects to be subject to feasibility studies (ADB, MOWRAM, Battambang and Pursat)

114. For Step 1, the “long list” of irrigation projects to be included in Output 2 feasibility studies was identified with the assistance of MOWRAM’s Project Management Unit (PMU) and the PDWRAMs in Battambang and Pursat. These were visited by project team members during the two field missions undertaken during the inception period (see Section 1.6). They are listed in Table IV-1.

Table IV-1 Long List of Candidate Irrigation Projects for Component 2

Name of Sub-project	Overall Gross Command area	Irrigation Scheme Area (ha)		Area irrigated in one year	Cost estimate[1]
	ha	Wet	Dry	*ha*	*Million USD*
Pursat River Basin					
Charek Irrigation Scheme	13,000	13,000	3,500	13,000	8.45
Chheu Taok Irrigation Scheme	4,224	4,224	112	1,318	9.00
Damnak Chheukrom Irrigation Scheme	16,100	16,100	6,000	10,000	23.00
Kbal Hong Left Irrigation Scheme	29,000	7,000	1,200	7,000	30.00
Kbal Hong Right Irrigation Scheme	4,700	1,200	50	1,200	
O Rokar Irrigation Scheme	4,700	4,700	200	4,700	8.00
Sangker River Basin					
Kanghot MC1 Sub-project	6,200	-	500	1,000	12.00
O Troung Anderk Reservoir	24,400	3,750	-	3,750	13.00
Steung Kra Nhoung Reservoir IS (new scheme)	Unknown	Unknown	Unknown	Unknown	Unknown
Thvak Irrigation Scheme	27,636	27,636	-	-	50.00

115. In Step 2 selection criteria for potential irrigation sub-projects were used to screen infeasible candidates as shown in Table 4-3.

116. Cambodia's Prakas No. 021 PRK.BST dated 3 February 2020 on Environmental Impact Assessment Classification for Development Projects specifies the environmental classifications for various types of projects. These are shown in Table 4-2.

Table IV-2 Cambodian environmental classifications for various types of projects

No.	Type of project	EIA (equivalent to ADB A)	Initial EIA (IEIA) (equivalent to ADB B)	Contract environmental protection (equivalent to ADB A)
142	Irrigation /diversion systems		(≥ 5.000 ha)	< 5.000 ha)
144	Wetland and coastal areas	(All sizes)		
179	Road constructions	(> 100 km)	(≥ 30 - 100 km)	(10 - <30km)
180	Railroad and road expansion	(> 100 km)	(≥ 50 - 100 km)	(10 - <50 km)
181	Road construction in the protected areas	(> 30 km)	(≥ 10 - 30 km)	(<10 km)
182	Renovations to road widen in the nature protected areas	(> 50 km)	(≥ 10 - 50 km)	(<10 km)

117. In Step 3, all available studies and other secondary data are reviewed so that the irrigation sub-projects can be screened to produce a short list according to the agreed selection criteria. This process was followed leaving only 2 sites in Battambang and 3 possible

sites in Pursat. During the January 2023 mission, the **2 Sub Projects were selected given the data suggested and PDWRAM priorities. These are Kanghot in Battambang and Kbal Hong in Pursat, two of the larger schemes.**

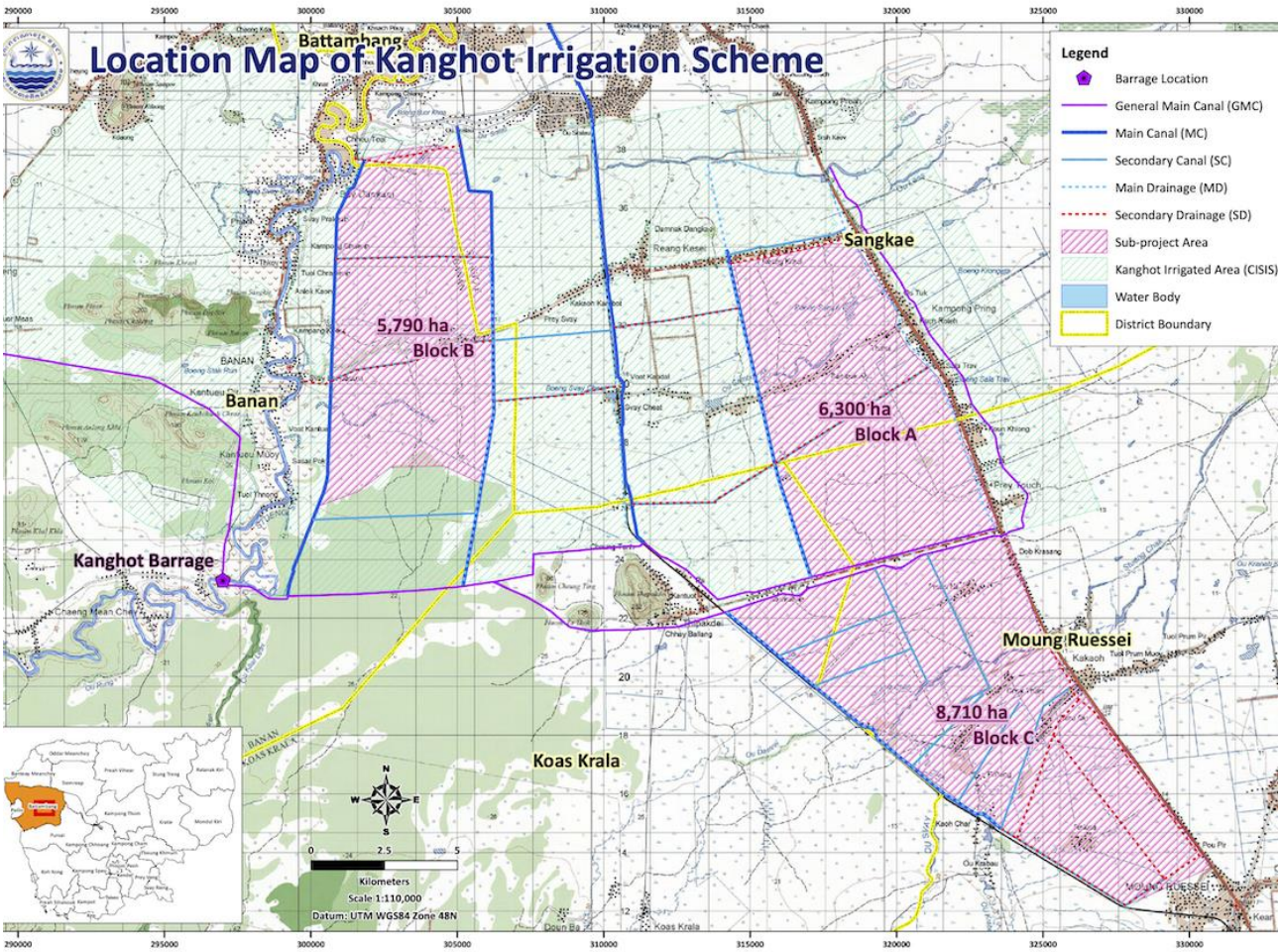
Table IV-3: Tentative screening of candidate sub-projects at Inception

Category	Criterion	Kbal Hong IS	Chheu Taok IS	O Rokar IS	Damnak Chheukrom IS	Charek IS	Kanghot MC1 Subproject	Thvak Dam IS	O Troung Anderk IS	Stung Kra Nhourng Subproject
Water	Expected available water resource in six years with future climate change impacts sufficient for additional irrigation	YES	YES	YES	YES	YES	YES	YES	YES	NO
	Scheme is located outside area with high risk of floods	PARTIALLY	YES	YES	YES	NO	YES	YES	YES	YES
	No negative impact to existing water use downstream	YES	YES	YES	YES	YES	YES	NO	YES	YES
Purpose	Irrigation scheme for both WS and DS crops	YES	YES	YES	YES	YES	YES	NO	NO	NO
	Command area 3,000 to 15,000 ha	15,000	4,224	4,700	16,100	13,000	6,200	27,636	24,400	Unknown
Cost / economics	Irrigation system at least partly functional for WS and DS at present	YES	YES	YES	YES	YES	YES	NO	YES	NO
	Gravity or mixed irrigation system	YES	YES	YES	YES	YES	YES	NO	YES	NO
Social / poverty	Located in Communes with poverty index (districts with poverty index) > project area average (21%)	21.2%	23.3%	21.5%	17.2%	23.3%	18.5%	28.7%	44.8%	45.0%
Environmental	Within ADB's category C-B	Catergory B	Catergory B	Catergory B	Catergory B	Catergory B	Catergory B	Catergory B	Catergory B	Doubtful
Other	Has the sub-project been previous funded by ADB?	NO	NO	NO	YES	NO	NO	NO	NO	NO

118. During the site visit in Battambang from 16 to 19 November 2022 and discussions with PDWRAM staff, the importance of developing the command area of main canal 1 (MC1) of Kanghot Irrigation system became evident. There is an opportunity to increase agricultural productivity of MC1 6,300 ha command area during the wet and in dry season by developing secondary and tertiary canals. The water resources in the Diversion Barrage can be increased by improving the operating procedures of the Sek Sork Reservoir.

119. During ADB inception mission, ADB, MOWRAM and the TRTA team expanded the proposal for the sub-project command area to be irrigated by MC1, MC4, and MC6 for the Kanghot IS. The total command area of 20,800ha is to be developed and modernize the secondary canals and tertiary canals within the associated structures in the irrigation scheme. This may increase irrigation efficiency and increase cropping to intensity twice per year. The layout of the sub-project is shown below.

Figure IV-1 Kanghot IS Area selected for Feasibility Study Component 2

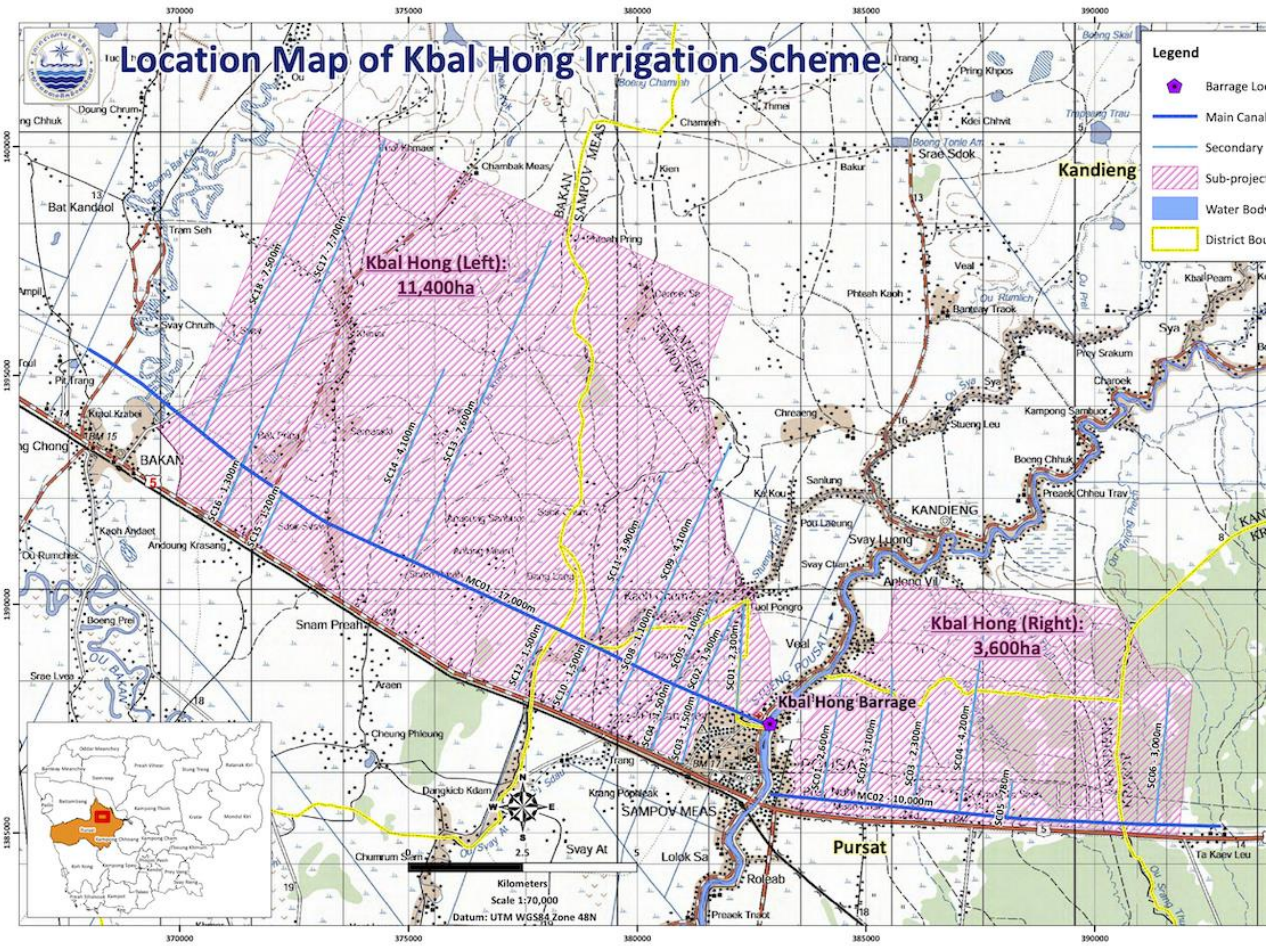


120. Presently, about 8,200ha is irrigated within the Kbal Hong command area during the wet season. The existing left- hand side command area is about 7,000ha and right-hand side command is about 1,200ha. The farmers cultivate rice twice in a year, in wet season about 8,200 ha and the dry season about 1,250 ha. The main canal left (MC1) is 34km in length and main canal right (MC2) is 14 km long. The scheme and irrigation canals are not yet rehabilitated and need to be modernized.

121. The layout of the proposed Kbal Hong sub-project is shown below and a total area of 15,000ha will be included in the Feasibility study.

122. A new regulator will be required as part of the Feasibility Study for the Kbal Hong IS.

Figure IV-2 Kbal Hong Irrigation areas for Feasibility Study Component 2



2. Fish Passage

123. From the previous study of the ecohydrology of the Tonle Sap River Basin group (ADB TA7610 2019), it was clear that migration of fish depends on a clear path from the Lake to the upper river and thus each blockage should be considered. Blockages to fish migration on the Sangker, Moung Russei and Svay Donkeo were thus identified and included in the ToR for the Fish Passage Expert to be recruited under the PPSF funding. Site visits were then made to each, including where some fish pass already existed and conceptual design or remedial measures proposed at each site.

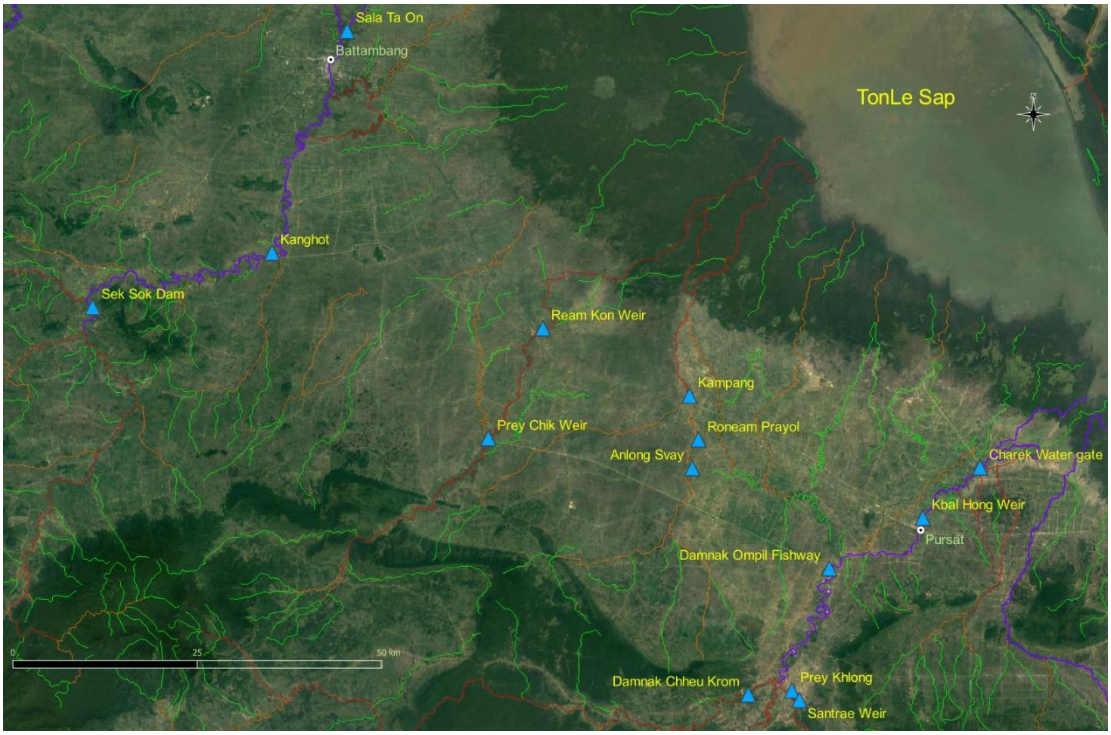
124. The Inland Fisheries Administration also provided their priorities for the area as shown in Table below. It is not known how they prioritised the seven sites but going forward with an assessment of all identified blockages was recommended as the best approach.

Figure IV-3 Priority Fish Passage sites provided by the Fisheries Administration Phnom Penh

Name of Structure	District	Coordinates Y	Coordinates X	Water levels (m) Downstream	Water levels (m) Upstream
Pursat River Basin					
Prey Klong	Phmon Kravanh	1364197	365433	23.67	25.42
Kampang Village	Bakan	1403650	352250	*	*
Anlong Svay	Bakan	1394060	352240	*	14.78
Srepopay Village	Phmon Kravanh	1362900	366700	*	33.71
Charoeuk Water Gate	Kandeang	1394100	390550	12.51	14.56
Sangker River Basin					
Kanghot	Banon	1423100	297500	*	*
Salata On	Sangke	1439520	307028	*	*

125. Figure 4-4 shows all 13 Fish Passage Barriers identified for the four main streams of Sangker, Moung Russei/Prek Chik Svay Donkeo, and Pursat River Basin. This includes barriers idenfied by the Fisheries Administration. The Sek Sork Dam is probably the most difficult to install due to height and dam safety considerations.

Figure IV-4 All 13 Fish Passage Barriers Identified for the four main streams of Sangker, Moung Russei/Prek Chik Svay Donkeo and Pursat River Basin



3. Drought Management

126. Drought tends to be a large scale slowly developing phenomena. There are numerous satellite based drought monitoring systems already available for the Mekong Basin such as that operated by Servir for the MRC and forecasting by the Meteorological department of MOWRAM. With the coming National Water Resource System, forecasting of

lack of rain is not within the sustainable capacity of the province and national or regional systems can be used supplemented by local monitoring of the river flows, reservoir storage

127. and local rain gauges. Such systems are already being studied by others so it is suggested that this aspect is included in the support to the RBMC of Component 1, rather than developed into a specific sub project.

C. IDENTIFICATION OF SUB PROJECTS COMPONENT 3, FLOOD RISK MANAGEMENT

1. Integrated Approach for Flood Risk Management

128. The management of floods has advanced significantly in recent years and the whole cycle of risk management is advocated. This includes hard and soft measures and recognises that flood risk can be managed but not eliminated. The ADB has produced two guides recently including the practical guide to flood risk management which summaries the range of measures of the whole flood risk problem.

Figure IV-5 Key Flood Management Cycle Components (Reference ADB Practical Guide To Integrated Flood Risk Management (IFRM) 2022)

129. The project mitigation actions form an important part of the cycle under the responsibility of MOWRAM but the IWRM Project will also strengthen other components of the management of risk including:

(i) Risk Identification and Analysis (Flood Modelling and Analysis)
(ii) Landuse planning – through the RBMC
(iii) Capacity Building for flood (Including with the FWUC)
(iv) Emergency Planning (Development of Community Based Flood Risk Plans
(v) Flood Forecasting
(vi) Improvements of information supplied to NCDM for flood warning and response

2. Physical Works for Flood Reduction

130. The nature of flooding differs from the irrigation projects in that flooding can be extensive and come from different sources so a first step is to identify where assets and people are at risk and select possible options. Recent floods in both Battambang and Pursat clearly show that the two more urban parts have the most flood risk and there these rivers were selected for the flood risk studies.

131. The first step in selection was then to carry out surveys of the river channel and gather hydrological data for extreme flood calculation for the Sangker and Pursat Rivers.

132. A number of suggested Sub Project components suggested by the PDWRAMs and the TRTA team at Inception were then screened for potential as given in Table 4-4.

133. An initial screening of potential physical works quickly eliminates the impractical concepts or those already under the responsibility of other government departments leaving Battambang for further study:

(i) Operation of Sek Sork Reservoir for flood attenuation (f)
(ii) Ou Sralau (k)
(iii) Minor Works such as critical banks or spill locations not yet identified

134. For Pursat

(i) Reservoir Operation for flood attenuation including Pursat 1
(ii) Improvement of Svay Ath a a Flood Relief Channel
(iii) Minor works such a critical banks or spill locations not yet identified

3. Soft Measures for Output 3

135. The soft components for Output 3 are critical for a successful outcome but are closely linked to the work of Output 1 and Output 2 especially in terms of the support for the PDWRAM and development of reservoir operation procedures for flood attenuation. Much of the risk management cycle falls naturally in Output 1 but for output 3 we explicitly include:

(i) Community Based Disaster Risk Management (including Gender Sensitive Response)
(ii) Flood Forecast Improvements
(iii) Development of Reservoir Operation Improvements including capacity building
(iv) Provision of Flood Mapping knowledge products

Table IV-4 Screening Options for Output 3

Name of project	Purpose of scheme	Proposed intervention	Cost ($m)	Study Exist	PDWRAM priority?	Comment
Pursat						
a. Svay Ath Drainage Canal	Enhance Spill of flood flows from the Pursat River to an old river course.	New offtake and Rehabilitate old channel of about 37.5km	16m	No	High	Capacity needs to be high to have effect. Some spill already occurs
b. Damnak Chheukrom IS link canal for flood mitigation	Convey flood water from the Pursat River to the Svay Don Keo River	Spill of existing canal to the Svay Don Keo River.		Yes	Low	Low Capacity of Canal likely no benefit in Pursat
c.Raise banks of Pursat River	Flood protection	Raise the banks to consistent level in Pursat	Include in Provincial works	No	Province is enhancing river banks	0.5m- 1m without major works
d. Charek Barrage	Operate to reduce backwater	Improve operation in flood	low	No	N/A	Can readily be assessed
e. Pursat 1 Flood Storage 1	Operate Reservoirs for flood storage esp Pursat 1	Agree operating procedures for relieving flood in Pursat	Low	No	N/A	Private operator of Reservoir but MME positive can be agreed
Battambang						
f. Sek Sork Flood Storage	Utilise **Sek Sork** Storage as given in feasibility	Update operating procedures and survey reservoir	0.05	Part	High	The dam was developed for this function but operating rules provided to PDWRAM problematic
g. Kanghot	Divert flow in irrigation canals	Enhance flow in canals during flood	N/A	Flood Emergency Repair under Wat4Cam	No	$5m damage from flood in irrigation canals in 2020 indicates risky solution
h.Flood protection works for Battambang	Mitigate the impacts of river and overland flooding in Battambang town	Various works, including flood levees outfalls to the Sangker River. Pou Thy Vong as diversion	Unknown	Yes	No	Works being carried out under Province/MPWT PTV stream 50% complete as a drainage channel not river flood.
jRehabilitation of Stung Chas (old Sangker watercourse)	Divert water from Sangker River during flood	Dredging and improving the flow capacity of Stung Chas	Unknown	No	Yes	Site visit indicates channel is now in urban part and would have many LAR issues
k. Ou Sralau	Similar to Stung Chas	Improve connection and conveyance of existing channel			High	Site visit indicates many bridges along channel but some potential

V. DESIGN CRITERIA

A. OVERVIEW

136. The purpose of the TRTA is to prepare a loan project with a number of coherent packages that achieve the desired outcome of helping the people of the target provinces of Battambang and Pursat to become more resilient to the shocks and impacts of climate change as related to water. The packages suggested must be integrated and they must be adapted to the local social and physical environment. The terms of reference for the consultant sets further constraints and desirable features of proposed packages and the various safeguards and procedures that must be adhered to under ADB and AIIB.

137. Cambodia has national procedures that must be adhered. These are mostly concerned with project implementation in the field of procurement, environmental standards and social protections and there is little guidance for physical design criteria. For design of works often international standards are followed or normal practices are adopted from other countries that the consultants are familiar with.

138. The standards for financial management and procurement are discussed in later sections and more detail is given in the Project Administration Manual (PAM).

B. PRINCIPLES OF IWRM

139. General principles, approaches and guidelines relevant to IWRM are numerous, but the Dublin principles are particularly useful. They were carefully formulated through an international consultative process culminating in the Conference on Water and the Environment in Dublin, held in 1992[6]. The principles are:

(i) Water as a finite and vulnerable resource:

- (a) Fresh water is a finite resource and the available quantity cannot be increased significantly by human actions.
- (b) Water availability can be decreased by poor management and therefore water is vulnerable to deterioration by human activity.
- (c) Freshwater may be regarded as a natural capital asset that needs to be maintained to ensure that the desired services it provides can be sustained.
- (d) Water is required for many different purposes, and the value or welfare derived from the water resource assets will vary with the use to which they are put.
- (e) There is a need for a holistic approach to water resource management, recognizing all the characteristics of the hydrologic cycle, and its interaction with other natural resources and ecosystems.

(ii) Participatory approach

- (a) Everybody needs water and so water is a subject in which everyone is a stakeholder.
- (b) Real participation only takes place when stakeholders are part of the decision-making process.
- (c) This can occur directly when local communities are involved in making water management choices.

[6] See, for instance: http://protosh2o.act.be/VIRTUELE_BIB/Werken_in_het_Water/IWB-Integraal_WaterBeheer/W_IWB_E23_Dublin_principles.pdf

(d) Participation also occurs if elected spokespersons can represent stakeholder groups.
(e) It can also occur through market processes, if appropriate pricing systems are in place, then stakeholders (or stakeholder groups) can signal their demands for water services.

(iii) The important role of women

(a) Women play a key role in the collection and safeguarding of water for domestic and agricultural use.
(b) But they generally have a less representation than men in management, problem analysis and decision making with respect to water.
(c) Because social and cultural circumstances vary from country to country, different mechanisms for increasing women's participation in decision making may be appropriate.
(d) There is a need to ensure that the water sector, as a whole, is aware of gender issues and that steps are taken to widen the range of activities through which women can participate in IWRM.

(iv) Water as an economic good

(a) Water has a value as an economic good.
(b) Many past failures in water resource management can be attributed to the fact that water is seen as a free good.
(c) When there is competition for water, this often leads to water being allocated to low value activities.
(d) Without pricing, there is no incentive to treat water as a limited asset.
(e) If water has a value, then the recovery of the full cost of supplying the water should be the goal (unless there are compelling reason not to do so – e.g., for social objectives).
(f) Economic pricing helps to ensure that demand is minimized and the water supply infrastructure can be properly maintained.

140. There are numerous other IWRM principles that have been defined and could be included here, but they largely just elaborate on the ones above.

141. Since 1992 the threat and impact of a changing climate has not negated these principles but is a strong factor that must be taken into account. The role of disaster and flood management should also be part of the Integrated approach.

4. Criteria from IWRM Project Terms of Reference

142. The terms of reference do not provide many specification or design criteria but set out some principles to be followed:

Output 1

143. The project should 'help' provinces establish effective river basin management committees. The principle is thus of support and improvement rather than remote provision of reports. A consultative approach is needed to get the provincial RBMC into an 'effective' and sustainable RBMC. Lessons from elsewhere on how to practically implement a 'climate adaptive' approach to planning need to be drawn upon.

144. Experience elsewhere and in other basins concerning River Basin Planning need to be taken account of as well as using national resources including the MRC planning processes for Basin development and other national examples.

145. Other ministries apart from MOWRAM need to be consulted and informed. The project steering committee has members from each relevant ministry so may be used for such purposes. The provincial departments especially the PDWRAM and PCDM must be included.

146. Other organizations that will need to be engaged in this project for its successful completion include:

(i) Ministry of Mines and Energy (MME)
(ii) Ministry of Environment (MOE) (Including PCDM)
(iii) National River Basin Management Committee (NRBMC)
(iv) Cambodia Climate Change Alliance (CCCA)
(v) Ministry of Agriculture Forestry and Fisheries (MAFF)

147. At commencement the Ministry of Agriculture, Forestry and Fisheries (MAFF) advised ADB that they will not be involved in the IWRM TRTA Project. Nevertheless the Fisheries Administration was fully engaged in connection with Fish Passage and for implementation stage, agricultural extension should naturally involve the relevant ministry.

148. Principes of Consultation and open access via the National Water Resources Data Centre Water Resource Information System should be followed.

C. OUTPUT 2 WATER AVAILABILITY

149. Physical Design Criteria for irrigation and water resource development are being derived for MOWRAM in a project supported by JICA. At feasibility for the TRTA typical standards of canal design sizing were used (using peak estimated flow demands and 80% reliable rainfall) and for the outline design of the new Pursat Regulator Japanese standards were used.

150. Geotechnical testing and analysis follows national standards and is described in Appendix 20 and 23.

151. Impact on downstream users within Cambodia as well as the International Waters of the Tonle Sap and Mekong will meet the requirements of the Mekong 1995 Agreement for equitable use including notification.

152. Priority in water availability will be given to drinking supply first, the irrigation and environmental flows including release through a fish pass.

153. For the formation of farmer groups standard protocols will be followed as outlined in feasibility studies Appendices 11 and 12.

154. Environmental Standards followed are outlined in the IEE (Appendix 6). Water quality tests for the discharge of Pursat WWTP into the Kbal Hong canal show no issues apart from the Total Phosphorus during the rainy season even though the waste water treatment plant (WWTP) was not fully functioning. In the dry season it may be expected that the water quality will decline if the works is still not functioning.

155. ADB Safeguards for Social Impact will be applied and impacts will minimised during detailed design particularly for smaller canals which will be finalised in close consultation with landowners and FWUC.

156. Resettlement processes and criteria are set out in the PAM and summarised in the relevant section below.

157. Fish passage guidance is provided by the Fisheries Expert appointed under the PPSF fund and it is noted that several practical criteria are outlined for fish migrating upstream and that consideration for fish passage downstream would heavily favour normal overtopping gates and not partially opening the large sluices. Downstream of the regulator gates a plunge pool of sufficient depth and without the baffles of standard USBR stilling basins is recommended. The fish pass should be designed for all types and size of fish that migrate from the Tonle Sap Lake and should account for the range of levels upstream and down.

158. The future need of the system for supply to fields using the AWD techniques should be considered and trials conducted to determine suitable features required.

159. Pumping systems such as that proposed for the MC2 at Kbal Hong should consider the running costs and carbon footprint and where possible all supplies should aim at gravity flows and where not possible then solar based pumping systems should be considered.

160. Within the irrigation systems, unlined channels for the most part will be constructed, and advantage should be taken to connect to small ponds and lakes to encourage rice field fisheries.

D. OUTPUT 3 DESIGN CRITERIA FOR THE FLOOD RISK MITIGATION SYSTEMS

161. The situation for flood risk management design mirrors that of Component 2 in that few technical standards are available. In Cambodia there is not a standard for flood protection (such as 1 in 20 year) so each case is examined on its merit.

162. The ToR encourages use of natural solutions or NBS for flood management measures. Where possible then the river banks should maintain natural vegetation reinforced with concrete blocks or geotextile in areas of high turbulence.

163. The flood passage across the natural floodplain including areas of irrigation system is eased by use of siphons for the canal at larger crossings and or with suitable inlet and outlet bypasses. Blocking of drainage lines by canals is avoided and in DED further enhancements of the flood passage and drainage system may be made.

VI. OUTPUT DEVELOPMENT

A. OUTPUT 1 STRENGTHENING THE RIVER BASIN MANAGEMENT

164. Within the Pursat and Sangker River Basins pressure on the water resources and flood management is increasing and changes in climate and infrastructure are not currently reflected in any River Basin Planning. The formation of multi sector River Basin Management Committees (RBMC) is already mandated under Cambodian Law and Committees are in place in Pursat and in the process of formation in Battambang. The provincial department of MOWRAM in each province has the lead responsibility to manage water resource and support the RBMC. It is proposed that the IWRM project provides support to create comprehensive forward looking River Basin Plans including climate change, environment and multiple use focussed on strategic planning for flood and drought. The Basin Plans for Sangker and Pursat will be prepared by the PMIC consultant with the PDWRAM, consulted and agreed at the RBMC and presented to stakeholders. Strengthening the capacity of the PDWRAM to support the work of RBMC is thus the core part of this output.

165. The Moung Russei falls in Battambang Province so could either be studied as a separate Planning document and RBMC or combined with the Sangker. The latter is the preferred option as the more efficient for consideration by a single Provincial RBMC. Similarly, the Svay Donkeo River Basin is closely linked to the Pursat and the major canals link between the two basins so a combined River Basin Plan is recommended. The existing RBMC and Water Allocation plan already follow this modality. For Battambang, the Mongkul Borei basin which borders the Sangker is largely separate and is a transboundary river with Thailand so a separate basin plan is justified. Work for that is also already progressing by the National Mekong Committee within MOWRAM jointly with the Thai side.

166. Other aspects of this Component include the strengthening of data available to all users including improvement of hydrometeorological collection and availability, Community Based Disaster Risk planning, Gender Action, flood and drought mapping and improvements in operational capacity working with other National Initiatives such as the National water resource information system and asset management.

167. Analysis of the water resource without support from storages in the catchments and the operation of dams for attenuating floods is critically important to the IWRM project Components 2 and 3. The best way to assure this operation occurs in practise is through the proposed Component 1 programme of work.

B. OUTPUT 2 IMPROVING WATER AVAILABILITY IN A CHANGING CLIMATE

168. Analysis has shown that a more erratic pattern of rainfall has a significant impact on water demands at field level and that irrigation supplies can effectively mitigate against the impacts. Under the current climate and infrastructure condition by use of rainfall and supplementary pumping from drains and canals famers in Battambang already cultivate 2 crops per year and a small dry season area with a cropping intensity 210% but expenses are high and yields are low. In Kbal Hong the irrigation system scarcely functions and only one wet season crop is grown. Both areas are thus vulnerable to climate change particularly changes towards more erratic patterns of rainfall. Both systems also suffer from lack of smaller canals to distribute water away from the main and secondary canals. This results in low efficiency of water use, conflict and water scarcity.

169. Under this Output, the project will restore and modernize two irrigation systems (three blocks of Kanghot in Battambang and the Kbal Hong Irrigation System in Pursat) to ensure more efficient irrigation service for a Gross Area of 33,340 ha and nett irrigated area of 28,666 ha.

170. In Battambang, three (3) existing Farmer Water User Groups will be strengthened and in Pursat, four (4) new FWUC will be created and capacity built. Female participation in all FWUC activities will be strongly encouraged. All FWUC will be supported with capacity building during the first years of establishment. For Kbal Hong one FWUC-APEX is proposed to represent all farmers of the whole irrigation area to facilitate internal coordination and coordination with the PDWRAM operations.

171. The project will (i) construct a new gated structure across the Pursat River replacing the old Kbal Hong regulator in Pursat town that was removed in 2018, ii) improve existing main canals, intakes and a pump station, (iii) secondary, tertiary canals and drains will be built or improved where they already exist. It will be possible to supply the majority of the area by gravity which will save the farmers significant expense in pumping and reduce GHG emissions.

172. Where major creeks pass across the canal either siphons or inlet/outlet structures will be provided to avoid damages during flood.

173. Access roads along canals will be provided with a laterite surface and set at levels resilient to climate change. Bridges at cross regulators and siphon crossings will be provided to ensure adequate access to the agricultural areas for mechanised farm practises.

174. Access tracks for farm machinery may be provided where requested by farmers along tertiary canals.

Kanghot Sub Project

175. This subproject in Battambang Province is focused on three blocks totalling 19,775 ha gross area and 17,020ha irrigated area out of the full design area of Kanghot IS of 47,000 ha. The subproject will serve 45 Villages with 8465 Households and population around 37,171. The upgrading will involve the following activities:

(i) Strengthening and capacity building of three (3) FWUC.
(ii) Minor Upgrading and repair of five (5) existing lined main canals and associated structures totalling 60.1km
(iii) Upgrading of 27 existing Secondary Canals totalling 118km and nine (9) new secondary canals totalling 50.4km.
(iv) Upgrading of 83 Sub Secondary or Tertiary Canals totalling 98.4km and an estimated 342 new tertiary canals of approximate length 398km.

Kbal Hong Sub Project

176. This subproject in Pursat Province is focussed on two irrigation areas, one area on each side of the Pursat river serving a gross area of 13,565 ha and irrigation service for 11,646ha. The project will serve 76 Villages with 8030 Households and population around 35,066. The upgrading will include the following activities

(i) Construction of a new regulator in the Pursat River that will span the full width of the river (110m) and raise water level with 5 gates each 4.5m high with provision for 2 fish ladders. The regulator will also provide a new road crossing of the Pursat and a control house for PDWRAM and the APEX FWUC. A number of alternative sites for the regulator were considered but without constructing additional new link canals which require more land acquisition and expense, it was concluded that the central site in town offered the most benefit at the lowest cost.
(ii) Construction of 3 new FWUC Buildings. Strengthening and capacity building of 4 FWUC is critical for the long term sustainability.

(iii) Minor Upgrading and repair of 2 existing unlined main canals and associated structures totalling 26km
(iv) Upgrading of 21 existing Secondary Canals totalling 71km and 8 New Secondary canals totalling 52km.
(v) Upgrading of 189 Sub Secondary or Tertiary Canals totalling 67.7km and an estimated 251 new tertiary canals of approximate length 255km.

177. One further Subproject will focus on providing and improving fish passage for all four rivers at a total of 12 sites. Working with the Inland Fisheries Administration new fish passes or remedial works at existing poorly performing structures will target a free passage from the Tonle Sap Lake up and down the four tributary rivers of the project area.

C. OUTPUT 3 MANAGING FLOOD RISK IN A CHANGING CLIMATE

1. Sub Project Sangker River Flood Management

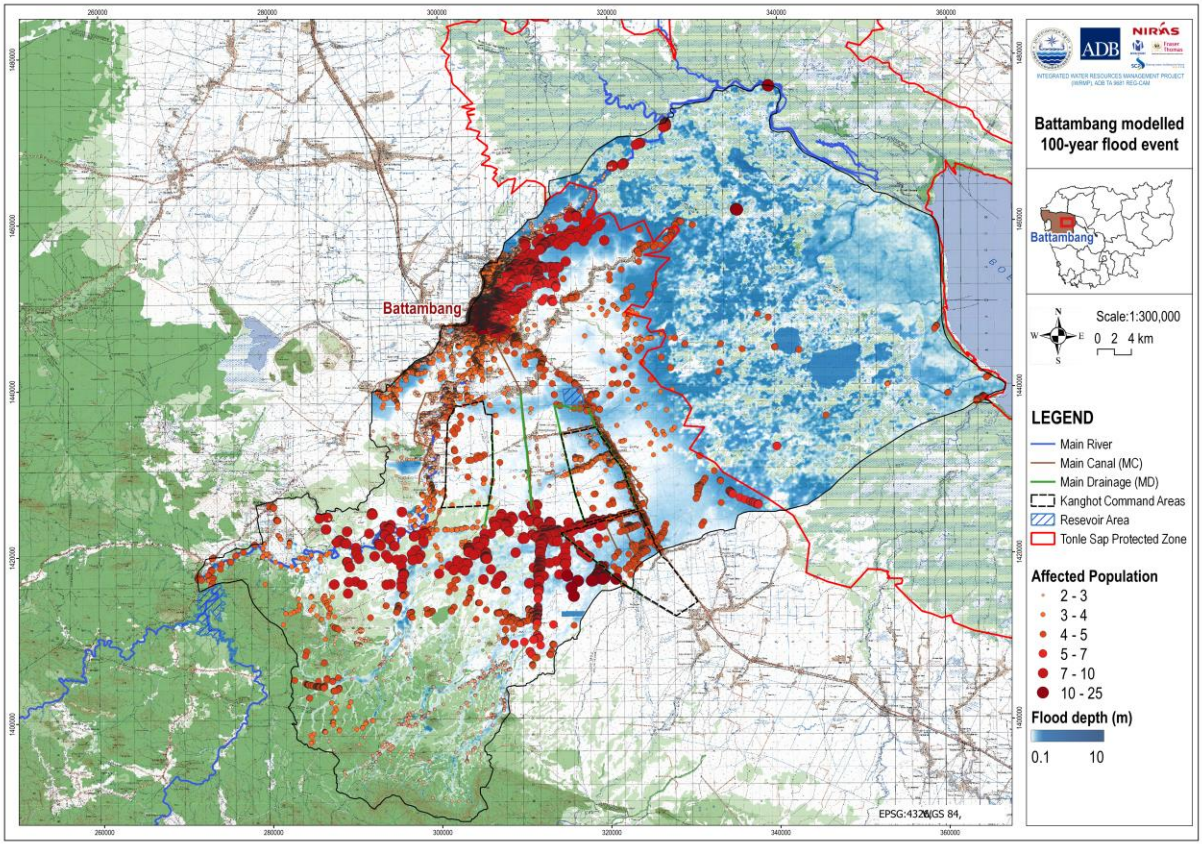
178. The flood risk in the Sangker project is from a combination of main river, small streams, rainfall and water level of the Tonle Sap Lake. Given the complex nature of the task a modelling approach using simulation of reservoir operations together with 2D flood modelling accounting for all four flood sources.

179. The records of flood damages available for Battambang Province indicate the magnitude of the flood issue in the area. In 2013 a population of 356,701 is recorded as directly affected by floods and 77,364ha of crop were damaged. The most recent flood in 2023 recorded 9,800 people and 3034ha of crop damage in Battambang province. It may be assumed that more than half occurred in the Sangker catchment. Under the NCDM 1294 system 2826 text warnings of flood were sent on 29 September.

180. To analyse the issue river sections and a number of floodplain locations between Sek Sork and Battambang were surveyed and the detailed ground model used by People in Need/NCDM for the town warning system were obtained and a baseline model was assembled. The flood outline and an indication of the people at risk is shown below. The pattern of flows is quite complex with various paths to the Tonle Sap Lake as well as the main river course passing through Battambang.

181. Figure 6-1 shows modelled flood outline and population affected in baseline 100 year flood in Sangker Basin downstream of Sek Sork reservoir. The Model result includes the Sangker River inflows without attenuation, local streams, direct rainfall but a moderate Lake level.

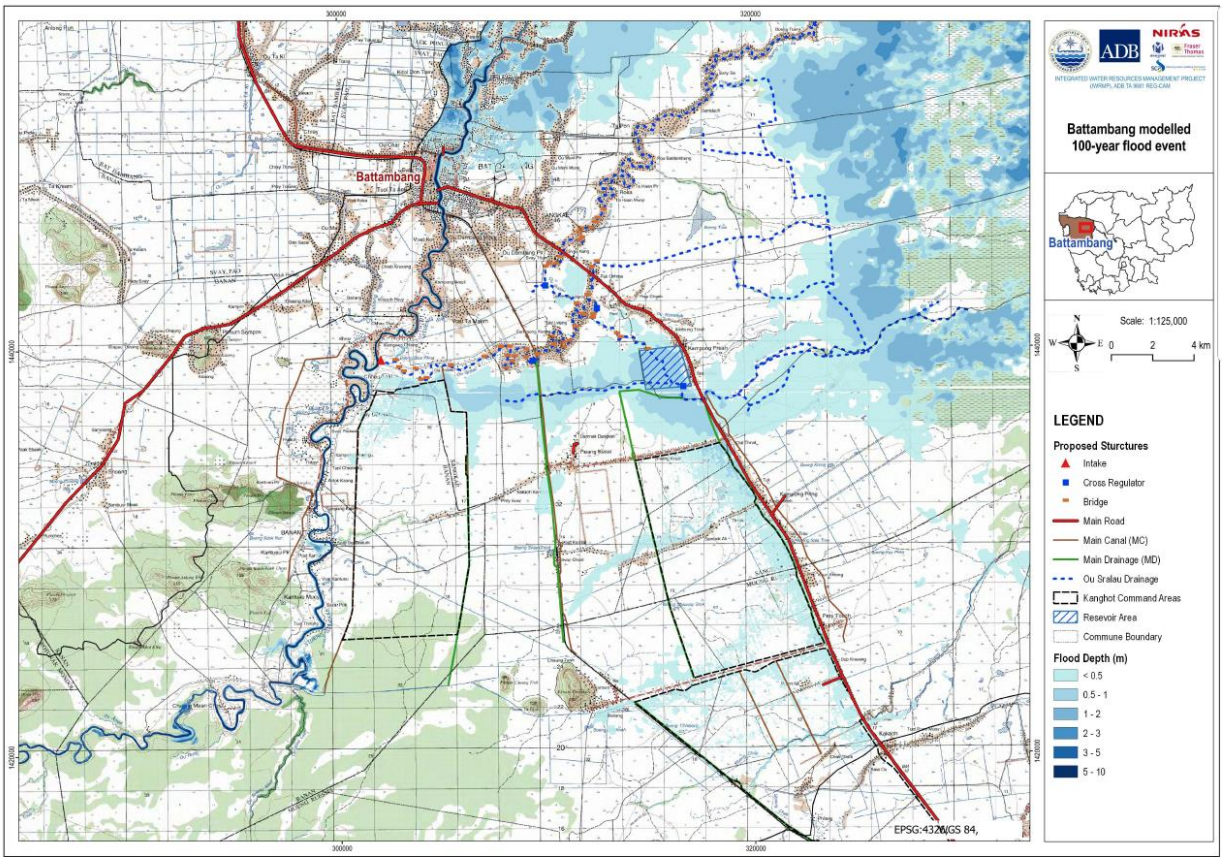
Figure VI-1 Modelled Flood Outline and Population affected in Baseline 100yr flood in Sangker Basin downstream of Sek Sork reservoir.



182. Using the surveyed river sections, the capacity of the channel through Battambang was estimated as 800-1000m^3/s dependant on the critical level chosen. The mechanism for most areas that flood in Battambang is generally not overbank flow as the banks are relatively high but lower lying areas flood from an inability to drain local rainfall. The river at Kanghot diversion can spill across the irrigation area but is limited by roads and canal banks. Local rivers (including the Chork) flow into Kanghot IS and unable to flow into the Sanker flow across the irrigation system and drainage network. Limited capacity to flow freely to the drainage points of the National Road result in floodwater accumulating upstream of the road.

183. If the river flows are high but there is not a coincident high local rainfall then there is less flooding as shown in Figure 6-2 Sangker River Flood (without local rainfall).

Figure VI-2 Sangker River Flood (without local rainfall)



184. In the feasibility study for Sek Sork multipurpose reservoir the storage above a normal operating zone was proposed as flood storage and it was expected that flood releases up to a 20 year event could be attenuated in the reservoir so that flooding in Battambang would be avoided except for in extreme flows. In practice since the reservoir has been operating there have been a number of significant flood events including that in 2020 that caused major damage in Kanghot IS ($5m was spent on repairs under Wat4Cam project) as well as flood in Battambang. Also in 2023 Battambang was flooded again though less seriously. The actual operating rules at Sek Sork were obtained and the detailed release records obtained from PDWRAM for 2021-2023.

185. The large radial gates at Sek Sork have the capacity to release flow far above a normal flood flow and thus the operating rules are important for both dam safety and for the attenuation or enhancement of flooding downstream. Analysis of the record indicates that the dam was operated in accordance with the rules as far as they can be interpreted and with the upstream information available but that there are significant shortcomings that mean at best releases follow inflow to the reservoir and more likely higher flows than incoming have been released when they did not need to be. The safety of the dam is a high priority for PDWRAM and there is no evidence that there have been any incidents of higher than expected water levels and there is no sign of any safety issues with the dam structure.

186. It is clear that the operating procedures and information available for Sek Sork operation during flood need to be improved. The PDWRAM also request a survey of the reservoir for better determining expected extent of the water surface at different reservoir levels. This survey would also inform the operating rules as an estimate of inflow on the basis of outflow measured and change in level depends on the area elevation relationship which from satellite and DEM analysis seems to be suspect.

187. Potential dam operation rules were tested in an HEC Ressim model which was applied as scenario inflow to flood model for assessing benefit.

188. For reducing flood risks other measures were also considered. At Inception measures within Battambang for the drainage system were proposed. It is apparent that these are important and that low lying areas are very dependent on the drainage and some pumping may be justified. However, this work is already ongoing by the local public works dept and does not need to be part of the IWRM project. Improvement of the rivers that spill to the Lake were suggested by the PDWRAM, these were visited and discussed. The most promising of these, the Ou Sralau was taken for further study.

189. The options for Battambang were studied in the model by running for different scenarios and testing the effect on flooding of land and property. The results of this were then taken forward to the economic analysis. Floods and the effectiveness of proposed mitigation measures are considered over a range of events with severity from 1:5 year to 1:100 year with a climate change allowance calculated from runoff modelling of increased rainfall. The maximum release from Sek Sork suggested is 650m^3/s as compared with over 2000m^3/s that has been released for a short period.

190. It is thus proposed that the flood risk management component for the Sangker river includes three direct components and two that are already included in the project:

(i) The operating rules for Sek Sork are updated and flood attenuation in the reservoir is expected in all but the most severe events. The maximum release should be tuned to the capacity of the channel at Battambang allowing for additional inflows from downstream tributaries. This would entail completing the survey of the reservoir, proposing new operating rules, implementing and building capacity in PDWRAM.
(ii) Improve the dam release monitoring, this is a semi manual system using a semi automated spreadsheet and separate look up tables of release for a given level and gate opening that is manually typed in.
(iii) Minor works at the Ou Sralau to improve capacity and control of the flow from Sangker.
(iv) Upgrade the Hydrometeorological data stations and transmission for operators of the dam. (Already included in the IWRM project output 1).
(v) Improved flood forecasting and warning (Included in Output 1).

191. We believe that further study at DED may define a flood standard that may be achieved but with the multiple sources of flooding in the areas this can only be defined relative to river flood, rainfall event, lake flood and the coincidence of these.

192. The calculated population at flood risk of a high event such as a 1:100 event is estimated as 94,600 increasing to 107,000 with climate change but no additional population growth. This can be reduced to 87,200 and 96,500 (with climate change) with the measures proposed. More details and statistics are given in Appendix 22 on reservoir and flood modelling. For river flood only the population at risk are reduced from 43,200 to 29,600 at 1:100 year event, a significantly higher proportion than when high rainfall occurs at the same time as high river flows. The total number of people in Battambang affected by flood will also depend on the drainage measures being taken and a combination of interventions and planning improvements will reduce flood risks but clearly the residual risks are still high and the good flood warning and response measures will still be required.

193. We strongly recommend against the diversion of floodwater into the irrigation canals of Kanghot as suggested in the Concept of this IWRM project. The experience of high flows

entering canals in 2020[7] highlighted the dangers of high flows in one part of the system causing overtopping damage in another without careful analysis and provision of overflows that do not depend on operation of gates at cross regulators etc. The flows released from Sek Sork exceeded 2000m^3/s in 2020 and the impact of a (say) 50m^3/s diversion into the canal system would have had a negligeable impact on the river flood downstream but could cause major damages within the IS such as the $6.4m repair cost that occurred in 2020.

2. Sub Project Pursat River Flood Management

194. The flood risks in the Pursat catchment are similar to those described above in Battambang and are from a combination of main river, small streams, rainfall and water level of the Tonle Sap Lake. Again, given the complex nature of the task, a modelling approach using simulation of reservoir operations together with 2D flood modelling accounting for all four flood sources was used. In this case the reservoir with potential to assist in controlling floods is the Pursat 1 Dam under construction for hydropower generation.

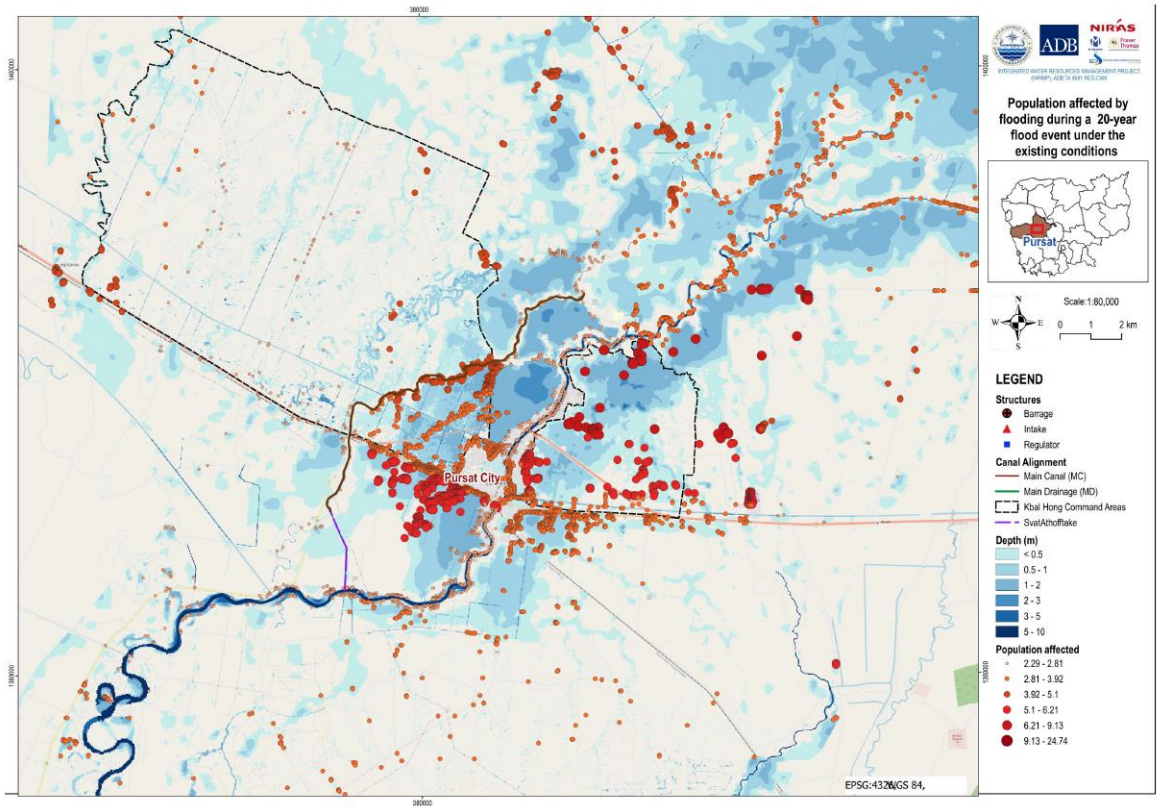
195. The records of flood damages available for Pursat Province indicate the magnitude of the flood issue in the area. In 2000 a population of 145,840 is recorded as directly affected by floods and 38,117ha of crop were damaged. Significant events also occurred in 2011 and 2013. The most recent flood in 2023 recorded 9,169 households were affected and 7199ha of crop damage in Battambang province. It may be assumed that most occurred in the Pursat catchment. 1379 households were evacuated in 2023, the highest number of any province in 2023. However only 1464 Text Warnings were sent under the 1294 System of PCDM indicating less take up of the system in Pursat than in Battambang.

196. To analyse the flood issue in Pursat, river sections and a number of floodplain locations between Damnak Ampil and Charek downstream of Pursat town were surveyed and together with cross sections of the Svay At channel and topography of the Kbal Hong IS. Firstly a 1D model of the sections was tested then a 2D baseline model was assembled. The flood outline and an indication of the people at risk is shown below. As in Battambang the pattern of flood flows around Pursat town is quite complex with various paths to the Tonle Sap Lake but the floodplain generally follows the river course.

197. Figure 6-3 shows the modelled flood outline and population affected in Baseline 20 year flood in Pursat Basin downstream of Bak Trakoun. The Model result includes the Pursat River inflows without attenuation, local streams, direct rainfall but a moderate Lake level. The population affected is more spread out than Battambang.

[7] 2021 WAT4CAM _Component 1: Rehabilitation and completion of irrigation and drainage infrastructures _ Repair Flood Damage (TA-INFRA Egis Eau)

Figure VI-3 Modelled Flood Outline and Population affected in Baseline 20yr flood in Pursat Basin downstream of Bak Trakoun.



198. The area is not as sensitive as Battambang to local rainfall events and high Lake levels do not greatly affect floods in the town or Kbal Hong IS as shown below.

199. Using the surveyed river sections, the capacity of the channel through Pursat was estimated as 700-800m3/s dependant on the critical level chosen. The mechanism for most areas that flood in Pursat has both overbank flow and flooding of low lying areas away from the river.

200. All available data on the Pursat 1 Dam was assembled including the feasibility design and any data that could be gleaned on likely operations during meetings with Ministry of Energy Hydropower department and at regional government offices.

201. Similarly to Battambang modelling of the reservoir operation (Pursat 1) during flood was completed in the HEC Ressim software and the effect on flooding simulated in a HEC RAS 2D model. The PDWRAM also indicated that they wished to develop the Svay At as a flood channel so this was investigated in the model.

202. Results of options for Svay At size and offtake arrangement were considered and the most beneficial selected.

203. It is thus proposed that the flood risk management component for the Pursat river includes two direct components and two that are already included in the project:

(i) The operating rules for Pursat 1 during flood are proposed for agreement with the Ministry of Energy and the developer such that flood attenuation in the reservoir can expected in all but the most severe events. This will entail working closely with the concerned parties as the construction continues.

(ii) Develop the Svay At channel and offtake with width of around 60m connecting channel and the natural width of the existing channel to a capacity of 200-300m3/s for floodplain flows on the left bank of the Pursat. This part of the subproject has a new channel 60m wide and 13km long connecting from a new spill offtake of the Pursat to join the existing Svay At channel.
(iii) Minor upgrades of other offtake channels.
(iv) Carry out Community Disaster Risk Mapping and Planning at communities where there is a remaining high residual risk of flood damages.
(v) Upgrade the Hydrometeorological data stations and transmission for PDWRAM and PDCM (Already included in the IWRM project output 1).
(vi) Improved flood forecasting and warning (Included in Output 1).

204. The calculated population at flood risk of a high event such as a 1:100 event is estimated as 22,000 increasing to 27,100 with climate change but no additional population growth. This can be reduced to 15,200 with the measures proposed. More details and statistics are given in Appendix 22 on Reservoir and flood modelling.

205. The total number of people in Pursat affected by flood will also depend on the drainage measures being taken and a combination of interventions and planning improvements that will reduce flood risks but clearly the residual risks are still high and the good flood warning and response measures will still be required.

VII. ENVIRONMENTAL AND SOCIAL IMPACTS

A. ENVIRONMENTAL IMPACTS

206. The Environment classification is confirmed as category B. An Initial Environmental Examination (IEE) and accompanying Environmental Management Plan (EMP) was produced for the entire project, covering the Kbal Hong Irrigation Scheme sub-project, and the Kanghot Irrigation Scheme sub-project, the two Flood Management Subprojects and the Fish Passage. This was produced in accordance with the ADB SPS (2009), and the Government's environmental regulations.

207. The main environmental impacts are potential downstream impacts, construction related short-term impacts on land and water bodies, and water pollution due to increased use of irrigation and potential increase in fertilizer. The IEE confirms that the project is not likely to cause any significant adverse environmental impacts. The initial water balance study shows that water availability downstream is sufficient under both current and projected climate conditions and Pursat River Residual Discharge will be more than the required minimum Environment Discharge. Additional water balance studies will be conducted during the detailed design to confirm the availability of water in the downstream communities and develop any additional mitigation measures if necessary.

208. Projected negative impacts during construction are temporary and can be minimized by the proposed mitigation measures and monitoring specified in the EMP, and inclusion of special environmental conditions in the bidding documents. The EMP will be updated to modify or include any additional mitigation and monitoring measures based on the detail design. The PDWRAM in Pursat will work with MOWRAM to carry out water quality testing at the selected sites to assess any negative impact on the water bodies and collaborate with the Provincial Department of Agriculture to ensure appropriate use of agricultural chemicals. Budget for water quality monitoring is included as part of the environmental monitoring costs. Main environmental safeguard responsibility lies with PMU and PIU assisted by the international and national environmental specialists (consultants). Any disputes as a result of adverse environmental impact will be solved through the Grievance Redress Mechanism set up under the project. The environment specialists will provide the guidance at the 1st stage while the Provincial Grievance Redress Committee may consult with the Provincial Department of Environment to seek for its technical opinion if necessary.

B. SOCIAL IMPACTS

1. Land Acquisition and Involuntary Resettlement

209. The project Output 1 is not anticipated to trigger involuntary resettlement (IR) impacts because there is no physical or economic displacement whereas Outputs 2 and 3 are expected to cause IR impacts. The subprojects identified in the preparatory stage under Output 2 are: (i) Kanghot Irrigation Scheme (IS) in Battambang; (ii) Kbal Hong IS in Pursat; and (iii) Kbal Hong barrage and intake structures. The Kbal Hong barrage and intake structures have a defined footprint and corridor of impact (COI) and therefore a basic resettlement plan (BRP) has been prepared for the impacts. The irrigation canal alignment for both IS subprojects are not identified and defined at the project preparation phase. For the sample areas example irrigation canal alignments were prepared for the study purposes only, and the preliminary estimated results for Kbal Hong IS and Kanghot IS subprojects are included in the BRP.

210. Unidentified and undefined subprojects under Output 2 and all subprojects under Output 3 IR impacts are unknown at this stage and therefore the impacts have been covered under a resettlement framework (RF). The RF has been prepared to guide the screening and

categorization of the subprojects regarding IR, IR impact assessment, preparation, and implementation of detailed resettlement plans (DRP) and due diligence reports (DDRs) and monitoring of DRP implementation. The RF requires impacts relating to land acquisition and IR for subprojects to be identified and defined at the detailed engineering design (DED) phase after loan approval. For subprojects developed during project implementation, measures will be undertaken to avoid and minimize resettlement impacts.

211. The General Department of Resettlement (GDR), as the lead agency for land acquisition and involuntary resettlement (LAR), is experienced in implementing resettlement activities consistent with the ADB's SPS (2009), Safeguard Requirements 2: Involuntary Resettlement. GDR finalized the BRP based on the preliminary design for Kbal Hong barrage and intake structures. At DED phase, the GDR will prepare a separate DRP for all subprojects/civil works packages based on the detailed measurement survey (DMS) and the DED. The Replacement Cost Survey (RCS) will be undertaken by an independent firm qualified and experienced in asset valuations to determine the market rates of affected assets. The DRPs will be approved by the government and cleared by ADB and disclosed on its website before contract award. No land acquisitions, site clearing, or physical and economic displacement will occur until the compensation at full replacement cost and other entitlements due to the affected persons (AP) are paid to them, in accordance with the DRP, and a comprehensive income and livelihood rehabilitation program, supported by an adequate budget, is in place to help displaced persons improve, or at least restore, their incomes and livelihoods (as required). However, civil works may proceed in sections or at sites where there are no IR impacts with prior agreement between ADB, the EA and the IA.

212. If there are any changes that may trigger additional land requirements or resettlement impacts, updated DRPs or DDRs with corrective action plans will be prepared by GDR. These DRPs/DDRs will be reviewed by ADB prior to the award of civil works and implemented prior to the commencement of the civil works. Implementation shall be monitored internally by the Department of Internal Monitoring and Data Management (DIMDM) of GDR.

213. The cost for all land acquisition, compensation and resettlement assistance under the subprojects will be financed from the national budget and no financing will be required from the ADB loan and grant. The government shall provide counterpart funds for land acquisition and compensation activities, specified in the agreed DRPs, and will meet any unforeseen obligations in excess of the DRPs budget estimate to satisfy resettlement objectives.

214. Acquisition of land through willing buyer/willing seller (WBWS) can take place where land markets are functioning, the transaction takes place with the seller's consent, and the seller receives a price consistent with prevailing market prices. This will not be applied to subprojects where there are multiple APs, or where there are no options to change the siting of infrastructure in the absence of agreements. The WBWS cases (where expropriation will not be used and is not an option) are not subject to SPS requirements. For such cases, ADB will have access to all the documentation for on-site verification at GDR and prepare a note to file. If agreement between the willing buyer and willing seller cannot be reached, alternate site will be selected. GDR will demonstrate to ADB the options to change siting in the absence of agreement, if WBWS method is applied for acquiring land and assets for the Project.

215. Where the process of negotiated settlement is applied in lieu of compulsory land acquisition (where failure of negotiation would result in expropriation), SPS requirements (paragraph 25, Appendix 2) will be followed and described in the BRPs/DRPs. Any land acquisition through negotiated settlement will be based on meaningful consultation with affected persons, including those without legal title to assets. A negotiated settlement will offer adequate and fair price for land and/or other assets. GDR will ensure that any negotiations with displaced persons openly address the risks of asymmetry of information and bargaining power of the parties involved in such transactions. For this purpose, GDR will engage an independent external party to document the negotiation and settlement processes. GDR will

agree with ADB on consultation processes, policies, and laws that are applicable to such transactions/negotiated land acquisition; third-party validation; mechanisms for calculating the replacement costs of land and other assets affected; and record-keeping requirements.

216. In case for connecting/tertiary canals where AHs (farmers) do not need or want parallel access roads and therefore the width of COI is negligible requiring only narrow strips of land, voluntary land donation can be considered in close coordination with the AHs and ADB. For voluntary land donation, the GDR has no active role and the process is implemented by PMU, PIU, local authorities, communes and farmer water user committee (FWUC). Voluntary land donation shall follow the following key principles (i) the donor has been fully informed about the project and available choices regarding the land and their implications, including refusal to donate the land, and has confirmed in writing their willingness to proceed with the donation; (ii) the amount of land is minor and will not reduce the donor's remaining land area below that which is required to maintain the donor's livelihood at current levels; (iii) no household relocation is involved; and (iv) the donor is expected to benefit directly from the subproject. Meaningful consultation and proper due diligence will be carried out to ensure that the donors are fully informed and are willing and not coerced in any way to donate the land.

217. GDR will provide a site handover letter to the IA, copying ADB upon completing payment of compensation and other entitlements due to APs. The letter shall be attached with a summary table indicating the location of the site, total number of APs in the DRP versus the total actual number of APs, including vulnerable; total compensation amount in DRP versus total compensated amount; and total number of APs entitled to income restoration plan (IRP) in the DRP, versus the total actual number of APs entitled to IRP. Any difference in the numbers and amounts will be explained accordingly. The letter will serve as a basis for ADB's no objection to commencement of works.

218. The PMU has the overall responsibility for the Project, including safeguards compliance. The PMU will coordinate with GDR to ensure compliance with involuntary resettlement safeguard requirements, in line with the "Land Acquisition and Involuntary Resettlement Standard Operating Procedures for Externally Financed Projects" (LAR SOP) and in the DRPs are met. The PMU will have full-time social safeguards staff who will support compliance of the project implementation with ADB safeguard requirements, including meaningful consultation. The Project Implementation Consultant (PIC) will support PMU to ensure that appropriate safeguards procedures are followed and that the implementation schedules are kept on track.

219. GDR will be responsible for establishing the grievance redress mechanism (GRM) for LAR, as described in the DRPs and will be made fully functional prior to DMS. The GRM will ensure grievances of APs are resolved in a timely manner and trigger remedial action. The GRM comprises a set of clear procedures to receive, record, and address concerns of complaints raised about safeguard issues at village, municipal, district, and provincial level.

220. Effective monitoring and public consultation with all stakeholders and APs at all stages of project implementation will be ensured. In compliance with ADB's information disclosure and consultation requirements, the safeguard documents required as per the loan agreement will be posted on ADB's website and disclosed to affected persons and communities in local language. Stakeholder consultations will continue through formal and informal meetings and focus group discussions.

2. Indigenous Peoples.

221. The project is classified as category C for indigenous peoples in accordance with ADB's Safeguard Policy Statement (2009) based on IP impact screening and socio-economic surveys conducted during the project preparation.

C. UPDATING OF SAFEGUARD PLANNING

222. As agreed by ADB and the Ministry of Water Resources and Meteorology, the environmental management plan, resettlement plan, indigenous peoples plan will be updated from time to time during project implementation, upon availability of detailed engineering design, and to reflect adaptive management of project changes and unforeseen circumstances or in response to project performance, ensuring that standards originally planned are not lowered.

223. The monitoring of the implementation of the DRPs will be done by the Department of Internal Monitoring and Data Management (DIMDM) of GDR. The DIMDM will validate that (i) entitlements and the corresponding compensation are paid in accordance with the Entitlement Matrix in the detailed RP; and (ii) GRM is functioning as per the guidelines. The DIMDM of GDR will prepare and submit to ADB the semi-annual social safeguards reports. At the same time, PMU will be in-charge of monitoring of compliance of construction related activities, and will submit a separate construction related semi-annual social safeguards monitoring report to ADB. The status of safeguards implementation, compliance issues and progress of corrective actions are to be reviewed by ADB and disclosed on ADB website. The status of safeguards implementation will be discussed at each ADB review mission with necessary issues and agreed actions recorded in Aide Memoires and Memorandum of Understanding.

224. The external monitor agency (EMA) will be engaged to monitor the implementation of any IR category A subprojects, especially for the physically relocated, AH with major impact and vulnerable AHs. The EMA semi-annual report will be submitted to GDR and ADB for review and disclosure at ADB website.

VIII. SOCIAL POVERTY AND GENDER ASPECTS

A. SOCIAL POVERTY AND GENDER ASSESSMENT

225. During project preparation an in-depth social, gender and poverty assessment was carried out including a review of secondary data and qualitative and quantitative research, including village meetings, gender and socially inclusive focus group discissions (FGDs) with target beneficiaries, women, FWUC members (where FWUCs exist) and commune level officials, PDWRAM staff. Sample surveys were carried out with 600 individual households of water user communities in 40 villages, 20 each in both sub projects with selected households in selected villages in order to understand (i) the extent of poverty, (ii) social and gender related conditions prevalent in the sub project areas, which lead to poor livelihoods, reduced food production and food security, increasing debt and risks related to climate change, drought and floods particularly affecting the poor, women and female headed households. The findings of the poverty, social, gender assessment formed the basis of the sections on gender, poverty, and social analysis and strategy in the summary poverty reduction and social strategy (SPRSS) of the project, and the gender action plan (GAP) which include actions and targets to ensure that women participate fully in project activities and benefit commensurately.

226. The total households in all the 141 target villages in 20 communes and 7 districts in the 2 provinces of Pursat and Battambang in which both IS are located is 30,739, with population of 134,229 in which 67,982 persons are female, equivalent to 50.65% of the population . The expected beneficiaries are the residents of four districts of Pursat and Battambang provinces. The two provinces had a combined poverty rate of 28.39% in 2022. The project is aimed at increasing household incomes for the population in the following districts in Pursat, namely, Pursat, Kandieng, and Bakan, and in Battambang province, namely Moung Russei, Sangker, Banan, and Koas Kralor, whose poverty rates are 25%, 26%, 19% in Pursat and 23%, 33%, 33%, and 59.9%, respectively. The project is expected to directly improve the economic conditions of approximately 23% of the population of the sub project areas, i.e. approximately 30,000 persons, of whom approximately 51-52% are women. Rural women's participation in farming and related activities is relatively higher to that of men in both sub projects. Female headed households and the rural poor are more or less totally dependent on security of farm based livelihoods for their subsistence. However, climate change induced floods and droughts, lack of adequate irrigation and domestic water resources availability, affects farming and fisheries based livelihoods' outcomes adversely.

227. In both sub project areas, the gender inequality and socio economic conditions and related constraints are similar. Both the project provinces of Pursat and Battambang have a combined poverty rate of 28.39% in 2023 , higher than the national average Female headed households form a higher than national percentage of total households in the sub project areas (32.7%) Most farmlands are privately held, with only 20% in Battambang province being irrigated and only 4% using government irrigation facilities. Landholdings are small on average at 0.96 ha in all the 19 communes covered by the two sub projects. While most of farmlands are cultivated by family labor, approximately >5% is rented out to small farmers and landless households, often recent migrants from other provinces, In both sub projects. A limited percentage of farmlands in the command areas, are irrigated by gravity. Only better off farmers can afford to pay energy costs for pumpimg water above the level of the irrigation canals, to irrigate farms situated in higher elevations. In the irrigated areas, farmers grow two rice crops, in the wet and dry seasons. Only in small areas with assured water supply, market oriented crops are grown such as cassava, and vegetables in home gardens in both sub project areas. Out migration is a livelihood strategy particularly among poor households in both sub projects, leading to a lack of adult labor supply for farming. Female headed households face such a dilemma along with other poor households, that reduce their ability to take up tenant farming. Livestock rearing is a livelihood strategy for women farmers.

228. While more women work in farming than men, their access to and control over water sector related decision making, access to technical knowledge and information, while improving, is still rather limited. Women constituted only 15% of FWUC members in 2021. In both sub project areas, there are no women members of existing FWUCs. Even where women participate as officials in FWUC sub-committees, they are working in passive roles such as accountants but not as decision makers. They have to rely on the help of male members of FWUCs for technical and managerial aspects of water resources management. Constraints faced by women are related to deeply ingrained gender roles, women's primary responsibility for domestic work, lack of adequate domestic water supply infrastructure, their lack of access to knowledge and information for water management and O&M, lack of self confidence, risks of gender based violence are among factors leading to relatively low levels of their participation in water resources management. Women stress the need for domestic work sharing and reduction of drudgery through better drinking water infrastructure, improved irrigation services, and gender sensitivity among all staff in implementing agencies as well as beneficiaries. Both women and men emphasize the need for training in gender sensitivity, equality, and social inclusion, technical training in water allocation, water management and O&M, financial aspects including record keeping, accounting, skills training and climate and water resilient farming techniques.

229. The GAP includes steps to mainstream gender in all three outputs of the project. Under Output I – Planning and Climate Change Adaptation Capabilities of Water Resources Management Strengthened, the measures for gender mainstreaming includes (i) provision for capacity development for female staff at national and sub national levels, in gender mainstreaming and gender responsive CCA, (ii) promotion of female staff in MOWRAM to decision making levels, (iii) at least 30% female staff training in project related technical areas, including IWRM, flood and drought forecasting, gender equality mainstreaming in FWUC organizing and strengthening, (iv) strengthening women's voices in project design through consultative meetings and FGDs; (v) strengthen women's membership in FWICs and FWUC committees of at least 25% women membership in FWUC management committees and a minimum of 30% women members of FWUCs holding single or joint land titles, and lastly, (vi) Women increasingly registering land titles in joint or single names, and skills training for FWUC members on gender equality in FWUCs, increasing roles for women in FWUC management.

230. The GAP supports the updating of MOWRAM's Gender Mainstreaming Strategy and Action Plan in Water Resources Sector. MOWRAM has adopted gender mainstreaming policies and planning but women's representation is still relatively low, particularly at decision making levels. The GAP includes measures and targets to increase women's representation at higher levels of decision making, capacity development of national sub national female staff in gender responsive IWRM, climate change adaptation and other technical areas. The GAP aims to assist in the updating of the MOWRAM Gender Mainstreaming Strategy and Action Plan In Water Resources Sector (GMSAP) (2024-28) by supporting GMAG and national level GFF monility to provinces to impart training to GFFs and other staff in gender responsive planning and techniques as well consultative measures to update the GMSP.

231. Under Output 2, Water Supply Capacity in Dry Season Increased, the GAP provisions include, (a) ensuring women's active participation in irrigation scheme planning, including membership, leadership, decision making particularly in water allocation and distribution plan, and mentoring effective management of FWUCs, (b) promoting women's economic empowerment and safety through contractual provisions for equal pay for equal work among men and women, protection against sexual harassment, provision of separate sanitation facilities and training in labor camps to manage social and health risks and use of safety equipment and protective gear, and lastly, (c) ensuring women's participation in village based trainings and in field demonstrations for climate resilient and profitable farming techniques.

232. Under Output 3, Flood Risk During Wet Season Reduced, the GAP supports gender mainstreaming capacity in flood risk mitigation for IWRM provinces, and promote women's opportunities in FWUCs and water resources management. GAP actions include (a) gathering sex disaggregated data at sub project commune level, on flood impact information, including suggestions for better risk reduction and protection of life, livelihoods particularly of poor and vulnerable sections, training FWUCs in the use of early warning systems using local communication systems, preparing flood risk mapping including location of vulnerable groups and women's assets.

233. Key GAP indicators are reflected in the Design Monitoring Famework (DMF). MOWRAM will track key gender disaggregated data in its database and will be responsible for monitoring the GAP through the GFF in the PMU and gender specialists in the PMIC team.

234. The project will implement the GAP in order to address gender issues such as women's low participation in water resources management, women's low representation in FWUCs, their limited roles on decision making in FWUCs, need for leadership and technical skills, economic empowerment through project construction and skills training. The project will directly benefit women who constitute more than 50% of the target population.

B. UPDATING AND IMPLEMENTATION OF THE GENDER ACTION PLAN

235. The responsibility for implementation of the GAP will rest with the PMU at MOWRAM with support from PMIC. The Team leader, Deputy Team Leader, and M&E consultants in the PMIC will address relevant gender aspects related to their areas of work.An international gender consultant will be recruited for a period of 6 person months and a national gender consultant for 30 person months will be recruited for guiding, monitoring and reporting to the PMU through the oroject implementation period. The gender consultant's workplan should be aligned to the key milestones of the project activities and targets under the GAP. The PMU will support the requirements of the gender consultants to ensure that gender mainstreaming training is provides to all staff of MOWRAM and PDWRAMs in the project provinces. The national condultant will need to ensure that substantive gender content is integrated into all capacity development and communication strategies of the project, wherever required. Gender related indicators will be included in the project performance monitoring system (PPMS) with data disaggreagated by gender, age and other appropriate factors, in all project progrss reports. A six monthly update on GAP implementation will be provided to ADB. Adequate resources have been provided for GAP implementation, monitoring and reporting, with consultant support provided by financial resources from the loan and government staff time in kind contribution.

236. With reference to the SPRSS, (RRP linked document) the GAP, stakeholder participation and consultation, labor, HIV /AIDS and other social risks will be implemented as follows: (a) the MOWRAM, DFWUC, PDWRAM, GMAG, GFF will ensure that all training for capacity development target national and sub national female staff, women in FWUCs, vulnerable women; (b) ensure that at least 30% of all participants in such trainings are women; (c) at least 30% women participation in training in drought and flood risk mapping; and forecasting system, early warning systems; (d) gender responsive consultations with women irrigators, in 30% of villages and at least two community consultation in each command area with 40% women members of FWUC management committees, FWUC sub committees; (e) at least 30% of FWUC members are women, and at leat 25% of management committee members of FWUCs are women; (f) women are to be included in all information sharing on project planning and developments, land registration procedures, skills training for improved water and soil conservation and improved productivity. Further, (g) at least 46% women participation must be ensured in IWRM training and monitoring activities; (h) women's economic participation and safety to be ensured during construction activities by (i) all contracts ensuring equal pay for both women and men in similar positions, (ii) zero tolerance for sexual harassment, (iii) separate toilet facilities for women at all work sites, (iv) training for

all workers in worker safety, equipment and protective gear use. Moreover, (i) at least 35% of farmers for in-field demonstrations are to be women; (j) at least 50% of FWUCs established in the sub project areas with at least 25% of women members in FWUC management committees and at least 40% women members at national levels.

C. STAKEHOLDER PARTICIPATION

237. The core of the project consists of gender equal and socially inclusive farmer participation. Provisions on participation have been sufficiently covered in the FWUC formation and strengthening, IWRM strengthening, flood risk prevention and protection planning, gender action plan, environmental impact assessment, and initial environmental examination of the subprojects and other project documents which ensure the project information is shared with the beneficiary communities and other stakeholders.

238. The preparation of River Basin Management Plans and the Community Based Disaster Risk Management Planning will need a high level of participation of beneficiary communities and stakeholders. The detailed design of project activities will also need close consultation and participation will be encouraged and facilitated. An easily accessible and effective grievance redress mechanism is to be set up in consultation with the communities. FWUCs established/ capacitated under the project will facilitate active participation of farmers in project activities. A separate participation plan, therefore, is not required.

IX. PROPOSED ORGANISATIONAL STRUCTURE

A. PROJECT IMPLEMENTATION ORGANIZATIONS

239. MOWRAM will be the executing agency (EA) and its department of Farmer Water User Communities (DFWUC) will be the implementing agency (IA). A PMU has been established in the DFWUC and is active on similar projects. The PMU is headed by the Secretary of State of MOWRAM as Project Director with assistance of the DFUC Director as Project Manager. The PMU were fully involved in the preparation of the project.

240. The overall project structure proposed is given below in Figure IX-1. The project will have a Steering Committee, Project Implementation Consultants (including safeguard Monitoring), and the Battambang and Pursat Provincial departments of MOWRAM will form project implementation units (PIU) to directly oversee the Goods and Works Contractors with support from the PMIC.

241. Details of the members of the Project Steering Committee are given in the Project Administration Manual attached as Appendix 2 and Chaired by the Minister of MOWRAM includes members from MOWRAM, MEF, Tonle Sap Authority, Cambodian National Mekong Committee, Ministry of Agriculture, Department of Hydrology and River Works, Department of Farmer User Community and Provincial departments.

Figure IX-1 Project Organisation Structure

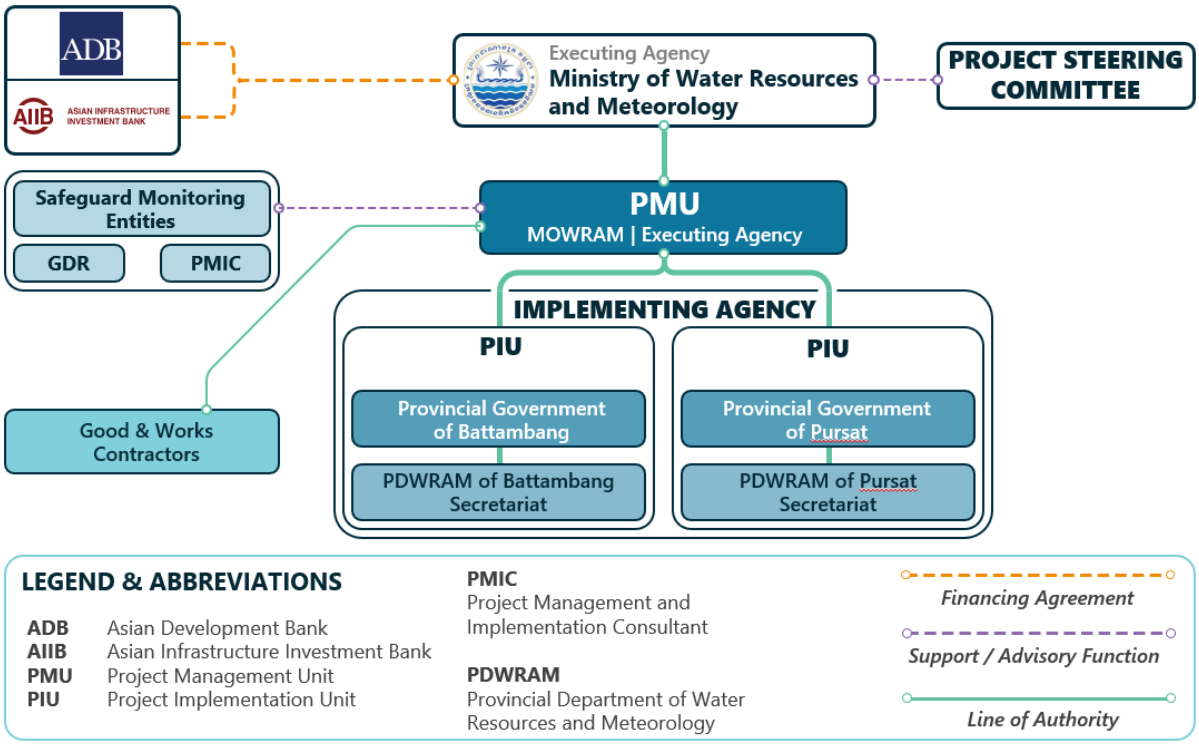
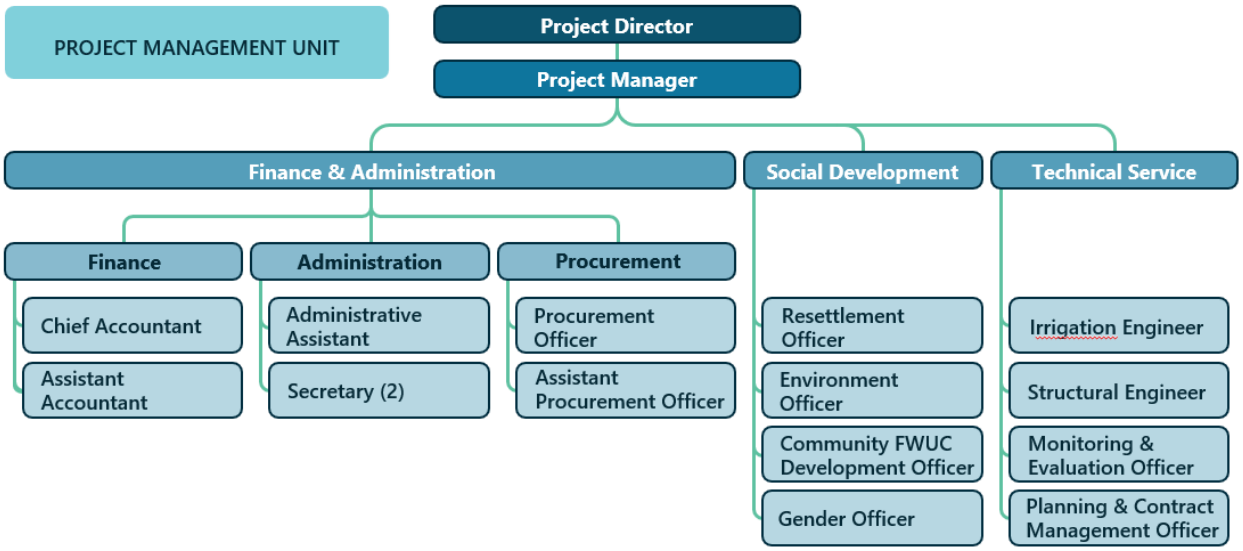
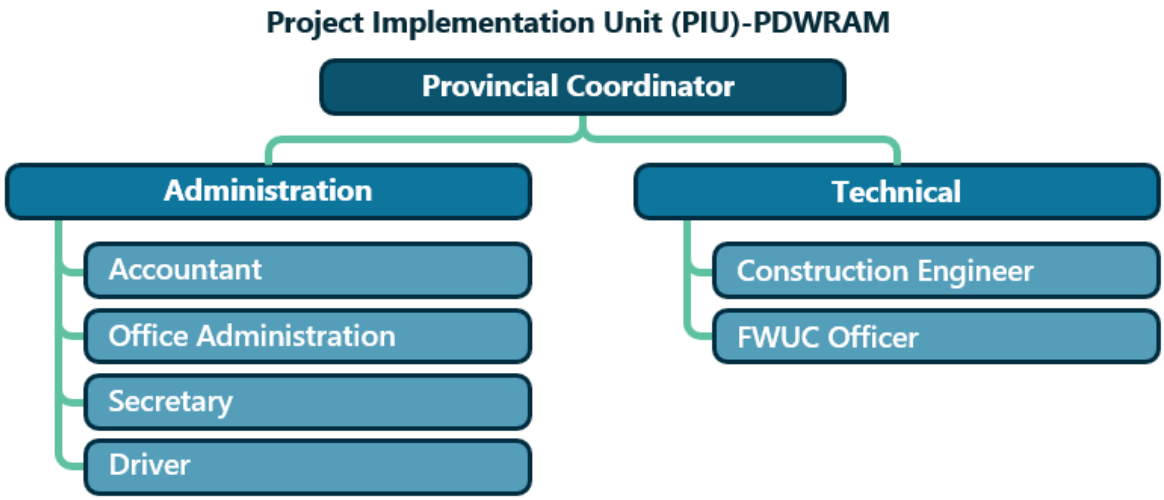


Figure IX-2 Organisational Structure of the Project Management Unit



242. The project management unit in MOWRAM will have 18 members and will be supported by Project Implementation Units in each province and a Project Implementation Consultant Team (PMIC). More details on the expected members of the PMIC are given in the PAM (Appendix 2).

Figure IX-3 Provincial Project Implementation Units (1 in Battambang and 1 in Pursat)



X. PROPOSED PROJECT IMPLEMENTATION SCHEDULE

A. IMPLEMENTATION ARRANGEMENTS

1. Project Readiness Activities

243. The project readiness activities and their expected completion dates are shown in Table X-1.

244. The Kbal Hong regulator construction is expected to take 3 years so is prioritised to start detailed engineering design under the AIIB PPSF grant for project preparation. Inventory of loss and preparation of the Basic Resettlement Plan have therefore also been prioritised.

245. Early activities include hydrometeorological equipment upgrading and creation of flood forecast systems, creating Farmer Water User Groups and support to the River Basin Committees.

246. The expected start of construction of the Kbal Hong regulator is in the dry season 2026.

B. PROJECT IMPLEMENTATION

247. The overall project implementation plan to 2030 is shown in Table X-2 and Table X-3. There are eight activities in Output 1 focussed primarily on the River Basin Management including getting water management plans in place prior to completion of construction activities under Outputs 2 and 3 in 2028. During 2029 and 2030 activities are concentrated on completing the safeguard work, building capacity and supporting the implementation of climate adaptive agricultural practices and strengthening the FWUCs.

Table X-1 Project Readiness Activities

Indicative Activities	2024				2025	Responsible Agency
	Q1	Q2	Q3	Q4	Q1	
Submission of EOI for DED for Kbal Hong barrage	Done					Firms
Submission of Proposal and Bid Evaluation for DED for Kbal Hong barrage	Done					PMU / Firms
Advance Contracting Actions of DED[a]		Apr →	Sep			
Start of Detailed Engineering Design (team 1)			Sep			ADB/ AIIB/ MOWRAM / PMU
Recruitment of DED consultant (team 2) for other works[b]			Jul →		Jan	AIIB / MOWRAM
Procurement consultant with use of retroactive financing to support MOWRAM's recruitment of the PMIC and bidding Kbal Hong barrage			Jul →		Jan	MOWRAM
Financial management consultant with use of retroactive financing to support MOWRAM complete the following actions before approval: • ensure timely project's budget preparation, submission and monitoring of the annual budget provisions • train the assigned project accounting staff at PMU and PDWRAM • develop project's chart of accounts following MEF's requirements to align with PAM cost categories and set up Sage50 accordingly • set up internal controls and processes, and • prepare templates for monthly, quarterly and annual reporting/reconciliation of project activities following MEF and ADB requirements			Sep →	Dec		MOWRAM
Establish project implementation arrangements		Apr →			Jan	MOWRAM, GDTA / PMU / PDWRAMs
ADB Loan Negotiations				Oct		ADB, Government.
AIIB Loan Negotiations				Oct		AIIB, Government
Obtain ADB Board Approval				Dec		ADB, Government
Obtain AIIB Board Approval				Dec		AIIB, Government
ADB Loan Signing				Dec		ADB, Government.
AIIB Loan Signing				Dec		AIIB, Government
Government legal option provided					Jan	MOWRAM, MEF
Government budget inclusion					Jan	MOWRAM, MEF
Declare ADB Loan Effectiveness					Jan	ADB
Declare AIIB Loan Effectiveness					Jan	AIIB

ADB = Asian Development Bank, AIIB = Asian Infrastructure Investment Bank, DED = detailed engineering design, EOI = expression of interest, GDTA = Department of Technical Affairs, MEF = Ministry of Economy and Finance, MOWRAM = Ministry of Water Resources and Meteorology, PAM = project administration manual, PDWRAM = provincial Department of Water Resources and Meteorology, PMIC = project management and implementation consultant, PMU = Project Management Unit, Q = quarter.

[a,b] The cost for the DED (team 1) and DED (team 2) will be financed by Asian Infrastructure Investment Bank under its Project Preparation Special Fund and implemented by the Ministry of Water Resources and Meteorology.

Table X-2 Overall Project Implementation Schedule

Activities	2024		2025				2026				2027				2028				2029				2030	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
A. DMF																								
Output 1: Planning, coordination, and climate change adaptation capacities of WRM strengthened																								
1.1 Upgrade hydrometeorological stations and staff training																								
1.2 Confirm RBC members in Pursat and Sangker RBC																								
1.3 Assist RBCs in developing climate-adaptive river basin management plans																								
1.4 Develop climate adaptive flood management and integrated reservoir operation plans, in consultation with stakeholders																								
1.5 Develop river flow management plans with water allocation rules																								
1.6 Seminars and consultation on river basin management plans																								
1.7 Develop drought and flood forecasting and warning systems																								
1.8 Two sustainable WRM operation and management strategies approved and their arrangements commenced																								
Output 2: Water supply capacity during dry season increased																								
2.1 Remodel Kbal Hong barrage at Pursat																								
2.2 Construct and/or upgrade irrigation canals at Kbal Hong and Kanghot																								
2.3 Construct fish passages and monitor operations																								
2.4 Establish FWUCs at Kbal Hong																								
2.5 Capacity building for FWUCs at Kbal Hong and Kanghot																								
2.6 Climate-adaptive agriculture support																								
2.7 Introduce and demonstrate the AWD																								
Output 3: Flood risks during wet season reduced																								
3.1 Construct Svay Ath offtake and channel works in Pursat																								

Table X-3 Overall Project Implementation Schedule (Continued)

Activities	2024		2025				2026				2027				2028				2029				2030	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
3.2 Construct Ou SraLau offtake in Battambang																								
3.3 Develop flood risk maps																								
3.4 Develop community flood preparedness plans																								
B. Project Management Activities[a]																								
Mobilize project management and implementation support consultant																								
Review and update the social and environment safeguard documents																								
Implement the gender action plan																								
Inception (I), annual (A) review, midterm (M) review, and final (F) review missions		I				A				M				A				A				F		
Periodic progress reports																								
Annual audited project financial statements																								
Project completion report																								

AWD = alternative wetting and drying, DMF = design and monitoring framework, FWUC = farmers water user community, Q = quarter, RBC = river basin committee, WRM = water resources management.

[a] Two detailed engineering consultant teams are being recruited with the target contract and fielding in September 2024 (team 1) and January 2025 (team 2) with financing from AIIB's project preparation special funds, to be administered by AIIB.

Source: Asian Development Bank

XI. PROJECT COST ESTIMATES

A. METHODOLOGY

248. Capital costs have been calculated for each sub project by completing an outline of the expected canal/channel sizes and necessary structures, and estimating quantities of excavation/fill, concrete, land acquisition, gates etc to derive a Bill of Quantities. Unit rates from similar projects in Pursat and Battambang (2022 prices) are then used to derive a cost of the civil works. A contingency of 5% is applied reflecting uncertainties of the design as further consultation and survey is needed. Design and Supervision cost is included in the estimate of PMIC and the separate advance works DED for Kbal Hong regulator and intakes, all based on time estimates and unit rates. PMIC work on support to RBMC, hydromet and flood forecasting systems are based on direct estimates of time required and cost of goods. Agricultural support is based on unit rates per hectare.

249. Operation and maintenance costs are estimated based on an annual estimation approach. For the Irrigation systems, unlined canals are to be used and annual routine O&M of earthworks are assumed as 5% of construction cost, structures 1% and a periodic O&M every 10 years of 30% of construction cost of earthworks and 10% of structures. For the flood schemes an operating cost of the hydromet and forecasting systems is estimated and similar operating costs for channels and structures.

B. PROJECT COST ESTIMATES

1. Cost Breakdown

250. The estimated cost breakdown for the project is given in Table 11-1. The base costs for the project are estimated as $154.3m before contingencies and financing. This includes estimated resettlement and land acquisition costs. After adding physical and financial contingencies and financing charges the total project financing comes to $198.18m which is 28.4% above the base cost. Inflation and contingency parameters used are given in Table 11-2 and the breakdown by output in Table 11-3. 85% of costs are associated with output 2.

2. Key Assumptions

251. The Key Assumptions used are:

(i) Base cost estimates in Q4 2023 Prices
(ii) Contingencies comprise physical and price as shown in **Error! Reference source not found.** total $24.2m
(iii) Taxes on civil works, consulting services, goods and PMU services are included amounting to $13.24m to be financed by ADB, AIIB and government of Cambodia in proportion $6.58m ADB loan $0.33m ADB grant$ 6.29m AIIB loan, government $0.03m.

252. More details are given in Appendix 2 and 3.

Table XI-1 IWRM Project Cost breakdown

KINGDOM OF CAMBODIA: INTEGRATED WATER RESOURCES MANAGEMENT PROJECT
RRP TABLE 2: SUMMARY COST ESTIMATES

Table 2: Summary Cost Estimates
($ million)

		Amount	%
	A. Base Costs a, b		
	Spare		
Output 1: Planning, coordination, and climate change adaptation capacities of water resources management strengthened			
SUB_1.1	Procurement, supply and installation of hydrometeorological equipment	0.63	0.3%
SUB_1.2	Development of flood and drought forecasting systems	0.45	0.2%
SUB_1.3	Support to NRBMC and Pursat & Sangker rivers basin committees	1.46	0.7%
Output 2: Water supply capacity during dry season increased			
SUB_2.1	Civil works for Pursat regulator/barrage (Kbal Hong irrigation system)	21.39	10.8%
SUB_2.2	Main canal for Kbal Hong irrigation system MC1	11.83	6.0%
SUB_2.3	Main canal for Kbal Hong irrigation system MC2	7.78	3.9%
SUB_2.4	Secondary canals for Kbal Hong irrigation system MC1	14.16	7.1%
SUB_2.5	Tertiary canals for Kbal Hong irrigation system MC1	5.73	2.9%
SUB_2.6	Secondary and tertiary canals for Kbal Hong irrigation system MC2	13.18	6.7%
SUB_2.7	Land acquisition and resettlement for Kbal Hong subproject	3.37	1.7%
SUB_2.8	Subsidiary canals for Kanghot irrigation system MC1	9.04	4.6%
SUB_2.9	Subsidiary canals for Kanghot irrigation system MC4	11.83	6.0%
SUB_2.10	Main and subsidiary canals for Kanghot irrigation system MC6 (existing)	10.78	5.4%
SUB_2.11	Main and subsidiary canals for Kanghot irrigation system MC7 and MCE	3.94	2.0%
SUB_2.12	Land acquisition and resettlement for Kanghot subproject	3.24	1.6%
SUB_2.13	Fish pass construction	6.20	3.1%
SUB_2.14	Farmer water user community establishment and capacity building	0.68	0.3%
SUB_2.15	Agriculture support services in Kbal Hong subproject - team 1	0.32	0.2%
SUB_2.16	Agriculture support services in Kbal Hong subproject - team 2	0.32	0.2%
SUB_2.17	Agriculture support services in Kanghot subproject - team 3	0.32	0.2%
SUB_2.18	Agriculture support services in Kanghot subproject - team 4	0.32	0.2%
SUB_2.19	Independent Third Party (ITP) Monitors for voluntary land donation (VLL	0.15	0.1%
SUB_2.20	Detailed risk assessment and community participation framework develc	0.15	0.1%
Output 3: Flood risks during wet season reduced			
SUB_3.1	Civil works for Pursat subproject	14.67	7.4%
SUB_3.2	Land acquisition and resettlement for Pursat subproject	1.75	0.9%
SUB_3.3	Civil works for Sangker subproject	2.78	1.4%
SUB_3.4	Land acquisition and resettlement for Sangke subproject	0.36	0.2%
Project management			
SUB_4.1	Project Management and Implementation Consultant (PMIC)	5.20	2.6%
SUB_4.2	Procurement Specialist (international)	0.07	0.0%
SUB_4.3	Procurement Specialist (national)	0.04	0.0%
SUB_4.4	Vehicles	0.36	0.2%
SUB_4.5	Computers and office equipment	0.08	0.0%
SUB_4.6	Motorcycles	0.01	0.0%
SUB_4.7	Office furniture	0.02	0.0%
SUB_4.8	PMU salaries	0.35	0.2%
SUB_4.9	PMU operation and maintenance	0.41	0.2%
SUB_4.10	Gender Action Plan	0.26	0.1%
SUB_4.11	Environmental management	0.71	0.4%
	Subtotal (A)	**154.32**	**77.9%**
	B. Contingencies c,d		
	Physical	8.77	4.4%
	Price	15.43	7.8%
	Subtotal (B)	**24.20**	**12.2%**
	C. Financing Charges During Implementation e		
	Interest during construction	**18.88**	9.5%
	Commitment charges	**0.79**	0.4%
	Subtotal (C)	**19.67**	**9.9%**
	Total (A+B+C)	**198.18**	**100.00%**

Note: Figures may not sum due to rounding.
Source: ADB estimates.

Table XI-2 Cost Estimate by Expenditure Category and Output (Million $)

	Output 1: Planning, coordination, and climate change adaptation capacities of water resources management strengthened		Output 2: Water supply capacity during dry season increased		Output 3: Flood risks during wet season reduced		Total cost
	Amount	% of Cost	Amount	% of Cost	Amount	% of Cost	
A. Investment Costs a,b							
Civil Works	-	-	115.85	86.9%	17.45	13.1%	133.30
Goods	0.64	58.0%	0.40	36.4%	0.06	5.7%	1.10
Land acquisition and resettlement	-	-	6.61	75.7%	2.12	24.3%	8.73
Consultants							
Consulting services (Environmental management)	0.01	1.8%	0.60	85.0%	0.09	13.2%	0.71
Consulting services (Gender action plan)	0.00	1.8%	0.22	85.0%	0.03	13.2%	0.26
Consulting services (Project management)	0.09	1.8%	4.52	85.0%	0.70	13.2%	5.31
Consulting services (Capacity development)	1.90	49.4%	1.95	50.6%	-	-	3.86
Land acquisition arrangement for tertiary canals	-	-	0.29	100.0%	-	-	0.29
Subtotal (A)	**2.65**	**1.7%**	**130.45**	**85.0%**	**20.46**	**13.3%**	**153.56**
B. Recurrent Costs a,b							
PMU salaries	0.01	1.8%	0.30	85.0%	0.05	13.2%	0.35
PMU operation and maintenance	0.01	1.8%	0.35	85.0%	0.05	13.2%	0.41
Subtotal (B)	**0.01**	**1.8%**	**0.64**	**85.0%**	**0.10**	**13.2%**	**0.76**
A+B	**2.67**	**1.7%**	**131.10**	**85.0%**	**20.56**	**13.3%**	**154.32**
C. Contingencies c,d							
Physical	0.27	3.0%	7.32	83.5%	1.18	13.5%	8.77
Price	0.22	1.4%	13.34	86.5%	1.87	12.1%	15.43
Subtotal (C)	**0.48**	**2.0%**	**20.66**	**85.4%**	**3.05**	**12.6%**	**24.20**
A+B+C	**3.15**	**1.8%**	**151.76**	**85.0%**	**23.61**	**13.2%**	**178.52**
D. Financing Charges During Implementation e							
Interest during construction	0.33	1.8%	16.05	85.0%	2.50	13.2%	18.88
Commitment charges	0.01	1.8%	0.67	85.0%	0.10	13.2%	0.79
Subtotal (D)	0.35	1.8%	16.72	85.0%	2.60	13.2%	19.67
Total Project Costs (A+B+C+D)	3.50	1.8%	168.48	85.0%	26.21	13.2%	198.18

Note: Figures may not sum due to rounding.
Source: ADB estimates.

XII. FINANCIAL AND ECONOMIC ANALYSIS

A. APPROACH FOR FINANCIAL AND ECONOMIC ANALYSIS

253. Financial and Economic Analyses were carried out for the four main infrastructure based sub-projects:

(i) Kanghot Irrigation System
(ii) Kbal Hong Irrigation System
(iii) Sangker Flood Management
(iv) Pursat Flood Management

254. In each case costs including capital and operations were estimated from a breakdown of the quantities of work required and appropriate unit rates together with benefits then discounted over the expected life of the project. The calculation for irrigation benefits of the first two Sub-Projects is based on the additional crop production and nett revenue per year whereas the two flood project make use of modelling at different return period floods to determine areas of crop damage and people affected and then with the application of damage functions to estimate damages at each return period. This is then integrated to give an estimate a mean annual flood damage avoided. The approach for flood analysis is in line with the principles of risk management and as recommended in a recent ADB Guide[8]. Other direct and indirect damages could be taken into account in the flood benefit calculation but benefits already outweighed potential costs by a significant margin.

255. Financial costs and benefits are adjusted using standard techniques accounting for taxes, transport, cost of labour etc to also give economic values of cost and benefits for each Sub Project as detailed in Appendix 3 and the individual feasibility studies Appendices 11-14. The summary of the Financial and Economic Rates of return and net present value for the preferred option for each Sub Project are given in Table 12-1 below.

256. The EIRR of each proposed Sub Project is above the minimum rate of 12% and the Net Present Values are all positive.

257. The net revenue for farmers is estimated to increase to over $2000/ha in both schemes, a significant uplift especially in Kbal Hong which currently has a low cropping intensity due to the non-functioning IS.

258. The returns on improving flood management are smaller but as the investment costs are smaller there is still a good rate of return on investment. In both cases the benefit comes from improvements in dam outflow regulation during flood and some works to relieve flood flows in the main channel through Battambang and Pursat urban areas. As the cost of dam improvement does not involve physical works but a combination of improved forecasting, operating rules and agreement through the River Basin Committees, the supporting costs of this work has been included in the Flood Cost estimates used.

[8] https://www.adb.org/sites/default/files/project-documents/52014/52014-001-tacr-en_0.pdf

Table XII-1 Summary of Economic Analysis for Sub Projects

Sub Project	Area Served (ha)	Invest-Ment ($m)	EIRR (%)	ENPV ($m at 9%)	Net Revenue Increment or Damage Avoided ($m/y)	O&M cost /y ($m)
Kanghot IS	17,020	41.56	22.35	42.73	19.0	1.05
Kbal Hong IS	11,646	82.54	15.94	42.42	21.4	2.22
Sangker Flood		3.39	51.36	17.35	3.26	0.04
Pursat Flood		17.33	11.30	8.4	3.9	0.4

259. Sensitivity tests were carried out for key parameters. The irrigation sub projects are primarily sensitive to investment costs and crop yield/price.

260. The flood sub projects are less sensitive to the cost of the works than the depth of flood that influences the damage caused through the depth/damage function assumed. For Pursat damages from properties are less critical than Battambang.

Table XII-2 Summary of Sensitivity Analysis for Sub Projects

Sub Project	Area Served (ha)	EIRR (%) Base	EIRR (%) Cost 10% Higher	EIRR (%) Crop Price 10% lower	EIRR (%) Property Flooded 10% lower	EIRR (%) O&M cost /y 10% Higher
Kanghot IS	17,020	22.35	20.6	19.3	-	22.2
Kbal Hong IS	11,646	15.94	14.6	13.5	-	15.7
Sangker Flood		51.36	48.0	51.2	47.9	51.3
Pursat Flood		11.3	10.9	33.5	10.83	11.21

XIII. PROCUREMENT AND FINANCIAL MANAGEMENT

A. PROCUREMENT

1. Procurement Procedures

261. Procurement of goods, works, consulting services, and non consulting services will follow the ADB Procurement Policy (2017, as amended from time to time) and the Procurement Regulations for ADB Borrowers (2017, as amended from time to time) and in compliance with ADB Safeguards Policy Statement (2009). All safeguards documents must be cleared by ADB prior to award of contracts and start of civil works, and this applies to both prior- and post-review packages.

262. Procurement packages will be jointly co-financed with AIIB; ADB will be the lead financier and its procurement policy will apply to all procurement under this project. As the AIIB cofinancing will be partially administered by ADB, universal procurement will apply. Bidding documents for cofinanced packages will reflect that ADB and AIIB are jointly financing the project; and that both ADB and AIIB may inspect and audit the procurement process undertaken and subsequent contracts entered into by the borrower. These arrangements form part of a cofinancing framework agreement signed by ADB and AIIB

263. A strategic procurement planning exercise was carried out to ensure that fit-for-purpose procurement approaches are developed to achieve value for money and the project's development objectives. All procurement will be undertaken by the PMU on behalf of MOWRAM. The Pursat and Battambang IAs will not undertake any procurement. Main procurement activities include for Output 1: one consulting services contract for Support to the River Basin Management Committees (RBMC) and flood forecasting system ($2,000,000) and one goods contract for supply, installation, commissioning and maintenance of AWS and AHS equipment for hydromet stations in Sangker and Pursat river basins ($700,000); for Output 2: 7 works contracts internationally advertised ($143 million) for construction of a new regulator (barrage), and for renovation of main, secondary and tertiary irrigation canals and associated works having values from $12 million to $28 million, and 3 works contracts nationally advertised ($21 million) for renovation of main, secondary and tertiary canals, and the new construction of fishways. The geographic location of the contracts are 5 contracts for the Pursat regulator and Kbal Hong irrigation system ($86 million) in Pursat province, 4 contracts for the Kanghot irrigation system ($48 million) in Battambang province, and 1 contract for fishways ($8 million) in various provinces; for Output 3: 2 contracts ($8 million) for flood prevention works, one each located in Pursat and Battambang provinces. Packaging approach is based on a) geographic location, b) works priority and scheduled readiness of designs and land availability, c) aggregation into packages by either nature of the work and/or by zone, and d) sizing taking account of market assessment and lessons learnt from previous projects in the irrigation sub- sector.

264. Value for money is achieved by a conventional approach to procurement through use of open competitive bidding with package size and scope tailored to market capacity in order to attract a reasonable number of responsive bids and to achieve competitive bid prices. Open competitive bidding using single stage one envelope bidding procedures will be applied for all civil works and goods packages to enhance efficiency and transparency. A consulting firm will support MOWRAM to undertake detailed design, to provide support for project and interface management in a professional manner, and to administer contracts with delegated powers as the Engineer under FIDIC 2017 conditions "acting neutrally" thus enhancing transparency and fairness.

2. Procurement Risk

265. **The procurement risk is assessed as substantial** reflecting the ADB's assessed risk rating of the country and sector having weak oversight and integrity systems, absence of an e-procurement system to enhance transparency, governance arrangements with excessive concentration of powers, and risk of delay due to land acquisition. Recognition is made of the extensive experience of the EA of donor financed projects, and recent project completion reports showing a pattern of improved timeliness in projects and successful use of advanced contracting. Risk mitigation measures include the use of appropriate packaging and qualification criteria to encourage price competition in bidding, the engagement of a consulting firm to act as the FIDIC Engineer and administer the contracts, and the systematic publication of contract award notices.

3. Advance contracting.

266. Advance contracting will be used for: (i) recruitment of project management and implementation consultants (PMIC), using quality- and cost-based selection (QCBS); (ii) recruitment of individual start-up procurement consultants using individual consultant selection (ICS); (iii) procurement of office equipment and vehicles through request for quotations and OCB for national advertisement, respectively. The steps to be concluded in advance will include pre-qualification and short-listing, tendering, and bid and proposal evaluation. The issuance of invitations to bid (for goods, works, and nonconsulting services) or requests for proposals (for consulting and nonconsulting services) under advance contracting will be subject to ADB approval. The borrower and MOWRAM have been advised that approval of advance contracting does not commit ADB to finance the project.

267. Post-review sampling approach. Prior review will be applied as a minimum for the first contract for all nationally advertised works, goods and non-consulting services and for all internationally advertised works, goods and consulting services. Subsequent contracts would be reviewed by post review. The post review (sampling) will be conducted during each loan review mission and may also be additionally conducted by request. Contracts for post review (sampling) will be selected by stratified random sampling.

268. Contract management. All ADB-financed goods and works contracts are envisaged to be conventional and managed with a transactional approach. The implementation arrangement on contract management will be contract administration by a project management and implementation support firm, with oversight and support by the PMU. A contract management plan will be prepared as required in ADB Procurement Regulations 2017. At the beginning of each civil works contract execution, an effective contract management plan will be developed to ensure that the contracts are successfully implemented and that the deliverables are met as agreed in the contract.

4. Procurement Plan

269. An 18-month procurement plan indicating procurement packages and review procedures for goods, works, consulting services, and non-consulting services is included in the Project Administration Manual.

B. FINANCIAL MANAGEMENT

270. The financial management assessment (FMA) was conducted in April-May 2023 and updated in February 2024 following ADB's guidance. The FMA assessed the financial management arrangements of the executing and implementing agencies, including fund flow, staffing, accounting policies and procedures, financial reporting and monitoring, internal and external auditing arrangements and financial information systems, and the sufficiency of the financial management arrangements for implementing the project. Based on the assessment, the key financial management risks identified are relatively minor, based on taking up the

same FM model as for existing and recent projects under the same executing agency, with the key findings being: (i) monitoring the fund flow to avoid delays in processing fund replenishments, (ii) institutionalizing projects' FM capacity within MOWRAM, (iii) the development of a project-specific FM Manual, including a few changes to the existing FM model, and (iv) MOWRAM carrying out internal audit for the project. **The overall pre-mitigation financial management risk of the project is Moderate, although the risk of the financing for the land acquisition and resettlement is High.** The executing agency is experienced in the administration of advance fund and Statement of Expenditures (SOE) procedures and has the capacity to administer these procedures for the project. The borrower and executing agency have agreed to implement an action plan to mitigate the project financial management risk. Procurement and Financial Management (Summary). (detailed are in the Strategic Procurement Plan and Financial Management Assessment).

5. Disbursement and Advance Funds Procedures

271. Disbursement of the loan and grant proceeds, including ADB-administered cofinancier funds, will follow ADB's Loan Disbursement Handbook (2022), as amended from time to time) and detailed arrangements agreed between the government and ADB.

272. A large proportion of the payments will be arranged through Direct Payments made by ADB, through the implementation of large contracts. MOWRAM will be responsible for (i) collecting and retaining supporting documents and (ii) preparing and sending withdrawal applications to ADB.

273. MOWRAM should establish and maintain separate advance account(s) for each funding source, with one advance account per source of financing (as required) held jointly by MEF/MOWRAM, and administered by MOWRAM. The currency of the advance account(s) is US$. The advance account(s) is to be used exclusively for ADB's and ADB-administered cofinancier funds share of eligible expenditures. MOWRAM administers the advance account and is accountable and responsible for the proper use of advances to the advance account, including advances to any subaccounts. Advance accounts will be replenished through WAs submitted to ADB.

6. Evaluation

274. The implementing agency, with PMIC support, will provide semi-annual updates on the project's performance through the PPMS. The status of achievement of performance targets or indicators of the project's outcome and output will be provided in the semi-annual updates. ADB review missions will review the PPMS semi-annually to evaluate the project's performance and the likelihood of delivering the desired outputs and achieving the envisaged outcome. Corrective actions will be agreed with the executing agency or implementing agency and recorded in the aide memoires or MOUs and subsequently monitored by ADB and the executing agency. Within 6 months of physical completion of the project, the executing agency will submit a project completion report to ADB.

7. Reporting

275. The executing agency will provide ADB with (i) quarterly progress reports in a format consistent with ADB's project performance reporting system and should include the project's financial progress, showing periodic and cumulative amounts of budgeted and actual sources and uses of funds (covering the total project cost) following the cost categories in the project administration manual and reconciled with ADB's records; (ii) consolidated annual reports including (a) progress achieved by output as measured through the indicator's performance targets, (b) key implementation issues and solutions, (c) updated procurement plan, and (d) updated implementation plan for the next 12 months; and (iii) a project completion report within 6 months of physical completion of the project. To ensure that projects will continue to

be viable and sustainable, project financial statements {and the AEFS}, together with the auditor's report, should be adequately reviewed.

8. Auditing and Public Disclosure

276. The executing agency will cause the project's financial statements to be audited following the International Standards on Auditing by an independent auditor acceptable to ADB. The audited project financial statements, together with the auditor's opinion, will be presented in English to ADB within 6 months from the end of the fiscal year by the executing agency. Attach the agreed audit terms of reference. Unless a country-specific audit terms of reference has been agreed with the borrower, use the audit terms of reference template, which may be edited to suit project-specific requirements.

XIV. APPENDICES

Appendix 1 Sector Assessment

Appendix 2 Project Administration Manual

Appendix 3a Economic and Financial Assessment

Appendix 3b Detailed Economic and Financial Assessment

Appendix 4a ADB Summary Poverty Reduction and Social Strategy

Appendix 4b TRTA Poverty and Social Analysis

Appendix 5 Gender Action Plan

Appendix 6 Initial Environmental Examination

Appendix 7 Resettlement Framework

Appendix 8 Basic Resettlement Plan

Appendix 9 Strategic Procurement Plan

Appendix 10 Financial Management Assessment

Appendix 11 Feasibility Study: Kanghot Irrigation Scheme Subproject, Battambag Province

Appendix 12 Feasibility Study: Kbal Hong Irrigation scheme Subproject, Pursat Province

Appendix 13 Feasibility Study: Sangker River Flood Risk Flood Management

Appendix 14 Feasibility Study: Pursat River Flood Risk Management

Appendix 15 Fish Passage Engineering Assessment

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Appendix 29 PPSF Social Economic Survey and Focal Group Discussions