DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MNISTRY OF IRRIGATION

PREPARATORY SURVEY ON CASCADE SYSTEM DEVELOPMENT PROJECT IN NORTH CENTRAL AND NORTHERN PROVINCES IN DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

MAIN REPORT
(ADVANCED VERSION)

DECEMBER 2021

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.
NTC INTERNATIONAL CO., LTD.

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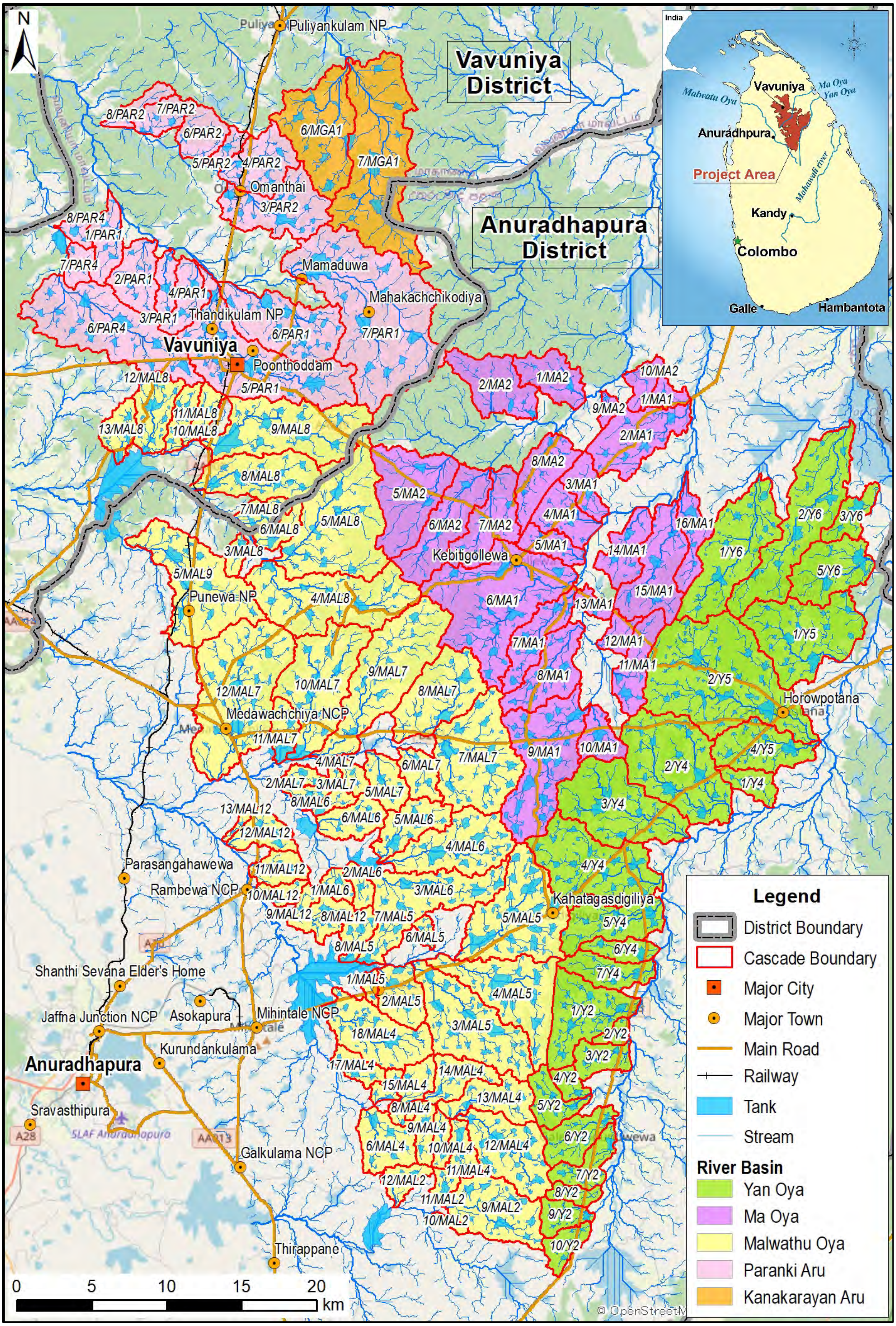
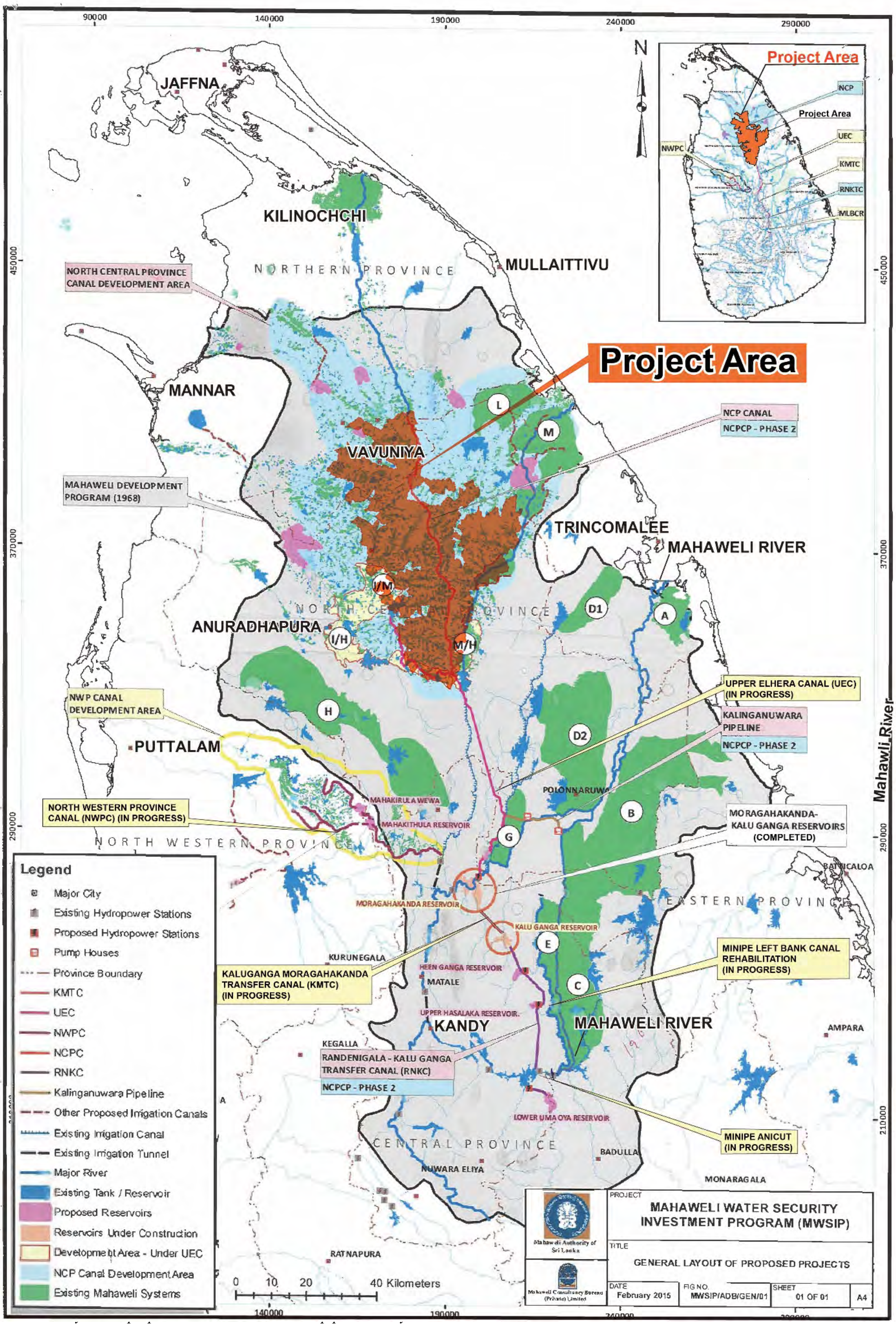


Source: Study Team

Location Map of the Project Area



General Layout of the Project under MWSIP

Photographs (1/2)

Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection	
Kick-off meeting at ID/MOI on 19th Feb. 2020	Kick-off meeting at Provincial Council on 27th Feb. 2020	Tank reservoir in the study area
		
Tank bund in the study area	Crack on the tank bund	Earth canal in the study area
		
Typical sluice structure		Taking water by pump (Serious silting)
		Non-disclosure information due to portrait protection
Typical spillway structure	Seriously damaged spillway	Temporary spillway
	Non-disclosure information due to portrait protection	
Bathing Steps	Drone Survey	

Source: Study Team

Photographs (2/2)

		Non-disclosure information due to portrait protection
Trial Construction		
Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection
FO meetings (Ichchankulam, Kiulekada, Naveli Kulam, Alagalla)		
Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection
Stakeholder meetings (Alagalla, Siyambalagaswewa, Ichchankulam)		
		Non-disclosure information due to portrait protection
Paddy Field	Combine Harvester	Anuradhapura Market
Non-disclosure information due to portrait protection	Non-disclosure information due to portrait protection	
Dambulla DEC Market	Livestock Silage	Livestock Advanced Farmer

Source: Study Team

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces in Democratic Socialist Republic of Sri Lanka

Executive Summary

Background of the Study

1. The Government of Sri Lanka (GOSL) has placed its priority on the development of the agriculture sector from the perspective of food security, poverty reduction, correction in regional disparities, and climate change resilience. In Sri Lanka, natural disasters due to the effects of climate change such as drought and flood have occurred frequently in recent years. Large-scale flooding took place in May 2016 and was followed by a historically severe drought across the country in late 2016 as well. *(Refer to Section 1.2)*

2. In order to uplift the economic situation in the dry zone, GOSL has initiated the Mahaweli Water Security Investment Program (MWSIP) including the North Central Province Canal (NCPC), with financial assistance from the Asian Development Bank (ADB). Through the construction of NCPC, water will be diverted from the Mahaweli River, as a new irrigation water source for the cascade tank systems in the dry zone.

   In the Project for Formulating Cascade System Development Plan under North Central Province Canal (CSDPP) carried out during the period from 2016 to 2018, the detailed survey was conducted in the six model cascade systems to confirm the present conditions of irrigation, disaster management, operation and maintenance, farm management, farmers organisation (FO), and the field verification program covering the four tanks was implemented for the development and rehabilitation of tank bund, irrigation facilities, and link canals. Based on the results, the overall cascade system development plan and the various projects were formulated for all the 128 cascade systems. *(Refer to Section 1.2)*

Objective of the Study

3. The objectives of the Study are i) to collect and analyse the data and information necessary for the project formulation, and ii) to prepare the project implementation plan, which covers the project scope, cost, implementation schedule, organisation structure for implementation, operation and maintenance (O&M), environmental and social considerations, project evaluation, etc. *(Refer to Section 1.4)*

Necessity and Priority of the Project

(Consistency with the National Development Plan)

4. The current government has set guideline for preparation of a five-year economic development target to guide the country towards a prosperous future. All ministries, departments, government institutions, provincial council, and local government bodies will be instructed to follow the guidelines laid out in the framework henceforth. However, the national development plan has not yet been published yet so far. *(Refer to Section 2.2(1))*

5. According to the Irrigation Department (ID)/ Ministry of Irrigation (MOI), the main thrust of the national development plan in water resources and irrigation sectors would be placed on a) climate adaptation, b) water resources development, and c) river basin development. In this regard, the development of river basins like cascade systems will be given the priority. Moreover, the ID/ MOI plans to rehabilitate 5,000 minor tanks for which different government agencies will be employed. *(Refer to Section 2.2(1))*

6. As for the agriculture sector, to minimise the foreign exchange spent on imported crops, ~~,~~ the current government has initiated a program of import substitution by encouraging local farmers to grow more of these crops. The main approaches considered are offering farmers with a government-declared farm gate price, providing subsidy of 50% on seed material for planting up to 0.3 ha, and imposing import restrictions. *(Refer to Section 2.2(1))*

(Consistency with Sustainable Sri Lanka 2030 Vision and Strategic Path (SDGs))

7. As a government policy paper to the United Nations (UN) 17 Sustainable Development Goals (SDGs), the report entitled as "Sustainable Sri Lanka 2030 Vision and Strategic Path" was prepared by the presidential expert committee and was published in January 2019 as a government policy paper for the UN 17 SDGs. The report sets out Sri Lanka's current country profile and status, key issues, and opportunities relating to sustainable development, future priorities and targets, and new initiatives and options to achieve the ambitious goals by 2030. The core framework seeks to harmonise the economic, social, and environmental dimensions of the sustainable development triangle. The practical pathway to achieve the sustainable development vision follows a Strategic Path of Balanced Inclusive Green Growth (BIGG) path, which will enable Sri Lanka to become a world leader of sustainability by 2030. *(Refer to Section 2.2(2))*

(Consistency with Overarching Agricultural Policy)

8. A number of national policies and strategy documents encompass activities in the agriculture sector. The most relevant of these policy documents include the New Trade Policy (2017), the National Policy on Sustainable Consumption and Development (2018), and the National Export Strategy (2018). Agricultural strategy, as expressed in the latest version of the Public Investment Program (PIP) 2017-2020, identifies two core strategic elements, namely: (i) food security of people by way of substituting possible imports and (ii) promoting exports of agro-based products through increased competitiveness in the international market. (Refer to Section 2.2(3))

9. The Overarching Agriculture Policy would achieve the vision and objectives through the statement of policy principles and policy action areas organised under ten thematic areas. The following policy principles, presented under the ten thematic areas, were examined in relation to the interconnectivity among the existing sub-sectoral policies and the alignment with all major development policies of the country: i) prosperous farmer community, ii) energising market linkages, iii) revitalising rural economy, iv) reaching to global value chain, and v) ensuring food and nutrition security and food safety. Historical developments, present scenarios, future prospects, lessons from experiences in global approaches, and best practices related to agricultural development were also considered. (Refer to Section 2.2(3))

(Development Assistance by Development Partners)

10. In order to uplift the economic situation in the dry zone, the GOSL has initiated several foreign-funded projects such as the Mahaweli Water Security Investment Program (MWSIP) with financial assistance from the Asian Development Bank (ADB), Climate Smart Irrigated Agriculture Project (CSIAP) by the World Bank (WB), and Climate Resilient Integrated Water Management Project (CRIWMP) by Green Climate Fund (GCF) and United Nations Development Programme (UNDP). (Refer to Section 2.6)

(Necessity and Urgency of the Project)

11. The Project is evaluated to be necessary and urgent as possible solutions to i) frequent occurrence of floods and droughts, ii) aging of tank irrigation facilities, iii) damage of farm roads, iv) mostly rice farmers, and v) not fully use of local resources, based on the preliminary problem analysis. *(Refer to Section 2.7)*

(Conduct Tank Inventory Survey and Field Inspection)

12. The Sri Lankan side proposed 124 tank cascade systems with the highest development priority among the 550 sub-projects existing in Anuradhapura and Vavuniya districts. The Study Team conducted tank inventory survey and field inspection for priority 124 tank cascade system to identify the ground situation and development needs. *(Refer to Section 3.1)*

(Proposed Project Outline and Components)

13. The objective of the Project is set as “development and rehabilitation of irrigation infrastructure (tanks, irrigation canals, and link canals) and farm roads in the cascade systems in the target area, in order to attain efficient use of water available for irrigation, flood prevention of farm lands and facilities, efficient transportation of agricultural products, and thereby promote agricultural development adaptable to climate change and improve agricultural productivity” *(Refer to Section 4.1)*

14. To achieve the above objectives, the Project takes three approaches, namely: (1) firm facility development with proper O&M, (2) crop and farm income diversification, and (3) create added value on agriculture produce. *(Refer to Section 4.1)*

15. The Project proposes four components as follows under above three approaches.

    Component 1: Cascade System Development
    Component 2: Soft Component
    Component 3: Project Management and Monitoring
    Component 4: Consulting Services

    The Component 1 includes two subcomponents, namely: infrastructure and facility development (Subcomponent 1.1) and procurement of machinery and equipment (Subcomponent 1.2). The Component 2 includes pilot activities related to (1) institution and capacity development of infrastructure O&M, (2) capacity development of cultivation techniques and provision of quality input, (3) post-harvest and marketing development, (4) livestock development, and (5) fishery development. To select the target tank cascade system for Subcomponent 1.1, 11 selection criteria are proposed. To select machinery and equipment to be procured under sub component 1.2, six selection criteria are proposed. *(Refer to Section 4.1, 4.2 and 4.3)*

Project Cost

16. [redacted]

Executing Agency

17. The executing agency is the MOI and implementation agencies are the ID for medium schemes (command area between 80 ha and 400 ha), Provincial Department of Irrigation (PID) for minor schemes (command area less than 80 ha) in Anuradhapura District, Department of Agrarian Development (DAD) for minor schemes (command area less than 80 ha) in Vavuniya District, and other supporting agencies. *(Refer to Sections 2.4 and 6.2)*

Project Organisation Structure

18. The MOI will establish the project management unit (PMU) and project implementation units (PIUs) along with the National Level Project Steering Committee (PSC) for the implementation of the Project. The PMU is responsible for overall project management and implementation including liaison between MOI and a lender, PSC and PIUs as well, and approval on all project activities proposed by PIUs. *(Refer to Section 6.2)*

Implementation Procedure

19. The implementation procedure for the Project has been proposed for Component 1 including detailed design works, procurement of contractors, infrastructure and facility development, procurement of machinery and equipment, and for Component 2 covering the selection of pilot FOs, preparation of annual plans and training materials, implementation of the programs, dissemination of pilot FO model to other FOs, procurement of contractor for training facilities/goods, and handing over training facilities/goods to FOs. PIUs will implement these activities after getting approval from the PMU. *(Refer to Section 6.3)*

Implementation Schedule

20. The project implementation period will be set at seven years; five years for cascade system development (Component 1), five years for soft components (Component 2), seven years for project management and monitoring (Component 3), and six years for consulting services (Component 4). The infrastructure and facility development (Subcomponent 1.1) will be implemented by five stage groups based on stage-wise implementation plan, and the procurement of machinery and equipment (Subcomponent 1.2) will be carried out on a quarterly basis. *(Refer to Section 6.4)*

Procurement Plan

21. Four types of procurement have been proposed for the Project, (i) civil works/facility, (ii) trainings, (iii) goods including machinery and equipment, and (iv) consulting services. . *(Refer to Section 6.5)*

Fund Management

22. Fund management for the Project has been proposed for (i) civil works/facility, (ii) trainings, (iii) goods including machinery and equipment, and (iv) consulting services. Advance procedure is

recommended to use for the above fund management, except for the international consultant for which the transfer procedure will be used. However, the disbursement procedure will be finalised by discussion between MOI and a lender during the project appraisal. *(Refer to Section 6.6)*

Contract Management

23. To implement the Project smoothly in accordance with the implementation schedule, PIUs need to organise construction supervision teams including a capable and experienced contract management expert in addition to the technical and management support by MOI and the Consultant. *(Refer to Section 6.7)*

Quality Control

24. Since the Project will implement many contract packages at once, it is proposed that the Consultant will prepare the check list for construction supervision and guide PIU engineering staffs on how to use it in order to ensure quality of the works performed by the contractors. *(Refer to Section 6.8)*

Safety Management

25. Safety management is to establish safe and health-conscious working environment in order to achieve the goal of "ensuring human safety". Special measures for COVID-19 shall be taken according to the government rules and guidelines. The establishment of such an environment should minimise the negative impact on the environment and/or society of the countries and consequently improve work efficiency and productivity. *(Refer to Section 6.9)*

Environmental and Social Impacts

26. Environmental and social impacts including issues on gender and ethnic coexisting communities were examined, and necessary management measures were proposed for the Project. The Project by nature does not involve construction of new irrigation facilities but involves the rehabilitation of existing minor and medium tank irrigation facilities, farm roads, and the creation of provision for agriculture promotion activities of the farmers. No land acquisition will be involved. Although no significant adverse impacts are expected, various environmental and social impacts may occur. These impacts can be minimised by adopting the proposed mitigation measures and implementing monitoring plans. *(Refer to Section 7.1)*

27. An environmental impact analysis/initial environmental examination (EIA/IEE) approval process for the Project is not required under the National Environmental Act. However, it is necessary to consult with relevant organisations such as the Forest Department, Department of Wildlife Conservation and/or the district secretariat, to examine the exact locations of the rehabilitation work and receive the concurrence for the implementation of the Project. *(Refer to Section 7.1)*

Gender Mainstream

28. Special consideration was given to gender and conflict prevention in the Project. For gender, gender mainstreaming policies as well as the current situation of women in rural areas of Sri Lanka were examined. Also, gender issues and needs for women in the study areas were discussed, and actions to address these issues and needs for implementation in the project framework were proposed. *(Refer to Section 7.2)*

Conflict Prevention

29. For conflict prevention, potential risks and issues of conflict that may be induced between ethnically different communities on water resource management by the Project were analysed. The risks of conflict will be mitigated by taking the actions suggested in the project framework. *(Refer to Section 7.3)*

Project Benefits and Economic Evaluation

30. The project benefits consist of the irrigation benefit and flood mitigation benefit on a monetary basis, which are tentatively estimated and assumed in the development plan proposed by the Study Team. *(Refer to Section 8.2)*

Risk Assessment and Management

31. The critical risks of the Project are assumed to be i) the risk of project cancellation or suspension resulting from the change in the development priority of the new government and ii) the risk of delay in project implementation resulting from the lack of staff in PID and DAD to implement the Project. It is especially important to take action to prevent the occurrence of these risks. *(Refer to Section 8.5)*

Adaptation Measures for Climate Change

32. The Project itself is a kind of adaptation measure for climate change. In addition, a pipeline canal system and partial desilting is proposed on a pilot basis in each model cascade. *(Refer to Section 8.6)*

Project Evaluation

33. [redacted]

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces in Democratic Socialist Republic of Sri Lanka

Final Report
Main Report
(Advanced Version)

Table of Contents

Location Map of the Project Area

General Layout of the Project under MWSIP

Photographs of the Study

Executive Summary

Page

CHAPTER 1 INTRODUCTION...1-1
1.1 General...1-1
1.2 Background of the Project...1-1
1.3 General Features of the Project...1-2
1.4 Objectives of the Study...1-2
1.5 Scope of the Study...1-2

CHAPTER 2 CONFIRMATION OF OBJECTIVE AND NECESSITY OF THE PROJECT...........2-1
2.1 General...2-1
2.2 Consistency with National Development Plan and Agriculture Sector Development Plan..........2-1
2.3 Economic and Social Conditions in the Project Area...2-5
2.3.1 Demography...2-5
2.3.2 Economy...2-8
2.4 Present Conditions and Issues in the Project Area...2-9
2.4.1 Tank Irrigation Infrastructure...2-9
2.4.2 Farm Road...2-12
2.4.3 Agriculture...2-13
2.4.4 Livestock and Fishery...2-17
2.4.5 Farmers Organisations in the Project Area...2-21
2.5 Climate and National Disasters in the Project Areas...2-26
2.5.1 Climate Condition...2-26
2.5.2 Natural Disasters...2-27
2.6 Development Assistance by Development Partners in the Project Areas...2-30
2.7 Necessity and Urgency of the Project...2-33

CHAPTER 3 SURVEY, INVESTIGATION AND ANALYSIS ON THE PROJECT..........................3-1
3.1 General...3-1
3.2 Tank Inventory Survey and Field Inspection...3-1
3.2.1 Sub-projects for Tank Inventory Survey...3-1
3.2.2 Database...3-2
3.2.3 Present Status of Infrastructure...3-6
3.2.4 Inspection and Assessment of Tanks and Related Facilities...3-12
3.2.5 Evaluation of STEIN...3-19
3.3 Study on Crack of Tanks Rehabilitated by CSDPP...3-20

3.3.1 Field Survey 3-20
3.3.2 Factors of Crack Occurrence 3-22
3.3.3 Crack Countermeasures 3-24
3.3.4 Trial Construction 3-25
3.3.5 Evaluation of Countermeasures 3-28

3.4 Drone Survey 3-30

3.5 Flood Analysis 3-33
3.5.1 Flood Discharge Estimation 3-33
3.5.2 Estimation of Flood Discharge 3-37
3.5.3 Result of Cascade Tanks Flood Discharge 3-39

3.6 Water Balance Study 3-40
3.6.1 Cropping Pattern 3-40
3.6.2 Preparation of Model for Water Balance Study 3-42

3.7 Present Condition of Agriculture 3-50
3.7.1 Agricultural Land Use 3-50
3.7.2 Cropped Area and Crop Production 3-52

3.8 Review of Farm Income and Farm Management Model 3-53
3.8.1 Review of Farm Household Income 3-53
3.8.2 Farm Management Model 3-55

3.9 Demand and Supply, Market and Distribution of Agricultural Products 3-58
3.9.1 Supply Chain of Major Crops 3-58
3.9.2 Demand and Supply of Paddy at Regional and Local Level 3-65

3.10 Study on Adoptability of Agriculture Monitoring Systems 3-67
3.10.1 Main Fields for Adoptability of Agriculture Monitoring Systems 3-67
3.10.2 Current Situation of Existing Systems 3-68
3.10.3 Measures to be Taken for Adoptability of Agriculture Monitoring Systems 3-69

3.11 Livestock, Fisheries, Fruit Tree Plantation 3-70
3.11.1 Livestock 3-70
3.11.2 Inland Fishery 3-71

3.12 Pipeline Canal System 3-73
3.12.1 Background and Objective 3-73
3.12.2 PVC-Pipeline Tank in Vavuniya 3-74
3.12.3 Study on the Standardised Pipeline Model 3-76

3.13 Partial Desilting Works 3-81
3.13.1 Background 3-81
3.13.2 Partial Desilting of Tank Bund 3-82
3.13.3 Procedure and Criteria for Selection of Tanks for Desilting Works 3-83

3.14 Emergency Spillway Gate 3-84

3.15 Link Canal 3-87

CHAPTER 4 SCOPE OF THE PROJECT 4-1

4.1 General 4-1
4.1.1 General Approach for the Project 4-1
4.1.2 Summary of the Proposed Project Scope 4-2

4.2 Component 1: Cascade System Development 4-3
4.2.1 Subcomponent 1.1: Infrastructure and Facility Development 4-3
4.2.2 Subcomponent 1.2: Procurement of Machinery and Equipment 4-7

4.3 Component 2: Soft Component 4-10
4.3.1 Target Area and Basic Concept for Component 2 Activity 4-10
4.3.2 Subcomponent 2.1: Institution and Capacity Development 4-12
4.3.3 Subcomponent 2.2: Agriculture Development 4-14
4.3.4 Subcomponent 2.3: Post-harvest and Marketing Development 4-17
4.3.5 Subcomponent 2.4: Livestock Development 4-19
4.3.6 Subcomponent 2.5: Fishery Development 4-21

4.4 Component 3: Project Management and Monitoring 4-22
4.5 Component 4: Consulting Services 4-25

CHAPTER 5 COST ESTIMATION 5-1
5.1 Basic Conditions of the Project Cost Estimation....................5-1
5.2 Total Cost of the Project 5-3
5.3 Breakdown of the Project Cost by Component 5-4
5.4 Cost Reduction 5-6

CHAPTER 6 IMPLEMENTATION PLAN OF THE PROJECT 6-1
6.1 General 6-1
6.2 Project Organisational Structure....................6-1
6.2.1 Project Organisation for Implementation Stage 6-1
6.2.2 Project Organisation for Operation and Maintenance Stage 6-5
6.3 Implementation Procedure 6-6
6.3.1 Subcomponent 1.1: Infrastructure and Facility Development....................6-6
6.3.2 Subcomponent 1.2: Provision of Machinery and Equipment....................6-9
6.3.3 Component 2: Soft Component 6-11
6.4 Implementation Schedule....................6-13
6.4.1 Overall Implementation Schedule 6-13
6.4.2 Component 1: Cascade System Development....................6-14
6.4.3 Component 2: Soft Component 6-14
6.4.4 Component 3: Project Management and Monitoring 6-17
6.4.5 Component 4: Consulting Services 6-18
6.5 Procurement Plan 6-18
6.5.1 Procurement Plan for Civil Work/Facilities 6-19
6.5.2 Procurement Plan for Goods 6-21
6.5.3 Procurement Plan for Training 6-21
6.5.4 Procurement Plan for Consultant....................6-21
6.6 Fund Management....................6-22
6.6.1 Civil Works/Facility 6-22
6.6.2 Goods 6-23
6.6.3 Trainings....................6-24
6.6.4 Consulting Services 6-25
6.7 Contract Management 6-25
6.8 Quality Control....................6-27
6.9 Safety Management for the Construction Works....................6-27
6.9.1 Construction Safety Issues 6-28
6.9.2 Safety Management....................6-29

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS, GENDER MAINSTREAMING AND CONFLICT PREVENTION 7-1
7.1 Environmental and Social Considerations....................7-1
7.1.1 Environmental and Social Conditions in the Project Area 7-1
7.1.2 National and Regional Government Organisations 7-12
7.1.3 Important Legislations and Policies Concerning Environmental and Social Considerations 7-12
7.1.4 Environmental Standard 7-15
7.1.5 EIA/IEE Process....................7-15
7.1.6 Components in the Proposed Development Plan 7-16
7.1.7 Scoping....................7-17
7.1.8 Survey Result 7-21
7.1.9 Impact Assessment....................7-25
7.1.10 Summary of Impacts 7-28
7.1.11 Comparison to the No-Project Alternative 7-28
7.1.12 Mitigation Measures....................7-29

7.1.13 Monitoring Plan 7-31
7.1.14 Stakeholder Meeting 7-33
7.1.15 Checklist 7-34
7.1.16 Conclusion and Recommendation on the Environmental and Social Considerations 7-34

7.2 Gender Mainstreaming 7-34
7.2.1 Sri Lanka's National Gender Policy 7-34
7.2.2 Gender Policy related to Agriculture Sector 7-35
7.2.3 Gender-oriented Actions by Other Development Partners' in Similar Projects 7-36
7.2.4 Gender Roles and Issues in the Study Area 7-37
7.2.5 Actions to be Taken 7-41

7.3 Conflict Prevention 7-41
7.3.1 Cascades with Mixed Ethnicity 7-42
7.3.2 Potential Risks and Issues 7-42
7.3.3 Suggested Actions to Mitigate Risks and Issues in the Project Framework 7-44

CHAPTER 8 PROJECT EVALUATION 8-1

8.1 General 8-1

8.2 Project Benefits 8-1
8.2.1 Irrigation Benefits 8-1
8.2.2 Flood Mitigation Benefits 8-4

8.3 Effects of the Project 8-6
8.3.1 Quantitative Effects 8-6
8.3.2 Qualitative Effects 8-7
8.3.3 Contribution to Sustainable Development Goals (SDGs) and Post-COVID-19 8-8

8.4 Operation and Effect Indicators 8-9
8.4.1 Operation Indicators 8-10
8.4.2 Effect Indicators 8-10
8.4.3 Monitoring Method and Structure for Operation and Effect Indicators 8-11

8.5 Risk Management 8-12
8.5.1 Approach to Risk Management 8-12
8.5.2 Identification and Assessment of Risks 8-13

8.6 Adaptation Measures for Climate Change 8-14
8.6.1 Climate Change Impact 8-14
8.6.2 Action Plan for Climate Change 8-16
8.6.3 Adaptation Measures for Climate Change 8-17

8.7 Project Evaluation 8-18
8.7.1 Economic Evaluation 8-18
8.7.2 Project Evaluation 8-23

Attachment

Page

Attachment 2.4-1 FO Financial Situation A2-1
Attachment 3.1-1 List of 124 Cascade System A3-1
Attachment 3.2-1 Site Inspection of STEIN Canal A3-5
Attachment 3.3-1 Cracks of the Tanks Rehabilitated by CSDPP A3-6
Attachment 3.3-2 Result of Plaster Survey on Cracks of Tanks Rehabilitated by CSDPP A3-9
Attachment 3.3-3 Cross Section Sketch and Photographs of Cracks at Puliyankram Tank A3-10
Attachment 3.3-4 Sub-section of Trial Construction at Puliyankram Tank A3-13
Attachment 3.3-5 Comparison of Trial Construction Countermeasures A3-15
Attachment 3.4-1 Drawing of 5 Tanks by Drone Survey A3-16
Attachment 3.5-1 Summary of Cascade Tank Flood Discharge A3-21
Attachment 3.6-1 Cropped Area and Cropping Intensity in Six Model Cascades A3-34
Attachment 3.6-2 Cropping Pattern under Three Models for Six Model Cascades A3-37
Attachment 3.6-3 Parameters of Water Balance Study on Cascade System A3-43
Attachment 3.6-4 Example Result of Simplified Water Balance Calculation Model A3-45

Attachment 3.6-5 Tank Capacity Survey Result by CSDPP A3-48
Attachment 3.8-1 Crop Budget after the Project and after NCPC Coming A3-50
Attachment 3.12-1 Top 50 Tank List by Elevation Gap for Pipeline Canal A3-51
Attachment 3.13-1 List of Target Tanks for Partial Desilting Works A3-52
Attachment 4.3-1 Location Map of Model Cascades A4-1
Attachment 4.5-1 Draft Terms of Reference for Consulting Services A4-2
Attachment 6.4-1 Review of CSDPP Implementation Schedule for Infrastructure and Facility Development A6-1
Attachment 6.5-1 Plan for Contract Packaging by Sub-project A6-5
Attachment 7.1-1 Detail Test Result of Water Quality Test of the Five Project Target Tanks A7-1
Attachment 7.1-2 Detail Test Result of Soil Test of the Five Project Target Tanks A7-5
Attachment 7.1-3 Detail Test Result of Bottom Sediments Test of the Five Project Target Tanks A7-9
Attachment 7.1-4 Environmental Sensitive Areas in Anuradhapura District A7-13
Attachment 7.1-5 Environmental Sensitive Areas in Vavuniya District A7-14
Attachment 7.1-6 Biological Environment of the Study Areas and Existing Vegetation and Flora and Fauna A7-15
Attachment 7.1-7 Environmental Standard A7-19
Attachment 7.1-8 List of Tanks Seemingly Overlap with Reserved Forest A7-23
Attachment 7.1-9 Monitoring Form A7-26
Attachment 7.1-10 Result of the Stakeholder Meetings A7-30
Attachment 7.1-11 Environmental Checklist A7-37
Attachment 8.2-1 Crop Budget of Paddy A8-1
Attachment 8.2-2 Crop Budget of Crops (Economic) A8-2
Attachment 8.2-3 Economic Benefit of Irrigation A8-6
Attachment 8.2-4 Flood Inundation Area Map Analysed by GIS A8-7
Attachment 8.2-5 Summary of Flood Damage Quantity A8-23
Attachment 8.2-6 Summary of Flood Damage Cost A8-25
Attachment 8.5-1 Risk Management Framework A8-27
Attachment 8.7-1 Cash Flow Table and Calculation of EIRR, NPV and B/C A8-31

Tables

Page

Table 1.3-1 General Features of the Project 1-2
Table 1.5-1 Area and Target Cascades 1-3
Table 1.5-2 Tank Facilities to be Developed and Rehabilitated by the Project 1-3
Table 2.2-1 Key Issues and Action Recommendations in Agriculture Sector 2-2
Table 2.2-2 Policy Statements in Ten Thematic Areas of Agricultural Sector 2-3
Table 2.3-1 Estimated Population of the Six Model Cascades 2-5
Table 2.3-2 Estimated Population by Gender and Locality 2-6
Table 2.3-3 Ethnicity of the Beneficiary Households of the Six Model Cascades 2-7
Table 2.3-4 Religion of the Beneficiary Households of the Six Model Cascades 2-7
Table 2.3-5 CBO Membership of the Six Model Cascades 2-8
Table 2.3-6 Monthly Household Income of the Beneficiary Households of the Six Model Cascades 2-8
Table 2.3-7 Primary Income Source by Six Model Cascades 2-9
Table 2.3-8 Divineguma/ Samurdhi Beneficiaries of the Six Model Cascades 2-9
Table 2.4-1 Cultivated Area of the Six Model Cascades 2-10
Table 2.4-2 List of Existing Facilities of the Six Model Cascades 2-10
Table 2.4-3 Rehabilitation Plan of the Six Model Cascades 2-11
Table 2.4-4 Structure of Irrigation Management System 2-11
Table 2.4-5 Major Problems and Causes in O&M for Irrigation Infrastructure 2-12
Table 2.4-6 Road Classification in Sri Lanka 2-13
Table 2.4-7 Major Problems and Causes in Maintenance for Farm Roads 2-13
Table 2.4-8 Average Landholding Size of the Six Model Cascades 2-13
Table 2.4-9 Distribution of Land Ownership and Tenure System of the Six Model Cascades 2-14
Table 2.4-10 Paddy Extent, Production and Yield in the Main Tank of the Six Model Cascades 2-15

Table 2.4-11	Paddy Extent, Production and Yield in the Other Tanks of the Six Model Cascades	2-15
Table 2.4-12	Paddy Extent, Production and Yield in the Irrigable Area of the Six Model Cascades	2-15
Table 2.4-13	Cultivated Extent of Other Crops in Highland	2-16
Table 2.4-14	List of Agricultural Service Centres	2-16
Table 2.4-15	Major Problems and Causes in the Agriculture Sector	2-17
Table 2.4-16	Dairy Farmers and Cattle Breeds	2-18
Table 2.4-17	Major Problems and Causes in Livestock Sector	2-19
Table 2.4-18	Main Features of Culture Based Fishery in Minor Tanks	2-20
Table 2.4-19	Summary of Major CBOs in the Project Area	2-23
Table 2.4-20	Major Problems and Causes in Functions of FOs	2-25
Table 2.5-1	Tentative Rehabilitation Cost Estimate for Flood Damage	2-29
Table 2.5-2	Flood Damage of the Small Tanks in Vavuniya	2-29
Table 2.6-1	List of Foreign Funded Projects in the Study Area	2-30
Table 2.6-2	List of Cascades Excluded from the Study	2-32
Table 2.7-1	Necessity and Urgency of the Project	2-33
Table 3.1-1	Summary of Adjustment of Benefit Irrigation Schemes under NCPCP	3-1
Table 3.2-1	Method for Preparation of Data Base	3-2
Table 3.2-2	Target of the Analysis	3-6
Table 3.2-3	General Feature and the Average Specification of the Existing Tanks	3-6
Table 3.2-4	General Feature and the Average Specification of the Sluice	3-7
Table 3.2-5	Average Number of Spillways and Specification	3-7
Table 3.2-6	Total Number and the Installation Rate of Other Facilities	3-8
Table 3.2-7	Rehabilitated Period of the Tanks	3-8
Table 3.2-8	Regular Maintenance Activity by FO	3-8
Table 3.2-9	Implementing Agency of Regular Maintenance Activities for Minor Tank	3-9
Table 3.2-10	Implementing Agency of Regular Maintenance Activities for Medium Tank	3-9
Table 3.2-11	Condition of the Houses in the Downstream Area of the Spillway	3-9
Table 3.2-12	General Feature and the Average Specification of the Irrigation Canal	3-10
Table 3.2-13	General Feature and the Average Specification of the Drainage Canal	3-10
Table 3.2-14	General Feature and the Average Specification of the Farm Road	3-11
Table 3.2-15	General Feature and the Average Specification of Farm Land, Agriculture Storehouse, and Farming Machinery	3-11
Table 3.2-16	General Criteria and Deformation Level of Facilities	3-12
Table 3.2-17	Check List for Facilities Inspection	3-12
Table 3.2-18	Target of the Analysis	3-13
Table 3.2-19	Summary of Inspection Result (Tank Bund)	3-14
Table 3.2-20	Summary of Inspection Result (Spillway and Spillway Canal)	3-15
Table 3.2-21	Summary of Inspection Result (Sluice and Irrigation Canal)	3-15
Table 3.2-22	Summary of Inspection Result (Reservoir)	3-16
Table 3.2-23	Conceptual Table of the Tank Bund Height	3-16
Table 3.2-24	Normal Freeboard and Minimum Freeboard in the Design Standard	3-17
Table 3.2-25	Minimum Freeboard and the Measurement Result of Fetch	3-17
Table 3.2-26	Afflux and Design Flood Discharge	3-17
Table 3.2-27	Proposed Dimension of Planned Normal Freeboard	3-18
Table 3.2-28	Outline of STEIN Trial Construction	3-19
Table 3.3-1	List of Crack Survey	3-21
Table 3.3-2	Procedure of Plaster Survey	3-21
Table 3.3-3	Results of Plaster Survey	3-22
Table 3.3-4	Important Matters of Quality Control	3-23
Table 3.3-5	Comparison of Crack Countermeasures	3-24
Table 3.3-6	Design Dimension Table of Six Countermeasures	3-25
Table 3.3-7	Selection Criteria	3-25
Table 3.3-8	Selection of Target Tank	3-26
Table 3.3-9	List of Cracks	3-27
Table 3.3-10	Condition of Countermeasures (as of 28th September 2020)	3-29

Table 3.3-11 Comparison of Conditions 3-29
Table 3.3-12 Tentative Evaluation of Countermeasures........ 3-30
Table 3.4-1 Tank List of Drone Survey........ 3-30
Table 3.4-2 Evaluation of Survey Methods........ 3-31
Table 3.4-3 Comparison of Reservoir Capacity by Different Survey Methods 3-31
Table 3.5-1 Probable Rainfall Depth for a 24-hour Storm Presented in the Irrigation Guideline........ 3-35
Table 3.5-2 Comparison of Unit Hydrograph and Rational Formula Methods........ 3-39
Table 3.6-1 Present Cropped Area and Cropping Intensity in the Model Cascade 3-40
Table 3.6-2 Cropped Area and Cropping Intensity by JIRCAS and Simplified Models........ 3-41
Table 3.6-3 Components of Water Balance of Cascade System........ 3-42
Table 3.6-4 Outline of Conditions........ 3-43
Table 3.6-5 Proportion of Cropping Area........ 3-43
Table 3.6-6 Outline of Conditions........ 3-44
Table 3.6-7 Command Area of Cascade (ID: 37)........ 3-45
Table 3.6-8 H-V Table of Assumed Integrated Tank (ID: 37)........ 3-45
Table 3.6-9 Comparison result of Six selected Cascades' Cropping intensity 3-46
Table 3.6-10 Summary of 124 Cascades water balance calculation 3-47
Table 3.7-1 Features and Characteristics of Agricultural Land Use in the Project Area........ 3-50
Table 3.7-2 Present Agricultural Land Use in the Project Area 3-51
Table 3.7-3 Cropped Area, Production and Yield of Crops in the Project Area........ 3-52
Table 3.7-4 Present Cropped Area and Cropping Intensity in the Project Area........ 3-53
Table 3.8-1 Monthly Income of Households in the District (LKR per month)........ 3-53
Table 3.8-2 Average Monthly Income of Farm Households (LKR per month) 3-54
Table 3.8-3 Number of Households by Farming Activities (Number of Households)........ 3-55
Table 3.8-4 Average Monthly Income by Farming Type (LKR per month)........ 3-55
Table 3.8-5 Average Holding Size in Model Cascades (ha)........ 3-56
Table 3.8-6 Average Holding Size by Farming Type (ha)........ 3-56
Table 3.8-7 Current Situation and Farm Management Model after NCPC........ 3-57
Table 3.8-8 Comparison of Annual Cropping Pattern of Present, after the Project and after NCPC........ 3-58
Table 3.8-9 Comparison of Annual Farm Income of Present, after the Project and after NCPC........ 3-58
Table 3.9-1 Imported Quantities and Value of Other Field Crops (2018) 3-61
Table 3.9-2 Government Declared Farm Gate Prices (LKR per Kg)........ 3-61
Table 3.9-3 Key Facts and Possible Solutions in Paddy/Rice Marketing 3-64
Table 3.9-4 Demand and Supply of Paddy at Regional and Local Level........ 3-65
Table 3.9-5 Past Demand and Supply of Paddy at Anuradhapura and Vavuniya Districts during the period from 2010 to 2015 3-66
Table 3.9-6 Future Crop Production under the Project 3-66
Table 3.10-1 Agriculture Monitoring Systems with Four Fields 3-68
Table 3.10-2 Measures to be Taken for the Adoptability of Agriculture Monitoring Systems........ 3-69
Table 3.11-1 Features of Livestock Farm Households in the Model Cascades........ 3-70
Table 3.11-2 Present Situation of Livestock discussed in FO Meetings 3-71
Table 3.11-3 Present Situation of Inland Fishery discussed in FO Meetings........ 3-71
Table 3.12-1 Pipelining and Open Earth Channel Benefit Comparison........ 3-74
Table 3.12-2 Outline of PVC-Pipeline Tank 3-74
Table 3.12-3 Pipeline System Hydraulic Calculation 3-78
Table 3.12-4 Comparison of Intake Facility Types 3-79
Table 3.13-1 Criteria for Screening of Tanks 3-83
Table 3.13-2 Criteria for Prioritisation of Tanks 3-84
Table 3.15-1 Outline of Link Canals........ 3-87
Table 3.15-2 Present Conditions of Link Canals........ 3-87
Table 4.1-1 Project Components 4-2
Table 4.2-1 Target Infrastructure and Facilities Development and Rehabilitation Works under Subcomponent 1.1........ 4-3
Table 4.2-2 Comparison of Infrastructure Development Units 4-5

Table 4.2-3	Contents of the Preliminary Design Report	4-5
Table 4.2-4	Criteria for Selection of Infrastructure and Facility Development Needs	4-6
Table 4.2-5	Target Machinery and Equipment to be Procured under Subcomponent 1.2	4-7
Table 4.2-6	Contents of the O&M Plan for Machinery and Equipment	4-9
Table 4.2-7	Selection Criteria for the Procurement of Machinery and Equipment	4-9
Table 4.3-1	Basic Approach and Programmes for Component 2	4-11
Table 4.3-2	Outline Programme of Capacity Improvement of FOs and the Relevant Government Officers for Water Management	4-12
Table 4.3-3	Outline Programme of Promotion of Awareness Campaign of Tank Day	4-14
Table 4.3-4	Outline Programme of Cultivation Skills Development with the Provision of Quality Inputs	4-15
Table 4.3-5	Outline Programme of Enhancement of Agriculture Extension System	4-16
Table 4.3-6	Outline Programme of Establishment of the Community Supported Agriculture Model	4-18
Table 4.3-7	Outline Programme of Stable Feed Production and Delivery through Entrepreneur Development	4-20
Table 4.3-8	Outline Programme of Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System	4-20
Table 4.3-9	Outline Training/Activity of Promotion of Inland Fishery Development in Selective Tanks	4-21
Table 4.4-1	Tentative List of Office Furniture and Equipment	4-22
Table 4.4-2	Tentative List of Vehicles and Motorbikes for PMU, PIUs, and the Consultant	4-23
Table 4.4-3	Training Programs for Manuals and Systems to be Used in the Project	4-23
Table 4.4-4	Training Programs for M&E Frameworks	4-24
Table 5.1-1	Basic Conditions of the Project Cost Estimation	5-1
Table 5.1-2	Approaches for the Project Cost Estimation	5-1
Table 5.2-1	Total Cost of the Project	5-3
Table 5.2-2	Disbursement Schedule of the Project	5-4
Table 5.3-1	Cost for Component 1: Civil Works	5-4
Table 5.3-2	Cost for Component 2: Institution and Capacity Development	5-5
Table 5.3-3	Cost for Component 3: Project Management and Evaluation	5-5
Table 5.3-4	Cost for Component 4: Consulting Service	5-6
Table 6.2-1	Proposed Members of the National Level Project Steering Committee	6-4
Table 6.2-2	Responsible Agencies for O&M	6-5
Table 6.3-1	Regular and Special Construction Meeting	6-8
Table 6.3-2	Training Facilities/Goods for Component 2	6-13
Table 6.5-1	Procurement Type of the Project	6-18
Table 6.5-2	Applicability of ICTAD SBD Procurement of Works	6-19
Table 6.5-3	Responsible Organisation and Officer for Pre-Construction Activities	6-20
Table 6.5-4	Standard Time Requirement for Pre-Construction Activities	6-20
Table 6.5-5	Points to be Considered in Contract Packaging	6-20
Table 6.5-6	Authority of Consultant Selection Committees for Contract Award Recommendation/Determination	6-22
Table 6.7-1	Major Claims during Contract Period (Samples)	6-26
Table 6.9-1	Basic Policies for Safety Management	6-29
Table 7.1-1	Land Use Pattern in Anuradhapura District (2018)	7-2
Table 7.1-2	Land Use Pattern in Vavuniya District (2018)	7-2
Table 7.1-3	Air quality Measurements as of 1999 in Anuradhapura	7-5
Table 7.1-4	Air Quality Data Obtained in October 2011 Parameter Concentration (micro g/m3)	7-5
Table 7.1-5	Noise Measurements for Per Aru Surface Water Extraction Project in Vavuniya	7-6
Table 7.1-6	Result of Water Quality Test of the Five Project Target Tanks	7-6
Table 7.1-7	Result of Water Quality Test of the Five Project Target Tanks	7-8
Table 7.1-8	Result of Bottom Sediments Test of the Five Project Target Tanks	7-9
Table 7.1-9	List of Wetlands in Anuradhapura District and their Current Status	7-10
Table 7.1-10	Archaeological Sites in Vavuniya and Anuradhapura Districts	7-10
Table 7.1-11	Distribution of Threatened Species of the Main Fauna Groups and Flora	

in Anuradhapura and Vavuniya Districts ... 7-11
Table 7.1-12 Key Legislations Concerning Environmental and Social Considerations ... 7-13
Table 7.1-13 Major Environment and Resettlement Policies ... 7-15
Table 7.1-14 Proposed Project Activity in Cascade Systems Development Plan ... 7-16
Table 7.1-15 Results of Scoping for Environmental and Social Impact Assessment ... 7-18
Table 7.1-16 Result of Water Quality Test of Five Target Tanks ... 7-22
Table 7.1-17 Environmentally Protected Areas in the Target Areas ... 7-22
Table 7.1-18 Potential Numbers of Target Tank Systems that Overlaps with Protected Areas ... 7-22
Table 7.1-19 Impacts of the Project ... 7-25
Table 7.1-20 Overview of Anticipated Negative Impacts ... 7-28
Table 7.1-21 Compared Impacts of the Project with No-Project Alternative ... 7-29
Table 7.1-22 Environmental and Social Issues and Mitigation Measures ... 7-29
Table 7.1-23 Monitoring Program ... 7-32
Table 7.1-24 List of Stakeholder Meetings ... 7-34
Table 7.2-1 Gender Differences in Involvement in Agriculture-related Activities ... 7-37
Table 7.2-2 Ethnic Groups and Decision-making Power (%) on Paddy Farming ... 7-38
Table 7.2-3 Female-Headed Households in Anuradhapura and Vavuniya Districts as Compared with the National Average (2012) ... 7-39
Table 7.2-4 Female-Headed Households in Target DSD ... 7-39
Table 7.2-5 Gender Issues, Needs and Actions to be Taken in the Project Framework ... 7-41
Table 7.3-1 Mixed Ethnicity Cascades in the Target Areas ... 7-42
Table 7.3-2 Suggested Actions to Mitigate Risks and Issues in the Project Framework ... 7-44
Table 8.2-1 Estimated Cropping Intensity at the Cultivated Area ... 8-1
Table 8.2-2 Summary of Economic Crop Budget ... 8-3
Table 8.2-3 Summary of Economic Crop Budget ... 8-3
Table 8.2-4 Summary of Economic Crop Budget ... 8-4
Table 8.2-5 List of Condition to Identify Inundation Areas by Flood ... 8-4
Table 8.2-6 Flood Damage of Short-listed Sub-projects ... 8-5
Table 8.2-7 Unit Flood Damage ... 8-5
Table 8.2-8 Total Flood Damage of Short-listed Sub-project ... 8-5
Table 8.3-1 Quantitative Effects of the Project ... 8-6
Table 8.3-2 Qualitative Effects of the Project ... 8-7
Table 8.3-3 Other Qualitative Effects Expected from the Project ... 8-8
Table 8.3-4 Contribution to SDGs Expected from the Project ... 8-8
Table 8.4-1 Proposed Operation Indicators of the Project ... 8-10
Table 8.4-2 Proposed Effect Indicators of the Project ... 8-10
Table 8.4-3 Monitoring Method and System for Operation and Effect Indicators ... 8-11
Table 8.5-1 Treatment for Risks ... 8-12
Table 8.5-2 Identification and Assessment of Major Risks of the Project ... 8-13
Table 8.6-1 Action Plan for Climate Change in Agriculture Related Sectors ... 8-16
Table 8.6-2 Climate Risk Assessment for the Project ... 8-17
Table 8.6-3 Adaptation Measures for Climate Change by the Project ... 8-18
Table 8.7-1 Calculation of Standard Conversion Factors ... 8-20
Table 8.7-2 Economic Cost of the Project ... 8-20
Table 8.7-3 Disbursement Schedule of Economic Project Cost (Unit: LKR in Million) ... 8-21
Table 8.7-4 Economic O&M Cost ... 8-21
Table 8.7-5 Economic Replacement Cost ... 8-21
Table 8.7-6 Economic Benefit of the Project ... 8-22
Table 8.7-7 Calculation Result of the Indicators for Economic Evaluation ... 8-23
Table 8.7-8 Result of Sensitivity Analysis ... 8-23
Table 8.7-9 Result of Evaluation of the Project ... 8-23

Figures

Page
Figure 1.2-1 View of Dri Aru Kulam Tank located at the end of the proposed NCPC ... 1-1
Figure 2.4-1 Source of Animal Feed and Milking Frequency ... 2-18
Figure 2.5-1 Average Annual Rainfall ... 2-26

Figure 2.5-2 Annual Climate Graph (upper: Vavuniya, lower: Anuradhapura) 2-26
Figure 2.5-3 Crop Damages in the Northern Province 2-27
Figure 2.5-4 Conditions of Irrigation in the North Central Province 2-28
Figure 2.5-5 Usage of Irrigation Tanks in the North Central Province 2-28
Figure 2.5-6 Flood Damage due to the 2014 Torrential Rains 2-28
Figure 2.5-7 Damaged Causeway 2-29
Figure 3.2-1 Structures of Database (1/3) 3-3
Figure 3.2-2 Structures of Database (2/3) 3-4
Figure 3.2-3 Structures of Database (3/3) 3-5
Figure 3.2-4 Schematic Diagram of Existing Normal Freeboard and Planned Freeboard 3-18
Figure 3.2-5 Site Inspection of STEIN Canals 3-20
Figure 3.3-1 Cracks on Tank Bund 3-21
Figure 3.3-2 Procedure of Plaster Survey 3-22
Figure 3.3-3 Factors of Cracks 3-23
Figure 3.3-4 Basic schematic Representative of Six Countermeasures 3-25
Figure 3.3-5 Location of Puliyankulam tank 3-26
Figure 3.3-6 Cracks on Top of Tank Bund (sketch) 3-27
Figure 3.3-7 The Site of Trial Construction 3-28
Figure 3.4-1 H-V Curves of Five Tanks 3-32
Figure 3.4-2 Depth – Capacity Based on All Data of Five Tanks 3-32
Figure 3.4-3 Type of Tanks by Tank Bund Height and Length 3-33
Figure 3.5-1 Concept of the Flood Analysis for the Cascade System 3-34
Figure 3.5-2 Hydrological Zone and the project area location 3-34
Figure 3.5-3 Rainfall Loss by SCS Method 3-35
Figure 3.5-4 Flood Routing by J.H.West Method 3-37
Figure 3.5-5 Hydrograph of inflow to cascaded tanks 3-39
Figure 3.5-6 Hydrograph of outflow from cascaded tanks 3-39
Figure 3.6-1 Average Cropping Pattern of Model Cascades 3-41
Figure 3.6-2 Schematic Figure of Water Balance in Cascade System 3-42
Figure 3.6-3 Image of simplified cascade model 3-44
Figure 3.6-4 Cropping Calendar 3-47
Figure 3.9-1 Supply Chain of Paddy/Rice 3-59
Figure 3.9-2 Supply Chain of Other Food Crops 3-59
Figure 3.12-1 Pipeline at Naveli kulam Cascade 3-73
Figure 3.12-2 Survey on Sampalthooddamkulam Tank 3-75
Figure 3.12-3 Model Pipeline Scheme Layout Plan 3-76
Figure 3.12-4 Pipeline System and Water Distribution Plan 3-77
Figure 3.12-5 Pipelines Dynamic Water Pressure Profile 3-78
Figure 3.12-6 Elevation gaps between Target Tanks and Irrigable area 3-80
Figure 3.13-1 Typical Location of Tanks with Serious Sedimentation 3-81
Figure 3.13-2 Typical Sedimentation Status of Tank Bed 3-81
Figure 3.13-3 Reformed Tank Bed Area and Sediment Mound after the Partial Desilting 3-83
Figure 3.14-1 Image of Flood pre-discharge system 3-84
Figure 3.14-2 Spillway Wall Slit and Flood Pre-discharge Sluice Gate (Ihala Abathale Tank) 3-85
Figure 3.14-3 Spillway Wall Slit Structure (left: drop type, right: natural type) 3-86
Figure 3.15-1 Link Canal in Ichchankulam Cascade 3-88
Figure 4.2-1 Procedure for the Selection of Subprojects for Infrastructure and Facility Development 4-4
Figure 4.2-2 Procedure for the Selection of Machinery and Equipment 4-8
Figure 4.3-1 Conceptual Institution Arrangement of Tank Day 4-13
Figure 4.5-1 Proposed Organisation Structure of the Consultant Team 4-26
Figure 6.2-1 Overall Project Organisation Structure 6-1
Figure 6.2-2 Organisation Structure of PMU at the Project Level 6-2
Figure 6.2-3 Organisation Structure of PIU Anuradhapura 6-3
Figure 6.2-4 Organisation Structure of PIU Vavuniya 6-3
Figure 6.2-5 Organisation Structure for the O&M Stage 6-5
Figure 6.3-1 Implementation Procedure of Subcomponent 1.1 6-6

Figure 6.3-2 Implementation Procedure of Subcomponent 1.2 6-9
Figure 6.3-3 Implementation Procedure of Component 2 6-11
Figure 6.4-1 Tentative Overall Implementation Schedule 6-13
Figure 6.4-2 Component 1: Cascade System Development 6-14
Figure 6.4-3 Subcomponent 2.1 Institution and Capacity Development 6-15
Figure 6.4-4 Subcomponent 2.2 Agriculture Development 6-16
Figure 6.4-5 Subcomponent 2.3 Post-harvest and Marketing Development 6-16
Figure 6.4-6 Subcomponent 2.4 Livestock Development 6-17
Figure 6.4-7 Subcomponent 2.5 Fishery Development 6-17
Figure 6.4-8 Component 3 Project Management and Monitoring 6-18
Figure 6.6-1 Fund Management for Civil Works/Facility 6-23
Figure 6.6-2 Fund Management for Goods 6-24
Figure 6.6-3 Fund Management for Training 6-24
Figure 6.6-4 Fund Management for Consultancy Services 6-25
Figure 6.7-1 Typical Sequence of Principal Events during Contract 6-26
Figure 7.1-1 Village Tank System in the Dry Zone of Sri Lanka 7-4
Figure 7.1-2 General Procedures for Applying Permission from FD and DWC 7-23
Figure 7.1-3 Overall Project Organisational Structure 7-32
Figure 8.6-1 Climate Change Simulation (Temperature) 8-15
Figure 8.6-2 Climate Change Simulation (Precipitation) 8-15
Figure 8.6-3 Successive No-rain Days 8-16
Figure 8.6-4 Annual Precipitation 8-16

Abbreviations

AD	Assistant Director
ADB	Asian Development Bank
AI	Agricultural Instructor
AIA	Archaeological Impact Assessment
APC	Agricultural Productivity Committee
ARDS	Agricultural Routine Data System
ARPA	Agriculture Research & Development Assistant
ASC	Agrarian Service Centre
ASMP	Agriculture Sector Modernization Project
B/C	Cost-Benefit Ratio
BIGG	Balances Inclusive Green Growth
BRRI	Bathalagda Rice Research Institute
BTL	Bund Top Level
CAO	Chief Accounting Officer
CBF	Community-Based Organizations
CBO	Community Based Organization
CCSC	Cabinet Appointed Consultant Selection Committee
CEA	Central Environmental Authority
CIDA	Construction Industry Development Authority
CIF	Cost Insurance and Freight
CMO	Cascade Management Organisation
COVID-19	Coronavirus Disease 2019
CPS	Country Partnership Strategy
CRIWMP	Climate Resilient Integrated Water Management Project
CSCS	Consultant Selection Committees
CSDPP	Project for Formulating Cascade System Development Plan under North Central Province Canal
CSIAP	Climate Smart Irrigated Agriculture Project
CTS	Construction Technological Services
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DCC	District Coordination Committee
DCS	Department of Census and Statistics

DCSC	Department Consultant Selection Committee
DEC	Dedicated Economic Centre
DFAR	Department of Fisheries & Aquatic Resources
DFC	Discount Cash Flow
DO	Divisional Officer
DOA	Department of Agriculture
DS	Divisional Secretariat
DSD	Divisional Secretariat Division
DWC	Department of Wildlife Conservation
DX	Digital Transformation
E/S	Engineering Service
EIA	Environment Impact Assessment
EIRR	Economic Internal Rate of Return
F/C	Foreign Currency
F2F	Farmer-to-Farmer
FD	Forest Department
FIRR	Financial Internal Rate of Return
FMRC	Farm Mechanization Research Centre
FMTC	Farm Machinery Training Centre
FO	Farmer Organization
FOGSL	Field Ornithology Group of Sri Lanka
FSL	Full Supply Level
GAP	Good Agriculture Practice
GCF	Green Climate Fund
GDP	Gross Domestic Product
GDP	Gross Domestic Product
GIS	Geographic Information System
GN	Grama Niladhari
GOSL	Government of Sri Lanka
GS	Grama Sewaka
HARTI	Hector Kobbekaduwa Agrarian Research and Training Institute
HFL	High Flood Level
HH	Household
HP	Hydraulic Particulars
IBA	Important Bird Areas
ICB	International Competitive Bidding
ICT	Information and Communications Technology
ICTAD	Institute for Construction Training and Development
ID	Department of Irrigation
IEE	Initial Environmental Examination
IMD	Irrigation Management Division
IPHT	Institute of Post-Harvest Technology
IPM	Integrated Pest Management
IPNM	Integrated Plant Nutrition Management
IRR	Internal Rate of Return
IWMI	International Water Management Institute
L/C	Local Currency
M&E	Monitoring and Evaluation
MCSC	Ministry Consultant Selection Committee
MDP	Mahaweli Development Program
MIS	Management Information System
MIWRM	Ministry of Irrigation and Water Resource Management
MMAIRD	Ministry of Mahaweli, Agriculture, Irrigation, and Rural Development
MMDE	Ministry of Mahaweli Development and Environment
MOI	Ministry of Irrigation
MPCS	Multi-Purpose Cooperative Society
MWSIP	Mahaweli Water Security Investment Program

NAAQS	National Ambient Air Quality Standards
NAQDA	National Aquatic Resources and Research and Development Agency
NCAR	National Centre for Atmospheric Research
NCB	National Competitive Bidding
NCP	North Central Province
NCPC	North Central Province Canal
NCPCP	North Central Province Canal Project
NEA	National Environmental Act
NGO	Non-Government Organization
NP	North Province
NWPCP	North Western Province Canal Project
NWSIP	Mahaweli Water Security Investment Program
O&M	Operation and Management
OFC	Other Field Crops
PCC	Project Level Coordinating Committee
PCSC	Project Consultant Selection Committee
PDAH	Provincial Department of Animal Production and Health
PDCA	Plan, Do, Check, Act
PDOA	Provincial Director of Agriculture
PID	Provincial Department of Irrigation
PIP	Public Investment Program
PIU	Project Implementation Unit
PMAI	Project Management Associate International
PMB	Paddy Marketing Board
PMC	Project Management Committee
PMU	Project Management Unit
PSC	National Level Steering Committee
PTWG	Provincial Technical Working Group
QBS	Quality Based Selection
QCBS	Quality Cost Based Selection
RDO	Rural Development Officer
RDS	Rural Development Society
RIDP	Rural Infrastructure Development Project in Emerging Regions
SBD	Standard Bidding Document
SCF	Standard Conversion Factor
SDGs	Sustainable Development Goals
SOE	Statement of Expenditure
SPEC	SPEC Co., LTD.
SWMC	Sub-watershed Management Committee
SWR	Shadow Wage Rate
TAMAP	Technical Assistance to the Modernizations of Agriculture Program in Sri Lanka
TEC	Tender Evaluation Committee
TOR	Term of Reference
TSL	Two-Step Loans
UDA	Urban Development Authority
UEC	Upper Elahera Canal
UN	United Nations
UNDP	United Nations Development Program
VAT	Value Added Tax
VIT	Vision Tec. In.
WB	World Bank
WLPA	Wildlife Protected Area
WMP	Mahaweli Water Management Panel
WSA	Water Spreading Area

Specific Terms of Sri Lanka

Ande	Share Cropping arrangements in which smallholders without animals herd and manage flock on behalf of a larger farmer and in return retain half the offspring
Anicut	A diversion weir to abstract water from a natural channel
Attam	Labour exchange between farmers
Asswedduma	Bunded and puddled (of land for paddy cultivation)
Chena	Slashing, Burning and shifting cultivation
Ganga	River
Grama Niladhari	Village level government officials
Maha	North east monsoon season
Oya/Ara	River
Pola	Weekly fair
Pradeshiya Sabha (PS)	Local Elected council (at divisional level)
Pangu	Shareholding or tenancy rotation
Purana	Old or Ancient
Shramadana	Self-help / Shared labour
Tank	A reservoir storing water for irrigation
Wewa	Water tank
Yala	South west monsoon season
Yaya	Paddy field

Measurement Units

Area			**Volume**		
cm^2	=	Square-centimetre(s)	cm^3	=	Cubic-centimetre(s)
m^2	=	Square-metre(s)	m^3	=	Cubic-metre(s)
km^2	=	Square-kilometre(s) (1,000,000 m^2)	km^3	=	Cubic- kilometre(s)
in^2	=	Square-inch(s) (645.16 mm^2)	in^3	=	Cubic- inch(s)
ft^2	=	Square-feet (929.0304 cm^2)	ft^3	=	Cubic- feet
ha	=	Hectare(s) (10,000 m^2)	L	=	Litre(s) (1,000 cm^3)
acre	=	Acre(s) (4,046.8 m^2 or 0.40468 ha.)	MCM	=	Million Cubic Metre (s)
Length			**Weight**		
mm	=	Millimetre(s)	g	=	Gram(s)
cm	=	Centimetre(s)	kg	=	Kilogram(s) (1,000 gr.)
m	=	Metre(s)	ton	=	Metric Tonne(s) (1,000 kg)
km	=	Kilometre(s) (1,000 m)			
in	=	Inch(s) (25.4 mm)			
ft	=	Feet (30.48 cm)			
Currency			**Time**		
US$	=	United State Dollar	s	=	Second(s)
LKR	=	Sri Lankan Rupee	min	=	Minute(s) (60 sec.)
			hr	=	Hour(s) (60 min.)

Exchange Rate (as of October 2020)

(1) US$ 1.0 = JPY 106

(2) US$ 1.0 = LKR 185

(3) LKR 1.0 = JPY 0.573

CHAPTER 1 INTRODUCTION

1.1 General

This is the Final Report prepared by the Study Team for the Preparatory Survey on the Cascade System Development Project, hereinafter referred to as "the Study".

1.2 Background of the Project

Sri Lanka has achieved relatively strong economic growth since the end of the civil war in 2009[1]. The agriculture sector in Sri Lanka has contributed to the gross domestic product (GDP) at current market prices by only 7.9% but has provided job opportunities to 25.5% of the total workers in 2018. The population living below the poverty line is still 4.1% of the total population in 2016, of which 92.0% live in rural or estates[2]. The Government of Sri Lanka (GOSL) has put the development priority on the agriculture sector from the perspective of food security, poverty reduction, correction in regional disparities and climate change resilience. In Sri Lanka, disasters due to the effects of climate change such as droughts and floods have occurred frequently in recent years. Large-scale flooding took place in May 2016 and was followed by a historically severe drought across the country in late 2016. With two rice cultivation cycles disrupted in 2016, agriculture GDP shrunk by 3.8% in 2016 and 0.8% in 2017. The food shortage contributed to food inflation accelerated to 14.4% in December 2017 and an increase in food imports by about USD200 million in 2017[3].

The climate of Sri Lanka varies from region to region, but the North Central and Northern provinces are categorized as dry zone in the agricultural ecology of Sri Lanka (average annual rainfall is 1,200-1900 mm/year, with most of the annual rainfall during the October-January rainy season). Frequent floods and droughts associated with climate change taking place in the country have resulted to the dry zone being left behind in terms of economic development.

In order to uplift the economic situation in the dry zone, GOSL has initiated the Mahaweli Water Security Investment Program (MWSIP) including the North Central Province Canal (NCPC), with financial assistance from the Asian Development Bank (ADB). Through the construction of NCPC, water will be diverted from the Mahaweli River, the largest river in the country, as a new irrigation water source for the cascade tank systems in the dry zone. In the Project of Formulating Cascade System Development Plan under

Source: Study Team

Figure 1.2-1 View of Dri Aru Kulam Tank located at the end of the proposed NCPC

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[1] GDP per capita is USD2,090 in 2009 and USD4,102 in 2018 at current prices according to the World Bank national accounts data, and OECD National Accounts data files. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=LK

[2] Economic Statistics of Sri Lanka 2019 published by the Department of Census and Statistics, http://www.statistics.gov.lk/EconomicStat/EconomicStatistics2019.pdf

[3] IMF Country Report No. 18/176 in June 2018, Sri Lanka Selected Issues. https://www.imf.org/en/Publications/CR/Issues/2018/06/19/Sri-Lanka-Selected-Issues-45998

the North Central Province Canal, hereinafter referred to as "CSDPP", that was carried out during the period from 2016 to 2018, the detailed survey was conducted in the six tank cascade systems to confirm the present conditions of irrigation, disaster management, operation and maintenance, farm management, farmers organisation etc., and the field verification program covering the four tanks was implemented for the development and rehabilitation of tank bund, irrigation facilities and link canals. Based on the results, the overall tank cascade system development plan, and proposed projects were formulated for all the 128 systems.

The objective of the Study is to formulate the implementation plan for the cascade system development project hereinafter referred to as "the Project" upon the request made by GOSL.

1.3 General Features of the Project

The general features of the Project are summarized as shown below:

Table 1.3-1 General Features of the Project

Project Name	Cascade System Development Project in North Central Province and Northern Province
Purpose	Development and rehabilitation of irrigation infrastructure (tanks, irrigation canals and link canals) and farm roads in the cascade systems in the target area, in order to attain efficient use of water available for irrigation, flood prevention of farm lands and facilities, efficient transportation of agricultural products, and thereby promote agricultural development adaptable to climate change and improve agricultural productivity.
Project Outline	Development and rehabilitation of irrigation infrastructure and farm roads of cascade system in North Central and Northern provinces
Target Area	Anuradhapura District in North Central Province (NCP) and Vavuniya District in Northern Province (NP)
Related Government Agencies	Executing agency: Ministry of Mahaweli Development and Environment (MMDE) (1) Implementation agencies: Department of Irrigation (ID) under the Ministry of Irrigation and Water Resources Management (MIWRM), Provincial Department of Irrigation (PID) in NCP, Department of Agrarian Development (DAD) in NP.

Note: (1) Executing agency has been changed from the Ministry of Mahaweli Development and Environment (MMDE) to the Ministry of Irrigation (MOI).
Source: Study Team

1.4 Objectives of the Study

The objectives of the Study are i) to collect and analyse the data and information necessary for the project formulation, and ii) to prepare the project implementation plan, which covers the project scope, cost, implementation schedule, organisation structure for implementation, operation and maintenance (O&M), environmental and social considerations, project evaluation, etc.

1.5 Scope of the Study

(1) Target Cascade Systems

CSDPP has identified the total 128 of cascade systems (1,024 tanks) in the target area. The location of cascade systems is shown on the location map, and the numbers of cascades listed in CSDPP are summarised in Table 1.5-1.

Table 1.5-1 Area and Target Cascades

Catchment	Total Cascade Systems in the CSDPP				
	Cascades (nos.)			Tanks (nos.)	Irrigation Area (ha)
	Anura-dhapura	Vavuniya	Total(*)		
Malwathu Oya	58	9	62	493	14,311
Yan Oya	24	0	24	226	7,942
Ma Oya	24	1	24	164	4,911
Parangi Aru	2	16	16	122	3,324
Kanagrayan aru	1	2	2	19	958
Total	109	28	128	1,024	31,446

Note: (*) Nine cascades lie over the two districts of Anuradhapura and Vavuniya
Source: Final Report of CSDPP (May 2018)

(2) Scope of the Study

(a) Infrastructure Development

Various facilities as shown in Table 1.5-2 are assumed to be developed and rehabilitated under the Project as the hard component. These facilities are targeted for the infrastructure development of the Study, where link canals will be newly constructed and other facilities will be improved/ rehabilitated under the Project.

Table 1.5-2 Tank Facilities to be Developed and Rehabilitated by the Project

Items	Facilities
1. Rehabilitation	・Tank Bund ・Spillway ・Intake Facility ・Irrigation Canal ・Drainage Canal ・Farm Road
2. New Construction	・Link Canal (To be discussed)

Source: Study Team

(b) Supporting Activities

In order to achieve the objective of the Project, supporting activities are indispensable to bring about the maximum effects of the infrastructure development. In the Study, institution and capacity development of the stakeholders, and agriculture development activities will be proposed as soft components in a participatory manner.

CHAPTER 2 CONFIRMATION OF OBJECTIVE AND NECESSITY OF THE PROJECT

2.1 General

This chapter deals with the confirmation of objective and necessity of the Project in principle by making a reference to the final report of the Project for Formulating Cascade System Development Plan under North Central Province Canal (CSDPP). Essential subjects necessary for the confirmation have been selected and summarised. In case that relevant data and information would be newly available, the data will be updated.

2.2 Consistency with National Development Plan and Agriculture Sector Development Plan

(1) National Development Plan

According to the news media on 6th December 2019, the Sri Lanka's current government has set a guideline for preparation of five-year economic development target to guide the country towards a prosperous future. All ministries, departments, government institutions, provincial council and local government bodies have been instructed to follow the guidelines laid out in the framework henceforth. Detailed planning is still under preparation by the responsible ministries due to delay caused by the outbreak of COVID-19 pandemic and the general election in August 2020.

According to the Ministry of Irrigation (MOI), the main trust of the plan in water resources and irrigation sectors would be placed on a) climate adaptation, b) water resources development, and c) river basin development. In this regard, development of river basins like cascade systems will be given a priority. Moreover, MOI plans to rehabilitate 5,000 minor tanks for which different government agencies will be employed.

As for the agriculture sector, to minimise the foreign exchange spent on imported crops, the current government has initiated a program of import substitution by encouraging local farmers to grow more of these crops. The main approaches are offering farmers with a government declared farm gate price, providing subsidy of 50% on seed material for planting up to 0.3 ha and imposing import restrictions.

(2) Sustainable Sri Lanka 2030 Vision and Strategic Path (SDGs)

As a government policy paper to adopt the United Nations (UN) 17 sustainable development goals (SDGs), the report entitled as “Sustainable Sri Lanka 2030 Vision and Strategic Path”, prepared by the presidential expert committee, was published in January 2019. The report sets out Sri Lanka’s current country profile and status, key issues and opportunities relating to sustainable development, future priorities and targets and new initiatives and options to achieve ambitious goals by 2030. The core framework seeks to harmonise the economic, social, and environmental dimensions of the sustainable development (SD) triangle. The practical pathway to achieve the sustainable development vision follows a strategic path balanced inclusive green growth (BIGG) path, which will enable Sri Lanka to become a world leader of sustainability by 2030.

Table 2.2-1 shows issues and key actions recommended in the agriculture sector in the above report and its relevance to the objectives of the Project.

Table 2.2-1 Key Issues and Action Recommendations in Agriculture Sector

<table>
<tr><th>Key Issues</th><th>Key Action Recommendation</th><th>Project Objective</th></tr>
<tr><td>Climate Change / Drought: A series of droughts and floods experienced during the years 2015 – 17 impacted on agriculture. There were severe droughts, heavy rains and flooding in 2015 while in 2016, the country experienced its worst drought in 40 years. This resulted in a poor Maha 2016/17 cropping season, with at least a 35% reduction in cultivation. In the Yala 2017 cropping season, the total cultivation was expected to be 50% or more below the average.</td><td rowspan="5">a) Enhance the capacity and the ability to better forecast seasonal rainfall and provide early warnings on extreme weather events leveraging on modern technology and develop institutional arrangements to speedily respond to such early warnings.
b) Develop drought tolerant crop varieties and cropping patterns which consume less water, labour and agrochemicals, and incentivize their adoption.
c) Educate farmers on the need to conserve water and the use of new technology for farming, value addition and marketing. Medium to Long Term Results can be obtained thus.
d) Enable farmers to overcome the scale constraint so that less water using crops can be produced, stored, value added and marketed profitably. This will facilitate the provision of effective credit, input supply, storage as well as insurance in a sustainable / commercially viable manner.
e) Educate consumers at large on better nutrition and appropriate changes in food habits. Consumption of less starch and sugar and increased consumption of fruits and vegetables may somewhat reduce the present high dependence on water for agriculture.</td><td>○</td></tr>
<tr><td>Labour Shortage: Yet the entire agriculture sector covering domestic food agriculture, plantation agriculture and minor export crops suffers from an acute labour shortage. Unemployment is highest among the rural youth. It should be noted that the lack of interest shown by the youth for agriculture stems from reasons more complex than merely low wages.</td><td>○</td></tr>
<tr><td>Land Degradation: It has been estimated that nearly one third of the land in Sri Lanka is subjected to soil erosion, the erodible proportion ranging from less than 10% in some districts to over 50% in others. It is commonly believed that the depletion of soil fertility has led to a loss of productivity of agricultural lands in the country.</td><td>-</td></tr>
<tr><td>Land Tenure: As per the Census of Agriculture (2002), the average size of a small holding in Sri Lanka declined by about 64% over the period 1946-2012 from 1.3 ha to 0.47 ha. About 1.65 million smallholder farmers operate on an average area that is less than 2 ha and contribute 80% of the total annual food production.</td><td>-</td></tr>
<tr><td>Poverty: Although absolute poverty in Sri Lanka declined from 22.7 to 6.7% from 2002 to 2012/13, a quarter of all Sri Lankans remain nearly poor, defined by living above the national poverty line (about US$1.5) but below US$2.50 per day (in 2005 PPP terms). Repeated crop failures can make these nearly poor fall into the poor category quite easily.</td><td>○</td></tr>
</table>

Source: Sustainable Sri Lanka 2030 Vision and Strategic Path published in January 2019 by the presidential expert committee.

(3) Overarching Agricultural Policy (Draft)

The Overarching Agriculture Policy (Draft) has been prepared and published by the Ministry of Agriculture in August 2019. The document has remained unchanged for a long time due to the presidential elections in November 2019, outbreak of COVID-19 and general elections in August 2020.

A number of national policy and strategy documents encompass the activities in the agriculture sector. The most relevant of these policy documents include the New Trade Policy (2017), the National Policy on Sustainable Consumption and Development (2018) and the National Export Strategy (2018). Agricultural strategy, as expressed in the latest version of the Public Investment Program (PIP) 2017-2020, identifies two core strategic elements, namely: (i) food security of people by way of substituting possible imports and (ii) promoting exports of agro-based products through increased competitiveness in the international market.

The Overarching Agriculture Policy would achieve the vision and objectives through the statement of policy principles and policy action areas organised under ten thematic areas. The following policy principle are presented under the ten thematic areas were examined in relation to interconnectivity among the existing sub-sectoral policies and the alignment with all major development policies of the country.

i) Prosperous farmer community
ii) Energising Energizing market linkages
iii) Revitalising rural economy
iv) Reaching global value chain
v) Ensuring food and nutrition security and food safety

Historical developments, present scenarios, future prospects, lessons from experiences from global approaches and best practices related to agricultural development were also considered. The ten thematic areas and the key elements discussed under each are shown in the following table.

Table 2.2-2 Policy Statements in Ten Thematic Areas of Agricultural Sector

Thematic Area	Policy Statement	Major Policy Trust Area	Project Objective
Reserving Natural Resources	(1) Promote and support exploration, conservation and utilisation of biodiversity and sustainable management of natural resources.	a) Sustainable utilisation of natural resources through community participation and appropriate regulations. b) Reduce dependence on gathering/natural harvesting through establishment of outgrowing systems and improving community-based resource management. c) Promote useful elements of biodiversity-friendly traditional practices integrated with modern technology, etc.	○
	(2) Promote eco-friendly farming systems for sustainable and efficient agricultural production.	a) Enhance sustainable management of ecosystems involving crops, livestock and poultry, aquatic resources, and native biodiversity. b) Introduce certification schemes and measures to enhance marketability of eco-friendly agricultural products. c) Ensure spatial planning considerations including environmental, economic, social and cultural aspects are addressed in the development of crops, livestock and poultry, and aquatic resources, etc.	○
Land Use Planning, Land Administration and Land Degradation	(1) Facilitate appropriate changes in the institutional and regulatory framework governing administration of agricultural and allied land, in a manner contributing to improving land productivity.	a) Introduce science-based and transparent land classification and approval procedure for the cultivation of more economical crops in the paddy lands. b) Enact a regulatory framework to limit sub-division of land below the current levels except where novel technologies are being used to improve productivity by revising provisions under the Land Development (Amendment) Act No. 16 of 1969. c) Energise investment climate for land by allowing landowners to consolidate ownership legally by eliminating restrictions on land	-

Thematic Area	Policy Statement	Major Policy Trust Area	Project Objective
		acquisition via different transfer procedures such as renting, leasing, etc.	
	(2) Ensure sustainable land management through proper land use planning and rational allocation of lands for different agricultural ventures for enhanced land productivity, while minimising land degradation.	a) Ensure rational and sustainable use of land through land use planning to support agricultural development. b) Mainstream a comprehensive approach to combating land degradation from diverse causes that includes research, extension and management and assistance programs that take a multi-faceted approach. c) Promote measures to increase land productivity by supporting integrated agricultural practices that enhance nutrient recycling, reduce soil erosion and land degradation, etc.	○
Agriculture Water Management	Ensure rational allocation of water for irrigated agriculture through participatory management of agriculture water resources while applying appropriate technologies and regulatory measures.	a) Improve efficiency of irrigation water use. b) Increase in sustainable water capture. c) Use cascade-level planning in the restoration and management of water resources. d) Protect quality and improve sustainable use of ground water by introducing legislation and institutionalising community-based management. e) Increased stakeholder participation in management of irrigation systems, etc.	○
Climate Change	Ensure a climate-resilient agriculture sector through appropriate adaptation and mitigation measures while addressing loss and damages caused by climate-induced disasters.	a) Mainstream climate action in policies, regulations, programs and plans in the entire agriculture sector. b) Strengthen efforts to combat climate-induced disaster risk reduction. c) Take measures to increase resilience of agriculture sector against the emerging climate change impacts by adopting suitable strategies. d) Building the capacity of farming community to adjust readily to unfolding changes of climate through increased awareness and supportive investments on adaptive actions, etc.	○
Food Security	Maximize the contribution of agriculture to food security through a multi-sectoral approach.	a) Promote agriculture modernisation by pursuing innovation through the value chain. b) Introduce and implement appropriate technologies to improve quality and safety of food. c) Mainstream nutritional considerations in the food production strategies, etc.	○
Border (Trade) Measures	Promote international trade in compliance with national and international obligations and standards, while addressing the needs of the domestic producers and consumers.	a) Develop management procedures and processes to minimise costs and delays in trade transactions. b) Ensure infrastructure and competency of human resources in deficient areas, c) Upgrade national quality certification process to international standards, etc.	
Effective Governance	Ensure a strong institutional mechanism and coordination for agriculture development at national and sub national levels with wider	a) Improve accountability for planning, coordination, and budgeting between the central and provincial authorities. b) Planning over longer time horizon to avoid wasteful program duplication and low effectiveness.	○

Thematic Area	Policy Statement		Major Policy Trust Area	Project Objective
	stakeholder participation.	c)	Promote operation of unified extension approach covering crops and livestock at the field level, etc.	
Development Subsidies for Value Chain Actors	Ensure efficiency and effectiveness of production support and service delivery, to enhance competitiveness in agriculture, safeguarding the farming community.	a) b) c)	Undertake necessary reforms in the governance structure for input and service supply in the agriculture sector to strengthen functioning under competitive market environment. Support the private sector to provide accountable, responsive service delivery systems where it has comparative advantage. Take measures to strengthen farmer organisations, etc.	○
Production Support and Service Delivery	Promote appropriate agricultural innovation and technology transmission through investments in research, education, training and partnerships for sustainable agricultural production.	a) b) c)	Take measures to strengthen public-private partnership in agriculture research and investment. Put in place an “Agricultural Knowledge and Information System” for effective transfer of innovative practices. Develop a comprehensive human resource and capacity building program covering all national and provincial agricultural institutions, etc.	○
Strengthening Education-Research-Extension	Encourage agricultural diversification in value chains through a balanced and streamlined approach using public and private goods and services to promote commercial agriculture.	a) b) c)	Create opportunities for faster mechanisation of agriculture operations through appropriate incentives. Modify the incentive framework for agriculture to make adoption of “modern” technologies affordable and profitable. Provide incentives for initiating product diversification, etc.	○

Source: Overarching Agriculture Policy (Draft) August 2019, Ministry of Agriculture, Rural Economic Affairs, Irrigation, and Fisheries, and Aquatic Resources Development, Ministry of National Policies, Economic Affairs, Resettlement and Rehabilitation, Northern Province Development and Youth Affairs, supported by EU-TAMAP.

2.3 Economic and Social Conditions in the Project Area

2.3.1 Demography

(1) Population

The number of members per household in the six model cascades varies between one to nine with an average of 3.7. The estimated total population would be 6,500 in the six cascades assuming the population density of 86 persons/km^2 or 168,000 in the project area.

Table 2.3-1 Estimated Population of the Six Model Cascades

Name of Cascade	No. of Target HH	Average Family Members	Estimated Population	Density (Persons/km^2)
Alagalla	212	3.5	742	132
Naveli kulam	221	4.0	884	68
Ichchankulama	300	3.9	1,170	89
Kiulekada	397	3.5	1,390	91
Rathmalawewa	395	3.9	1,540	91
Siyambalagaswewa	214	3.2	771	65
Total/Average	1,740	3.7	6,497	86

Source: CSDPP, HHS conducted in March 2017

The female population is distinctively higher than males in Sri Lanka as well as the project area due to the past civil war.

Table 2.3-2 Estimated Population by Gender and Locality

Item	Total	Male	Female	Urban	Rural	Population Density
	(no.)	(%)	(%)	(%)	(%)	(per km^2)
Anuradhapura District	860,575	48.8	51.2	5.9	94.1	119
Vavuniya District	172,115	49.2	50.8	20.2	79.8	86
National	20,359,439	48.4	51.6	18.2	77.4	310

Source: CSDPP, Final Report

(2) Ethnicity

Kiulekada and Siyambalagaswewa in Anuradhapura District comprise only Sinhala while Naveli kulam in Vavuniya District comprise only Tamil. Ichchankulama and Rathmalawewa are Sinhala-Sri Lankan Moor mixed and Alagalla on borders in Vavuniya District is Sinhala-Tamil mixed. The average of the six model cascades shows an almost the same distribution with the national average.

Table 2.3-3 Ethnicity of the Beneficiary Households of the Six Model Cascades

Name of Cascade	Sinhala	Tamil	Sri Lanka Moor	Others
Alagalla	85.2%	14.8%	0.0%	-
Naveli kulam	0.0%	100.0%	0.0%	-
Ichchankulama	64.0%	0.0%	36.0%	-
Kiulekada	100.0%	0.0%	0.0%	-
Rathmalawewa	79.3%	0.0%	20.7%	-
Siyambalagaswewa	100.0%	0.0%	0.0%	-
Average	74.0%	15.0%	11.0%	-
Anuradhapura District	91.0%	0.6%	8.2%	0.2%
Vavuniya District	10.0%	83.2%	6.8%	0.1%
National	74.9%	15.3%	9.3%	0.5%

Source: HHS conducted in March 2017 under CSDPP

(3) Religion

Religion distribution is almost similar to ethnicity. All the Sinhala and Muslim respondents are Buddhist and Muslim. Ichchankulama and Rathmalawewa in Anuradhapura District are Buddhist-Muslim mixed and Alagalla on borders in Vavuniya District comprises Buddhist, Christian and Hindi. The average of the six model cascades shows an almost the same distribution with the national average.

Table 2.3-4 Religion of the Beneficiary Households of the Six Model Cascades

Name of Cascade	Buddhist	Hindi	Muslim	Christian	Others
Alagalla	85.2%	1.5%	0.0%	13.3%	-
Naveli kulam	0.0%	100.0%	0.0%	0.0%	-
Ichchankulama	64.0%	0.0%	36.0%	0.0%	-
Kiulekada	100.0%	0.0%	0.0%	0.0%	-
Rathmalawewa	79.3%	0.0%	20.7%	0.0%	-
Siyambalagaswewa	100.0%	0.0%	0.0%	0.0%	-
Average	74.0%	13.4%	11.0%	1.5%	-
Anuradhapura District	90.1%	0.4%	8.3%	0.8%	0.4%
Vavuniya District	9.8%	69.4%	7.0%	8.9%	5.0%
National	70.1%	12.6%	9.7%	6.2%	1.5%

Source: CSDPP, HHS conducted in March 2017

(4) Community-based Organisations

There are several community-based organisations (CBOs) functioning in the project area. Almost all the households have a membership of farmer organisations (FOs). Death donation societies are also active with nearly 70% memberships, followed by Divineguma/Samurdhi with 14.0%, women groups in 13.9% and rural development societies in 13.7%.

Table 2.3-5 CBO Membership of the Six Model Cascades

Name of Cascade	FO	RDS	Coop	Divineguma /Samurdhi	Women Group	Death Donation Society	Others(1)
Alagalla	97.8%	37.0%	9.6%	9.6%	27.4%	79.3%	0.7%
Naveli kulam	100.0%	51.0%	1.9%	12.9%	25.8%	NA	NA
Ichchankulama	97.5%	7.1%	0.5%	4.0%	2.5%	51.5%	4.0%
Kiulekada	100.0%	2.4%	13.3%	16.5%	12.9%	94.9%	2.4%
Rathmalawewa	99.0%	0.4%	-	22.5%	5.1%	78.2%	1.5%
Siyambalagaswewa	98.7%	6.7%	0.1%	12.7%	22.7%	98.7%	0.1%
Average	98.9%	13.7%	4.5%	14.0%	13.9%	69.7%	1.8%

Note: (1) Including no answer
Source: CSDPP, HHS conducted in March 2017

2.3.2 Economy

(1) Monthly Household Incomes

According to the household survey conducted in 2017 under the CSDPP, the average monthly household income is estimated at LKR 32,500 per month, showing comparatively lower than those of the national, urban and rural sectors. In the six model cascades, the average monthly household income is recorded highest in Naveli kulam with LKR 41,700, followed by Alagalla and Ichchankulama. The lowest is Siyambalagaswewa with LKR 23,600, followed by Kiulekada and Rathmalawewa. About 15% of the households is earning below LKR 10,000 per month.

Table 2.3-6 Monthly Household Income of the Beneficiary Households of the Six Model Cascades

Name of Cascade District Sector	Income Level (LKR) in percentage (%)							Average (LKR)
	0-4,999	5,000-9,999	10,000-19,999	20,000-29,999	30,000-39,999	40,000-50,000	Over 50,000	
Alagalla	3.0%	5.9%	13.3%	13.4%	26.7%	17.0%	20.7%	40,229
Naveli kulam	0.0%	1.9%	9.1%	21.3%	24.5%	17.4%	25.8%	41,699
Ichchankulama	1.5%	14.1%	25.8%	15.7%	13.2%	8.0%	21.7%	33,699
Kiulekada	8.6%	8.6%	16.8%	15.7%	23.5%	18.1%	8.6%	28,667
Rathmalawewa	6.2%	13.8%	18.6%	15.7%	17.1%	12.0%	16.7%	31,190
Siyambalagaswewa	8.0%	14.7%	36.7%	22.7%	14.7%	4.0%	9.3%	23,581
Average	5.0%	10.4%	18.5%	17.1%	19.6%	13.0%	16.5%	32,527
Anuradhapura	-	-	-	-	-	-	-	58,326
Vavuniya	-	-	-	-	-	-	-	58,625
Colombo	-	-		-	-	-	-	104,581
National Average*1	3.3%	3.3%	2.9%	14.3%	15.0%	12.7%	42.7%	62,237
Urban Sector*1	1.5%	1.5%	4.8%	9.9%	11.9%	13.1%	57.4%	57,833
Rural Sector*1	3.5%	3.5%	9.7%	14.7%	15.5%	12.8%	10.4%	42,133

*Note: *1 For the national, urban and rural sectors, the income levels are modified according to the above classes.*
Source: HHS conducted under CSDPP in March 2017 for cascades, and Household Income & Expenditure Survey 2016 for districts and sectors

(2) Income Sources

The survey data revealed that the primary household income is derived from crop production, which accounted for nearly 50%, while off-farm employment of household members in government and private sector contributed to 34%. Income from engaging in miscellaneous skilled and unskilled non-farm labour activities accounted for 12%.

Table 2.3-7 Primary Income Source by Six Model Cascades

Name of Cascade	Govt Services	Private Sector	Crop Product	Live stock	Agri. Labour	Skill Labour	Unskilled Labour	Family Business	Others
Alagalla	51.9%	5.9%	25.9%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%
Naveli kulam	11.0%	3.2%	45.2%	5.2%	0.6%	11.6%	12.3%	3.2%	7.7%
Ichchankulama	22.2%	3.5%	71.2%	0.0%	0.0%	0.5%	1.5%	0.0%	1.0%
Kiulekada	44.7%	2.0%	46.3%	1.2%	0.0%	0.8%	3.9%	1.2%	0.0%
Rathmalawewa	34.5%	1.8%	41.5%	0.0%	0.4%	6.9%	4.4%	5.8%	4.7%
Siyambalagaswewa	17.3%	2.7%	65.3%	0.7%	0.0%	4.7%	9.3%	0.0%	0.0%
Average	31.3%	2.9%	49.3%	1.0%	0.2%	4.0%	6.8%	2.1%	2.3%

Source: CSDPP, HHS conducted in March 2017

(3) Social Safety Nets

The Divineguma/Samurdhi programme is a kind of social safety net implemented by the government. Under the programme, nearly 15% of the households in the six model cascades are recipients of its benefits. Rathmalawewa has the highest number of recipients representing 22.5%. Families having an income of less than LKR 15,000 per month are eligible, depending on the number of family members, receiving LKR 1,250 (less than three), LKR 2,150 (three) and LKR 3,050 (more than three) per month in net after the statutory deductions.

Table 2.3-8 Divineguma/ Samurdhi Beneficiaries of the Six Model Cascades

Name of Cascade	The Percentage (%) of Divineguma/Samurdhi Beneficiaries
Alagalla	9.6%
Naveli kulam	12.9%
Ichchankulama	4.0%
Kiulekada	16.0%
Rathmalawewa	22.5%
Siyambalagaswewa	12.6%
Average	14.7%

Source: CSDPP, HHS conducted in March 2017

2.4 Present Conditions and Issues in the Project Area

2.4.1 Tank Irrigation Infrastructure

(1) Present Conditions of Irrigation Infrastructure

The project area is located in the dry zone, where minor tank schemes[1] have been developed since the ancient times. Anuradhapura District has 2,333 tanks. It is the 2nd largest in the country after Kurunegala with 4,192 tanks. Vavuniya District has 453 tanks (5th largest). A large number of farmers depend on tanks for irrigation and domestic use purposes in the project areas.

According to the household survey conducted in March 2017, the annual crop intensity in 2016 was estimated at only 73% against the command area of 1,709 ha on an average of the six model cascades

[1] According to the Technical Guidelines for Irrigation Works, a minor irrigation scheme is defined as having a command area of 80 ha and below.

with 58% in Maha 2015/16 and 15% in Yala 2016, respectively. It was reported that severe flooding in Maha and severe drought in Yala occurred over the project area in the year of 2016.

Table 2.4-1 Cultivated Area of the Six Model Cascades

Name of Cascade	Command Area	Maha Season (1) 2015/16		Yala Season (2) 2016		Total	
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Alagalla	80	74.6	93.3	53.2	66.5	127.8	159.8
Naveli kulam	247	149.8	60.6	0.0	0.0	149.8	60.6
Ichchankulama	355	229.9	64.8	37.9	10.7	267.8	75.4
Kiulekada	313	195.4	62.4	48.3	15.4	243.7	77.9
Rathmalawewa	469	240.8	51.3	28.2	6.0	269.0	57.4
Siyambalagaswewa	245	104.8	42.8	86.4	35.3	191.2	78.0
Average	1,709	995.3	58.2	254.0	14.9	1,249.3	73.1

Notes: (1) Maha Season usually from October to March, (2) Yala Season from April to September (Refer to Section 2.5.1 for monthly rainfall)
Source: CSDPP, HHS conducted in March 2017

A detailed survey was conducted for existing irrigation facilities and farm roads from January to May 2017. The survey results are summarised in the following table. It is noted that the number of structures is basically one for each tank but there are several exceptional cases; one tank has two or more spillways and/or sluices and irrigation canals.

Table 2.4-2 List of Existing Facilities of the Six Model Cascades

Name of Cascade	No. of Tank	Tank Bund	Spillway	Sluice	Irrigation Canal	Farm Road
	(no.)	(m)	(m)	(no.)	(m)	(m)
Alagalla	5	2,861	104	12	4,460	3,400
Naveli kulam	15	9,033	344	26	19,657	7,200
Ichchankulama	10	7,316	353	27	16,148	6,637
Kiulekada	13	7,403	290	25	20,351	13,650
Rathmalawewa	15	8,935	286	23	24,700	4,000
Siyambalagaswewa	10	6,805	218	18	12,160	4,000
Average	68	42,353	1,595	131	97,476	38,887

Source: CSDPP, Final Report

Assuming irrigation water supply from the proposed NCPC, the rehabilitation plan was prepared by mainly making reference to the Technical Guidelines for Irrigation Works published by Eng. J.A.P. Ponrajah and also in consultation with the relevant FOs under CSDPP.

Table 2.4-3 Rehabilitation Plan of the Six Model Cascades

Name of Cascade	Headworks				Canal System			Farm Road
	Tank Bund (km)	Spillway (m)	Intake Sluice (no.)	Bathing Steps (no.)	Irrigation Canal (km)	Link Canal (1) (km)	Tertiary Canal (2) (km)	(km)
Alagalla	2.9	152	12	5	4.7	5.0	1.3	0.8
Naveli kulam	9.1	362	28	15	19.7	12.1	4.8	7.2
Ichchankulama	7.4	435	29	10	16.2	10.0	2.5	6.6
Kiulekada	6.9	339	26	12	20.4	13.8	1.5	12.4
Rathmalawewa	9.0	689	27	15	24.9	11.7	8.4	4.0
Siyambalagaswewa	6.8	381	18	10	12.2	9.3	3.4	4.0
Sub-Total	42.0	2,358	140	67	98.1	61.9	21.9	34.9
128 cascades	758	42,246	2,439	1,474	1,755	1,081	392	624

Notes: (1) New construction, Not all but selective by the Study
(2) New construction, to be excluded for the Study
Source: CSDPP, Final Report

Comparing the two tables above, it is obvious that almost all existing facilities should be rehabilitated/improved. The spillway's crest width needs to be expanded to safely discharge floods with a 1/25-year probability. Among the newly proposed structures are the following: i) bathing-steps for domestic use for bathing and washing clothes, ii) link canal for connecting upper tank and lower tanks directly within a cascade system and iii) tertiary canal for linking main and secondary canals of the proposed NCPC to a cascade system. These were planned to be constructed under CSDPP. However, it was decided to exclude the tertiary canals for the Study due to several reasons. Accordingly, the link canal will be carefully reviewed in the Study on condition of no water supply from NCPC.

For irrigation schemes, competent authority and management system of major and medium schemes are different from the minor schemes. The following table summarises the organisational structure of the irrigation management for different schemes:

Table 2.4-4 Structure of Irrigation Management System

Items	Major Scheme (CA= 400 ha and more)	Medium Scheme (CA= 80 to 400 ha)	Minor Scheme (CA= 80 ha and below)
Decision-making Body for Management	PMC (Project Manager, FO representatives, representatives of line departments)	PMC (Project Manager, FO representatives, representatives of line departments)	Farmers Organisations (FOs)
Competent Authority of the Management Body	Irrigation Management Division (IMD) under MIWRM (54 schemes) ID (49 schemes)	ID	DAD
Competent Authority for Technical Issues	ID	ID	PID DAD
Legislation	Irrigation Ordinance and subsequent amendment	Irrigation Ordinance and subsequent amendment	Agrarian Development Act No. 46 of 2000

Note: Irrigation Schemes other than Mahaweli Schemes specified by MMAIRD. PMC= Project Management Committee, CA= Command Area
Source: Study Team

Basically, FOs manage minor irrigation schemes with the support of competent government authorities such as the Provincial Irrigation Department (PID) and the Department of Agrarian Development (DAD). The 13th amendment of the constitution of Sri Lanka has provided for the establishment of provincial councils with the devolution of responsibility that includes provincial irrigation schemes. Although the 13th amendment defines that minor irrigation schemes are to be handed over to provincial councils, situations differ in different provinces. Concerning technical maintenance of irrigation, minor irrigations are managed by both PID and DAD. According to the 13th amendment of the constitution, PID is responsible on maintenance, repair and rehabilitation of minor irrigation, while DAD is in charge of protection of minor irrigation scheme as per the Agrarian Development Act of 2000. Institutional issues and management of irrigation schemes are handled by DAD as indicated by the Act. The principal decision-making of the minor irrigation is made in Kanna meetings of each FO, which is practically chaired by the Divisional Officer (DO) under the Agrarian Service Centre (ASC) and authorised by the assistant commissioner of DAD.

(2) Major Problems and Causes for Irrigation Infrastructure

Taking into account the results of site visits and discussions with the stakeholders in addition to the above, the preliminary problem analysis was conducted for irrigation infrastructure as summarised in the following table.

Table 2.4-5 Major Problems and Causes in O&M for Irrigation Infrastructure

Category	Major Problems	Major Causes
Operation (water distribution)	Lack of water	Frequent occurrence of droughts Sediment in tank Damage of spillway
	U/S and D/S problems	No discharge measuring devices No rule for water distribution or not properly controlled by water masters Illegal water-taking
	Low irrigation efficiency	No field turnout (concrete-made) No field canal
Maintenance and Repair	Damages to canals and structures	Frequent occurrence of floods Aging of facilities
	No repair to damaged structures	Lack of funds for repair and maintenance
	No regular maintenance	Low participation of members in joint maintenance

Source: Study Team

2.4.2 Farm Road

(1) Present Conditions of Farm Roads

The roads are broadly classified into five types in Sri Lanka as shown in the table below. In the Study, a certain section of local authority roads and other roads across the cascade systems are regarded as target for the rehabilitation under the Project. For the convenience, it is hereinafter called a “farm road”. The farm roads are generally used for last mile transportation of farm inputs and farm outputs, O&M for irrigation facilities and/or access to villages and cities. Many of these farm roads are unpaved resulting in damaged. It is also difficult passing through the farm roads during rainy seasons. To support farming activities, the damaged farm roads need to be repaired with gravel pavement.

Table 2.4-6 Road Classification in Sri Lanka

Type	Class	Description	Administration
Express Way	-	Connecting major cities, ports	Ministry of Highways and RDA
National Road	A/B	Connecting major cities	Ministry of Highways and RDA
Provincial Road	C/D	Major/Minor feeder roads	Ministry of Provincial Council & PRDA
Local Authority Road	E	Local roads	Pradeshiya Sabha
Other Roads	-	Irrigation roads, etc.	DAD, PID, etc.

Note: PRDA is Provincial Road Development Authority
Source: Road Development Authority (RDA)

(2) Major Problems and Causes for Farm Roads

Taking into account the results of site visits and discussions in addition to the above, the preliminary problem analysis was conducted for farm roads as shown in the table below.

Table 2.4-7 Major Problems and Causes in Maintenance for Farm Roads

Category	Major Problems	Major Causes
Maintenance and Repair	Damages to roads	Frequent occurrence of floods Mostly unpaved roads Lack or insufficient capacity of cross drains
	No repair to damaged structures	Lack of funds in administration for repair Low priority placed on improvement of damaged farm roads by administration and FOs
	No regular maintenance	Low participation of users in joint maintenance

Source: Study Team

2.4.3 Agriculture

(1) Landholding Size

In the project area, most households possess land under more than one land holding category. According to the detailed survey conducted under CSDPP, the average landholding size in the model cascades was estimated at 1.81 ha of farm land, consisting of i) 1.0 ha of irrigated land under tanks, ii) 0.1 ha rainfed land called as Akkarawela, iii) 0.4 ha of chena and iv) 0.3 ha of home garden probably lift-irrigated, with the variation of holding sizes depending on the cascade as shown in the following table.

Table 2.4-8 Average Landholding Size of the Six Model Cascades

Name of Cascade	Irrigated Land under Main Tank	Irrigated Land under Other Tanks	Total of Irrigated Land	Akkarawela Rainfed Land	Chena Lands	Home Garden Lift	Total
Alagalla	0.54 ha	0.13 ha	0.67 ha	0.06 ha	0.26 ha	0.26 ha	1.25 ha
Naveli kulam	0.75 ha	0.38 ha	1.13 ha	0.07 ha	0.81 ha	0.27 ha	2.27 ha
Ichchankulama	0.90 ha	0.05 ha	0.95 ha	0.01 ha	0.19 ha	0.36 ha	1.51 ha
Kiulekada	1.25 ha	0.14 ha	1.39 ha	0.02 ha	0.11 ha	0.53 ha	2.05 ha
Rathmalawewa	0.85 ha	0.20 ha	1.05 ha	0.21 ha	0.67 ha	0.27 ha	2.20 ha
Siyambalagaswewa	0.70 ha	0.22 ha	0.92ha	0.27 ha	0.03 ha	0.08 ha	1.30 ha
Average	0.84 ha (46%)	0.18 ha (10%)	1.02 ha (56%)	0.10 ha (6%)	0.39 ha (21%)	0.30 ha (17%)	1.81 ha (100%)

Source: CSDPP, HHS conducted in March 2017

(2) Land Ownership

A complex land ownership and tenure system operated in the irrigated command area of the cascades. The Ande System, a form of share cropping, is once legally binding under the Paddy Lands Act and was superseded by the Agrarian Act, 2000 No. 46. Cultivating irrigable lands under seasonal lease agreements with the owner are emerging in the area. In the model cascades surveyed in the CSDPP, over 82% of the irrigable lands are owner operated with or without additional pangu or leased in lands while 13% are pangu lands. The Ande system, accounted at 3%, is a form of share cropping under the Agrarian Act, 2000 No. 46 as shown in the following table.

Table 2.4-9 Distribution of Land Ownership and Tenure System of the Six Model Cascades

Name of Cascade	Ande (share cropping)	Own (1)	Pangu (shareholding or tenancy rotation)	Others	Total
Alagalla	14%	29%	56%	1%	100%
Naveli kulam	1%	96%	1%	2%	100%
Ichchankulama	9%	90%	0%	1%	100%
Kiulekada	0%	67%	25%	8%	100%
Rathmalawewa	0%	99%	1%	0%	100%
Siyambalagaswewa	0%	76%	23%	1%	100%
Average	3%	82%	13%	2%	100%

Note: (1) Own includes "own/ leased in" and "own/ pangu".
Source: CSDPP, HHS conducted in March 2017

(3) Paddy Cultivation

Paddy is cultivated in command areas of tanks in the cascades under irrigation and in highlands as a rain-fed crop in the Maha season. During the Yala season, however, cultivation in the command area of the model cascade systems surveyed in CSDPP is restricted to about 25% of the Maha season due to inadequate irrigation water supply. The Rathmalawewa Cascade shows the largest extent of rain-fed paddy in the Maha season.

According to the Department of Census and Statistics, the average yield of paddy in minor irrigation schemes in Anuradhapura District in 2015/16 was 4.66 tons per hectare. Except Alagalla, all other cascades showed a lower productivity level compared with the average yield of the district. The cultivated extents, production, and yields of paddy in the six cascades under study are shown in Table 2.4-10 to Table 2.4-12 (refer Appendix 2.4-1).

Table 2.4-10 Paddy Extent, Production and Yield in the Main Tank of the Six Model Cascades

Cascade	Irrigation Command Area	Main Tank (Irrigated)					
		Maha			Yala		
		Extent	Production	Yield	Extent	Production	Yield
Alagalla	80 ha	75 ha	384 t	5.3 t/ha	53 ha	242 t	4.5 t/ha
Naveli kulam	247 ha	195 ha	885 t	4.5 t/ha	48 ha	217 t	4.5 t/ha
Ichchankulama	355 ha	150 ha	592 t	4.0 t/ha	0 ha	0 t	- t/ha
Kiulekada	313 ha	230 ha	960 t	4.3 t/ha	38 ha	172 t	4.5 t/ha
Rathmalawewa	469 ha	241 ha	882 t	3.8 t/ha	28 ha	106 t	3.8 t/ha
Siyambalagaswewa	245 ha	105 ha	439 t	4.3 t/ha	86 ha	349 t	4.1 t/ha
Total	1,709 ha	996 ha	4,142 t	4.2 t/ha	253 ha	1085 t	4.3 t/ha

Source: CSDPP, HHS conducted in March 2017

Table 2.4-11 Paddy Extent, Production and Yield in the Other Tanks of the Six Model Cascades

Cascade	Other Tanks (Irrigated)						Highland (Rain-fed)		
	Maha			Yala			Maha		
	Extent	Produ ction	Yield	Extent	Produ ction	Yield	Extent	Produ ction	Yield
Alagalla	18 ha	76 t	4.2 t/ha	13 ha	43 t	3.3 t/ha	23 ha	7 t	2.3 t/ha
Naveli kulam	1 ha	2 t	2.8 t/ha	0 ha	0 t	- t/ha	8 ha	26 t	3.3 t/ha
Ichchankulama	78 ha	295 t	3.8 t/ha	0 ha	0 t	- t/ha	25 ha	80 t	3.2 t/ha
Kiulekada	12 ha	46 t	3.8 t/ha	7 ha	28 t	4.0 t/ha	25 ha	52 t	2.0 t/ha
Rathmalawewa	51 ha	151 t	3.0 t/ha	1 ha	6 t	4.3 t/ha	95 ha	192 t	2.0 t/ha
Siyambalagaswewa	34 ha	139 t	4.3 t/ha	29 ha	129 t	4.5 t/ha	21 ha	67 t	3.3 t/ha
Total	192 ha	708 t	3.8 t/ha	51 ha	206 t	4.0 t/ha	177 ha	424 t	2.4 t/ha

Source: CSDPP, HHS conducted in March 2017

Table 2.4-12 Paddy Extent, Production and Yield in the Irrigable Area of the Six Model Cascades

Cascade	Irrigation Command Area	Main Tank and Other Tanks (Irrigated)					
		Maha			Yala		
		Extent	Production	Yield	Extent	Production	Yield
Alagalla	80 ha	93 ha	460 t	4.9 t/ha	66 ha	285 t	4.3 t/ha
Naveli kulam	247 ha	192 ha	887 t	4.6 t/ha	48 ha	217 t	4.5 t/ha
Ichchankulama	355 ha	228 ha	887 t	3.9 t/ha	0 ha	0 t	- t/ha
Kiulekada	313 ha	242 ha	1,006 t	4.2 t/ha	45 ha	200 t	4.5 t/ha
Rathmalawewa	469 ha	292 ha	1,033 t	3.5 t/ha	29 ha	112 t	3.9 t/ha
Siyambalagaswewa	245 ha	139 ha	578 t	4.2 t/ha	115 ha	478 t	4.2 t/ha
Total	1,709 ha	1,188 ha	4,850 t	4.1 t/ha	304 ha	1291 t	4.2 t/ha

Source: CSDPP, HHS conducted in March 2017

(4) Other Crops Cultivation

In general, little effort has been made by farmers to diversify their lands in the command area to non-paddy crops and farmers preferred to continue paddy cultivation under the present situation. The cultivated extent under other crops in the command area is insignificant.

Cultivation of other seasonal crops largely takes place in highland areas such as the Akkarawela, chenas, and home gardens. These crops include coarse grains (maize and millet), grain legumes (green gram, black gram and cowpea), condiments (chilli and onion), and low country vegetables. According to the result of the detailed survey conducted in the model cascade systems under CSDPP, farmers in Alagalla and Naveli kulam (Vavuniya District) prefer cultivation of grain legumes and black gram in particular because of the high local demand. Cultivation of maize is limited in Alagalla and Naveli kulam largely due to poorly established produce marketing system. In cascades located in Anuradhapura District, Maha rain-fed cultivation of maize is well spread except in Siyambalagaswewa cascade due to lack of suitable lands.

Table 2.4-13 Cultivated Extent of Other Crops in Highland

Cascade	Maha Season: Rain-fed				Yala Season: Rain-fed	
	Coarse grain	Grain Legumes	Vegetables	Total	Sesame	Production
Alagalla	7.8 ha	17.7 ha	0.5 ha	26.0 ha	17.8 ha	7,674 kg
Ichchankulama	148.6 ha	- ha	- ha	148.6 ha	2.4 ha	- kg
Kiulekada	70.6 ha	1.4 ha	1.5 ha	73.5 ha	- ha	- kg
Naveli kulam	0.1 ha	27.5 ha	1.9 ha	29.5 ha	1.0 ha	450 kg
Rathmalawewa	179.6 ha	0.4 ha	0.2 ha	180.2 ha	- ha	- kg
Siyambalagaswewa	5.7 ha	3.4 ha	0.2 ha	9.3 ha	- ha	- kg
Total	412.4 ha	50.4 ha	4.3 ha	467.1 ha	21.2 ha	8,124 kg

Source: CSDPP, HHS conducted in March 2017

(5) Agriculture Extension Services

Provision of agricultural extension services to the farm community is provided by a number of organisations, each specialising on specific subject areas, including the Coconut Cultivation Board, Department of Export Agriculture, and some private organisations. Among them, technology transfer on paddy and other field crops in the project areas comes under the purview of the Provincial Departments of Agriculture (PDOA) located in Anuradhapura and Jaffna. The PDOAs functions under the respective provincial councils through the Provincial Ministries of Agriculture (refer to Appendix 2.4-2).

At the grass-root level, extension services for the farmers are provided by Agricultural Instructors (AIs) operating at ranges or, in the areas coinciding with that of the Agricultural Service Centres (ASCs). Their list is shown below. Based on the spread of the service areas, the AIs are supported by one or two newly recruited technical assistants and are stationed in the ASCs. The list of ASCs is shown for each district below:

Table 2.4-14 List of Agricultural Service Centres

Anuradhapura District		Vavuniya District
1. Thirappane	10. Ethakada	1. Madukanda
2. Siwalakulama	11. Punawa	2. Kovilkulam
3. Gaenbindunuwewa	12. Yakalla	3. Omanthai
4. Mihintale	13. Konwewa	4. Pampaimadu
5. Kahatagasdigilya	14. Horowpothana	5. Vengala Cheddikulam
6. Kallanchiya	15. Kapugollawa	6. Kanagarayankulam
7. Rambewa	16. Kotaweaw	
8. Medawachchiya	17. Padaviya	
9. Ratmalgahawewa		

Source: Study Team

(6) Problems and Major Causes in Agricultural Sector

In the CSDPP, analysis of the present condition of the agricultural sector in the project area was carried out and the problems and their major causes are listed briefly in the following table.

Table 2.4-15 Major Problems and Causes in the Agriculture Sector

Category	Major Problems	Major Causes
Production	High production cost	Short of agriculture labour force, high wage rates, low farm mechanisation for OFC
	Short of quality seeds and planting materials	Low availability of quality seeds and planting materials from sources (government and private sectors)
	Low crop intensity in irrigable area	Inadequate supply of irrigation water
	Low yield of paddy	Non adoption of recommended agronomic practices
	Small land area per household under tank command areas	High degree of land fragmentation over generations
	Flood damage in tank command area especially maize	-
Crop Diversification	Delay in crop diversification	High dependency on rice farming Active intervention by government to promote paddy through fertiliser subsidy and guaranteed price
	Lack of fund for profitable agriculture and default	High degree of default to banks and lending agencies
	Poor extension services	Lack of cultivation skill / know-how on vegetable and fruits
Processing/ Marketing	Low product quality (rice and vegetable) / low quality of paddy processing	Low attention to quality parameters, Inadequate promotion of post-harvest processing, Lack of grading and processing facilities
	Low farm gate price	Inadequate storage facilities Oligopoly of major trading companies in OFC market

Source: Study Team, based on CSDPP Final Report

2.4.4 Livestock and Fishery

(1) Livestock

Cattle rearing and poultry keeping are the main livestock activities in the project area. Although the number of households engaged in livestock is limited, the potential for increasing the farm income is high through the integration of crop and livestock. Large cattle and buffalo population dwindled rapidly over the past four decades with the advent of farm mechanization as well as other factors relating to such herd management as drastic reduction in the free grazing land.

(a) Dairy Farming

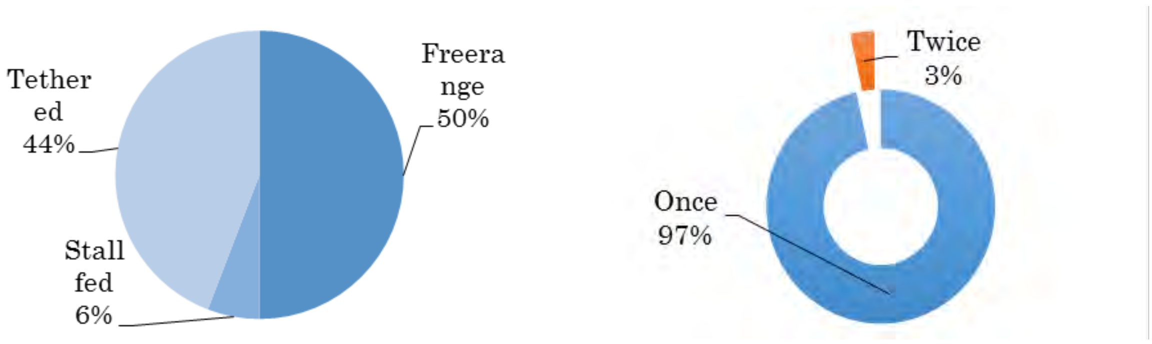
According to the detailed survey conducted in the model cascade systems under CSDPP, 116 households representing 9.93% are engaged in animal husbandry. However, the number of livestock farmers varies by cascade, ranging from the lowest 1.5% to the maximum 25% of the total farmers, as shown in the following table:

Table 2.4-16 Dairy Farmers and Cattle Breeds

Cascade	Households		Number of Animals			
	Number	In Cascade	Local	Crossbred	Not Specified	Crossbred %
Alagalla	11	8.2%	19	24	16	40.7%
Ichchankulama	34	17.2%	33	116	72	52.5%
Kiulekada	19	7.5%	87	56	0	39.2%
Naveli kulam	39	25.2%	303	90	137	16.9%
Rathmalawewa	4	1.5%	13	26	2	63.4%
Siyambalagaswewa	9	6.0%	73	0	0	00.0%
All Cascades	116	9.9%	528	312	227	29.2%

Source: CSDPP, HHS conducted in March 2017

Cattle in the cascade systems converts plants and grasses into milk, meat, and other products. Hence, the cost of production of these products is minimal. The cattle management practices carried in the project area are free range and tethered systems. Furthermore, farmers tend to milk only once a day knowing the quality and intake quantity of herbage.



A: Cattle Management System

B: Milking Frequency

Source: CSDPP, HHS conducted in March 2017

Figure 2.4-1 Source of Animal Feed and Milking Frequency

The daily milk production is mainly sold to MILCO Company. Under the guidance of the company, Cooperative Milk Producer Societies have been established where 57 of the cattle farmers hold membership. The average production of milk is 2.435 litres per cow per day. It is encouraging to observe that more women are gainfully engaged in the dairy sector.

(b) Poultry Farming

In the model cascades systems, only 59 households representing 5.1% of the survey sample were engaged in poultry farming, and majority of the 49 households were in Naveli kulam cascade. There were 387 hens laying 228 eggs a day.

Even though milk production strongly supports consolidating farm income, it has little impact on food security. On the other hand, family poultry keeping has a solid influence on household food security but very little impact on farm income. This may be the reason why only a few households are engaged in poultry keeping. These numbers could increase by making the family poultry sector support both food security and strengthen farm income. It must be noted that this activity will totally be handled by women members in the household to address gender inequality in the rural sector.

(c) Major Problems and Causes in Livestock Sector

In the CSDPP, analysis of the present condition of the livestock sector in the project area was conducted. The problems and their major causes are listed briefly in the following table.

Table 2.4-17 Major Problems and Causes in Livestock Sector

Category	Major Problems	Major Causes
Feeding	Non-availability of quality pasture/ fodder is considered as the major bottleneck in livestock production.	Shortage of improved grass and lands for grass cultivation
	Low milk production during rainy season	Short volume and low quality of feeds and limited access to feed resources
Breeding	Unfavourable pressure on feed and water resource	Large number of unproductive cattle
	Low distribution of crossbred dairy cattle	Unavailability of artificial insemination
	Unfavourable management condition	Low capacity of farmers
Capacity Building	Farmers' raising level remains at cattle keeper and does not adopt the mindset of dairy farmers Extensive farming without feed processing, forage cultivation, and adapting new animal breed	No training available to promote intensive dairy farming including feed processing, forage cultivation and adapting new animal

Source: Study Team

(2) Fishery

Inland fishery is broadly divided into two kinds of activities depending on the nature of the water body, namely, perennial tanks and seasonal tanks. Minor tanks of the cascades located in the project area are mostly categorised as seasonal tanks. Since no water is available for some period, particularly in the Yala season, limited number of farmers, probably 10 to 15 persons per minor tank, may conduct fishery on a part-time basis by utilising available water in the minor tank. In this case, they must have permission from the FO managing the minor tank and pay fees for the lease to the FO because the tank is a community asset of the farmers.

According to the detailed survey conducted in the six model cascades under CSDPP, fishery activities are found in four model cascades, and 7 FOs out of total of 29 FOs obtain a substantial income from the lease of tanks for inland fishery, mainly for local indigenous fish, and picking lotus flowers for sale.

Information gathered through discussions with officials of the National Aquaculture Development Authority (NAQDA) compiled to present the main features of Culture Based Fishery (CBF) in minor tanks, along with the issues and constraints are presented in the following table.

Table 2.4-18 Main Features of Culture Based Fishery in Minor Tanks

Item	Description	
Concurrence of NAQDA for CBF	・ Agreement of FO of the respective tank to carryout CBF farming ・ Certification of the relevant Grama Niladhari (GN) and the DO of DAD ・ Assurance that no cultural or religious barriers exist against CBF	
Selection of seasonal tank	・ Should retain water over a period of at least 6 – 8 months ・ Free of aquatic weeds and other obstacles ・ Access roads to reach the tank	
Main breeds	・ Carps: 7 varieties (3 Chinese and 3 Indian and Tilapia) ・ Indian carps: Catla, Mirigal and Tofu ・ Chinese carps: Common carp, Bighead carp and Siloo carp	
Selection of breeds	・ Based on the preferred stratum of the water body by the fish breed. ・ Tilapia is preferred by farmers because of the high demand, omnivorous feeding and natural breeding habit.	
Production of fry, fingerlings and advanced fingerlings	・ Larvae is produced at NAQDA Breeding Centre from eggs kept and kept in incubators to reach fry stage ・ Fry are incubated in NAQDA or privately owned external hatcheries until they reach fingerling stage in 45 – 60 days. The fingerlings are kept for another 30 days they are called advanced fingerlings.	
Costs of fingerlings and advanced fingerlings	・ Fingerlings: LKR 2.5 each used when water retention period in tank is minimum 8 months ・ Advanced Fingerlings: LKR 5.0 each used when water retention period in tank is minimum 5-6 months	
Stocking time	・ Ideal in January/February but before March when the tanks are full, and the spilling of water has stopped. ・ Early stocking may cause loss of fingerlings being washed out with spill water	
Stocking rate	・ Calculated based on 30% of the total water spread area of the tank at 2,000 fingerlings per ha.	
Feeding	・ Phytoplankton and zooplankton naturally found in the tank water provide the food resource to fish. The refuse of ruminants grazing in tank bed after drying up of the minor tanks in the Yala season promote the growth of planktons	
Recovery rate	・ In minor tanks, a survival rate of 55 - 60% of the stocked fingerlings is allowed.	
Harvesting	・ Dragnets with 2-inch mesh are used to catch the fish. ・ Average weight per fish at harvest 0.5 kg ・ Partial harvesting is resorted to if the tank dries up fast leaving little water for the total stocked to survive	
Cost and gross Income per Ha of WSA	Water spread area	1 ha
	Effective area	0.3 ha (30% of WSA)
	Stocking rate	2,000 fingerlings/ha
	No. of fingerlings for effective area	600
	Cost per fingerling	LKR 2.5
	Total cost of fingerlings for effective area	LKR 1,500
	Survival rate at harvesting	60%
	No of fish at harvest	360
	Average weight per fish at harvest	0.5 kg
	Total fish harvest	180 kg
	Selling price of fish at tank	LKR 220/kg
	Gross income	LKR 39,600 per ha.

Item	Description
Issues & Constraints	・ Unpredictability of rainfall pattern due to climate change make determination of the stocking time inaccurate affecting the ordering schedule of fingerlings. ・ Heavy aquatic weed growth covering the water surface prevents sunlight needed for growth of water planktons. ・ Sedimentation of silt in the tank bed shortens the period of water retention in the tanks. ・ Accumulation of chemicals in the tanks, including heavy metals, from farming causes health and environmental problems. ・ Lack of interest of FOs to continue as there is no individual benefits accrued to members.

Note: (1) Number of tanks under the cascade.
Source: CSDPP, HHS conducted in March 2017

2.4.5 Farmers Organisations in the Project Area

There are several Community-Based Organisations (CBOs) in operation in the project area. Some of them are formed with the intervention by the government under various schemes and some are formed based on the needs identified by the concerned community. Irrespective of name and functions of those CBOs, their common goal is to reach certain socio-economic objectives specially through increasing social capital. Brief description of the CBOs is given in Table 2.4-19 (refer to Attachment 2.4-1) where farmers organisation (FO) is the field level key stakeholder for the Cascade System Development Project. However, association with other organisations like Rural Development Societies, Divinaguma Societies and Cooperative Societies (especially fisheries societies and milk producers' societies) is useful for other related activities like agriculture, livestock, small scale income generation projects and marketing.

(1) Present Condition of Farmers Organisation

(a) Overview of Farmers Organisations

Farmers Organisations (FOs) are formed under the legal provision of the Agrarian Development Act No. 46 of 2000. The command area of an FO is defined initially based on the nature of irrigation scheme whether it is a major/medium irrigation tank or minor irrigation tank. Almost all the irrigation tanks under the Cascade System Development Project are minor tanks and FOs are formed based on the irrigation tank. However, there are many cases that one FO covers more than one minor irrigation tank. There are several FOs in one cascade system, and it is common for all the cascade systems. The main functions of FOs encompass operation and maintenance of irrigation facilities, water management and agricultural activities.

In general, membership of FO mainly consists of the farmers who cultivate in the FO command area and there are occasions that one farmer has membership in more than one FO depending on the land ownership in several irrigation tanks. Office bearers of the FO are selected mostly by consensus at a general meeting annually. The main office bearers selected include president, secretary, treasurer and Yaya Niyojitha (water master).

Support from the DAD to form and strengthening FOs is mandatory as per the Agrarian Development Act No. 46 of 2000. Preparation of by-laws which FO can define their own specific rules and regulations is permitted under the same act provided that the procedures mentioned in the act are followed. FOs in the project area are established firmly and through coordinating with relevant agencies, FOs cooperate with development programs and supporting services. The target DS divisions cover 760 FOs in Anuradhapura District and 225 FOs in Vavuniya District.

The necessity of forming Cascade Level Farmers Organisations has already been recognised and DAD is currently in the process of legalising the same proposing amendment to the Agrarian Development Act No. 46 of 2000. Several attempts have been made to establish the Cascade Level Farmers Organisation under certain special projects without any legal support but it was finally found ineffective.

(b) Activities of Farmers Organisations in the Target Area

One of the key activities of FOs is operation and maintenance (O&M) of irrigation facilities. Necessary technical support for such activities is provided by PID in Anuradhapura District while DAD provides for the same activities in Vavuniya District. In both districts, capacity building programs related to O&M is done by DAD. FOs have formed an O&M fund with the contribution of member farmers. In addition to the contribution, the O&M fund is strengthened by the deposited money collected from fines and income from contract works as shown in Attachment 2.4-1.

The O&M fund together with voluntary labour contribution of member farmers is utilised for general minor repairs of the irrigation facilities by FOs with the technical support of relevant technical officers.

Table 2.4-19 Summary of Major CBOs in the Project Area

CBO	Membership	Scale	Major Activities	Legislative Base and Registration	Competent authority	Government Support
Farmers Organisation (minor irrigation)	Landowners or tenants in the area defined. A minimum of 25 members are required to form FO.	In general, 01 FO per minor tank. May be more than 01 tank under 01 FO	・ Operation and maintenance of irrigation scheme. ・ Seasonal planning. ・ Coordinate to supply agricultural inputs.	・ Agrarian Development Act No 46 of 2000. ・ Registration with DAD.	・ Department of Agrarian Development. ・ Coordinate through Field Level Officer ARPA	・ Capacity building. ・ Seasonal planning ・ Irrigation management ・ Fertiliser subsidy ・ Contracting works
・ Rural Development Society (RDS). ・ Women Rural Development Society (WRDS)	Villagers living in the area defined.	Concept is one per village. There may be variations, 1-2 per village	・ Organise and implement voluntary works in the village. ・ Savings and credit program ・ Organise and conduct religious and cultural activities. ・ Organise health clinics ・ Conduct environmental conservation programs	・ Circular no A/C/3/1/1, 18.09.1978 and amended on 31.10.1978. ・ Registration with DS.	・ Provincial Department of Rural Development. ・ Coordinate through field level officer or Rural Development Officer (RDO) attached to DS office	・ Training and skill development ・ Income generating activities ・ Cultural programs ・ Infrastructure development. ・ Contracting works
Cooperative Societies:						
-Multipurpose cooperative society (MPCS)	Not specified	One per DS division	MPCS deal with several activities and main activity related to agricultural development is paddy purchasing.	・ -Cooperative Societies Act No 5 of 1972, amended Act No 32 of 1983, amended Act No 11 of 1992. ・ In addition, the provincial administration issue cooperative statute. ・ Registration with Provincial Department of Cooperatives.	・ Provincial Department of Cooperatives. ・ Coordinate through Cooperative Development Officer.	・ Monitoring and auditing ・ Infra structure support like providing mill ・ Provide capacity development programs ・ Credit facility for purchasing paddy ・ Interfere for conflict resolution.
Agricultural Development Cooperative Society	Mainly farmers	Not specified	Other cooperatives act on their specific purpose.			
Inland Fishery Production Cooperative Society	Those who are involved with inland fishery	Not specified				
Livestock/milk production Cooperative Society	Those who are involved with livestock/milk production	Not specified				
Thrift & Credit Cooperative Society	Generally, low-income groups	Not specified				
Divinaguma Community Based Organisation	Poor families who claim monthly income below LKR 3500.00.	1-2 CBOs per Grama Niladhari (GN) division. 15-20 CBOs will form Divinaguma Banking Society	・ Implement Divinaguma social welfare program ・ Provide credit facilities and recovery ・ Organise voluntary works ・ Undertake small scale contract works.	Circulars issued by the Samurdhi Authority. District Level Office does the registration.	・ Divinaguma District Office. ・ Coordinate through Samurdi Officer at field level	・ Livelihood development programs ・ Social and cultural development programs ・ Capacity building programs
Death Donation Society	People living in the area defined can obtain membership	1-2 societies per village.	・ Support members to bare cost of funeral. ・ Plan and implement activities of funeral house ・ Provide credit facilities for members other than funeral activities.	Formed by the community and register with the DS office as welfare society.	No particular competent authority. CBO itself plans and implements according to the constitution.	No special support.

Source: Study Team

The repair works which are considered to be beyond the FO capacity are contracted out by the authorities (PID in Anuradhapura District and DAD in Vavuniya District).

The FOs decide on the seasonal water management plan and crops that they cultivate in the forthcoming season during the cultivation meeting organised by DAD which is held before commencement of each agricultural season. Decisions taken in the Kanna meetings have legal power and FOs are responsible to comply with the decisions and plans confirmed in the Kanna meeting.

All the water management activities including operation of main sluice is currently done by the Yaya Niyojitha (water master) selected during the general meeting of FO. The water master is paid in kind or cash by farmers as decided in the Kanna meeting; currently collecting ½ a bushel[2] of paddy per acre is practiced. There are places where the practice is to collect a bushel of paddy per acre and to keep the 50% to the FO fund and release the balance to the water master.

In addition, FOs play an important role in the Government Fertiliser Subsidy Scheme by coordinating and assisting DAD (refer to Appendix 2.4-3).

(c) Possibility to Undertake Project Activities by FOs

The key stakeholder at the field level for any irrigation development work is the Farmers Organisation. With the introduction of the Participatory Irrigation Management Policy in the country in 1992, farmer participation in planning and implementation of irrigation related programs is inevitable. Regarding the rehabilitation of irrigation facilities by FOs through contracts as per government regulations, FOs are permitted to undertake contracts worth LKR 2 million. However, the current practice of subletting the contract to another party especially under minor irrigation schemes may lead to weak financial capacity, technical capacity, management capacity and institutional capacity of FOs.

In terms of sustainability, FO participation in irrigation system development is unavoidable as they are the caretakers now and even after rehabilitation. As a result of FO participation, a sense of ownership over the irrigation facilities can be strengthened and thereby the sustainability of the rehabilitated system can be assured through a properly planned O&M program.

In this regard, a well-planned capacity-building program covering financial capacity, technical capacity, management capacity and institutional capacity must be included to make use of FOs for the project activities, especially for small-scale contract works of their own scheme. This can be used as an entry point to strengthen the FOs not only for irrigation management work, but also for agriculture and other income generating activities.

(2) Problems related to Farmers Organisations

As FOs are the key stakeholders in the Cascade System Development program, the problems and possible causes identified here are directly related to the FOs. It is true that FOs are capable of playing a key role in the field of irrigation development and would thereby aim for a better agricultural production provided that their capacities are enhanced and that the problems they face are addressed.

[2] One bushel is equivalent to 0.03637 m^3.

Most of the FOs in the project area are suffering from scarcity of funds. They rely mainly on member contributions, which are too little in comparison with the amount required for O&M. Earnings from subletting contract works awarded to them are also contributed to the FO funds. It is reported that corrupt practices in the contract works and mismanagement of the FO funds have occurred in some FOs.

Lack of dedicated leaders with essential developmental and leadership skills is an impediment and a major reason for the observed minimal contribution of FOs in organisational development. FO members will contribute meaningfully if their leaders perform up to the standard level. Quality leadership is critical to FOs survival and fulfilment of purpose as resources (finance and personnel) are optimised.

There is a disturbing trend of leadership interlocking among people who are regarded as pioneers or popular with political activities. As a consequence, key office bearers serve for many years without giving opportunity for others especially young people to occupy positions of office bearers. This situation has influenced most of the young members to keep away from FO activities.

FOs are discouraged in farming due to drought hazard experience that had happened several times in the past and therefore they are reluctant to take challenges specially with new crops without assured irrigation water supply and ready market.

Taking these things into consideration, the preliminary problem analysis on FOs was conducted and is given in the following table.

Table 2.4-20 Major Problems and Causes in Functions of FOs

Major Problem	Major Causes
Lack of dedicated leadership	・ Many traditional leaders hold the position only for prestige but do not serve the members. ・ Same cadre bearing FO for long periods of time (no change of office cadre)
Poor cooperation of members	・ Weak social relations with the leaders ・ Lack of peer pressure for cooperative activities among members ・ Some members residing outside the area ・ Lack of sense of ownership
Corruption and mismanagement of FO funds	・ Lack of transparency in financial and accounting matter ・ Contract works without bidding process
Lack of trainings	・ No opportunity for leaders to learn new management skills ・ No opportunity for members to get trainings on new technical skills
Use of FOs for political purposes	・ Most of the leaders are politically active persons
Scarcity of funds	・ Insufficient amount of funds for O&M contributed by members ・ Less opportunities to generate FO funds
Second generation problem (no successor to farming)	・ Lack of interest of the youth in farming due to hard labour and low profit ・ Subdivision of land by inheritance
Lack of government support and subsidy for agriculture	・ No support for crop insurance ・ No timely and sufficient support from the government for disaster recovery from droughts and floods ・ No government subsidy for water saving technologies such as drip and sprinkler

Source: Study Team

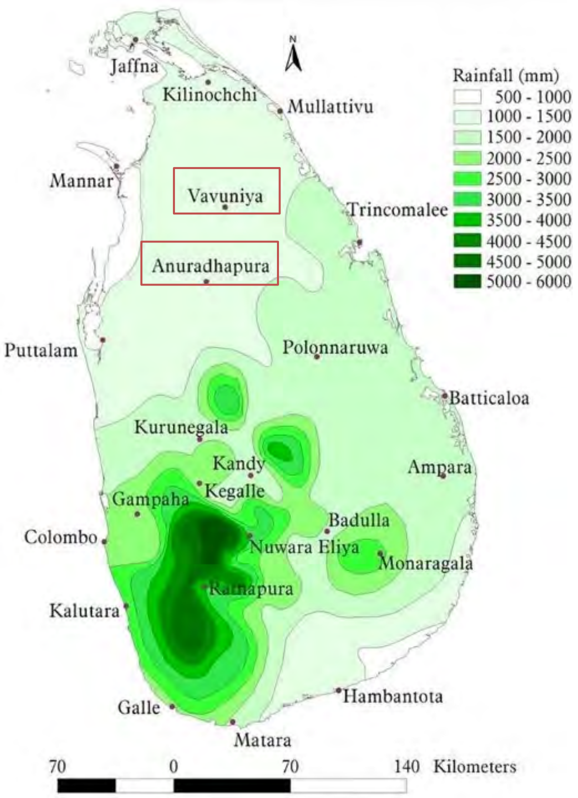
2.5 Climate and National Disasters in the Project Areas

2.5.1 Climate Condition

The island of Sri Lanka belongs to the tropical monsoon climate zone and is influenced by two monsoons. The rainfall pattern is strongly influenced by the direction of these monsoons, i.e. the southwest monsoon pours rainfall in the southwest part of Sri Lanka from May to September, while the northeast monsoon pours rainfall in the central part and the arid area of the north and northeast part of Sri Lanka from December to February.

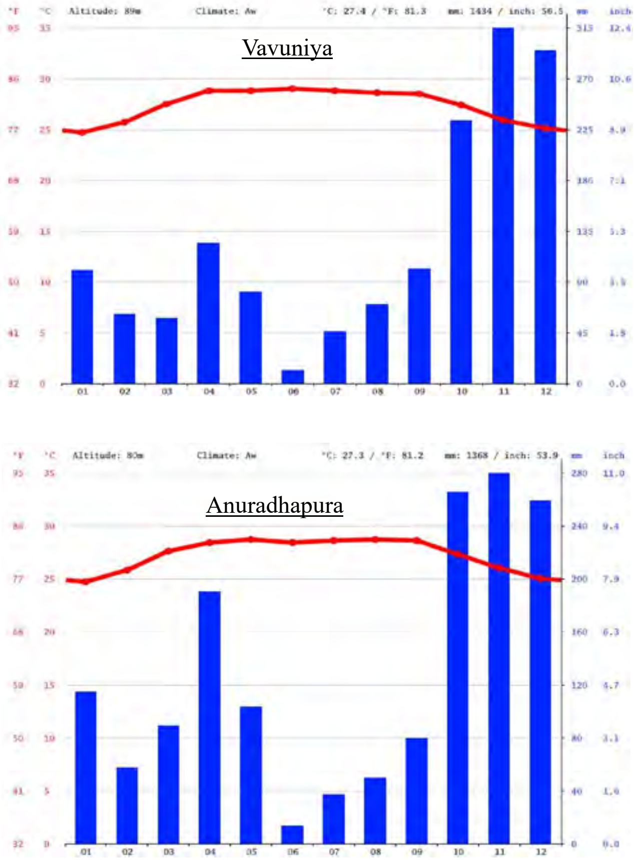
The climate of Sri Lanka is further subdivided to three zones, i.e. the wet zone, intermediate zone, and dry zone depending on the amount of annual rainfall. The wet zone is the area where annual rainfall has more than 2,000 mm while, the dry zone is defined where the annual evaporation exceeds the annual rainfall. The intermediate zone is the area between the wet and dry zones. The annual rainfall of the country is shown in Figure 2.5-1.

The project area lays on the Anuradhapura and Vavuniya districts where the climate category is dry zone. As shown in the figure, the area's limited annual rainfall ranges from 1,000 to 1,500 mm.



Source: *Premarathe et al; "Country Pasture/Forage Resource Profile, Sri Lanka"2006, FAO.*

Figure 2.5-1 Average Annual Rainfall



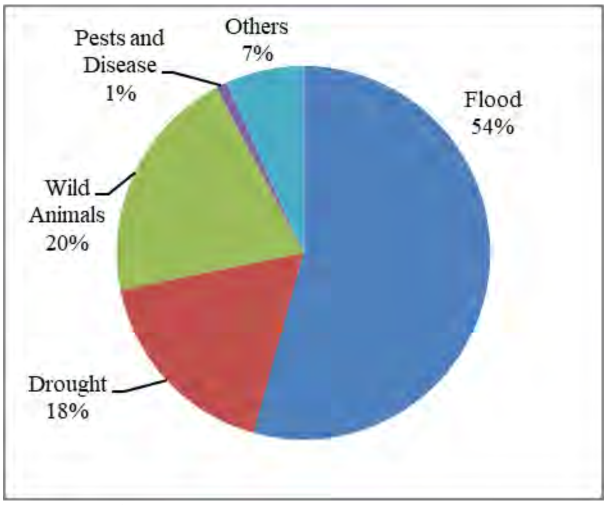
Source: *CLIMATE-DATA.ORG*

Figure 2.5-2 Annual Climate Graph (upper: Vavuniya, lower: Anuradhapura)

2.5.2 Natural Disasters

(1) Damage to Agriculture

According to a report by the Disaster Management Centre of the Ministry of Disaster Management (currently under the Ministry of Defence), floods, followed by droughts, have the most impact on the livelihoods of the people in Sri Lanka. It is reported that floods and droughts affected approximately 3,000,000 and 2,000,000 people, respectively, over three decades from 1974 to 2004. The climate in the Northern and North Central provinces is characterised by distinctive wet and dry seasons (the wet season, also known as the Maha season, occurs from October to January, and the dry season, also known as the Yala season, occurs from May to August). This climate typically causes torrential rains (floods) during the wet season and heat damage to crops (droughts) during the dry season. These two kinds of disasters are two sides of the same coin as they are both attributed to the amount of rainfall during the rainy season. Figure 2.5-3 shows the main causes of damage to agriculture. While flood damage accounts for the majority, drought and wild animals' damage account for 18% and 20%, respectively. Most of the wild animals' damage here is caused by elephants trampling the fields. For the resent climate situation in the Project area, see Section 8.6.

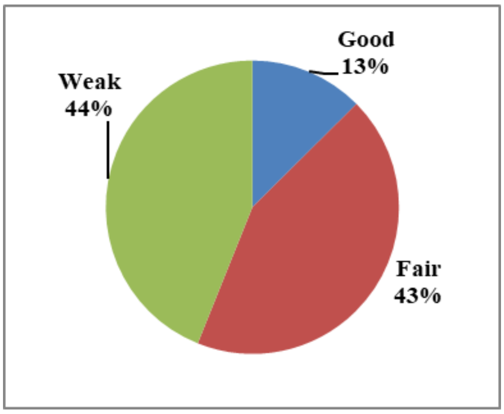


Source: Study Team

Figure 2.5-3 Crop Damages in the Northern Province

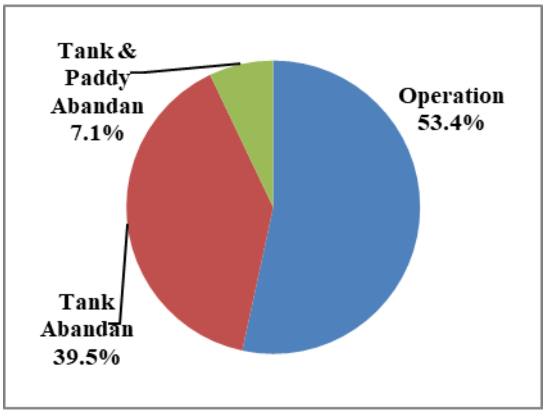
(2) Damage to Irrigation Facilities

Figure 2.5-4 shows the conditions of irrigation tanks according to a survey in the North Central Province (total of 2,316 tanks). Because of differences in the survey items between the Northern Province and North Central Province, it is difficult to compare the conditions of irrigation tanks in Anuradhapura and Vavuniya from the same points of view. Figure 2.5-4 however, indicates the overall conditions of the irrigation tanks with the sum of "good" and "fair" accounting for 56% and "weak" accounting for 44%. Figure 2.5-5 shows the statistics on the proportion of irrigation tanks functioning properly. Out of all tanks in the North Central Provinces, the tanks being in operation are 53%, and the abandoned tanks are 40%.



Source: *Study Team*

Figure 2.5-4 Conditions of Irrigation in the North Central Province



Source: *Study Team*

Figure 2.5-5 Usage of Irrigation Tanks in the North Central Province

(3) 2014 Flood Damage in North Central Provinces

Taking the heavy rain at the end of 2014 as an example, the actual flood damage is described below. When torrential rains hit Sri Lanka in 2014, Anuradhapura had 469.8 mm and 830.5 mm of rainfall in November and December, respectively. These figures are a record high for Anuradhapura District, whose annual average precipitation is approximately 1,250 mm.

The floods triggered by this heavy rain affected a total of 285 irrigation tanks (67 breached and 218 damaged) in the North Central Province. The floods also devastated 12,300 acres of farmland and affected more than 6,900 households of farmers. Rice production was estimated to have declined by 34,250 tonnes.

Non-disclosure information due to portrait protection

Source: *PID Flood damage report*

Source: *PID Flood damage report*

Figure 2.5-6 Flood Damage due to the 2014 Torrential Rains
(Left: tank breach, Right: spillway collapse)

Agricultural infrastructures, such as farm roads and irrigation canals, are also susceptible to floods. According to a report of the damage to individual DS divisions in the North Central Province caused by the torrential rains in 2014, a total of 321 km of farm roads and a total of 708 km of irrigation canals were damaged by the floods.

In the case of farm roads, the structure called causeway is especially vulnerable. It is a structure located at the point of intersection of an irrigation canal or natural channel and farm road. It is composed of conduits for water to flow through and a pathway lower than the roads on its both sides. It is and made of stones or concrete.

When flood occurs, a large amount of fast-flowing water will flow through the conduits of the causeways, and the structures will suffer damage due to overflow, scouring, or water pressure strengthened by the flood water with debris.

Source: PID Flood damage report

Figure 2.5-7 Damaged Causeway

The following table shows the necessary cost calculated by PID in 2015 to rehabilitate above mentioned damaged irrigation facilities.

Table 2.5-1 Tentative Rehabilitation Cost Estimate for Flood Damage

District	Rehabilitation of Minor Irrigation (LKR in Million)	Rehabilitation of Farm Road (LKR in Million)	Rehabilitation of Channel (LKR in Million)	Total (LKR in Million)
Anuradhapura	933	304	832.8	2,069.8
Polonnaruwa	30	17	16.8	63.8
Total	963	321	849.6	2,133.6

Source: PID (2015)

(4) 2014/2015 Flood Damage in Vavuniya District

The following table shows the flood damage of the small tanks in Vavuniya District. This was prepared by the Vavuniya DAD Office. Considering the serious damage in Anuradhapura District, it can be said that Vavuniya District is affected more severely than what the Vavuniya DAD Office initially thought. In the case of Vavuniya District, the conditions of tanks have been affected not only by natural disasters but also social matters like conflicts and evacuation of farmers. Besides, the number of staff and the capacity of Vavuniya DAD Office is limited.

Table 2.5-2 Flood Damage of the Small Tanks in Vavuniya

Damage	Content	Remarks
Crop Damage	95.5 acres	11 schemes
Tail Bund Cutting for Flood Damage	11 tanks	-
Breached Tank	2 tanks	-
Heavily Damaged but Protected Using Sandbags	9 tanks	-

Source: DAD (2015)

2.6 Development Assistance by Development Partners in the Project Areas

(1) Foreign Funded Projects

In order to uplift the economic situation in the dry zone, the Government of Sri Lanka (GOSL) has initiated the several foreign funded projects including the Mahaweli Water Security Investment Program (MWSIP) with financial assistance from the Asian Development Bank (ADB) as shown in the following table.

Table 2.6-1 List of Foreign Funded Projects in the Study Area

<table>
<tr><th>Project Name</th><th>DP</th><th>Outlines</th></tr>
<tr><td>Mahaweli Water Security Investment Program (MWSIP): Phase 1: 2015-2024 (Phase 2: 2025-2034)
* Phase 2 is not committed by ADB</td><td>ADB</td><td>The Program will contribute to the implementation of major water infrastructure under the Mahaweli Development Program (MDP) for the transfer of water from the water rich central wet zone to the dry zones in the North Western, North Central and Northern provinces for agriculture and domestic water consumption.
The Program financed by ADB is divided into two phases; Phase 1 will transfer water from the Mahaweli River Basin to existing reservoirs in the Central, North Central and North Western provinces, and Phase 2 will extend the transfer of water from the North Central Province reservoirs to the Northern Province.
<table>
<tr><th>Phase</th><th>Infrastructure</th><th>Systems Area (added)</th></tr>
<tr><td>1</td><td>・ Upper Elahera Canal and Kalu Ganga-Moragahakanda Transfer Canal.
・ North Western Province Canal (NWPC) Stage 1 Canal and Reservoirs
・ Minipe Left Bank Canal Rehabilitation</td><td>・ D1: 1,420 ha Kaudulla
・ MH: 4,210 ha
・ IH: 4,907 ha
・ I: 3,264 ha</td></tr>
<tr><td>2</td><td>・ Lower Uma Oya Dam and Canal
・ Randenigala – Kalu Ganga Transfer Canal
・ Kalinganuwara Pump Station
・ North Central Province Canal (NCPC)</td><td>・ B: Maduru Oya RB 10,000 ha
・ D1: Kantale sugar 6,576 ha
・ I: expanded to 5,264 ha
・ MH: expanded to 7,710 ha
・ NWP: expanded to12,420 ha
・ NCP: added at 47,500 ha</td></tr>
</table>
Finance assistance from ADB and co-financiers is USD 567 million and the Government of Sri Lanka provides USD 108 million for the implementation of Phase 1.</td></tr>
<tr><td>Climate Smart Irrigated Agriculture Project (CSIAP): 2018-2024</td><td>WB</td><td>The Project will be implemented in 11 districts of six provinces including the Northern and North Central provinces with the objective of implementing climate resilient agriculture systems in selected hot spot areas. The project development objective is to improve climate resilience of farming communities and productivity of irrigated agriculture in selected climatically vulnerable hot-spot areas in Sri Lanka. This objective will be achieved through increased adaptation of climate - resilient agricultural practices and technologies, improved agricultural productivity, and increased access to markets in targeted smallholder farming communities. The Project consists of the following four components.
1) Climate Smart Irrigated Agriculture Production and Marketing
2) Efficient Water Management for Agriculture
3) Project Management
4) Emergency Response
The total project cost is USD 140 million, of which USD 125 million will</td></tr>
</table>

Project Name	DP	Outlines
		come from the International Bank for Reconstruction and Development (IBRD) and USD 15 million from GOSL and beneficiaries.
Climate Resilient Integrated Water Management Project (CRIWMP): 2017-2024	GCF and UNDP	The Project is to strengthen the resilience of vulnerable smallholder farmers in the country's dry zone; particularly women, who are facing increasing risks of rising temperatures, erratic rainfall, and extreme events attributable to climate change. It will address technical, financial and institutional barriers related to achieving integrated water management to improve agriculture-based livelihoods of smallholder farmers in the dry zone. The Project targets poor and vulnerable households in three river basins -the Malwathu Oya, Mi Oya, and Yan Oya (rivers). 1) Upgrading and enhancing resilience of village irrigation systems and scaling up climate-resilient farming practices in three river basins of the dry zone 2) Enhancing climate resilient, decentralized water supply and management solutions to provide year-round access to safe drinking water to vulnerable communities 3) Strengthening climate and hydrological observing and forecasting system to enhance water management and adaptive capacity of small holder The total project cost is USD 52.08 million, of which USD 38.08 million will be financed through a grant received from the Green Climate Fund (GCF) and USD 14 million from GOSL.
Rural Infrastructure Development Project in Emerging Regions (RIDEP): 2017-2021	JICA	The objective of the Project is to raise the living standards and to develop livelihoods of local people through basic infrastructure such as rural roads, medium and small size irrigation and potable water supply facilities in North Central, Northern, Eastern and Uva provinces thereby contributing to development of rural economics and reducing regional disparities in the country. The Project consists of the following four components with the number of sub-projects. 1) Rehabilitation of Rural Roads – 275 2) Construction of Irrigation Facilities and Rehabilitation – 151 3) Drinking Water Supply – 98 The loan amount is JPY 12,957 million.
Agriculture Sector Modernisation Project (ASMP): 2013-2016	WB	The Project is aligned with the Country Partnership Strategy (CPS) 2013-2016. The Project seeks to contribute to two CPS focus areas, namely: "Supporting structural shifts in the economy" and "Improved living standards and social inclusion" through: (a) improving agricultural productivity and competitiveness to strengthen the links between rural and urban areas and facilitate Sri Lanka's structural transformation; (b) providing and strengthening rural livelihood sources, employment opportunities in agriculture and along agriculture value chains, as well as market access for the poor, bottom 40%, and vulnerable people, thereby improving income sources and livelihood security in lagging rural areas; and (c) contributing to improved flood and drought management, through project's linkages to the water and irrigation sectors and a climate-smart agriculture approach. The development objectives of the Project for Sri Lanka are to support increasing agriculture productivity, improving market access, and enhancing value addition of smallholder farmers and agribusinesses in the project areas. 1) Agriculture Value Chain Development 2) Productivity Enhancement and Diversification Demonstrations 3) Project Management, Monitoring and Evaluation
Technical Assistance to the Modernizations of Agriculture	EU	The European Union (EU) supports a part of ASMP (WB). The primary objective is to make the agricultural sector more productive, diversified, climate-resilient, market-oriented and equitable. The major result areas are as follows.

Project Name	DP	Outlines
Program in Sri Lanka (TAMAP) 2018 - 2021		1) Based on sector needs assessment, help identify and assess issues and challenges facing the process of modernising the agriculture sector. 2) Development of an overarching agriculture policy with a view to enhance agricultural productivity, efficiency and sustainability. 3) Development of a coherent implementation strategy for the overarching agricultural policy. 4) Assist develop an action plan along with resource and financial budgets to provide a medium-term expenditure framework (MTEF), along with a robust and pertinent monitoring and evaluation (M&E) system. 5) Help develop an agriculture sector reform contract to accommodate EU budget support The technical assistance (TA) amount is LKR 810 million.

Source: Study Team based on Websites of the relevant development partners

It was reported by the Ministry of Mahaweli, Agriculture, Irrigation, and Rural Development(MMDE)/ Department of Irrigation (DOI) that eight cascades out of the original 128 cascades for the Study would overlap with CRIWMP and also 17 cascades with CSIAP. After the cross-checking, it was found that three cascades of CRIWMP and one cascade of CSIAP overlap with the original 128 cascades. Consequently, the number of cascades for the Study was confirmed to be 124.

Table 2.6-2 List of Cascades Excluded from the Study

Name of Project	Name of Cascade	Cas No.	Symbol	Command Area (ha)	District
CRIWMP	Siwala Kulam	1	9/MAL2	449.4	Anuradhapura
	Aluth Halmillewa	57	5/MAL8	477.7	Anuradhapura
	Rathmala Wewa	81	4/Y5	357.3	Anuradhapura
CSIAP	Mahakirimetiyawa	72	1/Y2	502.4	Anuradhapura

Source: Study Team

2.7 Necessity and Urgency of the Project

As already discussed in the preceding sections in Chapter 2, the preliminary problem analysis of the Project was made by considering the result of discussion with stakeholders and field observation. Based on the preliminary problem analysis, the possible solution to each event by the Project has been proposed with judgement of necessity and urgency as shown in the following table.

Table 2.7-1 Necessity and Urgency of the Project

Event	Result	Possible Solution by the Project
Frequent occurrence of floods	・ Damage to irrigation and other infrastructure ・ Losses in agricultural production, private and public properties	Proper design and improvement of spillways and tank bunds for floods $\boxed{\text{Necessity}}$ / $\boxed{\text{Urgency}}$
Frequent occurrence of droughts	・ Low agriculture production	Introduction of water saving agriculture and facilities $\boxed{\text{Necessity}}$ / $\boxed{\text{Urgency}}$
Aging of irrigation facilities	・ Low irrigation efficiency ・ High maintenance cost	Improvement of irrigation facilities followed by proper O&M $\boxed{\text{Necessity}}$ / $\boxed{\text{Urgency}}$
Damage of farm roads	・ More time to access to farmland/ markets ・ Damage to farm production	Improvement of farm roads followed by proper O&M $\boxed{\text{Necessity}}$ / $\boxed{\text{Urgency}}$
Mostly rice farming	・ Low profits in comparison with OFCs	Crop diversification (rice to OFCs) with good access to markets $\boxed{\text{Necessity}}$ / $\boxed{\text{Urgency}}$
No use of local resources	・ No increase in farm income	Promotion of livestock, fisheries and upland farming $\boxed{\text{Necessity}}$ / Urgency

Source: Study Team

The improvement of the infrastructure (tank irrigation facilities and farm roads) and introduction of crop diversification are urgently needed to increase farm incomes through the intervention of the Project. While, the promotion of livestock, fisheries and upland farming are also needed, this will depend on the willingness of the beneficiary farmers. In case that beneficiary farmers show strong willingness to do it, then it is considered as urgent.

CHAPTER 3 SURVEY, INVESTIGATION AND ANALYSIS ON THE PROJECT

3.1 General

At the meeting with the project implementing agencies PID North Central Province and DAD Vavuniya, the Sri Lankan side proposed 124 tank cascade systems with the highest development priority among the 550 sub-projects existing in these target areas so far. The 124 proposed sub-projects are in line with the beneficiaries of the North Central Province Canal project, which is currently planned as a national project in Sri Lanka, and Sri Lankan side expects synergistic effect of the NCPC project and this project. The Study Team investigated the content of the proposal from the Sri Lankan side and confirmed its validity. 124 tank cascade systems extends to 5 basins. The breakdown is 62 sub-projects for Malwathu Oya, 24 for Yan Oya and Ma Oya, 16 for Parangi Aru and 2 for Kanagarayanaru. The number of tanks belonging to them is about 950, and when abandoned tanks and tanks for environmental conservation are added, it is about 1100. The number of farmers cultivating in the 124 sub-projects is about 30,000.

The list of 124 tank cascade systems is shown in Attachment 3.1-1. The summary of 124 tank cascade systems are as follows.

Table 3.1-1 Summary of Adjustment of Benefit Irrigation Schemes under NCPCP

Sub-watershed	No. of Sub-projects (nos.)	Working Tank for Cultivation (nos.)
Malwathu Oya	60	471
Yan Oya	22	185
Ma Oya	24	163
Parangi Aru	16	111
Kanagarayanaru	2	25
Total	124	955

Source : Study Team

The Study Team conducted the field survey for 124 tank cascade systems to identify the development needs in the irrigation sector. Various activities including inventory survey of cascade systems, field investigation and interviews, trial construction and drone survey, study and analysis on water balance, pipeline canal system, partial desilting works, agriculture, livestock and fishery were conducted. Outputs of these activities will serve a basic information and data for the scope of works and cost estimate.

3.2 Tank Inventory Survey and Field Inspection

3.2.1 Sub-projects for Tank Inventory Survey

The purpose of the database is to use for the preparation of the rehabilitation and the new construction plan and asset (structure) management. The conditions of irrigation and rural infrastructure in the target area were surveyed for the database. The survey items are mainly basic information, dimension and deterioration of structures, and conditions of maintenance etc. The methods of survey are interview with FO (Famer Organisation) by sub-contractor, GIS and site survey by the Study Team as follows.

3.2.2 Database

(1) Method of Survey

The purpose of the database is to use for the preparation of the rehabilitation and the new construction plan and asset (structure) management. The conditions of irrigation and rural infrastructure in the target area were surveyed for the database. The survey items are mainly basic information, dimension and deterioration of structures, and conditions of maintenance etc. The methods of survey are interview with FO (Famer Organisation) by sub-contractor, GIS and site survey by the Study Team as shown in the following table.

Table 3.2-1 Method for Preparation of Data Base

No.	Items	Details	Method
1	Basic information	Name, location, FO etc.	Interview by sub-contractor, GIS data, site survey, secondary data by the Study Team
2	Ethnic group	Sinhala, Tamil etc.	
3	Religion	Buddhist, Hindu etc.	
4	Sector workers	Agriculture, industry etc.	
5	Tank	Existing and plan conditions, bund (length, width, height) etc.	
6	Sluice	Type, capacity, number etc.	
7	Spillway	Type, length, design flow etc.	
8	Other facilities	Sluice culvert, emergency spillway, bathing step etc.	
9	Rehabilitation and maintenance	Latest rehabilitation year, rehabilitation plan, regular maintenance activities etc.	
10	Flood conditions of spillway downstream are	Number of houses (less than 100 m, 100 m to 500 m)	
11	Inspection of condition	Tank bund, spillway, sluice, reservoir etc.	
12	Irrigation canal	Type, length, irrigation area etc.	
13	Drainage canal	Type, length	
14	Farm road	Pavement, length, width	
15	Farmland	Crop (rainy and dry season), plot size	
16	Agricultural storehouse	Paddy marketing board (PMB) and multi-purpose cooperative society (MPCS) capacity	
17	Farming machinery	4-wheel tractor, combine harvester etc.	

Source: Study Team

(2) Configuration of Database

The database is prepared based on tank-wise. For the software of the database, Microsoft Excel is selected by considering maintenance and broad utility. The structures of the database are classified systematically to be recognised easily as shown in Figure 3.2-1 to Figure 3.2-3. The orange cells in the figures are surveyed by the Study Team and the blue cells are analysed by using GIS. The white cells are filled by a sub-contractor and reviewed by the Study Team.

Data Base

Group	Sub-group	No.	Check Point No.	Item
1. Basic Information		1	(1-1)	ID of Cascade
		2	(1-2)	Symbol of Cascade
		3	(1-3)	Name of Cascade
		4	(1-4)	Symbol of Tank
		5	(1-5)	Name of Tank
		6	(1-6)	State
		7	(1-7)	District
		8	(1-8)	GN
		9	(1-9)	ASC
		10	(1-10)	Owner
		11	(1-11)	Management Organisation
		12	(1-12)	Name of FO
		13	(1-13)	Date of Survey
		14	(1-14)	Name of Interviewer
		15	(1-15)	Name of Interviewee
		16	(1-16)	Phone No of Interviewee
2. Ethnic Group		17	(2-1)	Sinhala
		18	(2-2)	Tamil
		19	(2-3)	Moor
		20	(2-4)	Others
3. Religion		21	(3-1)	Buddhist
		22	(3-2)	Hindu
		23	(3-3)	Islam
		24	(3-4)	Roman Catholic
		25	(3-5)	Others
4. Sector Workers		26	(4-1)	Agriculture
		27	(4-2)	Industry
		28	(4-3)	Service
		29	(4-4)	Others
5. Tank		30	(5-1)	Left Bank Beginning Point: Cordinate (X)
		31	(5-2-1)	Left Bank Beginning Point: Cordinate (Y)
		32	(5-2-2)	Central Point: Cordinate (X)
		33	(5-2-3)	Central Point: Cordinate (Y)
		34	(5-2-4)	Right Bank Beginning Point: Cordinate (X)
		35	(5-2-5)	Right Bank Beginning Point: Cordinate (Y)
		36	(5-3)	Type
	Existing	37	(5-4)	Width of Bund Top
		38	(5-5)	Width of Bund Bottom
		39	(5-6)	Height of Bund
		40	(5-7)	Slope of Bund (US)
		41	(5-8)	Slope of Bund (DS)
	Plan	42	(5-9)	Width of Bund Top
		43	(5-10)	Width of Bund Bottom
		44	(5-11)	Height of Bund
		45	(5-12)	Slope of Bund (US)
		46	(5-13)	Slope of Bund (DS)
		47	(5-14)	Length of Bund
		48	(5-15)	Depth of Reservoir
		49	(5-16)	Capacity of Reservoir
		50	(5-17)	Own Catchment Area

Note: (1-1) ~ (17-5) are "Check Point No."
Source: Study Team

Figure 3.2-1 Structures of Database (1/3)

Data Base / 5. Tank		51	(5-18)	Reservoir Area
		52	(5-19)	Depth
		53	(5-20)	Capacity of Reservoir
		54	(5-21)	Irrigation Area by GIS
		55	(5-22)	Irrigation Area by FO
		56	(5-23)	Number of Benefit Farmers
6. Sluice	Left Bank	57	(6-1)	Type
		58	(6-2)	Capacity
	Center	59	(6-3)	Type
		60	(6-4)	Capacity
	Right Bank	61	(6-5)	Type
		62	(6-6)	Capacity
	Others (total)	63	(6-7)	Type
		64	(6-8)	Number
		65	(6-9)	Capacity
7. Spillway	Left Bank	66	(7-1)	Type
		67	(7-2)	Elevation
		68	(7-3)	Length
		69	(7-4)	Design Flow
	Right Bank	70	(7-5)	Type
		71	(7-6)	Elevation
		72	(7-7)	Length
		73	(7-8)	Design Flow
	Others	74	(7-9)	Type
		75	(7-10)	Elevation
		76	(7-11)	Length
		77	(7-12)	Design Flow
8. Orther Facilities		78	(8-1)	Sluice Culvert
		79	(8-2)	Emergency Spillway
		80	(8-3)	Bathing Step
		81	(8-4)	Water Gauge
		82	(8-5)	Rain fauge
		83	(8-6)	Others
9. Rehabilitation and Maintenance		84	(9-1)	Latest Rehabilitation Year
		85	(9-2)	Rehabilitation Plan
	RegularMaintenance Activities	86	(9-3)	Repair
		87	(9-4)	Dreging
		88	(9-5)	Weeding
10. Flood Conditions of Downstream of Spillway	Number of Houses	89	(10-1)	Less than 100m
		90	(10-2)	100 to 500m
11. Inspection Results	Tank Bund	91	(11-1)	Piping Hole
		92	(11-2-1)	Crack (Bund Top)
		93	(11-2-2)	Crack (Bund Slope)
		94	(11-3)	Leakage
		95	(11-4)	Erosion
		96	(11-5)	Slope Slide
		97	(11-6-1)	Wild Plant
		98	(11-6-2)	Damage by Animals
	Spillway	99	(11-7)	Damage
		100	(11-8-1)	Subsidence

Source: Study Team

Figure 3.2-2 Structures of Database (2/3)

Data Base

11. Inspection Results	Spillway	101	(11-8-2)	Blocked by Vegetatuion etc.
	Spillway Canal	102	(11-8-3)	Damage
		103	(11-8-4)	Blocked by Vegetatuion etc.
	Sluice and Irrigation Canal	104	(11-9-1)	Damage (Intake Works)
		105	(11-9-2)	Damage (Outlet Works)
		106	(11-9-3)	Damage (Irrigation Canal)
		107	(11-9-4)	Damage (Intake Tower and Gate)
		108	(11-10-1)	Subsidance (Intake Works)
		109	(11-10-2)	Subsidance (Other Works)
		110	(11-10-3)	Subsidance (Irrigation Canal)
		111	(11-10-4)	Subsidance (Intak Tower and Gate)
		112	(11-10-5)	Blocked (Intake Works)
		113	(11-10-6)	Blocked (Outlet Works)
		114	(11-10-7)	Blocked (Irrigation Canal)
		115	(11-10-8)	Blocked (Intake Tower and Gate)
	Reservoir	116	(11-11)	Driftwood
		117	(11-12)	Slope Slide
		118	(11-13)	Sediment
12. Irrigation Canal	Left Bank	119	(12-1)	Type
		120	(12-2)	Length
		121	(12-3)	Irrigation Area
	Center	122	(12-4)	Type
		123	(12-5)	Length
		124	(12-6)	Irrigation Area
	Right Bank	125	(12-7)	Type
		126	(12-8)	Length
		127	(12-9)	Irrigation Area
	Others (total)	128	(12-7)	Number
		129	(12-8)	Type
		130	(12-9)	Length
		131	(12-9)	Irrigation Area
13. Drainage Canal	Left Bank	132	(13-1)	Type
		133	(13-2)	Length
	Center	134	(13-3)	Type
		135	(13-4)	Length
	Right Bank	136	(13-5)	Type
		137	(13-6)	Length
14. Farm Road		138	(14-1)	Pavement (Main Material)
		139	(14-2)	Length (total)
		140	(14-3)	Width (Typical Dection)
15. Farm Land	Crop	141	(15-1)	Rainy Season
		142	(15-2)	Dry Season
		143	(15-3)	Plot Size (Standard)
16. Agricultural Storehouse		144	(16-1)	PMB Capacity
		145	(16-2)	MCPS Capacity
17. Farming Machinery		146	(17-1)	4 Wheeled Tractors
		147	(17-2)	2 Wheeled Tractors
		148	(17-3)	Combine Harvesters
		149	(17-4)	Threahers
		150	(17-5)	Power Sprayers

Source: Study Team

Figure 3.2-3 Structures of Database (3/3)

3.2.3 Present Status of Infrastructure

The summary of the data collected from the inventory survey is shown below. In this section, present status of the tanks and tank related facility will be shown with a simple tabulation of each item. The total number of benefit farmers, tanks, and cascades, which are the targets of the analysis are as follows (refer to Appendix 3.2-1).

Table 3.2-2 Target of the Analysis

Items	Surveyed	Target
Total number of cascades	124	124
Total number of tanks	955	955
Total number of benefit farmer	54,455	54,455

Source: Study Team

(1) Tank

The following table shows the general feature and the average specification of the existing tanks. The average existing bund top width is rather narrower than the 3 m which is set by the study team. The existing average bund slopes of both sides are also gentler than 2.0 set by the study team. The result of the type of tanks by irrigated area should be noted. In Sri Lanka, the tank is categorised into three types. There are small tanks (village tanks), medium scale tanks, and large tanks. There is no major tank, and 94% are minor tanks and 6% are medium tanks among the target tanks.

Table 3.2-3 General Feature and the Average Specification of the Existing Tanks

	Item		Average Value
1)	Total length of tank band		683,423 m
2)	Average specification of the tank bund	Width of bund top	2.6 m
		Width of bund bottom	20.3 m
		Height of bund	3.7 m
		Slope of bund (upstream side: U/S) (1:X)	2.3
		Slope of bund (downstream side: D/S) (1:X)	2.4
		Normal freeboard (bund top level - spillway crest level)	1.06 m
		Length of tank bund	715.6 m
3)	Average specification of reservoir	Depth of reservoir	2.7 m
		Capacity of reservoir	425,441 m^3
		Own catchment area	1.574 km^2
		Reservoir area	0.155 km^2
4)	Average irrigation area of tank	Organised data from Gazette, ID,PID, and DAD	29.5 ha
5)	Category of tank	Major	0
		Medium	55
		Minor	900
6)	Average number of benefit farmer per tank		57

Source: Study Team

(2) Sluice

The following table shows the general feature and the average specification of the existing sluice. Of the 1,902 sluices, 58% are tower type, and 36% of the sluice are wall type. The sum of others and unknown types accounts for 6% of the sluices. The table also shows the average number and the capacity of tank sluice. Regarding the installation position of the sluice, one is often installed at the centre of the tank bund and the other is installed on either the left or right side.

Table 3.2-4 General Feature and the Average Specification of the Sluice

Items	Quantities
Total number of sluices	1,902 sluices
・ Tower type	58%
・ Wall type	36%
・ Others & unknown	6%
Average number of sluices per tank	2.0 sluices

Source: Study Team

(3) Spillway

The following table shows the general feature and the average specification of the existing spillway. Of the 1,064 spillways 67.8% are drop wall type, and 27.7% of the spillways are natural type. The average existing normal freeboard is 1.06 m and is planned to be set between 0.9 m and 2.1 m in the Study.

Table 3.2-5 Average Number of Spillways and Specification

Item		Average Value
1) Total number of spillways	Total number of spillways	1,064
	・ Drop wall type	67.8%
	・ Natural type	27.7%
	・ Other type	4.5%
2) Average number of spillways per tank		1.11
3) Average capacity of the spillway per a tank	Average width of spillway	20.2 m
4) Average normal freeboard	Average difference between bund top elevation and spillway crest elevation	1.06 m

Source: Study Team

(4) Other Facilities

The following table shows the total number of the emergency spillway, bathing step, water gauge, rain gauge, and others. The number of tanks with these facilities and the installation rate for the 955 tanks are also shown in the following table.

Table 3.2-6 Total Number and the Installation Rate of Other Facilities

Facilities	Total Number of Facilities	Total Number of Tanks Installed the Facilities	Installation Rate of the Facility on the Tank
Emergency spillway	104	98	10.3%
Bathing step	571	354	37.1%
Water gauge	192	189	19.8%
Rain gauge	4	4	0.4%
Others	3	2	0.2%

Source: Study Team

(5) Rehabilitation and Maintenance

(a) Implementation Status of Rehabilitation

The following table shows the implementation status of the tank rehabilitation for 955 tanks by rehabilitated period. It could be noted that 48.9% of the tanks have been rehabilitated in any kind of way within the last 20 years. It is also necessary to pay attention to the result that 49.6% of the tanks have not been rehabilitated in the past. Only three tanks out of 955 tanks have a rehabilitation plan.

Table 3.2-7 Rehabilitated Period of the Tanks

Rehabilitated Period	Number	Rate
Within 10 years	284	29.7%
10-19 years	121	12.7%
20-29 years	31	3.2%
30-39 years	16	1.7%
40-49 years	13	1.4%
More than 50 years ago	2	0.2%
Not to be rehabilitated	474	49.6%
Unknown	14	1.5%
Total	955	100.0%

Source: Study Team

(b) Status of Regular Maintenance Activity

The following table shows the current status of the regular maintenance activities by FO in the 955 tanks. Although weeding is carried out in 97.8% of the tanks, the implementation rate of repair and desilting by FO is very low. According to historical research of tank management in Sri Lanka, desilting and repair of tanks have been implemented by the famers before the British colonisation. As the table shows, it is very rare in recent years for FO to repair tanks and carry out desilting by themselves.

Table 3.2-8 Regular Maintenance Activity by FO

Type of Regular Maintenance	Yes	No	Rate (Yes)	Total (%)
Repair	6	942	7	0.6
Desilting	1	954	0	0.1
Weeding	934	20	1	97.8

Source: Study Team

The following table shows the implementing agency and procedure of regular maintenance activities in recent years. It is important to note that the implementing agency depends on the category of tank. In addition, regular maintenance of minor tanks in Anuradhapura is implemented by PID, while that for minor tanks in Vavuniya is done by DAD.

Table 3.2-9 Implementing Agency of Regular Maintenance Activities for Minor Tank

Type of Regular Maintenance	Condition Check	Identification of Necessary Work	Procurement	Implementation of Work
Repair	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)
Desilting	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)	PID (Anuradhapura) DAD (Vavuniya)
Weeding	FO	FO	(No procurement)	FO (normally without payment)

Source: Study Team

Table 3.2-10 Implementing Agency of Regular Maintenance Activities for Medium Tank

Type of Regular Maintenance	Condition Check	Identification of Necessary Work	Procurement	Implementation of Work
Repair	ID and PID	ID and PID	ID and PID	ID and PID
Desilting	ID and PID	ID and PID	ID and PID	ID and PID (partly by FO without payment)
Weeding	ID and PID	ID and PID	ID and PID	ID and PID

Source: Study Team

(6) Flood Condition of Spillway Downstream Area

The following table shows the location status of the houses in the downstream area of the spillway. There are 165 houses within less than 500 m point of the downstream area of the spillway. The tanks where there are houses within less than 500 m point from the spillway accounted for 4.2% of the 955 tanks.

Table 3.2-11 Condition of the Houses in the Downstream Area of the Spillway

Item		Area	Number	Rate (%)	Average Number
1)	Percentage of tanks with houses in downstream area	House within less than 100 m point	33 tanks	3.5	-
		House between 100 m point and 500 m point	15 tanks	1.6	-
		Total (House within less than 500 m point)	40 tanks	4.2	-
2)	Average number of houses per tank in the downstream area	House within less than 100 m point	99 houses	-	0.10 house
		House between 100 m point and 500 m point	66 houses	-	0.07 house
		Total (House within less than 500 m point)	165 houses	-	0.17 house

Source: Study Team

(7) Irrigation Canal

The following table shows the general feature and the average specification of the existing irrigation canal.

Table 3.2-12 General Feature and the Average Specification of the Irrigation Canal

	Items		Number	Length (m)	Rate (%)
1)	Total length	Total length of irrigation canal	-	1,160,573	-
		Length of irrigation canal per tank	-	1,215	-
2)	Type of irrigation canal	Earth	1,845	1,150,842	99.1
		Concrete	20	7,836	0.7
		Others	8	1,860	0.2
		Unknown	1	35	0.0
		Total	1,874	1,160,573	100

Source: Study Team

(8) Drainage Canal

The following table shows the general feature and the average specification of the existing drainage canal. In the inventory survey, 83 drainage canals were investigated and all are earth canals except for one. It should be noted that the excess water from the spillway flows naturally down to the lower areas which are non-cultivated land in many reservoirs in the rural area. Such excess water is eventually taken up by the tank located further downstream.

Table 3.2-13 General Feature and the Average Specification of the Drainage Canal

	Items		Number	Quantities
1)	Total length	Total length of drainage canal	-	79,889 m
		Length of drainage canal per a line	-	963 m
		Installation rate	-	8.7%
2)	Type of drainage canal	Earth	82	79,389 m
		Concrete	0	0 m
		Others	1	500 m
		Unknown	0	0 m
		Total	83	79,889 m

Source: Study Team

(9) Farm Road

The following table shows the general feature and the average specification of the existing farm roads. All identified 554 farm roads are gravel pavement (earth road). The total length of the farm road, length per a tank, average width, and the length of each pavement type are shown in the following table.

Table 3.2-14 General Feature and the Average Specification of the Farm Road

Items			Number	Length (m)	Rate (%)
1)	Total length and other average specifications	Total length	-	6,343,852	-
		Length per tank	-	974	-
		Average width	-	2.65	-
2)	Pavement type of farm road	Gravel (earth)	554	6,343,852	100
		Asphalt	0	0	0
		Concrete	0	0	0
		Total	554	6,343,852	100

Source: Study Team

(10) Farmland, Agriculture Storehouse, and Farming Machinery

The following table shows the current status of farmland in Maha and Yala, and ownership of agriculture storehouse, and farming machinery.

Table 3.2-15 General Feature and the Average Specification of Farm Land, Agriculture Storehouse, and Farming Machinery

Item		Description	Unit	Quantity
3)	Farmland	Crop		
		Maha (paddy)	tank	911
		Maha (OFC)	tank	0
		Maha (others)	tank	0
		Yala (paddy)	tank	233
		Yala (OFC)	tank	1
		Yala (others)	tank	4
		Standard plot size	acre/plot	1.67
4)	Agriculture storehouse per tank	Average capacity of PMB	ton	85.0
		Average capacity of MPCS	ton	94.7
5)	Average number of machineries per tank	Average number of 4-wheel tractors	no.	3.9
		Average number of 2-wheel tractors	no.	7
		Average number of combine harvesters	no.	0.6
		Average number of thrashers	no.	0.3
		Average number of power sprayers	no.	1.9

Source: Study Team

(11) Site Survey Results by the Study Team

The Study Team conducted a follow-up survey to cross-check data from the local subcontractor, which is separate from the Inventory Survey performed. The objective of the survey is to record important specifications such as the general dimension of the tank bund, existing normal free board, and spillway width of 10% of the target tanks. This is to be conducted by the local project staff. The data collection sheets are attached as Appendix 3.2-2.

3.2.4 Inspection and Assessment of Tanks and Related Facilities

The purpose of the inspection of the tanks and related facilities is to understand the current deformation status and problems of the facilities.

(1) Inspection of Tanks and Related Facilities

The inspection of tank and other related facilities was conducted as a part of the Inventory Survey. The purpose of the tank inspection is to understand the present deformation status of tanks and related structures and the possible problems of the facilities. In order to conduct an efficient survey in a limited period, the interview survey for FO and the measurement of key dimensions of the structure are simultaneously done. The interview survey was conducted with the FO using the questionnaire and the criteria prepared in advance. In addition, a data cross check was carried out by referring to the results of the field investigation, which targets 10% of the tanks. This was done by the local engineer of the study team.

(a) Inspection Criteria

In the process of setting the criteria for the inspection, the relationship between the confirmed deformations of the facility and its effect on the facility in terms of the structural performance was considered. In addition, the criteria were also set in consideration of the original performance, such as the water supply performance, of the facility as an irrigation infrastructure.

The Study Team has set four levels of criteria for the inspection and were identified as follows: 1) “Very Serious”, 2) “Serious”, 3) “Moderate” and 4) “No”. A general relationship between the criteria and the deformation level of the facilities are shown in the table below(refer to Appendix 3.2-3).

Table 3.2-16 General Criteria and Deformation Level of Facilities

Criteria of the Study	Deformation Level (Current Status of the Facility)	Criteria of MAFF
Very Serious	・ The deformation affecting seriously the structural stability of the facility is recognised ・ Serious deterioration of water supply performance is expected	S-1, S-2
Serious	・ The deformation affecting the structural stability of the facility is recognised ・ Slight deterioration of water supply performance is expected	S-2, S-3
Moderate	・ Deformation is recognised ・ Almost no deterioration of water supply performance is expected.	S-3, S-4
No	・ Almost no deformation is recognised	S-5

Source: Study Team

The list of the facilities for the tank inspection and the check points are as follows:

Table 3.2-17 Check List for Facilities Inspection

Facility		Deformation or Problem of Facility	Check Point No.
Tank bund	-	Piping hole	(11-1)
	Bund top	Crack	(11-2-1)

Facility		Deformation or Problem of Facility	Check Point No.
	Bund slope		(11-2-2)
	-	Leakage	(11-3)
	-	Erosion	(11-4)
	-	Slope slide	(11-5)
	-	Wild plant	(11-6-1)
	-	Damage by animals	(11-6-2)
Spillway	-	Damage	(11-7)
	-	Subsidence	(11-8-1)
	-	Blocked by vegetation etc.	(11-8-2)
Spillway & Spillway canal	-	Damage	(11-8-3)
	-	Blocked by vegetation etc.	(11-8-4)
Sluice & Irrigation canal	Intake works	Damage	(11-9-1)
	Outlet works		(11-9-2)
	Irrigation canal		(11-9-3)
	Intake tower & gate		(11-9-4)
	Intake works	Subsidence	(11-10-1)
	Outlet works		(11-10-2)
	Irrigation canal		(11-10-3)
	Intake tower & Gate		(11-10-4)
	Intake works	Blocked	(11-10-5)
	Outlet works		(11-10-6)
	Irrigation canal		(11-10-7)
	Intake tower & gate		(11-10-8)
Reservoir	-	Driftwood	(11-11)
	-	Slope slide	(11-12)
	-	Sediment	(11-13)

Source: Study Team

(b) Inspection Results and Analysis

The total number of target cascades, target tanks, and benefit farmers are shown in the following table.

Table 3.2-18 Target of the Analysis

Items	Surveyed	Target
Total number of target cascades	124	124
Total number of target tanks	955	955
Total number of benefit farmer	54,455	54,455

Source: Study Team

The results of the tank inspection are shown in Appendix 3.2-4. The summary of the results are as follows:

1) Tank Bund

Eight inspection items are set for understanding the current deformation status of the tank bund. It is shown that at least 7% of target tanks have some serious deformation of their tank bund caused by piping holes, cracks, leakage, erosion, slope slide, exuberance of wild plants, and damage by animals. It is also shown that at least 28% of the tank bunds are still in good condition in terms of their structural integrity. Leakage stop measurements are taken for tanks evaluated as “Very Serious”, “Serious”, and “Moderate” in the “Piping Hole” and “Leakage”.

Table 3.2-19 Summary of Inspection Result (Tank Bund)

No.	Check Point	No (Good Condition) (%)	Moderate (%)	Serious (%)	Very Serious (%)
11-1	Piping hole	60.1	36.0	2.6	1.3
11-2-1	Crack (Bund top)	33.1	65.1	0.9	0.9
11-2-2	Crack (Bund slope)	57.5	41.5	0.5	0.5
11-3	Leakage	37.5	55.4	3.6	3.5
11-4	Erosion	45.5	52.3	0.4	1.8
11-5	Slope slide	48.6	47.2	0.4	3.8
11-6-1	Wild plant	27.6	65.2	1.6	5.6
11-6-2	Damage by animals	41.0	52.5	3.8	2.7

Source: Study Team

2) Spillway and Spillway Canal

Three inspection items are set for understanding the current deformation status of the spillway, and two items are set for the spillway canal (drainage canal). It is shown that at least 13% of the spillway has some serious deformation, and at least 41% of the spillway is in good condition in terms of its structural integrity. About the problems caused by the blockage of the structure, at least 7% of the spillway has some serious blockage due to vegetation or sediment, and at least 44% of the spillway is in good condition.

Considering the results of the spillway canal, it is important to note that only 7.6% of tanks have spillway canals, and that all of these canals are earth type canals. Even though 92.4% of tanks have no straight structure for setting the flow direction of excess water from the spillway, at least 39% of the tanks have no problem. However, at least 5.1% of them do have serious problems. Based on this situation, the spillway canal is installed for tanks evaluated as “Very Serious”, “Serious”, and “Moderate” in their acquired “Damage”.

Table 3.2-20 Summary of Inspection Result (Spillway and Spillway Canal)

No.	Check Point	No (Good Condition) (%)	Moderate (%)	Serious (%)	Very Serious (%)
11-7	Spillway: Damage	41.4	45.9	9.0	3.7
11-8-1	Spillway: Subsidence	54.1	42.0	1.1	2.8
11-8-2	Spillway: Blocked by vegetation etc.	43.6	49.5	5.2	1.7
11-8-3	Spillway canal: Damage	39.1	55.8	3.1	2.0
11-8-4	Spillway canal: Blocked by vegetation etc.	44.8	46.5	6.7	2.0

Source: Study Team

3) Sluice and Irrigation Canal

Twelve inspection items are set for understanding the current deformation status of the sluice and the irrigation canal. It is shown that at least 5% of the intake and outlet structure has some serious damage. At least 3% of irrigation canals and at least 5% of intake towers with a gate have some serious deformation. It is also shown that at least 39% of intake and outlet structures are in good condition, and at least 38% of irrigation canals and at least 45% of intake towers with a gate are in good condition in terms of their structural integrity. About the problems caused by the blockage of the structure, at least 2% of the whole sluice structure has some serious blockage due to vegetation or sediment, and at least 56% of the whole sluice has no blockage problem.

Table 3.2-21 Summary of Inspection Result (Sluice and Irrigation Canal)

No.	Check Point	No (Good Condition) (%)	Moderate (%)	Serious (%)	Very Serious (%)
11-9-1	Damage (Intake works)	39.1	56.1	4.2	0.6
11-9-2	Damage (Outlet works)	47.2	49.6	2.7	0.5
11-9-3	Damage (Irrigation canal)	38.5	58.6	1.8	1.1
11-9-4	Damage (Intake tower & gate)	45.1	50.2	2.3	2.4
11-10-1	Subsidence (Intake works)	53.1	44.7	1.5	0.7
11-10-2	Subsidence (Outlet works)	54.5	43.5	1.3	0.7
11-10-3	Subsidence (Irrigation canal)	53.8	44.6	0.9	0.7
11-10-4	Subsidence (Intake tower & gate)	53.9	44.1	1.0	1.0
11-10-5	Blocked (Intake works)	57.9	40.6	1.2	0.3
11-10-6	Blocked (Outlet works)	59.6	39.0	1.0	0.4
11-10-7	Blocked (Irrigation canal)	60.0	38.6	1.0	0.4
11-10-8	Blocked (Intake tower & gate)	56.3	42.1	1.0	0.6

Source: Study Team

4) Reservoir

Three inspection items are set for understanding the current status of the whole tank as a reservoir. It is shown that at least 4% of tanks have a serious problem with driftwood, and at least 47% are in good condition. Moreover, at least 8% of tanks have a serious problem with slope slide, and at least 42% are in good condition.

On the other hand, it is important to carefully consider the result of sediment accumulation. Although at least 20% of tanks have a serious problem with sediment, 5% have no problem with regards to sediment accumulation. In 64% of tanks that have been assessed as “Moderate”, although the possible irrigated area has not changed recently, operation and maintenance of tanks have become difficult due to the sedimentation. Please see also Section 3.13 for the background of the sedimentation problem and the current efforts of the government to solve the problem.

Table 3.2-22 Summary of Inspection Result (Reservoir)

No.	Check Point	No (Good Condition) (%)	Moderate (%)	Serious (%)	Very Serious (%)	Unknown (%)
11-11	Reservoir (Driftwood)	46.9	48.7	2.2	2.2	−
11-12	Reservoir (Slope slide)	42.0	49.6	5.1	3.3	−
11-13	Reservoir (Sediment)	5.4	63.6	14.9	4.9	11.2

Source: Study Team

(2) Assessment of Tank Bund Height and Spillway Width

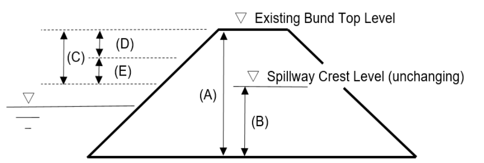
Existing tank bund height and existing spillway width are assessed by the result of the inventory survey.

(a) Assessment of Tank Bund Height

1) Assessment Method

The sufficiency of the existing tank bund cross section is assessed by comparing the existing normal free board and the planned normal free board. It is assumed that the existing spillway crest level is not changed in the study. The following table contains the conceptual data for the relationship of the tank bund height, the spillway crest level, and the normal freeboard consisting a minimum freeboard and afflux.

Table 3.2-23 Conceptual Table of the Tank Bund Height

<table>
<tr><td rowspan="3">(A) Existing Tank Bund Height</td><td rowspan="2">(C) Normal Freeboard</td><td>(D) Minimum Freeboard</td><td rowspan="3">
</td></tr>
<tr><td>(E) Afflux</td></tr>
<tr><td colspan="2">(B) Spillway Crest Level
(= Full Supply Level)
*basically, assumed not to be changed in the study</td></tr>
</table>

Source: Study Team

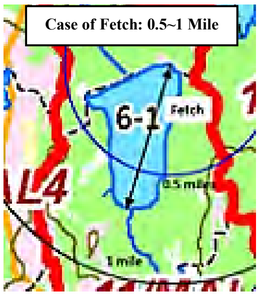
The existing tank bund height and other related data of the target tanks are collected through the inventory survey. The planned tank bund height is established by combining the existing spillway crest level with the normal freeboard, which is examined in the study.

2) Establishment of the Planned Tank Bund Height

It is now necessary to examine the minimum freeboard and the afflux to formulate the planned normal freeboard. The following table, which is extracted from the irrigation department’s standard, shows the recommended dimension of the normal freeboard and minimum freeboard considering “fetch”. The study applies the table for the decision of the minimum freeboard by simply measuring the fetch of 955 tanks on the map. On the other hand, it is important to carefully consider the result of sediment accumulation for all tanks. Although at least 20% of tanks have a serious problem with accumulated sediment, 5% of tanks do not have this problem. In 64% of tanks assessed as “Moderate”, although possible irrigated area is not changed recently, operation and maintenance of tanks has become difficult due to the sedimentation.

Table 3.2-24 Normal Freeboard and Minimum Freeboard in the Design Standard

Fetch [1]	Normal Freeboard	Minimum Freeboard
0 to 0.5 miles (0 to 0.8 km)	3 feet (0.9 m)	2 feet (0.6 m)
0.5 to 1 mile (0.8 to 1.6 km)	4 feet (1.2 m)	3 feet (0.9 m)
1 to 2.5 miles (1.6 to 4.0 km)	5 feet (1.5 m)	4 feet (1.2 m)
2.5 to 5 miles (4.0 to 8.0 km)	6 feet (1.8 m)	5 feet (1.5 m)



Note: (1) Fetch is the distance over which the wind can act on a body of water, and it can be taken as the longest dimension of the water spread of the reservoir.
Source: Irrigation Department/A.J. Ponrajah (1984) p.82

The following table shows measurement result of the fetch for the 955 tanks on the map. It shows that the minimum freeboards for the target 955 tanks are selected from 2 feet, 3 feet and 4 feet. The minimum freeboard is quoted from Sri Lankan technical standard “Design of Irrigation Headworks (1982)”, which have been commonly used to set minimum freeboard. Most of damaged tanks by recent floods are old tanks which were constructed or rehabilitated before 1982 when above mentioned technical standard formulated. Hence it can be said that these minimum freeboard values are appropriate and acceptable.

Table 3.2-25 Minimum Freeboard and the Measurement Result of Fetch

Fetch	Minimum Freeboard	Number of Tanks	Rate (%)
0 to 0.5 miles (0 to 0.8 km)	2 feet (0.6 m)	829	86.8
0.5 to 1 mile (0.8 to 1.6 km)	3 feet (0.9 m)	117	12.3
1 to 2.5 miles (1.6 to 4.0 km)	4 feet (1.2 m)	9	0.9
2.5 to 5 miles (4.0 to 8.0 km)	5 feet (1.5 m)	0	0

Source: Study Team

Although afflux was set to 2 feet and 3 feet in CSDPP, the study team added another 1.5 feet considering the cost effectiveness and the large number of minor tanks in the target tanks. The following table shows the newly set criteria for the afflux setting in the Study.

Table 3.2-26 Afflux and Design Flood Discharge

Design Flood Discharge	$Q < 15\ m^3/s$	$15\ m^3/s < Q < 50\ m^3/s$	$Q > 50\ m^3/s$
Afflux	1.5 feet (0.45 m)	2 feet (0.6 m)	3 feet (0.9 m)
Type of Spillway	Apply the same type of existing spillway	Apply the same type of existing spillway	Drop type

Source: Study Team

3) Assessment Criteria for Tank Bund

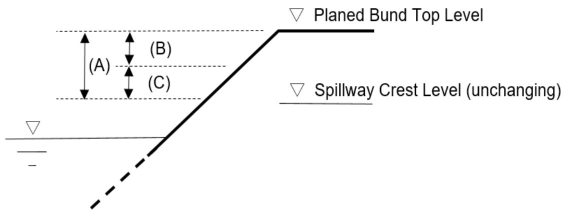
The planned normal freeboard, which is the criteria for the assessment of the existing tank bund, is calculated by the following formula.

(A) Planned Normal Freeboard = (B) Minimum Freeboard + (C) Afflux

The proposed dimension of each component is showed in the table below.

Table 3.2-27 Proposed Dimension of Planned Normal Freeboard

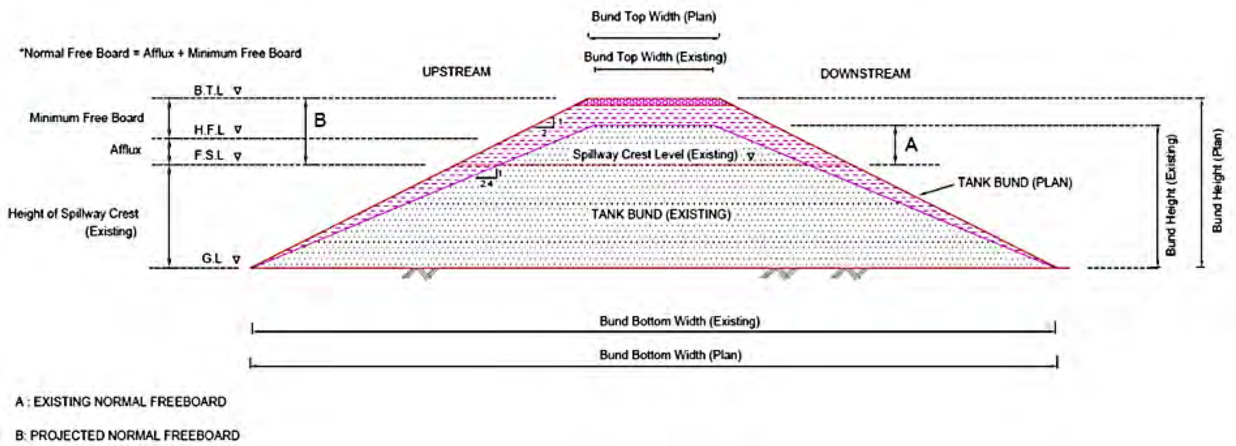
Spillway Crest Level	(A) Planned Normal Freeboard	
	(B) Minimum Freeboard	(C) Afflux
Basically, adopt existing spillway crest level	2 to 4 feet (0.6 to 1.2 m)	1.5 to 3 feet (0.45 to 0.9 m)



Source: Study Team

For the spillway crest level, the measurement result from the tank inventory survey is used. For (B) Minimum Freeboard, the measurement result of the fetch of each tank on the map is used. For (C) Afflux, the result of the design flood discharge of each tank is used.

The following figure shows the difference between the (A) Existing Normal Freeboard and the (B) Planned Normal Freeboard, which set by the Study Team.



Source: Study Team

Figure 3.2-4 Schematic Diagram of Existing Normal Freeboard and Planned Freeboard

(b) Assessment of Spillway Width

1) Assessment Method

Whether the existing spillway has sufficient width is assessed by comparing the existing spillway width and the planned spillway width. The data for the existing spillway width of the target tanks are collected through the inventory survey. The planned spillway width is calculated based on the design discharge of each tank calculated in Section 3.5.

2) Establishment of the Planned Spillway Width

The planned spillway width (L) is calculated based on the following equations[1] and three types of affluxes.

$$Natural\ Type\ Spillway \quad Q = 1.56 \times L \times H^{1.5} \quad (m^3/s)$$

$$Drop\ Wall\ Type\ Spillway \quad Q = 1.84 \times L \times H^{1.5} \quad (m^3/s)$$

where L is the planned spillway width, Q is design flood discharge and H is the afflux (3 types). The equation for natural type spillway is considered to be an equation for the broad crested weir with rectangular cross section, and the equation for drop wall type spillway is considered to be an equation for the sharp-crested weir. In the equations above, 1.56 and 1.84 are coefficient of discharge, and considered to be valid.

3) Assessment Criteria for Spillway

The calculated planned spillway width (L) is the criteria for the assessment of the existing spillway width.

3.2.5 Evaluation of STEIN

(1) STEIN Trial Construction in CSDPP

A trial construction was implemented from June to July in 2017 to evaluate the material called as STEIN[2] in CSDPP. STEIN was developed by SPEC CO., LTD. (SPEC), supervised the trial construction for three canals. The target canals are as shown in the following table. Those lengths are 64 m in Kulekada Ihala wewa, 35 m in Puliyankulam, and 76 m in Kakkayar Puliyan kulam (the total length is 175 m).

Table 3.2-28 Outline of STEIN Trial Construction

Name of Cascade	Name of Tank	Name of Canal	Length of Trial Construction	Dimension of Cross Section
Kiulekada	Kiulekada Ihara wewa	Left bank canal	64 m	Trapezoid (bed: 0.50 m, height: 0.35 m) Rectangle (bed: 0.50 m, height 0.35 m)
Kiulekada	Puliyankulam	Right bank canal	35 m	Trapezoid (bed: 0.30 m, height: 0.45 m)
Naveli kulam	Kakayar Puliyan kulam	Left bank canal	76 m	Rectangle (bed: 0.50 m, height: 0.35 m)

Source: Study Team

[redacted]

i) [redacted]

ii) [redacted]

iii) [redacted]

[1] Source: Irrigation Department/ A.J. Ponrajah (1984) p.79-p.81

[2] [redacted]

(2) Site Inspection

The STEIN trial construction site was inspected as written below.

i) Left bank canal of Kiulekada Ihara wewa: 15 February 2020
ii) Right bank canal of Puliyankulam: 15 February 2020
iii) Left bank canal of Kakayar Puliyan kulam: 16 - 15 February 2020

All canals were functioning for the distribution irrigation water from sluices to paddy field as shown in Figure 3.2-5 and Attachment 3.2-1.

Left Bank canal of Kiulekada Ihara wewa | Right Bank Canal of Puliyankulam | Left Bank Canal of Kakayar Puliyan kulam

Source: Study Team

Figure 3.2-5 Site Inspection of STEIN Canals

(3) Interview with SPEC

[redacted]

i) [redacted]

ii) [redacted]

iii) [redacted]

3.3 Study on Crack of Tanks Rehabilitated by CSDPP

3.3.1 Field Survey

The Study Team surveyed the tanks rehabilitated by CSDPP from 15 to 16 February 2020 in Anuradhapura and Vavuniya districts as shown in Table 3.3-1 and Figure 3.3-1 and Attachment 3.3-1.

Table 3.3-1 List of Crack Survey

No.	Name of Tank (Cascade)	District	Survey Date	Rehabilitation Year
(1)	Puliyankulam (Kiulekada) (1)	Anuradhapura	15 Feb. 2020	2017
(2)	Halmillawatiya (Kiulekada) (1)	Anuradhapura	15 Feb. 2020	2017
(3)	Kiulekada Ihara wewa (Kiulekada)	Anuradhapura	15 Feb. 2020	Unknown
(4)	Galkadaewa (Kiulekada)	Anuradhapura	15 Feb. 2020	2016
(5)	Vala Sinna kulam (Naveli kulam) (1)	Vavuniya	16 Feb. 2020	2017
(6)	Panichan kulam (Naveli kulam) (1)	Vavuniya	16 Feb. 2020	2017

Note: (1) Rehabilitated by CSDPP
Source: Study Team

These tanks have cracks on the top of the tank bunds. The dimension of the cracks is written below.

i) Length: several metres to over 100 metres.
ii) Width: several centimetres to approximate 30 centimetres.
iii) Average depth by plaster test: several centimetres to approximately 70 centimetres.

Puliyankulam | Halmillawatiya | Kiulekada Ihara Wewa

Galkadawewa | Vala sinna kulam | Panichan kulam

Source: Study Team

Figure 3.3-1 Cracks on Tank Bund

The plaster survey was conducted to measure depth of cracks at Puliyankulam and Halmillawatiya tank in Kulekada cascade (Anuradhapura district) from 28 February to 6 March 2020. The Study Team measured the depth of cracks at eight points (five in Puliyankulama tank and three in Halmillawatiya tank).

The survey was implemented in Accordance with the following procedure as shown in Table 3.3-2 and Figure 3.3-2.

Table 3.3-2 Procedure of Plaster Survey

Step	Description
Step 1:	Select typical cracks on the top of the tank bund in Puliyankulam and Halmillawatiya.
Step 2:	Remove weeds along the cracks.
Step 3:	Pour plaster into the cracks (Puliyankulam: 4 March 2020, Halmillawatiya: 28 February 2020)
Step 4:	Excavate and measure the depth of the cracks after a few days. (Puliyankulam: 6 March 2020, Halmillawatiya: 3 March 2020)

Source: Study Team

Step 2: Remove weeds along the cracks

Step 3: Pour plaster into the cracks

Step 4: Measure the depth of the cracks

Source: Study Team

Figure 3.3-2 Procedure of Plaster Survey

The results of plaster survey are shown in the following table. The cracks in Puliyankulama are generally deeper than Halmillawatiya because it has a higher embankment. The average depth is approximately 70 cm. Even though the deepest crack is 110 cm, it is still less than the free board (120 cm). The detail result of the plaster survey is shown in Attachment 3.3-2.

Table 3.3-3 Results of Plaster Survey

ID	Tank	No.	Depth (cm)	Remarks
96-7	Halmillawatiya	1	8	-
		2	-	Failure
		3	60	-
		4	40	-
96-10	Puliyankulama	1	100	-
		2	110	-
		3	70	-
		4	50	-
		5	68	-

Source: Study Team

3.3.2 Factors of Crack Occurrence

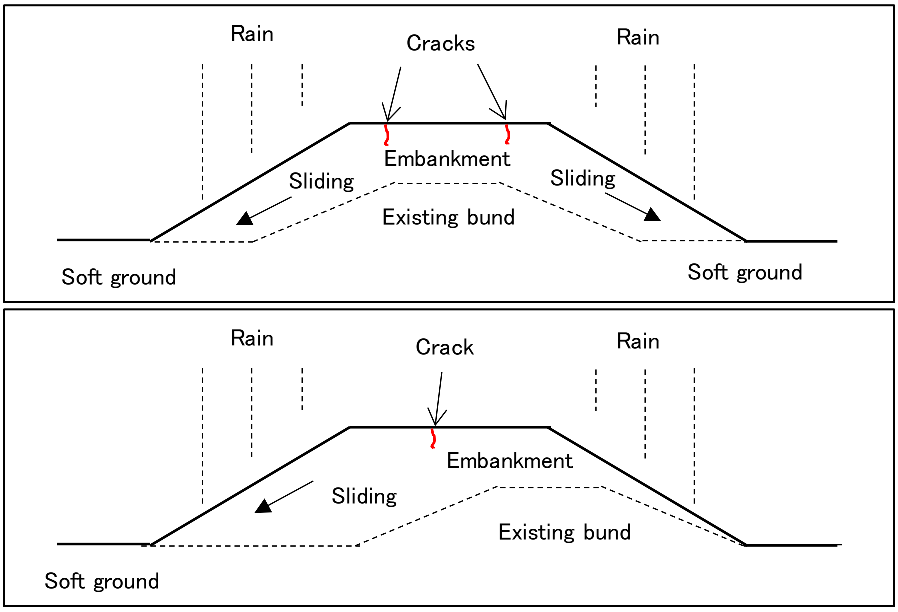
Features and factors of cracks was discussed with Provincial Irrigation Department (PID) and Department of Agrarian Development (DAD) Vavuniya as shown below. The cracks are occurred by effecting comprehensively factors as shown in the following figure.

i) Feature

- Feature 1: Some tank bunds have cracks.
- Feature 2: Cracks expand during the dry season and shrink during the rainy season.
- Feature 3: Serious cracks causing bund slide or breach are generally s rare case.

ii) Factors

- Factor 1: The tank bund has a soft ground.
- Factor 2: The quality of embankment materials is not appropriate.
- Factor 3: The integration of the existing bund and the embankment is not enough.



Source: Study Team

Figure 3.3-3 Factors of Cracks

The improvement of the tank bund design is proposed to address factor 1 and factor 2. An improvement in construction quality control is proposed to address factor 3.

(1) Improvement of Tank Bund Design

Although the soft ground of tank bunds is a main factor for the formation of the cracks, the improvement of the soft ground or counterweight fill, which are fundamental countermeasures, is not financially practical for small irrigation schemes.

The quality of embankment materials is also a main factor. Borrow pits of embankment materials are actually limited within in a tank reservoir area. Procurement of embankment materials from other areas is not financially and environmentally practical.

Simple methods for repair are proposed to reduce the occurrence of the cracks and to prevent the expansion of existing cracks.

(2) Improvement of Construction Quality Control

The main factor of crack is also assumed that the contractor didn't keep the quality control. In construction stage, supervisors should pay much attention to important matters to integrate existing bund and embankment as shown in the following table.

Table 3.3-4 Important Matters of Quality Control

Important Matters	Description
Management of contractors	Instruct contractor to manage soil moisture and compaction control (especially thickness of compaction layer, number of compaction).
Compaction of tank bund slope	Compact embankment vertically by compactor.
Stepping	Implement stepping (30 cm) surely to integrate existing bund and embankment.
Compaction Test	Take samples every 750 m^3 and confirm the test result is above 95% of maximum dry density of the material (the norm of PID and DAD).

Source: Study Team

3.3.3 Crack Countermeasures

The Study Team discussed with MMAIRD, Provincial Irrigation Department (North Central Province), and DAD Vavuniya regarding the countermeasures of the cracks on the top of tank bunds. Recommendations for the standard countermeasures were derived from the agencies written below.

i) Replacement material: sandy soil and clay soil
ii) Mix proportion of materials:
Clay: Sand = 30% to 40%: 60% to 70% or Clay: Sand: Gravel = 1: 1: 1
iii) Crack Depth
Average depth of the cracks is generally 60 cm (average depth of the plaster survey implemented by the Study Team is 71 cm).

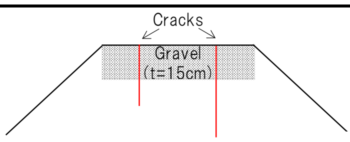
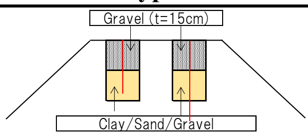
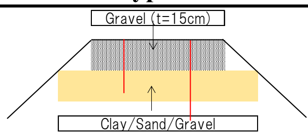
The article (Guidelines on Civil Works Rehabilitation Job Specific, R. K. Malhotra) shows the following technical points.

i) Trench width: 40 cm (the width of typical compactors is 30 cm)
ii) Filling materials:
In case crack depth is less than 60cm: Fine sand: Water = 1: 4
In case crack depth is more than 60 to less than 100cm. Clay: Sand = 1: 4
In case crack depth is more than 100cm. Bentonite: Water = 1: 14
iii) Compaction machine: Compactor or hand rammer.

Two basic types are proposed as crack countermeasures as shown in the following table. Type-A is to repair the cracks. Type-B is to improve the top layer to prevent the future occurrence and expansion of existing cracks. After the Study Team discussed with related agencies; Type-A is selected based on the following points.

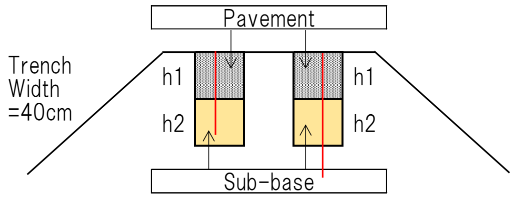
i) Cost of type-B is higher than Type-A in view of the quantity of clay, sand, and gravel.
ii) Construction of Type-B is more difficult than Type-A in view of compaction of layers.
iii) Track records of Type-B is not available.

Table 3.3-5 Comparison of Crack Countermeasures

Items	Existing	Basic Countermeasure	
		Type-A	Type-B
Standard Drawings			
Concept	-	Repair by Trench	Layer Improvement Design
Pavement	Gravel	Gravel	Gravel
Sub-base	Clay	Clay/Sand/Gravel	Clay/Sand/Gravel

Source: Study Team

Six countermeasures are proposed based on the advice from PID and DAD Vavuniya as shown in the following table. Mix proportion of the sub-base materials are clay: sand = 1:2 and clay: gravel = 1:2 because, generally, clay: sand = 35%:65% and clay: sand: gravel = 1:1:1.



Source: Study Team

Figure 3.3-4 Basic schematic Representative of Six Countermeasures

Table 3.3-6 Design Dimension Table of Six Countermeasures

Type		1	2	3	4	5	6
Pavement	Depth h1 (cm)	15	15	15	15	15	15
	Material	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel
Sub-base	Depth h2 (cm)	15	15	45	45	75	75
	Material	Clay: Sand (1: 2)	Clay: Gravel (1: 2)	Clay: Sand (1: 2)	Clay: Gravel (1: 2)	Clay: Sand (1: 2)	Clay: Gravel (1: 2)
Construction Method		By farmer	By farmer	By contractor	By contractor	By contractor	By contractor

Source: Study Team

3.3.4 Trial Construction

(1) Selection of Tank for Trial Construction

One tank is selected from the target tank of the Study (970 tanks) for trial construction. The selection criteria are shown in the following table. The criteria were discussed and agreed with related agencies at the inception meeting on 27 February 2020.

Table 3.3-7 Selection Criteria

No.	Items	Description
1	Crack occurrence	Occurred cracks on the top of the bund
2	Recently rehabilitated	Rehabilitated within a few years
3	Drawings	Drawings of bund rehabilitation are available
4	Location	Good access
5	Cooperation of FO	FO is cooperative
6	Repair plan	Crack repair is planned
7	Standard size	Not too big and small

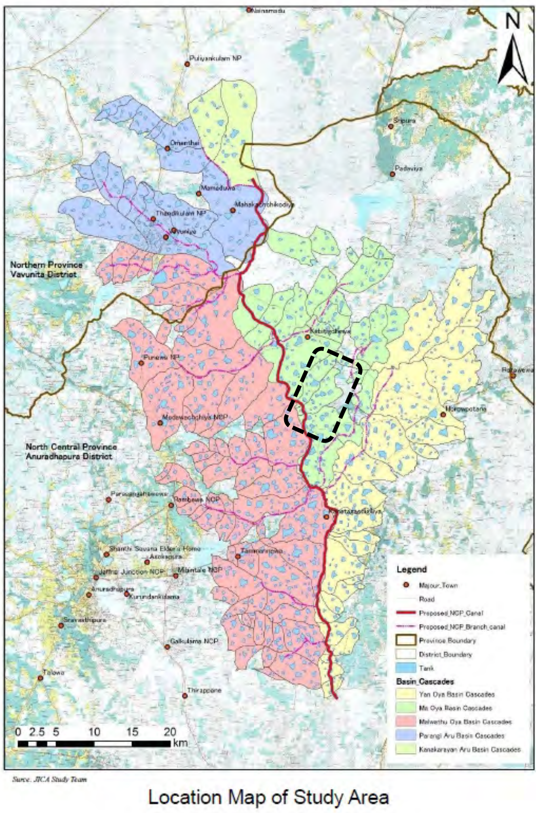
Source: Study Team

Four tanks rehabilitated for the field verification program by CSDPP are selected as the candidate tanks for the trial construction. The dimension of those tanks is shown in the following table. In view of “7. Standard size (for small schemes in the target area)” and “5. Cooperation of FO” based on the above criteria, Puliyankulam is selected. The location of Puliyankulam tank is shown in Figure 3.3-5.

Table 3.3-8 Selection of Target Tank

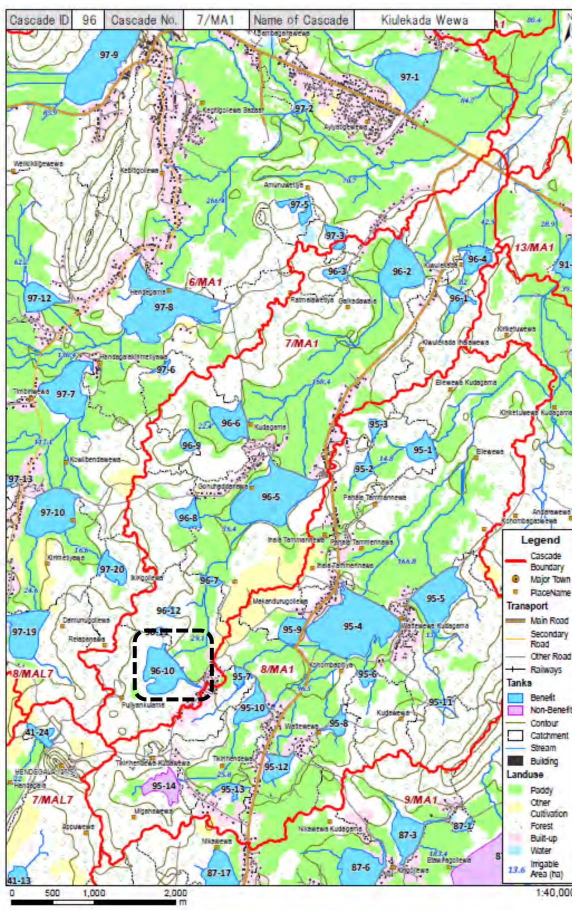
Name of Tank	Puliyankulam	Halmillawatiya	Vala sinna kulam	Panichan kulam
Name of cascade	Kiulekada	Kiulekada	Naveli kulam	Naveli kulam
Name of FO	Perakum	Perakum	Vala sinna kulam	Vala sinna kulam
Number of farmers	59	33	14	12
Irrigation area (ha)	38	16	17	12
Reservoir capacity (1,000 m^3)	266.0	3.2	64.1	9.1
Tank bund height (m)	3.7	3.0	2.8	2.0
Tank bund length (m)	730	332	500	375
Number of spillways (nos.)	1	2	1	1

Source: Study Team



Location of Kiulekada Cascade

Source: Study Team



Location of Puliyankulam tank

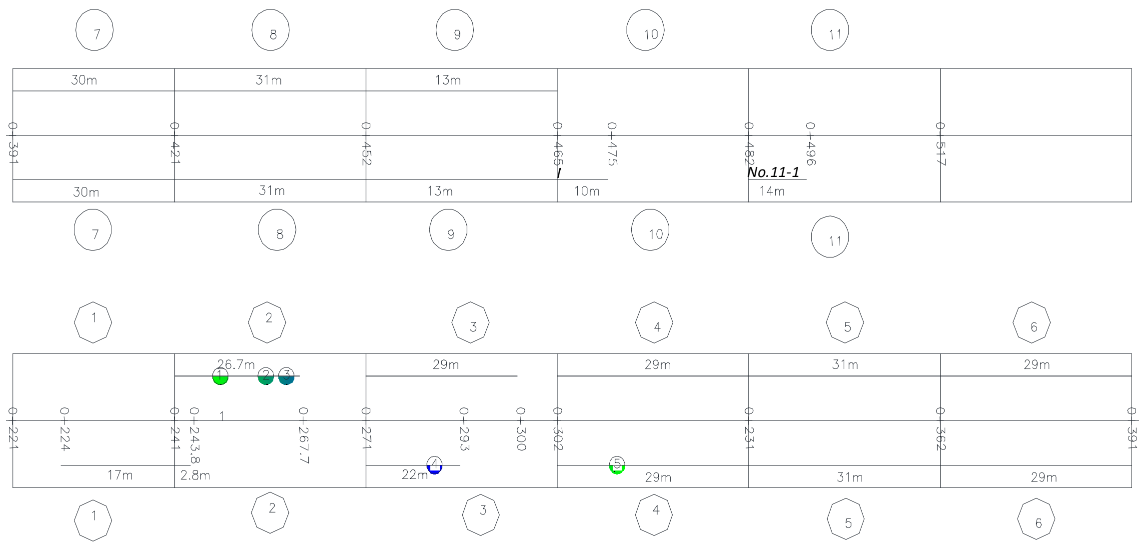
Source: Study Team

Figure 3.3-5 Location of Puliyankulam tank

(2) Detailed Survey

The detailed survey was conducted to measure dimension of the cracks to prepare trial construction design in Puliyankulam tank (Kulekada cascade in Anuradhapura) from 4 to 6 March 2020.

The number of the cracks and their location was recorded based on the CSDPP design in 2017. Parallel cracks occurred between chainage 0+302 and 0+465 section as shown in Figure 3.3-6 and Table 3.3-9 and Attachment 3.3-3 because it has a higher tank bund and both sides have an (upstream and downstream) embankment. The dimension of cracks are 2 cm to 3 cm in width and 20 cm to 50 cm in depth (the deepest crack in the plaster survey was 110 cm). The sub-section of 6-type countermeasure are set as shown in Attachment 3.3-4.



Source: Study Team

Figure 3.3-6 Cracks on Top of Tank Bund (sketch)

Table 3.3-9 List of Cracks

Chainage	Crack No	US/DS	Length (m)	Width (mm)	Depth (mm)	Plaster Test No.
0+224	1-1	US	17.0	20	270	-
0+241	1-2	DS	-	-	-	-
	2-1	US	2.8	20	300	-
0+271	2-2	DS	26.7	20	310	No.1, No.2, No.3
	3-1	US	22.0	20	300	No.4
0+302	3-2	DS	29.0	10	250	-
	4-1	US	29.0	30	270	No.5
0+331	4-2	DS	29.0	30	300	-
	5-1	US	31.0	20	200	-
0+362	5-2	DS	31.0	20	250	-
	6-1	US	29.0	30	500	-
0+391	6-2	DS	29.0	30	250	-
	7-1	US	30.0	20	300	-
0+421	7-2	DS	30.0	35	300	-
	8-1	US	31.0	25	350	-
0+452	8-2	DS	31.0	20	250	-
	9-1	US	13.0	20	290	-
0+465	9-2	DS	13.0	20	200	-
	10-1	US	10.0	20	450	-
0+482	10-2	DS	-	-	-	-
	11-1	US	14.0	20	320	-
0+496	11-2	DS	-	-	-	-

Source: Study Team

(3) Implementation of Countermeasures

The trial construction was conducted to examine the above mentioned countermeasures. Before the construction, the Study Team got an approval of the trial construction from PID and FO of Puliyankulam tank. The contract was signed by both parties on 14 July 2020 and the work was started on 17 July 2020.

The work schedule is attached in Appendix 3.3-1. The seasonal rain caused the temporary interruption of work and the contactor had to reschedule.

Daily performance of the contractors was monitored by the field staff of the Study Team, who instructed the contractors to improve the quality of works, keeping supervision records. The sample record is attached in Appendix 3.3-1.

Quality control tests such as soil compaction tests for filling materials were carried out at the laboratories of the counterpart agencies (PID). The test results passed the requirements indicated in the Technical Specification. The test result is shown in Appendix 3.3-1.

Base on the contract, the contractors were instructed to prepare the necessary safety equipment. Daily monitoring of the safety control manager was conducted using the abovementioned record.

The work is inspected by PID and handed over on 24 August 2020 with the approval of PID and FO as shown in Appendix 3.3-1.

The photograph of the trial construction is shown below.

Before the trial construction **During the trial construction** **After the trial construction**

Source: Study Team

Figure 3.3-7 The Site of Trial Construction

If there are any defects within six months after the completion of work, the contractor shall carry out all necessary works at the contractor's cost (defect liability). The Study Team will monitor each countermeasure after the construction and evaluation in September.

3.3.5 Evaluation of Countermeasures

The sub-base depth of type-3 and type-4 is changed from a design of 45 cm to 30 cm by the construction supervision. After completion of the trial construction, the Study Team had observed the condition of the construction site every week until the end of September 2020. There were no cracks in the trial areas as shown in following figures.

Table 3.3-10 Condition of Countermeasures (as of 28th September 2020)

	
Type-1	Type-2
	
Type-3	Type-4
	
Type-5	Type-6

Source: Study Team

The cracks were evaluated based on the comparison of conditions between CSDPP, before the trial construction and after the trial construction as shown in the following table. The conditions of CSDPP and after trial construction are same.

Table 3.3-11 Comparison of Conditions

After CSDPP (Sept. 2017)	Before trial construction (Feb. 2020)	After trial construction (Sept. 2020)
		

Source: Study Team

Six countermeasures were implemented and all of them were available. Usually, the cracks occur after the Maha season (heavy rain). The Study Team proposed to observe and evaluate the next Yala (dry) season. So tentatively, type-2 is selected for the best countermeasure so that the cost is the lowest as shown in the following table. The cost of each countermeasure is shown in Attachment 3.3-5.

Table 3.3-12 Tentative Evaluation of Countermeasures

Type		1	2	3	4	5	6
Pavement	Depth h1 (cm)	15	15	15	15	15	15
	Material	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel
Sub-base	Depth h2 (cm)	15	15	30	30	75	75
	Material	Clay: Sand (1: 2)	Clay: Gravel (1: 2)	Clay: Sand (1: 2)	Clay: Gravel (1: 2)	Clay: Sand (1: 2)	Clay: Gravel (1: 2)
Construction Method		By farmer	By farmer	By contractor	By contractor	By contractor	By contractor
Cost (LKR/m)		1,324	876	1,781	885	4,084	1,844
Evaluation			Selected				

Source: Study Team

3.4 Drone Survey

The Project will tentatively include 124 cascade and 955 tanks. Before the rehabilitation of target tanks, a topographic survey will be implemented. Considering the number of the tanks, reasonable and economical survey methods are needed. The Study Team evaluated normal survey (grid survey in this case) and drone survey in view of cost, survey period, and data accuracy.

The Study Team selected five tanks based on CSDPP as shown in the following table. The result of drone survey is shown in Attachment 3.4-1.

Table 3.4-1 Tank List of Drone Survey

District	Cascade	Tank	Reservoir Area	Remarks
Anuradhapura	Kiulekada	Puliyankulam	21 ha	Surveyed by CSDPP
		Kudagama	10 ha	—
		Ikirigollawa	7 ha	—
Vavuniya	Naveli kulam	Vala sinna kulam	11 ha	Surveyed by CSDPP
		Omanthai kulam	20 ha	—

Source: Study Team

(1) Cost and Survey Period

The Study Team has collected estimates and survey period from three contractors. Based on the estimates, the cost and period of the drone survey are less than the normal survey. The drone survey is advantageous in view of cost and period as shown in Table 3.4-2.

Table 3.4-2 Evaluation of Survey Methods

Item	Normal Survey			Drone Survey		
Contractor	A	B	C	A	B	C
Survey Period (day)	15	15～17	15	10	12～13	10
(including analysis)	Average 15 days			Average 10 days		
Survey Cost (LKR in Million)	3.641	4.207	3.621	2.803	2.479	3.366
	Average 3.823			Average 2,883		
Evaluation	-			Selected		

Source: Study Team

(2) Data Accuracy

The reservoir capacity of Puliyankulan tank and Vala sinna kulam tank has been compared using the survey datasets. As shown in Table 3.4-3, there is a small difference in the reservoir capacity by the normal survey and the drone survey.

Table 3.4-3 Comparison of Reservoir Capacity by Different Survey Methods

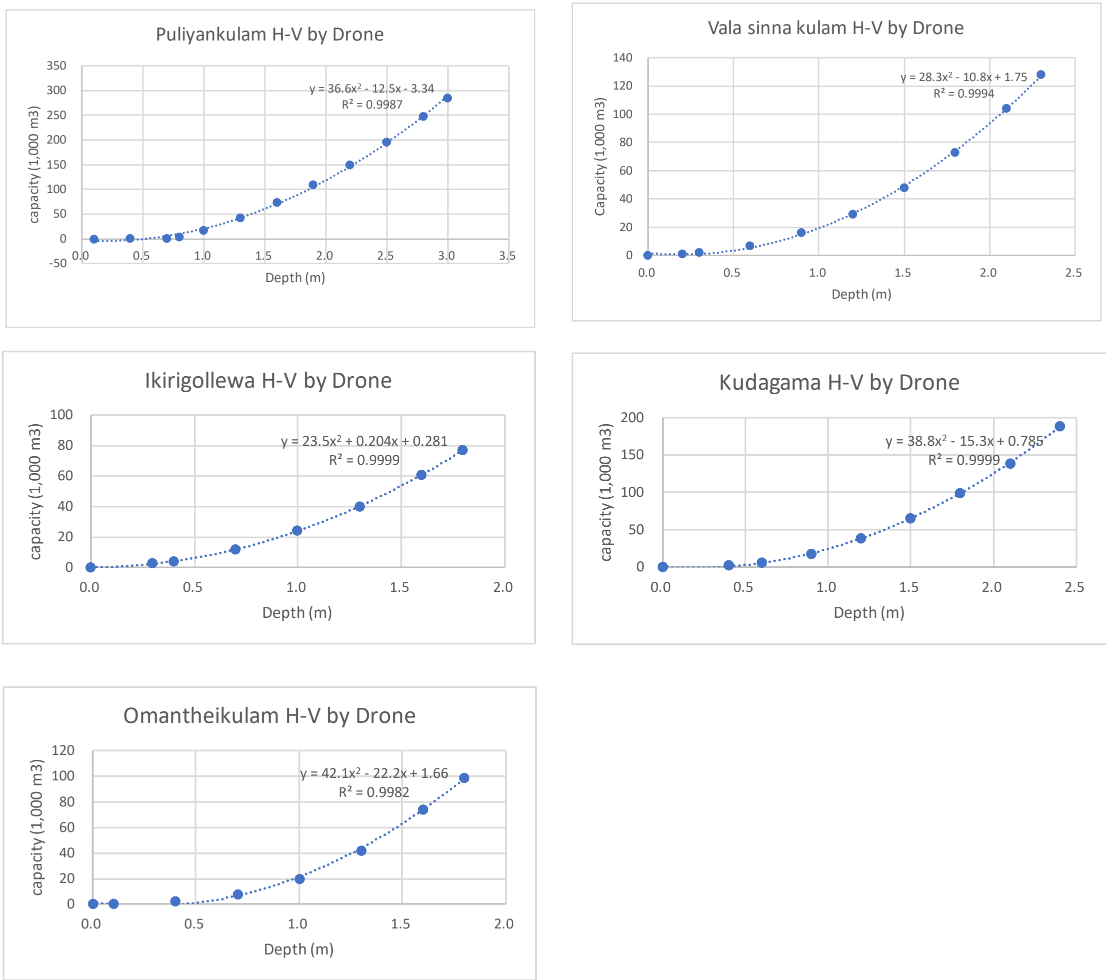
Tank Name	Normal Survey (1,000 m^3)	Drone Survey (1,000 m^3)
Puliyankulam	255	285
Vala sinna kulam	109	128

Source: Study Team

It is difficult to say which survey method is more reliable by comparing only two cases. However, in general, the accuracy of normal survey depends on the grid interval and surveyor's workmanship, while the accuracy of the drone survey is getting improved year by year. In fact, these days, the drone survey is widely used in many countries. Judging comprehensively, the drone survey can be used for the topographic survey of empty tank reservoirs.

(3) Evaluation of Drone Survey

The H (depth) – V (capacity) curves of the tanks surveyed by the drone are shown in Figure 3.4-1. The quadratic equation is applied to all the curves. The correlation coefficient is around 1.0, which means high correlation.

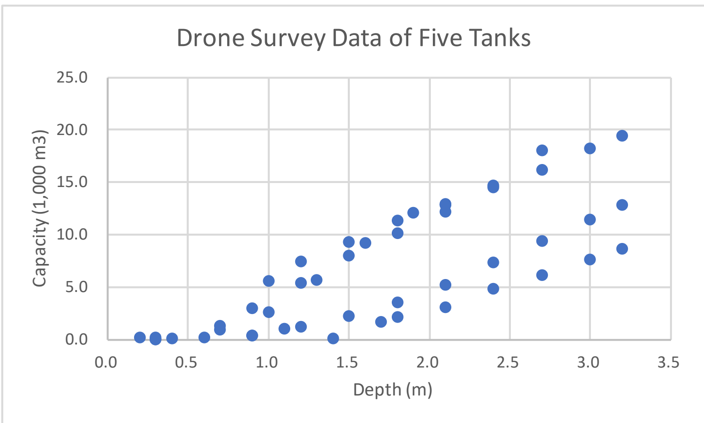


Source: Study Team

Figure 3.4-1 H-V Curves of Five Tanks

(4) Generalisation

The graph (depth-capacity) of five tanks surveyed by the drone is shown in Figure 3.4-2. The graph shows that each tank has topographical characteristics. There is no correlation among the data of the five tanks. Therefore, it is difficult to generalise the H-V curve by five tanks.

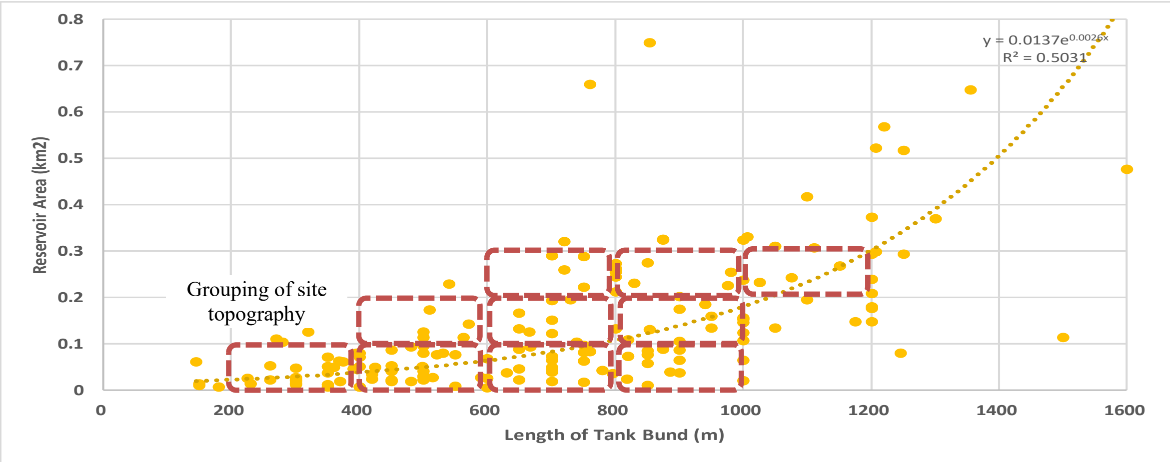


Source: Study Team

Figure 3.4-2 Depth – Capacity Based on All Data of Five Tanks

(5) Grouping of Tank Site's Topography

From the above analysis, it reveals that the H-V curve of each tank has a high correlation, but the generalisation of five tanks is difficult. The H-V curve will depend on the site topography. Study Team assumed that the tank bund length (m) and reservoir area (km^2) among others can be used as parameters for representing the site topography. Figure 3.4-3 indicates the distribution of 955 tanks by the tank bund length and the reservoir area, and the grouping of site topography. The 10 groups will be proposed for the drone survey to generate own H-V curve.



Source: Study Team

Figure 3.4-3 Type of Tanks by Tank Bund Height and Length

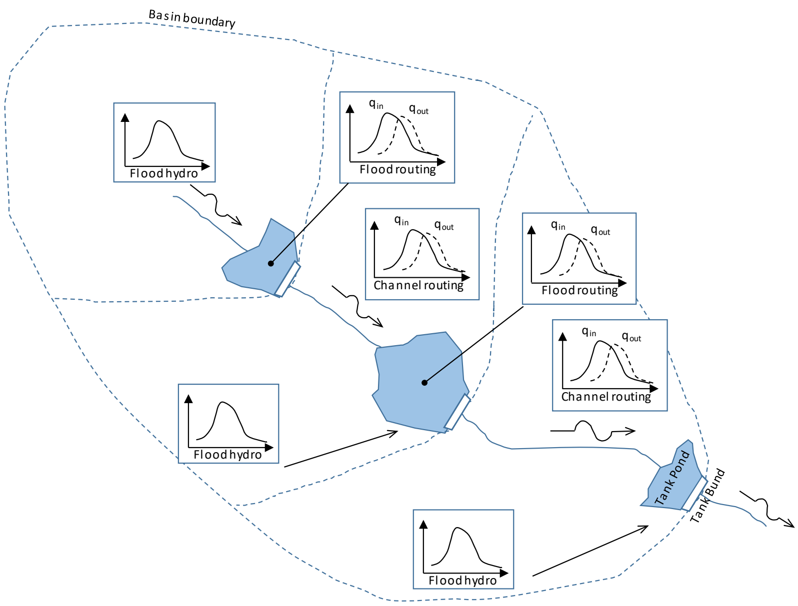
It is recommended that at least 3 tanks will be surveyed by drone in each group to develop own H-V curve by different group, which will be applied for other tanks having similar site topography.

3.5 Flood Analysis

3.5.1 Flood Discharge Estimation

(1) Basic Condition and Methodology

Generally, in Sri Lanka, Rational Formula Method is commonly used to estimate flood discharge of small tanks. However, the Rational Formula Method is not suitable to analyse flood discharge with hydrograph as cascaded tanks, as it is shown below figure. Based on the discussion with the counterpart, the study for flood discharge estimation follows Unit Hydrograph Method mentioned in Sri Lankan technical standard named "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah the same as CSDPP. Flood analysis is conducted tank by tank sequentially considering cascade system. The guideline was formulated by Department of Irrigation and it includes the methodology of hydrological analysis, design of spillway, bund, and sluice, and so on. Although the guideline can be used as a standard even today generally, there are a few missing parts to calculate flood discharge with Unit Hydrograph Method, as they are stipulated and supplemented in the following explanation.

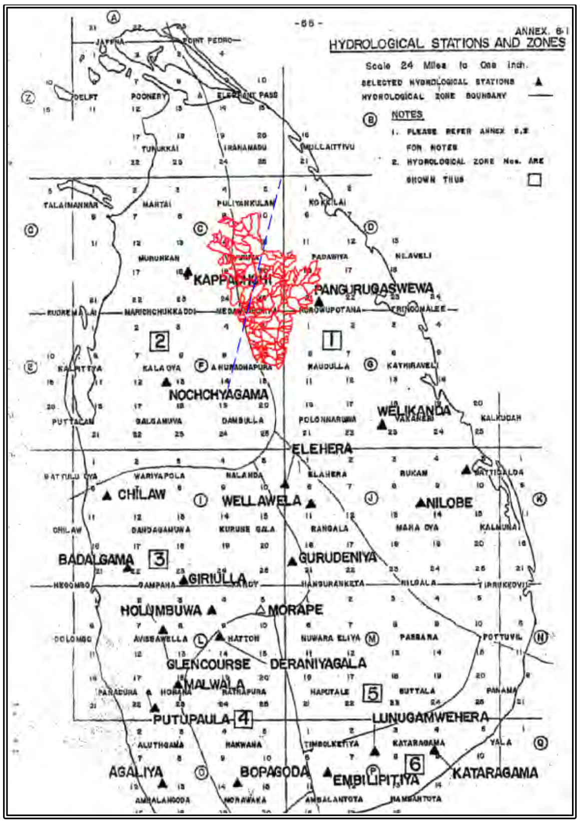


Source: Study Team

Figure 3.5-1 Concept of the Flood Analysis for the Cascade System

(2) Zone and Hydrological Station

According to the guideline, the country of Sri Lanka is divided into six hydrological zones as shown in the following figure. The project area is classified into Zone 1 and Zone 2. The nearest hydrological stations, namely: Pangurugasuwewa and Kappachchi, are selected as references for each cascade.



Source: "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 3.5-2 Hydrological Zone and the project area location

(3) Rainfall Intensity

The rainfall intensity is given in the guideline corresponding to the climate zone and return period. The cumulative rainfall depth for the 24-hour storm presented in the guideline is shown in the following table. In case of a minor (village) tank, the return period of 25 years is common in accordance with the Technical Guideline.

Table 3.5-1 Probable Rainfall Depth for a 24-hour Storm Presented in the Irrigation Guideline

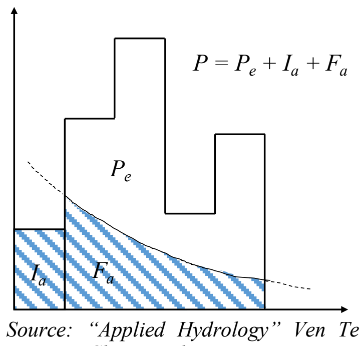
Zone	Return Period	Hour											
		2	4	6	8	10	12	14	16	18	20	22	24
Zone 1	100	8.2	9.5	9.8	10.2	10.5	10.8	11.2	11.5	11.9	12.2	12.6	12.9
Zone 1	50	7.3	8.4	8.7	9.1	9.4	9.7	9.9	10.2	10.5	10.8	11.1	11.4
Zone 1	25	6.4	7.3	7.6	7.9	8.1	8.4	8.7	9	9.2	9.5	9.8	10
Zone 2	100	7.6	8.5	8.9	9.4	9.8	10.3	10.7	11.1	11.6	12	12.4	12.9
Zone 2	50	6.6	7.5	7.9	8.3	8.7	9.2	9.6	10	10.4	10.8	11.2	11.6
Zone 2	25	5.9	6.8	7.1	7.4	7.8	8.1	8.4	8.7	9.1	9.4	9.7	10.1
Zone 3	100	7	7.8	7.9	8	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8
Zone 3	50	6.3	7	7.2	7.3	7.4	7.5	7.6	7.8	7.9	8	8.1	8.2
Zone 3	25	5.5	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7	7	7	7.1
Zone 4	100	5.5	8.3	9.5	10.2	10.8	11.5	12.7	13	13.5	14.1	14.8	15.3
Zone 4	50	5	7.2	7.5	9.3	9.8	10.4	10.9	11.5	12.1	12.6	13.3	13.8
Zone 4	25	4.5	6.8	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3
Zone 5	100	4.3	5.4	6.2	6.9	7.5	8	8.5	8.9	9.3	9.7	9.8	10.2
Zone 5	50	3.8	4.9	5.6	6.2	6.7	7.1	7.5	7.9	8.3	8.6	9	9.3
Zone 5	25	3.5	4.4	5	5.5	5.9	6.3	6.6	6.9	7.2	7.5	7.8	8.1
Zone 6	100	7	9.4	9.8	10.2	10.5	10.8	11.2	11.6	12	12.3	12.6	12.8
Zone 6	50	6.4	8.5	9	9.2	9.5	10	10.2	10.5	10.8	11	11.4	11.5
Zone 6	25	5.7	7.5	8	8.3	8.6	8.8	9.1	9.5	9.7	10	10.2	10.4
Zone 7	100	6.5	10.5	12	14.5	16	17	19.5	20.5	21.5	22.5	23	23.5
Zone 7	50	6	9.2	11.4	13	14.3	15.5	16.5	17.4	18.2	18.9	19.5	20.3
Zone 7	25	5	8	8.8	11.2	12.1	13	14	14.7	15.8	16.7	17.7	18.4

Note: Unit is in inches.
Source: Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah

(4) Rainfall Loss

Rainfall loss is the loss of the initial rainfall due to absorption by the dry soil and infiltration to the ground. Although rainfall loss is not mentioned in Sri Lankan guideline, this factor should be considered for actual flood discharging. In the Study, the rainfall loss is calculated by the Soil Conservation Services Method for the following points.

- The method was developed by Soil Conservation Service (SCS) of Department of Agriculture (USDA), USA and widely utilized for rainfall loss calculation.
- The method is stipulated in various guideline and textbooks such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.



Source: "Applied Hydrology" Ven Te Chow, et al

Figure 3.5-3 Rainfall Loss by SCS Method

The rainfall after deduction of rainfall loss is called as rainfall excess. The rainfall after deduction of rainfall loss is calculated by the following equation:

$$P_e = \frac{(P - I_a)^2}{P - I_a + S},$$

where P_e is the rainfall excess, P is the total rainfall, I_a is initial loss, and S is the potential maximum retention.

(5) Flood Hydrograph

(a) Method to Derivation of Flood Hydrograph

In the guideline, Snyder Unit Hydrograph is introduced. The coefficients of the Snyder's Hydrograph are proposed based on the closest hydrological station, and the shape of the unit hydrograph is developed which may fit the Sri Lankan's hydrological characteristics.

(b) Equation for Estimation of Peak Flow

The equation of the unit peak flow of the flood hydrograph by Snyder's Method is shown below.

$$q_p = \frac{640 \cdot C_p \cdot A}{t_p},$$

where q_p is unit peak flow, t_p is basin lag, A is the basin area in square mile, C_p is the coefficient that varies according to the physical characteristics of the catchment, and t_p is expressed by the following equation.

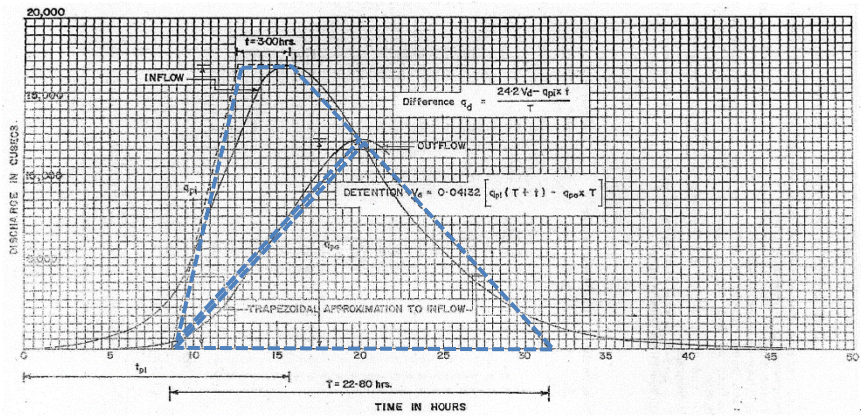
$$t_p = C_t (L \cdot L_C)^{0.3},$$

where L is length of the longest river course of catchment in miles, L_c is length from the point of interest to the point on the river course closest to the centroid of the catchment in miles, and C_t and C_p are given to the closest hydrological stations.

For example, in case of Kappachchi Hydrological Station, C_t and C_p are 4.42 and 0.87 respectively.

(c) Flood Routing

The inflow of the flood flow will be released from the spillway, but a part of the inflow will be stored in the reservoir. The guideline recommends to use the method developed by J.H. West ("Journal of Hydrology, 23-1974"). The method uses a simple graphical solution to estimate the flood discharge through a spillway. The graphic solution assumes the inflow as a trapezoid, and outflow is assumed to be an isosceles triangle.



Source: "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 3.5-4 Flood Routing by J.H.West Method

According to the guideline, the peak outflow is estimated by the following equation.

$$q_d = \frac{555.5V_d - q_{in}}{T},$$

where q_d is peak outflow through spillway in cumecs, V_d is stored flood discharge in the reservoir in millions m^3, q_{in} is peak inflow, and T is base hours of inflow and outflow as shown in Figure 3.5-4.

(d) Channel Routing

Channel routing is not mentioned in Sri Lankan guidelines but it should be considered for the flood analysis in the cascade tanks system. In this analysis, channel routing is calculated by Muskingum Method for below points.

i) The method is stipulated in various guideline and textbooks such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.
ii) The method is widely used as relatively simple method for channel routing without special program for calculating.

(e) Flood Discharge for Cascaded System

The flood discharge estimation for the cascaded system is not described in the guideline. The Study Teamdiscussed the methodology of the cascade flood analysis with the counterpart.

3.5.2 Estimation of Flood Discharge

The Rational Formula Method has been commonly used to estimate flood discharge of small tanks in Sri Lanka. However, based on the discussion with the counterpart, the study for flood discharge of each cascade tanks were calculated based on Unit Hydrograph Method mentioned in "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah.

This section mentions the comparison results of flood discharges between Rational Formula and above-mentioned Unit Hydrograph Method. It is expected that the flood discharges of Unit Hydrograph Method (25-years return period) are larger (safer side) than Rational Formula (50-year return period) although small figure of return period and flood discharge of Unit hydro graph method can be safety factor against future increase of rainfall and flood discharge.

The following items are findings of comparison results of flood discharge estimation.

i) Generally, flood discharge calculated with the Rational Formula becomes smaller compared with Unit Hydrograph Method. It is because flood discharge with the Rational Formula can be reduced out of rainfall with the run-off coefficient, which the value is from 0.3 to 0.5 in accordance with the catchment area slope condition. On the other hand, the Unit Hydrograph Method mentioned in the Technical Guidelines for Irrigation Works can make reduction from rainfall only with flood routing with in the reservoir. That is the reason why Study Team counted (4) Rainfall Loss instead.

ii) Comparing common case (the Rational Formula, where return period is 50 or recently 100 years and run-off coefficient is 0.3) with Unit hydrograph method (the return period is 25 years), the flood discharge with the Unit Hydrograph Method becomes larger (safer side) than result of Rational Formula regardless of tank location in a cascade (lower or upper stream tank).

iii) Comparing upper and lower cascaded tanks, the gap of flood discharge between the Rational Formula Method and Unit Hydrograph Method becomes larger in upper tanks than lower tanks. As the lower tanks will be, the more flood routing effects of tanks can be expected.

iv) On the other hand, the catchment area slope of upper tanks become larger in the upper stream and the run-off coefficient of the Rational Formula Method become larger than 0.3, probably 0.4 or 0.5 in accordance with slope condition. Thus, the gap of upper tanks can be acceptable, considering an increase in the run-off coefficient.

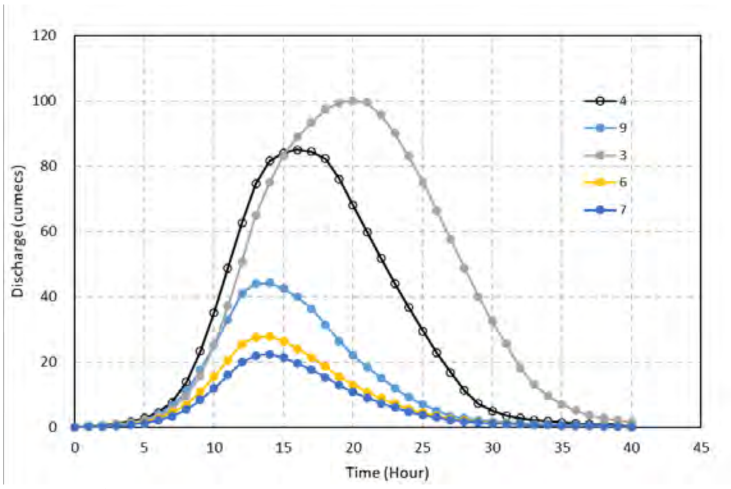
v) It is said that the rainfall will increase by about 10% to 20% due to climate change. The calculated flood discharge with a Unit Hydrograph can be also regarded as a safety factor against the future increase of rainfall and flood discharge.

vi) In developed countries, rainfall data and discharge measurement records are accumulated. A correlating equation between rainfall and discharge is studied to calibrate the Unit Hydrograph model before calculating flood discharge with the method. Calibration with actual recorded data is important to estimate a more accurate flood discharge with the Unit Hydrograph method, although these are not mentioned in “Technical Guidelines for Irrigation Works (1989)”. Therefore, the Study Team recommends C/P agencies to accumulate the records of these hydrological data in the target area.

Table 3.5-2 Comparison of Unit Hydrograph and Rational Formula Methods

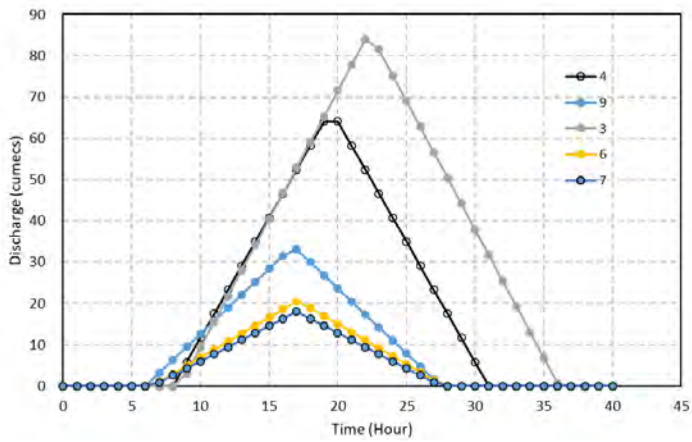
ID No.	Catchment area (km^2)	Unit Hydrograph Method		Rational Formula	
		Return period: 25 years		50 years C=0.3	100 years C=0.3
		Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Peak flow (m^3/s)	
12-3	15.31	104.3	**83.5**	65.7	70.6
12-4	6.89	84.9	**67.9**	43.6	46.4
12-6	1.10	27.7	**20.7**	6.5	7.0
12-7	0.96	22.3	**18.0**	4.7	5.2

Source: study team



Source: Study Team

Figure 3.5-5 Hydrograph of inflow to cascaded tanks



Source: Study Team

Figure 3.5-6 Hydrograph of outflow from cascaded tanks

3.5.3 Result of Cascade Tanks Flood Discharge

The results of the flood discharge of each cascade tank are summarised in Attachment 3.5-1.

3.6 Water Balance Study

3.6.1 Cropping Pattern

(1) Present Cropped Area under CSDPP

In CSDPP, the detailed survey was conducted in the six model cascades during the period from January to May 2017 in order to identify the present ground situation. This survey includes the cropped areas in the irrigable area, as shown in the table below.

Table 3.6-1 Present Cropped Area and Cropping Intensity in the Model Cascade

Cascade	Irrigable Area	Maha Season Paddy		Yala Season Paddy		Total Paddy	
Kiulecada	313 ha	230 ha	(73%)	38 ha	(12%)	268 ha	(86%)
Alagalla	65 ha	65 ha	(100%)	53 ha	(82%)	118 ha	(182%)
Naveli kulam	247 ha	195 ha	(79%)	48 ha	(20%)	244 ha	(99%)
Ichchankulama	355 ha	150 ha	(42%)	0 ha	(0%)	150 ha	(42%)
Rathmalawewa	469 ha	241ha	(51%)	28 ha	(6%)	269 ha	(57%)
Siyambalagaswewa	245 ha	105 ha	(43%)	86 ha	(35%)	191 ha	(78%)
Total	1,694 ha	986 ha	(58%)	254 ha	(15%)	1,240 ha	(73%)

Note Brackets () show cropping intensity
Source: CSDPP Report, with modification based on the adjustment of the irrigable area.

According to the survey results, only paddy was cropped in the irrigable area, and the main features of cropped area are explained below.

i) Average cropping intensity of paddy seems rather low as 73% annually, consisting of 58% in the Maha season and 15% in the Yala season. This is due to the severe drought observed in 2016 to 2017.
ii) Annual cropping intensity of each cascade shows a wide variation ranging from 42% in Ichchankulama to 182% in Alagalla. A larger catchment area may probably bring higher cropping intensity, since the ratio of catchment area against irrigable area shows a high value in Alagalla (5.5) and Naveli kulam (4.9) while a low value is manifested in Ichchanlulama (3.4), Kiulekada (4.1) and Siyambalagaswewa (4.4).

(2) Cropped Area and Cropping Pattern Estimated by JIRCAS and Simplified Models

A cascade system consists of several small tanks. For example, there are 68 tanks under the six model cascades. In order to estimate the cropped area in each cascade system, a water balance study is to be conducted based on the available irrigation water and water requirement. The procedure for each cascade is rather complicated since water is flowing from tank to tank and various factors are interrelated like run-off, return flow, discharge from spill, etc. In addition, data availability is another factor that adds difficulty to the task of conducting a water balance study.

As mentioned in the next section, two methods are compared, namely; JIRCAS model and the simplified model, in this study for applicability of water balance in the six model cascades. As a result, the simplified model is selected showing a good representation of the actual situation more practically.

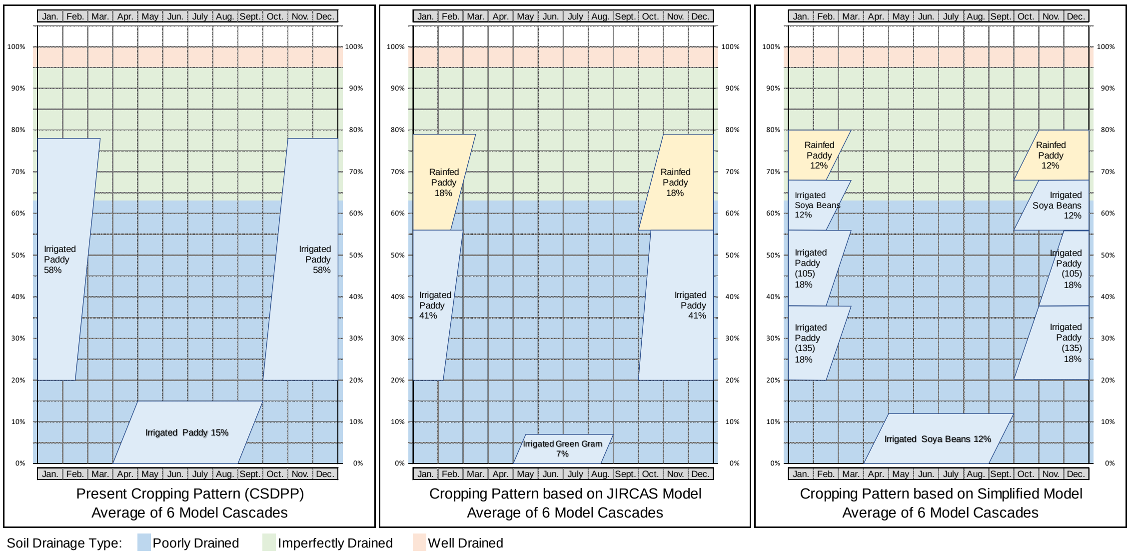
In the command area, farmers may also practice rainfed farming, since they always expect rainfall and crop growth based on their experience. Then, some parts of crops may grow under rainfed condition. Taking this situation into account, in the cropping pattern and cropping intensity, rainfed crops are allocated based on the cropping pattern practiced in CSDPP, as shown in Attachment 3.6-1, for each of the model cascades, and summarised in the total area of model cascades below.

Table 3.6-2 Cropped Area and Cropping Intensity by JIRCAS and Simplified Models

Cascade	Irrigable Area	Maha Season Crop	Yala Season Crop	Total Paddy
Present CSDPP				
・ Irrigated paddy	1,694 ha	986 ha (58%)	254 ha (15%)	1,240 ha (73%)
JIRCAS Model				
・ Irrigated paddy		690 ha (41%)	- (-)	690 ha (41%)
・ Rainfed paddy		296 ha (17%)	- (-)	296 ha (17%)
・ Irrigated OFC		- (-)	79 ha (5%)	79 ha (5%)
Total	1,694 ha	986 ha (58%)	79 ha (5%)	1,065 ha (63%)
Simplified Model				
・ Irrigated paddy		610 ha (36%)	- (-)	610 ha (36%)
・ Rainfed paddy		173 ha (10%)	- (-)	173 ha (10%)
・ Irrigated OFC		203 ha (12%)	137 ha (8%)	340 ha (20%)
Total	1,694 ha	986 ha (58%)	137 ha (8%)	1,123 ha (66%)

Note: Brackets () show cropping intensity
Source: Study Team

In the above table, it is noted that irrigated paddy under CSDPP without NCP Canal is grown under farmers practices in which inadequate irrigation water (irrigation with water less than the theoretical water requirement) is usually applied, while crop water requirement under the models is strictly applied. This may lead to the application of proper farming practices with appropriate dosage of input under the models, and higher unit yield will be obtained as a result. Cropping patterns in each model cascade are illustrated for CSDPP in Attachment 3.6-2, and the average pattern of the six model cascades is shown in the figure below:



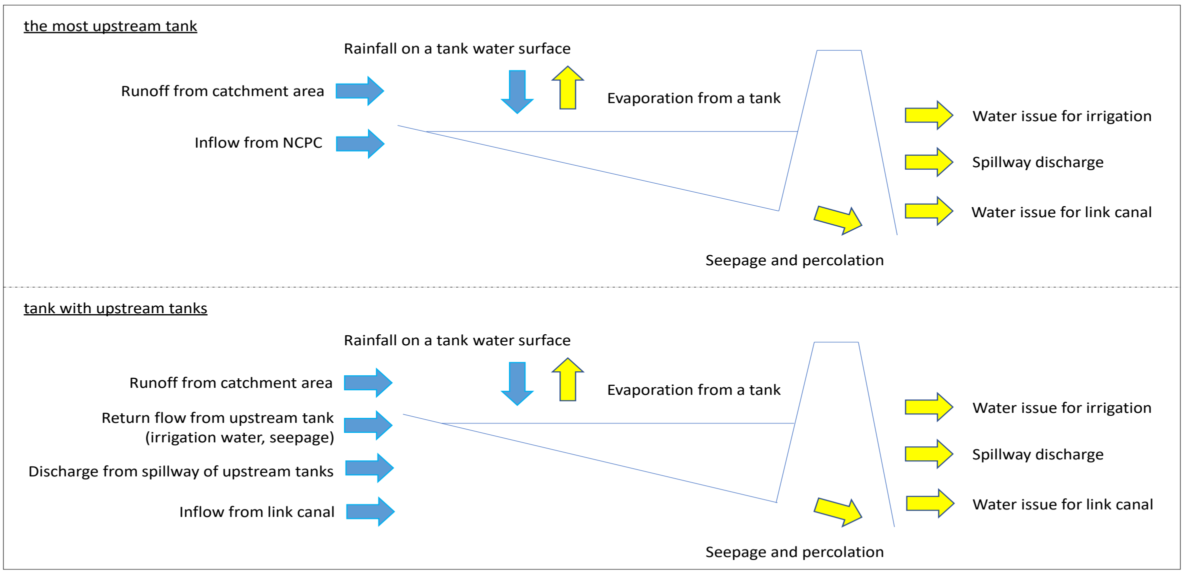
Source: Study Team

Figure 3.6-1 Average Cropping Pattern of Model Cascades

3.6.2 Preparation of Model for Water Balance Study

(1) JIRCAS Model

The water balance study for CSDPP was carried out using the simulation model development by Japan international Research Centre for Agriculture Sciences (JIRCAS) as shown in the following table.



Source: CSDPP, Final Report

Figure 3.6-2 Schematic Figure of Water Balance in Cascade System

The basic data and parameters used for water balance study are summarised as shown in the following table. Each parameter is explained in Attachment 3.6-3.

$$ROF + RAINTK + RETFLW + SPLIN + TLNIN = EVLOSS + WTQ + SPLOUT + SPLOSS + LNOUT + \varDelta Q$$

Table 3.6-3 Components of Water Balance of Cascade System

	Components	Index	No.
Inflow to a tank	Runoff from catchment area	RUNOF	(1)
	Rainfall on a tank water surface	RAINTK	(2)
	Return flow from upstream tanks	RETFLW	(3)
	Discharge from spillway of upstream tanks	SPLIN	(4)
	Inflow from NCPC or link canal	TLNIN	(5)
Outflow from a tank	Evaporation from a tank	EVLOSS	(6)
	Water issue for irrigation	WTQ	(7)
	Spillway discharge	SPLOUT	(8)
	Seepage and percolation	SPLOSS	(9)
	Water issue to link canal	LNOUT	(10)

Source: Study Team based on CSDPP, Final Report

(a) Conditions

The water balance study was prepared in the six model cascades by CSDPP, namely Kiulekada, Alagalla, Naveli kulam, Ichchankulama, Rathmalawewa and Siyambalagaswewa with the two cases of the Maha season and the Yala season without NCPC (the existing conditions).

Table 3.6-4 Outline of Conditions

No.	Items	Condition	Description
1	Target cascades	Six model cascades	Selected by CSDPP (1)
2	Rainfall	1/4 drought year (2002)	Calculation based on record of rain gauge station
3	Water demand	Each crop	Calculation based on the criteria in Sri Lanka
4	Own catchment	Each tank	Calculation based on GIS data by CSDPP
5	Water spread area	Each tank	Calculation based on GIS data by CSDPP
6	Spillway length	Each tank	Calculation based on GIS data and the criteria in Sri Lanka
7	Irrigable area	Each tank	Calculation based on inventory survey by CSDPP
8	Runoff coefficient	0.18	Based on the JIRCAS Model
9	Crops	Maha: Lowland Paddy (105), Yala: Green gram (75)	Selected based on the criteria in Sri Lanka
10	Cropping period	Maha: from 1 Nov. Yala: from 1 May.	Before full-case rainy season After Sinhalese new year
11	Initial depth of tanks	Zero (on 1 Oct.)	End of dry season
12	Conveyance efficiency	60% (on farm for upland crops)	Based on the criteria in Sri Lanka

Note : (1) CSDPP
Source: Study Team

(b) Results

The results of the six cascades without NCPC (the existing conditions) are summarized in the following table. Cropping area in the Maha season is 22% to 75% and in the Yala season is 1% to 12%. The proportion of cropping area in the Yala season is low in any cascades.

Table 3.6-5 Proportion of Cropping Area

Cascade	Proportion of Cropping Area (%)		
	Maha	Yala	Total
Kiulekada	40	7	47
Alagalla	75	4	79
Naveli kulam	44	12	56
Ichchankulama	44	4	48
Rathmalawewa	42	1	43
Siyambalagaswewa	22	2	24

Source: Study Team

(2) Simplified Water Balance Calculation Model

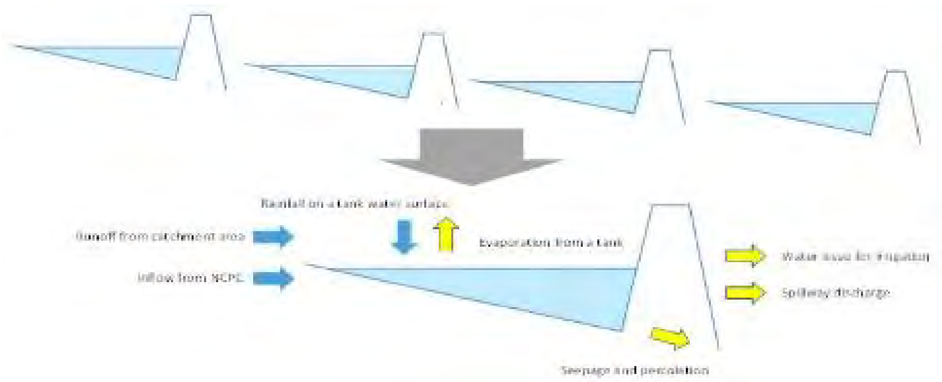
It is necessary to establish simplified water balance calculation model for tanks in cascade since the JIRCAS model is difficult to be applied for a large number of all target cascades and tanks (JIRCAS model requires input of all relevant tank data and trial calculation of all irrigable area).

The simplified water balance calculation model requires data input and calculation for only one assumed integrated tank, as it is mentioned below.

(a) Conditions for Simplified Water Balance Calculation

Basic conditions of simplified water balance calculation are summarized as follows:

i) A cascade is assumed as one tank with integrated catchment area, as it is shown in the following figure.



Source: Study Team

Figure 3.6-3 Image of simplified cascade model

ii) Conditions to calculate the irrigation water requirement, such as return period, rainfall data, crop water requirement, irrigation efficiency are set based on the Technical Guidelines for Irrigation Works (A.L.P.Ponrajah).
iii) Water balance calculation is conducted every half a month period.
iv) Maximum irrigable area for Yala and Maha season is calculated within each cascade water resource capacity.

Table 3.6-6 Outline of Conditions

No	Items	Condition	Description
1	Target cascades	All targeted cascades	
2	Rainfall	1/4 drought year	Technical Guide Lines
3	Water demand	Each crop	Technical Guide Lines
4	Own catchment	Each tank	Calculation based on GIS data by CSDPP
5	Water spread area	Each tank	Calculation based on GIS data by CSDPP
6	Irrigable area	Each tank	Inventory survey by CSDPP Calculation based on GIS data by CSDPP
7	Crops	Refer to Figure 3.6-4	
8	Conveyance efficiency	80%	Technical Guide Lines
9	Application efficiency	60%	Technical Guide Lines

Source: Study Team

The example result of simplified water balance calculation model is attached in Attachment 3.6-4

(b) Modelisation of Cascade with Tanks

The following assumptions are used for cascade modelisation:

i) Tank conditions, like WSA (ha), catchment (ha), and irrigable Area (ha) within the cascade are integrated as a summarized condition of a cascade, as it is shown below.
ii) Each tank conditions, like WSA (ha), catchment (ha), and irrigable area (ha) within cascade, is extracted from the GIS cascade database.
iii) The relation between WSA (ha) and tank capacity is set based on an actual survey result conducted under CSDPP (refer to Attachment 3.6-5).

Table 3.6-7 Command Area of Cascade (ID: 37)

Tank No.	WSA (ha)	Catchment (ha)	Command Area (ha)
37-1	52.4	269.4	141.7
37-2	5.1	64.4	8.5
37-3	11.0	99.2	8.1
37-4	1.0	45.5	6.5
37-5	9.0	69.3	14.2
37-6	21.9	136.0	26.3
Total	100.4	683.7	205.3

Source: Study Team

Table 3.6-8 H-V Table of Assumed Integrated Tank (ID: 37)

Depth (m)	Capacity (m^3)	Cumulative Capacity (m^3)
0.50	471	471
1.00	3,563	4,035
1.50	12,373	16,408
2.00	29,698	46,106
3.00	63,193	209,299
4.00	390,168	599,467
5.04	802,221	1,401,688

Source: Study Team

(c) Verification of Simplified Model

Comparison results of six selected cascades' cropping intensity estimated by three methodologies: i) calculation with "JIRCAS model" method, ii) calculation with "simplified water balance calculation model" and iii) "interviewed survey result", are shown in the following table. The table result shows that a "simplified model" result is almost an average between the "JIRCAS model" and the "interviewed survey result."

With regards to the interviewed survey, the results are expected to be a little higher than actual figures, as the interview was conducted when annual precipitation was more than 1/4 drought year and interview was conducted to see average or normal cultivation area.

Therefore, the calculation methodology of the "simplified water balance calculation model" set with the conditions mentioned earlier can be regard as appropriate and acceptable to estimate the irrigable cultivation area within cascade system.

(d) Cropping Calendar for Water Balance Calculation

Taking into account the CSPDD concept of crop diversification from nominal crops to market oriented high value crops, crop calendar is standardized based on the selected typical crops and annual schedules as shown in the following figure.

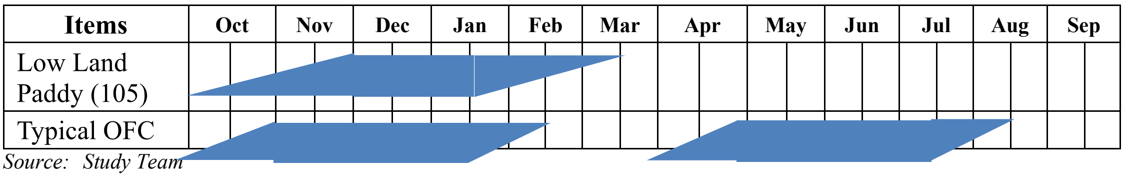
i) With regard to low land paddy, 105 days variety is selected.
ii) With regard to OFC, "Soya bean" is assumed to represent the typical and standard OFC among other coarse grains, grain legumes, condiments and vegetables from the view of average growing period and water requirement.
iii) Calculating possible crop cultivation area of the Maha season, first fix OFC area is 12% out of the total irrigable area, referring the same proportion as CSDPP for such OFCs as condiments and vegetables. Then seek possible paddy cultivation area within targeted cascade tanks capacity.

Since limited water is available, only OFC is anticipated to be cropped in the Yala season.

Table 3.6-9 Comparison result of Six selected Cascades' Cropping intensity

Cascade	① Integrated Irrigable area(ha)	② Integrated catchment area (ha)	③ Integrated WSA (ha)	JIRCUS Model			Simplified Model			Interviewed Survey result				
				MAHA	YALA	Total	MAHA	YALA	Total	MAHA		YALA		Total
Kiulekada	313	1,277	140	40%	7%	47%	48%	8%	55%	229.9ha	73%	37.9ha	12%	86%
Alagalla	65	360	64	75%	4%	79%	81%	13%	94%	65.0ha	100%	53.2ha	82%	182%
Naveli kulam	247	1,218	112	44%	12%	56%	55%	10%	65%	195.4ha	79%	48.3ha	20%	99%
Ichchankulama	355	1,217	118	44%	4%	48%	39%	7%	46%	149.8ha	42%	0.0ha	0%	42%
Rathmalawewa	469	1,751	202	42%	1%	43%	45%	7%	52%	240.8ha	51%	28.2ha	6%	57%
Siyambalagaswewa	245	1,077	170	22%	2%	24%	51%	8%	59%	104.8ha	43%	86.4ha	35%	78%
Average				41%	5%	45%	48%	8%	56%		58%		15%	73%

Source: Study Team



Source: Study Team

Figure 3.6-4 Cropping Calendar

(e) 124 Cascades Water Balance Calculation with Simplified Model

The following table shows the summarised results of the existing water balance calculation for 124 cascades, which were conducted based on the above-mentioned crop calendar and the simplified model.

The number of cascades that annual crop intensity rate is less than 50% are 39. "Annual crop intensity" shows a close correlation with "Catchment area/irrigable area" and "Catchment area/ Water Spreading Area (WSA).

Table 3.6-10 Summary of 124 Cascades water balance calculation

Cas ID	Symbol	Cascade Name	Benefit Tanks	Command Area (ha)	Maha Paddy Crop Intensity	Maha OFC Crop Intensity	Yala OFC Crop Intensity	Annual Crop Intensity
2	11/MAL2	Bora Wewa	3	40.90	37%	12%	7%	56%
3	12/MAL2	Pairimaduwa Wewa	6	188.60	28%	12%	6%	47%
4	10/MAL2	Galwaduwagama	2	24.30	35%	12%	6%	53%
5	12/MAL4	Abagaha Wewa	3	99.20	80%	12%	15%	106%
6	11/MAL4	Periya Kulam	2	76.90	32%	12%	7%	50%
7	10/MAL4	Kon Wewa	2	119.40	14%	12%	4%	30%
8	9/MAL4	Pahala Halmillewa	3	85.80	40%	12%	8%	61%
9	8/MAL4	Tharanogolllawa	2	23.40	88%	12%	52%	152%
10	7/MAL4	Siyambalabedigaswewa	1	12.20	0%	6%	0%	6%
11	6/MAL4	Mahagal kulam	8	145.80	77%	12%	15%	104%
12	13/MAL4	Ichchankulam	7	218.60	36%	12%	8%	55%
13	14/MAL4	Katukaliyawa	10	118.60	67%	12%	13%	92%
14	15/MAL4	Kasamaduwa	4	90.70	28%	12%	6%	46%
15	16/MAL4	Ittiktiya	4	76.90	25%	12%	5%	43%
16	17/MAL4	Galmaduwa	5	85.80	46%	12%	9%	68%
17	18/MAL4	Palugas Wewa	17	275.70	54%	12%	11%	77%
18	3/MAL5	Mekechchawa	29	615.50	61%	12%	13%	86%
19	2/MAL5	Abagahawela	7	181.10	88%	12%	33%	133%
20	1/MAL5	Ethawetuna Wewa	2	15.00	86%	12%	15%	113%
21	4/MAL5	Ella Wewa	13	487.60	38%	12%	9%	59%
22	5/MAL5	Ranpathwila Wewa	26	754.70	12%	12%	3%	27%
23	6/MAL5	Kukulawa Wewa	3	42.10	33%	12%	7%	51%
24	7/MAL5	Konketupothana	8	130.30	32%	12%	7%	51%
25	8/MAL5	Gekarawa Wewa	4	65.60	46%	12%	9%	66%
26	8/MAL12	Kongollawewa	6	117.40	32%	12%	7%	52%
27	10/MAL12	Nika Wewa	3	18.20	88%	12%	36%	136%
28	9/MAL12	Mekicha Wewa	3	13.00	88%	12%	44%	143%
29	11/MAL12	Kuda Wewa	2	58.70	55%	12%	10%	77%
30	12/MAL12	Rathmalgaha Wewa	3	113.80	56%	12%	11%	80%

Cas ID	Symbol	Cascade Name	Benefit Tanks	Command Area (ha)	Maha Paddy Crop Intensity	Maha OFC Crop Intensity	Yala OFC Crop Intensity	Annual Crop Intensity
31	13/MAL12	Kudagama Wewa	4	72.90	5%	12%	2%	19%
32	3/MAL6	Tibiri Wewa	2	329.00	58%	12%	12%	83%
33	2/MAL6	Gonawa Ihala Wewa	21	24.70	80%	12%	15%	107%
34	1/MAL6	Gonawa Wewa	3	41.70	34%	12%	7%	53%
35	4/MAL6	Kapirilgama Wewa	3	728.70	37%	12%	8%	57%
36	5/MAL6	Siyabalagaswewa	21	200.80	51%	12%	11%	74%
37	6/MAL6	Thalgaha	10	205.30	26%	12%	6%	44%
38	7/MAL6	Walketu Wewa	6	214.00	58%	12%	11%	81%
39	8/MAL6	Dumminnegama	4	64.80	17%	12%	4%	33%
40	2/MAL7	Lidawewa	2	44.10	28%	12%	6%	45%
41	7/MAL7	Pihibiyagollawa	3	650.00	48%	12%	11%	70%
42	6/MAL7	Kirimetiyawa	24	136.30	36%	12%	8%	56%
43	5/MAL7	Ralapanawa	6	105.30	46%	12%	10%	68%
44	4/MAL7	Kardan Kulam	8	84.60	15%	12%	4%	31%
45	3/MAL7	Diulgas Wewa	2	7.30	88%	12%	17%	116%
46	8/MAL7	Gagurane Pathaha	2	243.00	81%	12%	16%	109%
47	9/MAL7	Kirigollewa	9	567.90	58%	12%	13%	83%
48	10/MAL7	Kudagama Wewa	17	736.50	65%	12%	14%	91%
49	11/MAL7	Kuda Wewa	15	75.30	36%	12%	8%	56%
50	12/MAL7	Madawachchiya Wewa	4	767.70	52%	12%	11%	76%
51	4/MAL8	Parana Halmillewa	30	573.40	66%	12%	14%	92%
52	5/MAL9	Kidewaran Kulam	21	615.90	50%	12%	11%	73%
53	3/MAL8	Thibiri Wewa	20	53.40	45%	12%	9%	67%
54	6/MAL8	Dutuwewa	2	47.40	77%	12%	15%	104%
55	7/MAL8	Alagalla	1	157.00	22%	12%	5%	40%
56	8/MAL8	Nochchikulam	5	557.10	29%	12%	7%	48%
58	9/MAL8	Irataperiya Kulam	14	517.80	55%	12%	12%	79%
59	10/MAL8	Kurundan Kulam	18	29.70	46%	12%	10%	68%
60	11/MAL8	Kandapuran Kulam	3	62.00	37%	12%	8%	56%
61	12/MAL8	Karuweppan Kulam	3	52.50	77%	12%	15%	104%
62	13/MAL8	Suduventapulavu	7	35.90	76%	12%	15%	102%
63	10/Y2	Ihalagal Kulam	2	4.10	87%	12%	5%	104%
64	9/Y2	Eluwan Kulama	2	41.30	88%	12%	20%	120%
65	8/Y2	Meegaswewa	2	41.30	30%	12%	6%	48%
66	7/Y2	Kannimaduwa Wewa	3	128.30	36%	12%	8%	56%
67	6/Y2	Pahala Nittawa	4	30.00	49%	12%	9%	70%
68	5/Y2	Puliyan Kulam	2	86.10	71%	12%	15%	97%
69	4/Y2	Ella Wewa	5	85.50	33%	12%	7%	52%
70	3/Y2	Olukolagala Wewa	3	152.30	24%	12%	6%	42%
71	2/Y2	Punchihammillawa	3	42.50	24%	12%	5%	41%
73	7/Y4	Hettuwewa	2	138.50	61%	12%	12%	86%
74	6/Y4	Kon Wewa	5	100.40	46%	12%	9%	68%
75	5/Y4	Ithalwatuna Wewa	3	415.60	28%	13%	7%	47%
76	4/Y4	Maha Hammillewa	28	552.80	55%	12%	11%	78%

Cas ID	Symbol	Cascade Name	Benefit Tanks	Command Area (ha)	Maha Paddy Crop Intensity	Maha OFC Crop Intensity	Yala OFC Crop Intensity	Annual Crop Intensity
77	3/Y4	Moragahadigiliya	12	439.70	62%	12%	19%	93%
78	2/Y4	Pemorakewa	20	684.60	29%	12%	10%	51%
79	1/Y4	Patanaya	4	69.20	51%	12%	15%	78%
80	2/Y5	Nilla Wewa	39	1126.80	48%	12%	16%	76%
82	1/Y5	Ralapanawa	14	390.30	37%	12%	13%	62%
83	1/Y6	Hammillawa	14	469.30	23%	12%	11%	47%
84	5/Y6	Dutu Wewa	3	231.60	69%	12%	26%	108%
85	2/Y6	Kapugollewa Ela	8	481.00	42%	12%	18%	71%
86	3/Y6	Wagollakada	3	240.50	13%	12%	7%	32%
87	9/MA1	Maha Wewalkadawala	30	985.10	23%	12%	6%	41%
88	10/MA1	Walahawidda Wewa	6	218.00	17%	12%	7%	36%
89	11/MA1	Ulpathagama Wewa	2	222.50	3%	12%	3%	19%
90	12/MA1	Ulpotha	1	15.80	88%	12%	31%	131%
91	13/MA1	Kiriketu Wewa	2	58.30	28%	12%	9%	49%
92	15/MA1	Mahatikka Wewa	9	385.70	39%	12%	13%	64%
93	14/MA1	Elapattewa	7	165.20	44%	12%	14%	70%
94	16/MA1	Gallewa Wewa	4	292.80	7%	12%	4%	23%
95	8/MA1	Ihala Thammennawa	13	308.30	30%	12%	7%	49%
96	7/MA1	Kiulekada Wewa	11	304.00	35%	12%	8%	55%
97	6/MA1	Ayiyatige Wewa	22	640.00	58%	12%	12%	82%
98	5/MA1	Palupuliyam Kulama	7	137.90	32%	12%	10%	54%
99	4/MA1	Ithalwiddawa Wewa	11	305.40	21%	12%	8%	40%
100	3/MA1	Mahanettiyawa	4	132.80	36%	12%	12%	60%
101	2/MA1	Olugaskada	10	544.00	22%	12%	10%	44%
102	10/MA2	Sinhaya Ulpotha	1	16.20	72%	12%	15%	99%
103	1/MA1	Pahala Herath Mamillewa	2	35.30	64%	12%	22%	98%
104	9/MA2	Medagama Wewa	1	22.70	61%	12%	16%	89%
105	7/MA2	Kunchuttuwa	3	135.60	70%	12%	14%	97%
106	8/MA2	Puliyan Kulama	7	83.40	88%	12%	41%	141%
107	6/MA2	Maha Ralapanawa	5	125.30	88%	12%	20%	123%
108	5/MA2	Migakada Wewa	2	74.10	88%	12%	80%	180%
109	2/MA2	Viharahalmillawa	2	39.40	88%	12%	48%	155%
110	1/MA2	Nikawewa	1	18.00	88%	12%	148%	248%
111	5/PAR1	Puthuk Kulam	18	753.90	50%	12%	11%	73%
112	4/PAR1	Putuk Kulam	5	128.30	23%	12%	6%	41%
113	3/PAR1	Periya Kulam	2	46.00	88%	12%	18%	118%
114	2/PAR1	Kollamutamadu Kulam	5	97.10	43%	12%	9%	65%
115	1/PAR1	Chinna Kulam	6	233.80	26%	12%	6%	44%
116	6/PAR1	Parandikallu	24	596.70	35%	12%	8%	56%
117	6/PAR4	Periyakada	13	460.00	71%	12%	15%	98%
118	7/PAR4	Kidachchuri	4	257.90	63%	12%	13%	88%
119	8/PAR4	Mullaik Kulam	2	48.20	29%	12%	6%	47%

Cas ID	Symbol	Cascade Name	Benefit Tanks	Command Area (ha)	Maha Paddy Crop Intensity	Maha OFC Crop Intensity	Yala OFC Crop Intensity	Annual Crop Intensity
120	7/PAR1	Karunkalisinna Kulam	9	380.10	88%	12%	20%	120%
121	3/PAR2	Marutan Kulam	10	313.00	53%	12%	11%	77%
122	4/PAR2	Naveli Kulam	13	259.30	43%	12%	10%	64%
123	5/PAR2	Kasawapulaiyan Kulam	2	48.10	24%	5%	5%	33%
124	6/PAR2	Alankulam	3	57.70	84%	12%	20%	116%
125	7/PAR2	Podun Kulam	4	108.40	56%	12%	12%	80%
126	8/PAR2	Palaimoddalk Kulam	1	54.70	58%	12%	12%	82%
127	7/MGA1	Chamalan Kulam	9	422.00	73%	11%	15%	100%
128	6/MGA1	Periyapuliyan Kulam	10	391.70	50%	12%	11%	73%
		Total/ Average	**7.8**	**227.2**	**49%**	**12%**	**14%**	**74%**

Source: Study Team

3.7 Present Condition of Agriculture

3.7.1 Agricultural Land Use

Agricultural land use in the project area is broadly classified into the command area, highland area and home gardens. The command area is located in the cascades, and irrigated by gravity from the minor or medium tanks. The highland area consists of a lift irrigated area and rainfed area. Home gardens are usually located in the village cluster and utilised under rainfed or lift irrigated condition. The features and characteristics of each land use category are shown below.

Table 3.7-1 Features and Characteristics of Agricultural Land Use in the Project Area

Land Use		Features and Characteristics
Command area	Gravity irrigated	・ The land is within the irrigated command area of the Tanks. ・ The predominant soil group is low humic gley and has slopes of less than 2%. ・ Paddy is traditionally cultivated in the Maha season with 100% intensity and a maximum of 30% in the Yala season. ・ Crop diversification in the command area during the Yala season is insignificant.
Highland area	Lift irrigated	・ Source of irrigation water is agro-wells. ・ Crop irrigation in the highland area refers to water lifted off agro-wells. Typically, 6 m in diameter, 6 to 8 m deep and spaced 200 m apart, an agro-well can irrigate about 0.2 to 0.5 ha. ・ In Anuradhapura district, 4,400 ha of land area is irrigated from 9,000 agro-wells, of which 890 wells are abandoned. ・ Main seasonal crops cultivated are the cash crops (chilli and big onion) and vegetables in the Yala season. ・ There is a developing trend to grow permanent and semi-permanent fruit crops such as mango, guava, papaya, and banana in the irrigated highlands
	Rainfed	Paddy lands: ・ Occupy the upper slopes on the main distributary canals from the tank bordering the irrigated paddy fields. ・ The soil types are imperfectly drained RBE soils that occur between the well-drained RBEs in the upper slopes and poorly drained LHGs in the valley bottoms.

Land Use		Features and Characteristics
		▪ Paddy is grown in the Maha season and the land is abandoned during the Yala season. Other lands: ▪ Located in lands adjoining the state-owned forest lands, cultivated and/or developed lands issued with annual permits under the Crown Land Ordinance, usually on long-term basis. ▪ The term "chena" is not applicable now as it refers to a system of shifting cultivation of land practiced by farmers in the past. ▪ Seasonal crops such as maize, coarse cereals, grain legume, condiments, and vegetables as are grown in the Maha season under rain-fed conditions. ▪ No Yala season cultivation.
Home garden	Rainfed / irrigated	▪ Located in the highlands usually in the village cluster. Average land holding size is 0.4 ha. ▪ Besides the houses of farmers and sometimes those of direct dependants, the limited land area is used for growing vegetables, fruits and coconuts as well as for backyard poultry mainly for home consumption. The home-garden is also used for dairying. ▪ Cultivation of seasonal crops is during the Maha season but can be continuous if irrigation is possible with the use of dug wells/agro-wells.

Source: Study Team, modified and compiled from CSDPP Final report.

Taking into account the above agricultural land use as well as the cropping area in Anuradhapura and Vavuniya districts (Resource Profile 2014/15 in each Divisional Secretariat), the total agricultural land in the project area is estimated at 64,400 ha, consisting of: i) 31,200 ha of the irrigated command area under minor tanks, ii) 4,500 ha of the lift irrigated highland area, iii) 11,800 ha of the rainfed paddy highlands, and iv) 16,900 ha of rainfed highlands, as illustrated below:

Table 3.7-2 Present Agricultural Land Use in the Project Area

Land Use Category	Area	Remarks
1. Command area		
Gravity irrigated	31,200 ha (48%)	Paddy land irrigated by minor tanks in cascades. Fully planted in normal Maha season, but 20% to 30% planted in Yala season.
2. Highland area		
Lift irrigated	4,500 ha (7%)	Irrigated by agro-wells on home garden and chenas in Yala season. No irrigation in Maha season by utilising rainfall and saving operation cost of pumps.
Rainfed		No irrigation facilities
Paddy land	11,800 ha (19%)	Paddy land not irrigated, mostly located on highland without irrigation facilities.
Other land	16,900 ha (26%)	Seasonal crops such as coarse cereals, grain legume, condiments, and vegetables as are grown in the Maha season under rain-fed conditions.
Sub-total	33,200 ha (52%)	
3. Home garden rainfed / irrigated	- ha (-%)	Vegetables, fruits, and rood and tuber crops, not included in the GN level records
4. Total	64,400 ha (100%)	

Source: CSDPP Final report, compiled based on Section 3.8.2 Cropped Area and Crop Production in the Project Area.

3.7.2 Cropped Area and Crop Production

In the Project area, paddy is the main crop, and such other crops are planted as coarse cereals, grain legumes and condiments (refer to Appendix 3.7-1 for the general situation of the present agriculture). Major coarse cereals are maize with a small area of millet, and grain legumes include green gram. black gram, soybeans and cowpea. Condiments are chilly, big onion, and red onion. Other crops are increasing their cropped area like vegetables, fruits trees, root and tubes. According to the CSDPP report, the extent and production of major crops in the project area are compiled based on the Resource Profiles 2014/15, as shown below:

Table 3.7-3 Cropped Area, Production and Yield of Crops in the Project Area

Crops		Description
Cereals	Paddy	・Maha irrigated: 31,200 ha, 98,300 tons, 3.1 ton /ha (1.7 to 4.3 ton/ha) ・Maha rainfed: 11,800 ha, 26,400 tons, 2.2 ton/ha (1.2 to 3.9) ・Yala irrigated: 13,600 ha. 43,000 tons, 3.1 ton/ ha (1.4 to 4.3) ・Total cropped area: 56,600 ha, total production: 167,700 tons, average 3.0 ton/ha ・Major issue: low crop intensity (144% in irrigation command area, 132% including rainfed area) and low yield (national average: 4.2 ton/ha)
	Maize	・Significant increase in cropped area in Anuradhapura, supported by private intervention. ・Cropping in rainfed highland area in Maha, ・Maha rainfed: 15,300 ha, 63,000 tons, 4.1 ton/ha) ・Yala irrigated: 1,100 ha, 3,200 tons, 2.8 ton/ha ・Total cropped area: 16,400 ha, total production: 66,200 tons, average 4.0 ton/ha
Other field crops (OFCs)	General	・Maha rainfed: 19,600 ha under rainfed in highland ・Yala irrigated: 4,460 ha irrigated in the command area and lift irrigation. ・Productivity level is comparable to those of the National Food Production Programme and crop enterprise budgets of DOA.
- Grain legumes	Green gram	・Maha: 430 ha, 530 tons, 1.23 ton/ha, Yala: 80 ha, 150 tons, 1.9 ton/ha
	Black gram	・Maha: 1,700 ha, 2,400 tons, 1.5 ton/ha, Yala: 30 ha, 100 tons, 3.9 ton/ha
	Soybeans	・Maha: 530 ha, 1,890 tons, 3.6 ton/ha. Yala: 1,400 ha, 3.790 tons, 2.7 ton/ha
	Cowpea	・Maha: 600 ha, 760 tons, 1.26 ton/ha, Yala: 170 ha, 180 tons, 1.02 ton/ha
- Condiments	General	・Productivity level is far short of the National Food Production Programme and crop enterprise budgets of DOA.
	Chilli (green)	・Maha: 580 ha, 3,450 tons, 5.9 ton, Yala: 720 ha, 3,760 tons, 5.25 ton/ha
	Big onion	・Maha: 217 ha, 1,460 tons, 6.74 ton/ha, Yala 950 ton, 11,830 tons, 12,59 ton/ha
Other crops	General	・No consistent records are available at the local administration level. ・Crops are usually raised in lift irrigated highlands in the Yala season and rainfed area in the Maha season
	Vegetables	・Tomato, bitter gourd, snake gourd, luffa, pumpkin, cumber, eggplant, okra, capsicum and long bean ・Minor extent in the command area at the Yala season
	Fruits	・Banana, papaya, wood-apple, orange, mango, pomegranate, cashew, guava, passion fruit, watermelon, and jackfruits
	Roots / Tubers	・Cassava and sweet potato

Source: CSDPP Final report.

Taking into account the data of farm household survey conducted in the six model cascades under CSDPP in 2017 together with the above table, the cropped areas in each land use category are estimated at 125% for the irrigated command area under the cascade system and 118% in the highland area, as shown in the table below.

Table 3.7-4 Present Cropped Area and Cropping Intensity in the Project Area

Land Use Category		Maha Season	Yala Season
1. Command area			
Gravity irrigated	31,200 ha	Paddy: 31,200 ha (100%)	Paddy: 7,800 ha (25%)
2. Highland area			
Lift Irrigated	4,500 ha	(Rainfed) Coarse cereals: 1,100 ha (24%) Grain legumes: 800 ha (38%) Condiments: 800 ha (18%) Total: 3,600 ha (80%)	(Irrigated by agro-well) Coarse cereals: 1,100 ha (24%) Grain legumes: 1,700 ha (38%) Condiments: 1,700 ha (38%) Total: 4,500 ha (100%)
Rainfed			
Paddy land	11,800 ha	Paddy: 11,800 ha (100%)	No crops without irrigation
Other land	16,900 ha	Coarse cereals: 14,500 ha (91%) Grain legumes: 2,400 ha (9%) Condiments: 0 ha (0%) Total: 16,900 ha (100%)	No crops without irrigation
Total Cropped Area	64,400 ha	63,500 ha (99%)	12,300 ha (19%)

Source: CSDPP Final Report with modification based on the results of farm household survey in CSDPP.

3.8 Review of Farm Income and Farm Management Model

3.8.1 Review of Farm Household Income

(1) Income Level of Households in Anuradhapura and Vavuniya Districts

According to the Household Income and Expenditure Survey 2016 conducted by the Department of Census and Statistics, the household income in Anuradhapura and Vavuniya districts is estimated as shown in the following table.

Table 3.8-1 Monthly Income of Households in the District (LKR per month)

District	Mean Household Income		Monetary Income		Non-Monetary Income & Income in-kind		Gini Coefficient
Anuradhapura	58,300	100%	50,800	87.2%	7,500	12.8%	0.36
Vavuniya	58,600	100%	52,900	90.3%	5,700	9.7%	0.35
Sri Lanka	62,200	100%	52,900	85.1%	9,300	14.9%	0.41

Source: Household Income and Expenditure Survey 2016, Department of Census and Statistics.

Monthly household income is LKR 58,300 in Anuradhapura district and LKR 58,600 in Vavuniya district, and they are slightly lower than the national level. This situation may be a reflection of the difference in industry composition and employment structure between the two districts and the national level.

(2) Average Monthly Household Income by Model Cascade

Farm household survey was conducted under CSDPP in January to March 2017. Sample numbers covered by is 1,168 farm households who cultivate the irrigated command area in the cascades, and the sample number is equivalent to 67% of total benefited households (1,739 households) in the model cascades. The survey result shows that the average monthly income is estimated at LKR 32,500 over the model cascades as summarised below.

Table 3.8-2 Average Monthly Income of Farm Households (LKR per month)

Cascade	Crop Income		Livestock Income		Off-farm Income		Total	
Alagalla	10,400	25.9%	0	0.0%	29,800	74.1%	40,200	100.0%
Ichchankulama	24,000	71.2%	0	0.0%	9,700	28.8%	33,700	100.0%
Kiulekada	13,200	46.0%	300	1.2%	15,100	52.8%	28,600	100.0%
Naveli kulam	18,800	45.2%	2,200	5.2%	20,700	49.6%	41,700	100.0%
Rathmalawewa	12,900	41.5%	0	0.0%	18,200	58.5%	31,100	100.0%
Siyambalagaswewa	15,400	65.3%	200	0.7%	8,000	34.0%	23,600	100.0%
Average	16,000	49.2%	400	1.2%	16,100	49.6%	32,500	100.0%

Source: Study Team, modified and compiled from CSDPP Final Report.

From the above table, the following features regarding income can be observed.

i) One household income in the survey is below the monetary incomes indicated in the Household Income and Expenditure Survey 2016 in both districts, with the proportion against the district monetary income ranging from the lowest 46% in Siyambalagaswewa to 80% Alagalla and Naveli kulam.

ii) Household income shows a wide variation ranging from the lowest of LKR 23,500 in Siyambalagaswewa to the highest at LKR 40,200 in Alagalla cascade, due to the difference in situation of crop income and off-farm income.

iii) Livestock income seems to be insignificant. This is mainly due to the small number of households engaged in livestock. In Naveli kulam, for example, some of farmers obtain a larger income from livestock.

(3) Farming Type by Income Activities

Farm households are engaged in the various income activities not only crop growing and livestock keeping but also various off-farm income activities. Based on the income activities, farm households are categorized into several farming with number of households, as shown in the following table:

Table 3.8-3 Number of Households by Farming Activities (Number of Households)

Cascade	Crop Income only	Crop & Off-farm Income	Crop, Livestock & Off-farm Income	Crop, (Livestock)(1) & Off-farm Income	Off-farm only	Total
Alagalla	20	101	3	11	0	135
Ichchankulama	112	51	14	21	0	198
Kiulekada	29	206	14	6	0	255
Naveli kulam	1	98	39	16	1	155
Rathmalawewa	39	229	2	5	0	275
Siyambalagaswewa	38	103	8	1	0	150
Total	239	788	80	60	1	1,168

Note: (1) the households keep livestock without income, probably livestock products for home consumption only.
Source: Study Team, modified and compiling from CSDPP Final Report

Out of a total of 1,168 households in the six cascades, 142 households (12% of total households) are keeping livestock (cattle and/or poultry), and 79 households (7%) obtain income from livestock, mainly dairy. Particularly in Naveli kulam located in Vavuniya, the proportion of livestock farmers is the highest compared with other model cascades.

The generated income by farming type is shown in the following table.

Table 3.8-4 Average Monthly Income by Farming Type (LKR per month)

Farming Activities by Income Source	No. of HH	Crop Income	Livestock(1) Income	Off-farm Income	Total Income
Crop only	239	15,600	0	0	15,600
Crop + Off-farm	789	10,900	0	25,400	36,300
Crop + Livestock + Off-farm	79	16,900	15,100	13,200	45,200
Crop + (Livestock)(1) + Off-farm	60	13,200	0	16,100	29,300
Off -farm only	1	0	0	15,000	15,000
Total	1,168	16,000	400	16,100	32,500

Note: One household has crop growing activities with no crop income, probably for home consumption only.
Note: (1)The households keep livestock without income, probably livestock products for home consumption only.
Source: Study Team, modified and compiled from CSDPP Final Report.

About 20% of the total surveyed farm households (239 households) obtain income only from crop growing, and the total income seems low, compared with other farming types. The majority of farmers (68% of the sample households) obtains income from crop production and off-farm work, and off-farm income seems to be their main income. The farm households keeping livestock (12% of total households), who are either getting income from livestock or not, they also have off-farm income with almost the same portion.

3.8.2 Farm Management Model

The results of the farm household survey show the average land holding size of farmland in each model cascade. This is shown in the following table.

Table 3.8-5 Average Holding Size in Model Cascades (ha)

Cascade	Irrigated Command Area	Rainfed Highland	Home Garden	Total
Alagalla	0.7	0.3	0.3	1.3
Ichchankulama	1.1	0.9	0.3	2.3
Kiulekada	1.0	0.2	0.4	1.5
Naveli kulam	1.4	0.2	0.5	2.1
Rathmalawewa	1.1	0.9	0.3	2.2
Siyambalagaswewa	0.9	0.3	0.1	1.3
Average	1.0	0.5	0.3	1.8

Source: Study Team, modified and compiled from the CSDPP Final Report.

Model cascades were selected in the last CSDPP study representing physical and socio-economic situation in each cascades zone. Moreover, the land holding size in each model cascade is considered as the basic farm manage model to show such effect of the project such as an increase in income. In addition, such farming types containing livestock rearing and other activities will be taken into consideration to estimate the farm income through modifying the farm management model in the planning process of the cascade system development.

Average land holding size by farming type is shown in the following table currently.

Table 3.8-6 Average Holding Size by Farming Type (ha)

Farming Type by Income Source	No. of HH	Command Area	Rainfed Highland	Home Garden	Total
Crop only	239	1.12	0.70	0.26	2.08
Crop + Off-farm	789	0.99	0.43	0.28	1.70
Crop + Livestock + Off-farm	79	1.29	0.46	0.57	2.32
Crop + (Livestock)(1) + Off-farm	60	1.03	0.65	0.36	2.04
Off-farm only	1	0.79	0.50	0.28	1.77
Total	1,168	-	-	-	-

Note: (1) The households keep livestock without income, probably livestock products for home consumption only.
Source: Study Team, modified and compiled from CSDPP Final Report.

Not only the current situation but also the future situation to be expected after NCPC coming would be different based on the above farming type and land holding size. The future situation of the farming type after NCPC, namely farm management models are shown in the following table.

Table 3.8-7 Current Situation and Farm Management Model after NCPC

Farming Type	Land Holding of Command Area	Current Situation	Farm Management Model after NCPC
Crop only	1.12 ha/HH[(1)]	Income comes 100% from farming, but it is the lowest out of 5 farming types. Command area is more than 1ha.	・ Increment of income is expected by crop diversification. ・ After crop diversification would be settled, at first poultry and secondly dairy cattle can be introduced for income source gradually. ・ Depends on water retention of tank, fishery can be introduced gradually.
Crop + Off-farm	0.99 ha/HH	Income comes 70% from farming and 30% from off-farm work. Command area is less than 1ha.	・ Increment of income is expected by crop diversification with possible range to do off-farm work. ・ After crop diversification would be settled, at first poultry and secondly dairy cattle can be introduced for income source gradually. ・ Depends on water retention of tank, fishery can be introduced gradually.
Crop + Livestock + Off-farm	1.29 ha/HH	The balance of income of farm, livestock and off-farm is good and farm income is the highest out of 5 farming types. Command area is more than 1ha.	・ Increment of income is expected by crop diversification. ・ At the same time with crop diversification, dairy cattle and backyard poultry can be enhanced more for income source continuously. ・ Depends on water retention of tank, fishery can be introduced gradually.
Crop + (Livestock)[(2)] + Off-farm	1.03 ha/HH	Income comes from off-farm work more than farm even though command area is more than 1 ha.	・ Increment of income is expected by crop diversification with possible range to do off-farm work. ・ At the same time with crop diversification, dairy cattle and backyard poultry already possessed can be considered as new income source. ・ Depends on water retention of tank, fishery can be introduced gradually.
Off-farm only	0.79 ha/HH	Income comes from off-farm work only and command area is less than 1 ha.	・ Increment of income is expected by crop diversification with possible range to do off-farm work. ・ After crop diversification would be settled, at first poultry and secondly dairy cattle can be introduced for income source gradually. ・ Depends on water retention of tank, fishery can be introduced gradually.

Note: (1) HH is household
(2) the households keep livestock without income, probably livestock products for home consumption only.
Source: Study Team, compiled from CSDPP Final Report.

As for each farm situation of present, after the Project, after NCPC coming, cropping patten & intensity and income of farming-type wise are shown in the following tables. Crop budget for income calculation is referred to in Attachment 3.8-1.

Table 3.8-8 Comparison of Annual Cropping Pattern of Present, after the Project and after NCPC

	Season	Irrigation Type	Crop	Crop Intensity	
Present	Maha	Irrigated	Paddy	58%	
		Rainfed	Paddy	42%	Total
	Yala	Inadequately irrigated	Paddy	25%	125%
after the Project	Maha	Irrigated	Paddy	45%	
			Black gram	4%	
			Chilli	4%	
			Eggplant	4%	
		Rainfed	Paddy	43%	
	Yala	Irrigated	Green gram	4%	
			Chilli	2%	
			Big onion	2%	
			Eggplant	3%	Total
		Inadequately irrigated	Paddy	14%	125%
after NCPC	Maha	Irrigated	Paddy	64%	
			Black gram	1%	
			Soybean	17%	
			Chilli	4%	
			Eggplant	8%	
	Yala	Irrigated	Paddy	18%	
			Soybean	18%	
			Green gram	4%	
			Soybean	16%	
			Big onion	6%	
			Chilli	11%	Total
			Eggplant	11%	178%

Source: Study Team, compiled from CSDPP Final Report.

Table 3.8-9 Comparison of Annual Farm Income of Present, after the Project and after NCPC

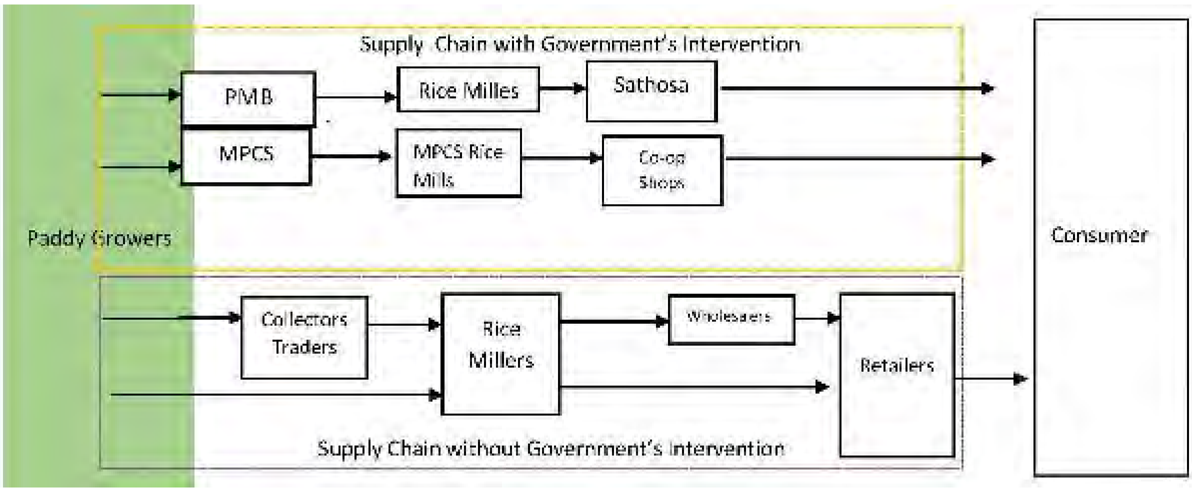
Farming Type	Command area (ha)	Income (LKR thousand per year)		
		Present	after the Project	after NCPC
Crop only	1.12	187	256	568
Crop + Off-farm	0.99	131	226	502
Crop + Livestock + Off-farm	1.29	203	295	655
Crop + (Livestock) + Off-farm	1.03	158	236	523
Off-farm only	0.79	0	181	401

Note: The households keep livestock without income, probably livestock products for home consumption only.
Income of present condition is calculated from each monthly income from Table 3.8-4.
Incomes after the Project and after NCPC are calculated based on cropping pattern shown in Table 3.8-8 and crop budget shown in Attachment 3.8-1.
Source: Study Team

3.9 Demand and Supply, Market and Distribution of Agricultural Products

3.9.1 Supply Chain of Major Crops

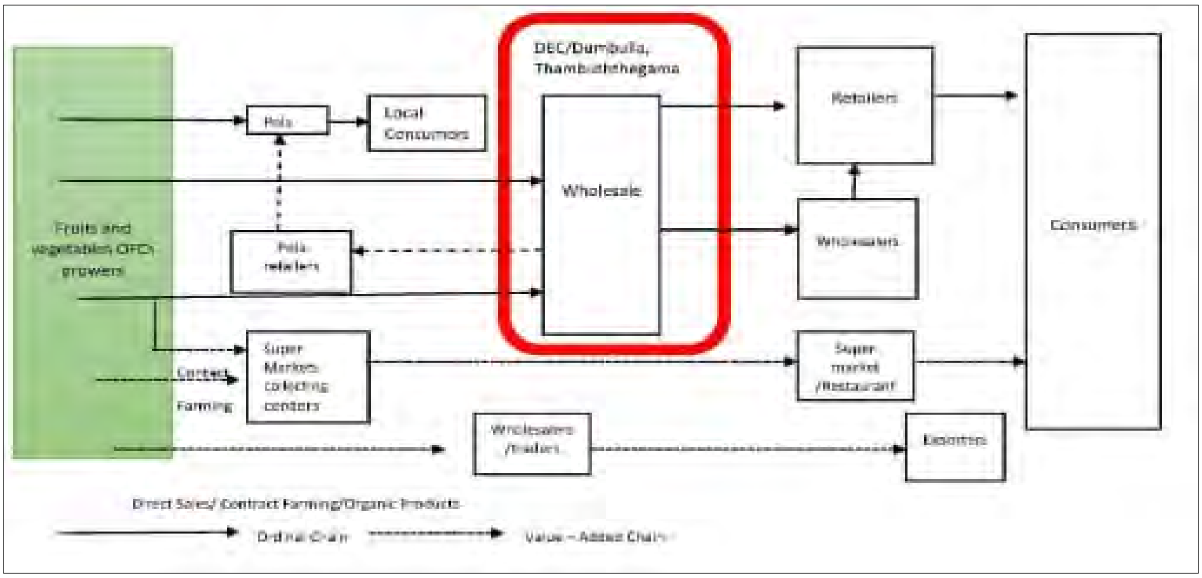
The supply chain of food crops is divided into two main channels: paddy/rice and the others. The following figure shows the supply chain of paddy/rice in the project area. The government directly intervenes with the paddy/rice market by setting a guaranteed price. The Paddy Marketing Board (PMB) or Multi-Purpose Cooperative Society (MPCS) purchases paddy directly from farmers at a guaranteed price.



Source: CSDPP Final Report

Figure 3.9-1 Supply Chain of Paddy/Rice

The supply chain of the other crops including OFC, vegetables, and fruits without intensive government's intervention, is divided into two categories: an ordinal, domestic chain and a newly emerged, value-added chain (Figure 3.9-2). Pola, a weekly market or village fair, is a key nexus where farmers or collectors directly transact with nearby consumers in a production area. The dedicated economic centre (DEC), a public wholesale market, is another key arena where farmers or collectors transact their produce with a broader range of distributors. Out of the 13 DECs, Thambuththegama DEC (in Anuradhapura district, North) and Dumbulla DEC (in Matale district, Central Province) are accessible from the project area. In particular, the Dumbulla DEC is located at the centre of the country and functions as a central nexus of produce from all over the nation.



Source: CSDPP Final Report.

Figure 3.9-2 Supply Chain of Other Food Crops

The next section describes the detailed marketing situation of each crop.

(1) Market Situation of Paddy/Rice

(a) High Self-sufficient Rate with Government's Market Intervention

According to the CSDPP report, the rice self-sufficiency rate in Sri Lanka has remained above 80% since the early 1980s, and the government continuously protects rice farmers through market intervention and a package of production subsidy for the national food security.

The PMB, as a key player in market intervention, purchases 2,000 kg of paddy per farmer every harvesting season at a guaranteed price. The MPCS also purchases paddy directly from farmers at the guaranteed price. The MPCS, however, changes its volume of paddy to be purchased every year, following the governmental budget and mandate.

(b) Lower Farm-gate Price at Harvest Season

Although the guaranteed price secures 2,000 kg of paddy/season, farmers have to bear a lower price during, the February and August harvesting seasons. According to the Institute of Post-Harvest Technology (IPHT), small-scale farmers store 30% or 590 kg for self-consumption after selling to the PMB and thereupon sell 70% or 2,350 kg paddy to millers or collectors immediately after harvesting at the lowest price of the year, to pay for their production cost.

(c) Lack of Quality Control Yet High Value Varieties are Popular

A recent study shows that in 2012, only 11% of raw rice available in the local market are of export quality. Supposing that the country aims to export rice, therefore, all stages of production, post-harvest, and storage need to be significantly improved (refer to Appendix 3.9-1).

While certain improved varieties occupy majority of the paddy land in the country, recently, traditional varieties are being demanded in the urban market typically among health-conscious consumers, and sold at a higher price (refer to Appendix 3.9-2).

(2) Market Situation of Other Field Crops

(a) Low Domestic Production

Sri Lanka spent LKR 47 billion for importation of other field crops in 2018, which included coarse grains, grain legumes, and condiments, despite the fact that they can be produced locally for import substitution and there by save a significant proportion of foreign exchange spent annually.

Table 3.9-1 Imported Quantities and Value of Other Field Crops (2018)

Item	Crop	Quantity (ton)	Value (LKR in Million)
Condiments	Big Onion	246,200	12,742
	Red Onion	15,300	1,503
	Chillies	52,900	11,182
Grain Legumes	Black Gram	12,400	1,365
	Chickpea (whole + split)	27,300	4,231
	Green Gram	16,400	2,238
	Cowpea	8,100	1,000
Oil Crops	Gingelly seed (sesame)	260	32
	Ground nut	4,300	784
	Soybean	6,400	447
Coarse Grains	Kurakkan (finger millet)	3,100	218
	Maize: seed (planting material)	1,500	1,000
	Maize-Other	119,100	4,937
	Potato	158,700	5,287
Total			46,965

Source: Department of Census and Statistics.

To minimise the foreign exchange spent on import of these crops, the newly elected government has initiated a program of import substitution by encouraging local farmers to grow more of these crops. The main approaches are offering the farmer with a government declared farm gate price, providing a subsidy on seed material and imposing import restrictions. Accordingly, the following farm gate prices were declared effective from early 2020.

Table 3.9-2 Government Declared Farm Gate Prices (LKR per Kg)

Crop	Government Price (LKR/kg)	Crop	Government Price (LKR/kg)
Maize	50.00	Dry chilli	600.00
Big Onion	100.00	Soybean	125.00
Red Onion	110.00	Finger millet	175.00
Black gram	220.00	Sesame	200.00
Green Gram	200.00	Turmeric	80.00
Groundnut	220.00	Ginger	125.00

Source: Provincial Department of Agriculture, Anuradhapura.

However, the farm gate prices of all these crops have increased substantially during the recent months due to market shortages and high demand. Some farmers have expressed their keenness to grow more of these crops in the next season.

(b) Contract Farming of Other Field Crops

There are Forward Sales Contract (FSC) systems with farmers in the project area operated by private sector companies. These include FSC on maize where farmers registered with the CIC Agribusiness, among others, are provided with seeds and fertilisers and in return, the farmers concur to sell their maize harvest to the company at an agreed price.

A similar FSC system functions in the Vavuniya District where Ceylon Biscuits Limited buys the grain legumes from contract farmers. Farmers are issued with seeds and fertilizers and the company buys back the produce at an agreed price. The Company investment is made under an insurance coverage while the farmers are insured against crop losses through intervention of the International Labour Organization.

The FSC systems are faced with some problems with the 2019/2020 Maha crop as the currently operating farm gate prices are much higher than that stated in the contract agreements. Many farmers tended to violate the contract agreements and preferred to sell their produce to collectors at the currently operating high open market prices. However, the involved companies are often unable to take any action against such farmers due difficulties they encounter in following legal procedures and the number of individual farmers involved.

(3) Market Situation of Vegetables

(a) Clear Price Seasonality

Prices of vegetables in Sri Lanka show clear seasonality. Wholesale prices of most vegetables drop during two high seasons, namely March-April and August-September. On the contrary, the local market faces a lack of supply and the prices of vegetables skyrocket during off-seasons between October and February, and between May and July.

(b) High Valued Chain by Supermarkets

Apart from the ordinal market, supermarket franchises create a higher value channel for farmers. Unlike OFCs, they normally do not contract with producers. Instead, they establish a network of farmers. For instance, Cargills Food City, a supermarket franchise run by Cargills (Ceylon) PLC, set eleven collecting stations in major production areas and its extension officers at each station. Prior to bringing their produce to a collecting centre, farmers communicate with the officer in order to confirm the demand and prices, normally higher than the market price. Both Cargills and farmers have no obligation to transact with them. Farmers show their products and sell them to DECs or other wholesale markets if Cargill refuses to purchase them or farmers find a better price elsewhere.

(c) Low Quality Awareness and Potential of Value-Added Market

Awareness of the quality standards of fresh vegetables is still limited. Cargill Food City has its own quality standard of vegetables including size, shape, and colour, but not pesticide residue and taste (sweetness, sourness, and ripeness). Supermarkets are mainly concerned with transportation damage or loss. Proper post-harvest training can improve the quality of the produce and guide farmers to match market preference.

(4) Market Situation of Fruits

(a) Clear Price Seasonality and Necessity of Increase in Domestic Production

Fruits and vegetables have a similar marketing structure. The price of fruits fluctuates seasonally. The supply chain also shapes a similar route from farmers to Pola or DEC (via collectors) as the ordinal chain, and farmers or collectors to supermarket or wholesalers as a value-added chain.

Moreover, the government promotes production of fruits through the Food Production National Programme (2016-2018). The programme aims to increase its intake up to 200 g per capita per day, against a current intake of 100 g per capita per day ("Food Production National Programme 2016-2018" Presidential Task Force on National Food Production). Under these conditions, domestic production of fruits can be encouraged with the consideration of price seasonality.

(b) Potential for Export

In Sri Lanka, some fruits are exported mainly for Middle East and European Union (EU) countries. For Middle Eastern countries, mango, papaya, and pineapple are major produces, while banana and mango go to EU countries. At present, the exporting countries are mostly where Sri Lanka expatriates.

In addition, the market of organic fruits for exports has functioned as a niche market, creating a value-added market in Sri Lanka since the 1980s. Organic agri-business has two types: plantation companies and companies that organise small farmer groups. Plantation companies, based in Colombo or plantation areas, export tea and spices while the other companies organise small-scale farmers to export tropical fruits to EU countries. For instance, in Anuradhapura, Tropical Health Food (Pvt) Ltd. and Lanka Organics (Pvt) Ltd. organise small-scale farmers to gain a group organic certificate (Development of Organic Farming and Its Mechanism in Sri Lanka, Komodo Daichi, 2006). In Vavuniya district, a company called PODIE Spices organises small farmers and assists them to gain a group certification of organic products.

(5) Summary of Market Situation

Based on the above market situation of each commodity, the key facts and possible solutions of crop markets and the possible solutions are summarized as shown in the following table.

Table 3.9-3 Key Facts and Possible Solutions in Paddy/Rice Marketing

Key Facts	Possible Solutions
Paddy/Rice ・High self-sufficiency rate (>80%) ・Intensive market intervention by the government ・Lower farm-gate price during harvesting seasons ・Lack of quality control ・High demand of traditional varieties	・Encourage off-season sale to overcome lower prices during harvesting seasons ・Introduce high-value varieties for high-end consumers
Other Field Crops ・Lack of domestic production ・Monopolised supply of grain legumes ・Increase in contract farming of feed crops and necessity in a proper regulation	・For grain legumes, establish linkage of farmers and major buyers like food trading companies ・For condiments and oil seed, increase production and provide post-harvest training for farmers ・For feed crops, make a linkage of farmers and buyers for contract farming with contracts/agreements
Other Field Crops ・Clear price seasonality ・Low awareness of quality ・Potential in value added markets	・Encourage off-season production and sale ・Linkage of farmers and buyers (supermarkets) ・Partnership between hotel industries and producers to create a high-valued chain
Fruits ・Clear price seasonality ・Promotion of fruits consumption by the government ・Potential in value added markets (supermarket, export, organic, and hotels)	・Encourage production in order to fulfil future demand increase ・Make a linkage of farmers and buyers, in particular organic products for export ・Partnership between hotel industries and producers to create a high-valued chain

Source: Study Team modified from CSDPP Final Report

3.9.2 Demand and Supply of Paddy at Regional and Local Level

Based on the production and population data in the CSDPP Report, demand and supply of paddy are estimated for supply and demand at the local and regional level, as shown in the table below.

Table 3.9-4 Demand and Supply of Paddy at Regional and Local Level

Supply Side	Demand Side
Paddy Production and Supply ▪ Paddy production in the project area is estimated at 167,700 tons in 2014/15, consisting of 98,300 tons in 2014/15 Maha and 43,000 tons in 2015 Yala from the command area, and 26,400 tons in 2015 Yala from the rainfed area. ▪ Total annual supply of paddy from the project area (128 cascades) is estimated at 167,700 tons (with husk). Marketable surplus from farm households ▪ Marketable surplus after consuming the local demands by farm households is estimated at about 147,400 tons (88% of production), and this volume is marketed in the regional and national markets. Marketable surplus to be sold in the national level ▪ Out of the above marketable surplus, 61,200 tons (36%) is consumed by the regional demand, and the remaining 86,200 tons of paddy (52%) is marketed at the national level. Condition of estimation ▪ It is noted that paddy/rice from other production area as well as imported rice are sold and consumed at the regional level, however this volume is considered small to be neglected.	Local demand (128 target cascades) ▪ It is estimated at 31,400 farm households in the command area, based on the average holding size of 1.0 ha per households. ▪ Population of farm households in the 128 cascades is estimated at about 116,200 applying the average family size of 3.7 persons. ▪ Annual per capita consumption of 112 kg milled rice on average for 2012 to 2016, according to the Food Balance Sheet 2013-2017. Assuming at 65% of paddy milling rate, 112 kg of milled rice is equivalent to 172 kg of paddy (with husk). ▪ Local demand for home consumption(1) in farm families is estimated at 20,000 tons of paddy, equivalent to 12% of production. In addition, about 100 kg/ha may be used for seeds for the next season and other use. Accordingly, local demand can be 20,300 tons in the form of paddy. Regional demand (project area) ▪ Population in the project area (eight DN divisions in Anuradhapura and four divisions in Vavuniya) is estimated at 472,000 on average during the period from 2012 to 2016. ▪ Population except farm families in the cascades are 355,800 (= 472,000 – 116,200). ▪ Therefore, regional demand of rice in project area is estimated at about 61,200 tons of paddy, based on the per capita consumption.

Note: Per capita consumption is quoted from the Food Balance Sheet 2013-2017, Department of Census and Statistics, July 2019.
Note: (1) As for paddy for home consumption, refer to Appendix 3.9-3.
Source: Study Team estimated based CSDPP Final Report.

Out of a total of 167,700 tons of paddy harvested in the project area, farm families consumed 20,300 tons or 12% of the total production, and 61,200 tons or 36% is regionally marketed and consumed. The remaining 86,200 tons or 52% is marketed at the national level.

Regarding the past situation of demand and supply for paddy, limited information is available for the project area, and therefore information at the district level is quoted from the Department of Census and Statistics, as shown below table.

Table 3.9-5 Past Demand and Supply of Paddy at Anuradhapura and Vavuniya Districts during the period from 2010 to 2015

Item	Anuradhapura District	Vavuniya District	National Total
Paddy production	606,900 tons (15%)	61,200 tons (1.5%)	4,125,000 tons
Demand for consumption	140,600 tons	28,500 tons	3,373,200 tons (82%)
Marketable surplus	466,300 tons (62%)	32,700 tons (4.3%)	751,800 tons (18%)

Source: Study Team, estimated based on the information from Department of Census and Statistics.

As shown in the above table, during the past period of 6 years from 2010 to 2015, the two districts produced on average 668,100 tons (606.900 tons + 61,200 tons) of paddy equivalent 16.5% of the national total, and supply about 499,000 tons (466,300 tons +32.700 tons) corresponding 66% of the national marketable surplus. This indicates that the districts, particularly Anuradhapura is the national paddy/rice supply centre.

On the other hand, paddy production in Vavuniya has been fluctuating frequently, and low production less than the local demand has resulted into the negative surplus (short of production against the local demand) in two years of 2010 and 2014.

It is envisaged that the project will bring the effect to stabilize the crop production through rehabilitation and improvement of the irrigation and related facilities along with technical support to farmers and FOs. As the result, the future production under the project is expected as shown in the table below.

Table 3.9-6 Future Crop Production under the Project

Item		Cropped Area(1)	Unit Yield(2)	Production(1)
Maha Season	Irrigated paddy	12,700 ha (45%)	5.6 ton/ha	71,000 tons
	Irrigated OFCs(3)	3,400 ha (12%)	-	38,000 tons
	Rainfed paddy	12,100 ha (43%)	3.2 ton/ha	38,800 tons
	Sub total	28,200 ha (100%)		147,800 tons
Yala Season	Irrigated OFCs(3)	3,100 ha (11%)	-	39,100 tons
	Inadequately irrigated paddy	3,900 ha (14%)	2.9 ton/ha	11,400 tons
	Sub total	7,000 ha (25%)		50,500 tons
Grand total		35,200 ha (125%)		
	Irrigated paddy	12,700 ha (45%)		71,000 tons
	Rainfed/inadequately irrigated paddy	16,000 ha (57%)		50,200 tons
	Paddy total	25,700 ha (10%)		121,200 tons
	OFCs	6,500 ha (23%)		77,100 tons

Note: (1) Cropped area and production of each crop are rounded figures area shown in the above table.
(2) Unit yields of OFC are varied by crops: grain legumes 1.75 ton/ha, condiments 10 to 11.5 tons/ha and vegetables 22 to 23 tons.
(3) OFC is represented by such crops as grain legumes (green gram, black gram), condiments (chili and big onion), and lowland vegetables (eggplant) for estimation of production and net income.
Source: Study Team.

Due to the crop diversification in the command area to be initiated under the project, total paddy production may slightly decrease from the present production to about 121,000 tons, and about 100,000 tons of paddy will be marketed after self-consumption of paddy by farm households, then, this will bring the stable income from paddy to farm households to accelerate crop diversification.

Regarding OFCs, production from the command area will be expected through improvement of facilities as well as the various support and effort. Since OFCs may change in future depending on the market situation, such crops as legumes, condiments and vegetables are assumed to be produced based on the present condition. Taking into account the self-consumption of OFCs to be conservatively estimated at 20,000 tons at the same level of paddy consumption, approximately 57,000 tons of OFCs will be sold to earn additional income for farm households.

3.10 Study on Adoptability of Agriculture Monitoring Systems

3.10.1 Main Fields for Adoptability of Agriculture Monitoring Systems

In the recent years, agriculture monitoring systems have been developed by various organisations and private companies to obtain the accurate data related to crop production. DOA also has developed the system “Crop Look Field” for prediction of crop yield, early warnings to counteract impending crop failures and decision making of policies based on data that AIs collect on sites. However, it currently has some issues on operation, quality and data dissemination currently.

In 2018, Vision Tec. In. (VIT), a Japanese private company researching and developing Information and Communications Technology (ICT) for agriculture, conducted the Feasibility Survey on the Establishment of a Paddy Field Information Management System for improving agriculture productivity and enhancing food safety in Sri Lanka under CSDPP. As the result, VIT proposed its monitoring system, Agrilook, which can be useful for the following four fields.

i) To evaluate planting/ harvesting areas and crop yield properly and immediately
ii) To advise dosing of fertiliser and agro-chemical for increasing yield
iii) To support for the private sector to conduct farming guidance and research activity
iv) To develop efficient agriculture insurance system

In the Survey, existing and available agriculture monitoring systems in Sri Lanka including Crop Look Field and Agrilook, will be clarified on purpose, operation and issues. It will then be evaluated from the point of feasibility of introduction to the Project based on the above four fields and the current situation of existing systems.

3.10.2 Current Situation of Existing Systems

(1) Collection of Information of Existing Systems

The current situation and possibility of operation from the view of the four fields are shown in the following table.

Table 3.10-1 Agriculture Monitoring Systems with Four Fields

Systems	Organisation	Fields for introduction of systems				Situation of Systems
		1)	2)	3)	4)	
1. Systems in Sri Lanka						
Crop Look Field	DOA	○	-	-	-	It is difficult to get the accuracy of data collection and input by AI, and to get high-quality satellite image.
National Information System	NAICC	○	-	-	-	-System has currently collapsed. To review, correct, and upgrade the system is not a priority at the moment.
Project for Paddy Land Area Mapping Project	NRMC	○	-	-	-	-Not in operation due to the lack of budget for the cost of a satellite. -Alternative and upgraded system is under preparation, so development of this system is low priority now.
Project for Predicting Rice Yield Using High-Resolution Satellite Data	NRMC	○	-	-	-	- Not in operation. Detail is unknown.
Project for characterizing Agro-Eco-Environment for Mapping Frequent Floods and Improving Productivity of Arid Land Agriculture	NRMC	-	-	-	-	- Not in operation. Detail is unknown. - NRMC came to consider the development of the system except flood component. Flood mapping will come out under the purview of the Irrigation Department.
Project for monitoring and early warning utilizing satellite technology	NRMC	-	-	-	-	- Not in operation due to the lack of budget for the cost of a satellite. - Detail is unknown.
2. System in other country						
Agrilook	VIT	○	○	○	○	-It is difficult to require an accurate image and timely data. -Japanese only -It is necessary to adjust the system to the condition of Sri Lanka. It will take time to get various kinds of real time data.

Note: Fields for introduction of systems are 1) To evaluate planting/ harvesting areas and crop yield properly and immediately, 2) To advise dosing of fertilizer and/or chemical for increasing yield, 3) To support for private sector to conduct farming guidance and research activity, 4) To develop efficient agriculture insurance system

Source: Study Team

As for systems in Sri Lanka, only Crop Look Field is in operation related to the field 1): evaluation of planting/ harvesting areas and crop yield. However, it has difficulties on accuracy of data collection/ input and budget allocation for satellite cost. Other systems have not been operated mainly because of the high cost of satellite image.

(2) Discussion with IWMI

The discussion was held with the International Water Management Institute (IWMI) regarding the adoptability of agriculture monitoring systems on 26th August 2020. IWMI pointed out a demand in developing agriculture monitoring systems using remote sensing technologies with the following opinions.

i) If real time and accurate data can be obtained with sufficient equipment, remote sensing technologies can qualify current crop area and predict crop yield.
ii) It is possible to make a linkage between crop condition (less growth, pest attack, disease) and the recommended dosage of fertilisers and agrochemicals through the verification of crop growth by remote sensing technologies.
iii) Verified data of recommended dosage of fertilisers and agrochemicals can be shared to the private sector, which can in turn research for those kinds of products and provide farmers with additional farming guidance.
iv) It is possible to make a linkage between production data analysed by systems and crop insurance in order to make the insurance service more effective. In addition, it is important to make the farmers realize the importance of crop insurance.

3.10.3 Measures to be Taken for Adoptability of Agriculture Monitoring Systems

Based on the information of agriculture monitoring systems collected from the related organisations, measures to be taken for adoptability of the systems are shown as follows.

Table 3.10-2 Measures to be Taken for the Adoptability of Agriculture Monitoring Systems

Fields for Adoptability of Agriculture Monitoring Systems	Measures to be Taken
0) General points for operation	• To consider how to collect real time and accurate data of crop, soil, climate, cultivation management like fertilisers and agro-chemicals, etc. with proper equipment. • To develop the suitable system with adjustment of actual condition in Sri Lanka with real time and accurate data. • To allocate sufficient budget to procure required equipment for collecting data and to develop the system that can process the huge data. • To implement capacity development of officers who collect various data and make analysis through the system.
1) To evaluate planting/ harvesting areas and crop yield properly and immediately	• To clarify required data for analysis of planting area and yield. • To consider how to collect required data effectively and accurately based on human resource (for example, use of equipment) • To prepare detailed planning of monitoring, evaluation and dissemination.
2) To advise dosing of fertilizer and agro-chemical for increasing yield	• To verify proper dosing of fertiliser and agro-chemicals for sufficient yield through a model farm. • To set up the system with the verified and recommended dosing data.
3) To support the private sector to conduct farming guidance and research activity	• To provide the private sector with the verified data on proper cultivation management. • To discuss and collaborate for farming guidance and research activity between government organisations and private sector.
4) To develop efficient agriculture insurance system	• To clarify the required data for judgement to apply crop insurance in discussion with related organisations. • To develop the procedure for the application of crop insurance with analysed data and the farmer's opinion.

Source: Study Team

Currently, MOA is under consideration regarding the development and extension of new monitoring systems to be merged with other existing systems in the future. Enhancement of agriculture monitoring system is a strong demand of MOA although there are many measures to be taken for its achievement.

3.11 Livestock, Fisheries, Fruit Tree Plantation

3.11.1 Livestock

(1) Review of Farm Household Survey Data

According to the farm household survey conducted by CSDPP, about 139 farm households (12% of a total 1,168 farm households) in the six model cascades are engaged in livestock rearing, either cattle or poultry or both. The main feature of livestock farm households is shown in the following table.

Table 3.11-1 Features of Livestock Farm Households in the Model Cascades

Livestock	Cattle only	Cattle and Poultry	Poultry Only	Total of Cattle and/or Poultry
No. of livestock households	90 (65%)	36 (26%)	13 (9%)	139 (100%)
With crop income	90	36	13	139
With livestock income	50	26	3	79
No livestock income	40	10	10	60

Source: Study Team based on the farm household survey data conducted under CSDPP.

The above table gives the following indications regarding livestock farm households.

- All the livestock households obtain income from crop production, and no farm household depends on only livestock income.
- The present poultry activities are considered mainly for home consumption with small income generation, although it is not so popular activity in the project area.
- Regarding cattle rearing, 126 farm households are engaged and 76 households (60%) of cattle households obtain income from the selling milk. On the other hand, 50 households (40%) have no income from dairy and this means that their livestock products are for home consumption only.

(2) Present Situation Confirmed in the FO Meetings

In CSPDD, the situation of livestock was mainly surveyed through the farm household survey carried out in the model six cascades. In this study, the present situation of livestock activities including poultry is discussed with FO at the model cascades. Based on the result of FO meetings (refer to Appendix 3.11-1, Appendix 3.11-2), the present situation is described below:

Table 3.11-2 Present Situation of Livestock discussed in FO Meetings

Item	Present Situation
Cattle	・ The number of farmers keeping cattle varies by FO ranging from 10% to 80%. Livestock income is generated from sales of milk and culled animals. Milk is also consumed at farm household for home nutrition. ・ Cattle rearing is predominantly traditional form with indigenous cattle. ・ Farmers are willing to upgrade or start dairy farming under the technical and financial support to purchase stock. ・ In some FO meeting, the women member expressed their interest in rearing cattle.
Cattle feeding	・ Free grazing and tethered grazing are commonly practiced, and stall feeding is limited. Farmers understand that cow dung placed in the field is important as a farm manure. ・ Cut and feed system is practice in the limited area.
Silage making	・ No silage making is commonly practiced due to lack of technical knowledge and insufficient materials (green crop residue).
Record keeping	・ No regular record keeping is practices except for farm registration, milk sales vouchers and artificial insemination receipts.
Poultry	・ Number of farmers engaged in poultry varies ranging from 10% to 90% depending on the location. ・ Free range chicken is practiced with small flock size with less than 10 birds in the home garden. Small size of home garden is limiting the flock size.
Poultry feeding	・ Scavenging is the common feeding with kitchen refuse and grain waste. Processed feeds are not available and not used.
Replacement stock	・ Only indigenous birds are raised, and improved stock is not available.

Source: Study Team.

3.11.2 Inland Fishery

The target tanks in the cascade systems are categorised into seasonal tanks, and some of the tanks are utilised for the "culture-based fish farming". Other tanks may not be able to introduce the fishery since short water retain period and shallow water depth do not allow to conduct fish farming. After rehabilitation of tanks under the project, some tanks may become available for fish farming because the water retain period may extend and water depth may increase.

According to the FO meeting conducted in the six model cascades, the present situation of inland fishery is compiled in the table below s (refer to Appendix 3.11-3 as well).

Table 3.11-3 Present Situation of Inland Fishery discussed in FO Meetings

Cascade	FO	Fishery Activities
Kiulekada	Gonahathdenawa	・ No present fish farming activities. ・ Several years ago, the Gonahathdenawa tank was stocked with 30,000 fingerlings. It was not successful because of the existing predatory local fish species.
	Govi Udana	・ No present fish farming activities. ・ Tanks are required to be desilted and thereby increase the water holding period for successful fish culture.
	Parakum	・ No culture-based fish farming is practiced. ・ Sometime ago, the Puliyankulam tank had been stocked with 25,000 fingerlings, however, by the expected time of maturity, no fish were found. ・ Farmers believe that the stocked fish were smaller than the standard size of fingerlings and were totally devoured by the indigenous local fish population that existed in the tank.

Cascade	FO	Fishery Activities
Alagalla	Priyakomasan Kulam	・ All the tanks were stocked with fingerlings in the month of January and is ready for harvesting in July 2020. ・ DAD and the National Aquaculture Development Authority (NAQDA) coordinated the program of stocking the fingerlings. ・ The FO is responsible for managing the fish farming activities. ・ The tank is leased out to a contractor by the FO for harvesting. ・ FO members retain the right to catch fish from the tanks using fishing rods for their home consumption.
	Ekamuthu Theeruwegama	・ At present no commercial inland fishing activity. ・ Last year, the tank was stocked with 15,000 fingerlings. ・ Fish harvesting had to be completed before the correct harvesting time because the tank went dry. The catch, though not fully mature was sold out at Rs. 50,000.
	Alagalla	・ FO earns an income from selling the local fish naturally found in the tank. ・ Local fish come down the streams flowing into the tank. ・ It is doubtful if fingerlings could be introduced as the local fish are of predatory species.
Ichchankulama	Ambagahawewa	・ At present no fishing activity. ・ Several years ago, the Pahala Puliyankulama tank has been stocked with 25,000 fingerlings. The population has been drastically reduced due to predatory local fish found in the tank. Few people engage in fishing of the local indigenous fish and the introduced Tilapia fish.
	Pahala Kainaththama	・ At present no commercial inland fishing activity in the area. ・ Several years ago, 100,000 fingerlings were released to the tank. The stocked population rapidly declined due to predation by indigenous fish in the tank. Few individuals are engaged in catching the local fish and Thilapia that comes down from the upper tanks and streams.
	Karakolawewa	・ At present no inland fishery activity in the tank. ・ It is possible to introduce fingerlings to the Karakolawewa tank if water is available.
Naveli kulam	Arasan Kulam	・ At present no inland fishery activity in the tank.
	Mahilan Kulam	・ At present no commercial inland fishing activity in the area. ・ Farmers are willing to engage in fish farming if water is available to sustain the population.
	Valisinna Kulam	・ At present inland fish farming is not an economic activity. ・ If water is available in the tanks, farmers are willing to engage in fish culture.
Rathmalawewa	Isuru Minimuthu	・ No stocking of fingerlings has been undertaken. ・ About 10 farmers in the village are engaged in fishing of local fish in the tank. ・ Farmers observed that culture-based fish farming in the tank would be difficult as it is heavily infested with aquatic weeds and presence of local predatory fish.
	Dutugemunu	・ Local breeds of fish are found in Mahawewa tank. ・ Two years ago, the FO leased out the tank to an outside party for harvesting at Rs. 250,000. ・ Culture fish can be introduced to the Kudawewa, Ataweerawewa and the Olugaskada kudawewa if adequate water could be made available in the tanks.
	Weliwawa	・ No fresh water fish farming is practiced at present. ・ Farmers wish to engage in fish farming with the available water in the tank.

Cascade	FO	Fishery Activities
Siyambalagas-wewa	Dilena Tharu	・ At present no fishery activity. ・ The water in the tanks is retained for periods of less than 4 months. The tank goes dry by the time the Maha crop is harvested. No dead storage due to built-up of sedimentation of dead water weeds and sand in the tank and down flow from the upper tanks requires de-silting.
	Parakum	・ At present no commercial inland fishing activity in the area. ・ Fish farming can be introduced to Kehendewa Mahawewa. However, the tank needs to be cleaned of aquatic weeds. ・ Farmers are willing to manage the tank with stocked fingerlings.
	Shakthi	・ At present no commercial fishery activity. ・ The tanks need de-silting to improve the dead storage in order to retain water at least over a part of the Yala season.

Source: Study Team

3.12 Pipeline Canal System

3.12.1 Background and Objective

Water saving and better utilisation of limited water resources is a crucial issue, as the target area is located in a dry zone and draught risk is increasing under the changing climate. Therefore, the importance of sufficient introduction of the pipeline system from the conventional open earth channel system has been increasing.

It was confirmed that a few cases of pipeline systems were introduced in Vavuniya and relevant governmental agencies have intentions to introduce more cases.

Source: Study Team

Figure 3.12-1 Pipeline at Naveli kulam Cascade

The project will formulate a standardised model pipeline system, which can be applied to other schemes as prototype model. In addition, the necessary cost and candidate model cascades and tanks will be studied here.

The pipeline system was also tested at Naveli Kulam Cascade under a previous JICA project as a pipe-lined link canal. It was confirmed that the system can be constructed with locally available materials and can be operated and maintained by FO.

The following table, which was originally prepared by DAD Vavuniya Office, shows the characteristic of a pipeline system in comparison with a conventional open earth channel system. It can be said that the pipeline system has many merits like an efficient system operation, time savings, better adaptation to OFC, prevention of illegal water use, and many more besides water savings

Table 3.12-1 Pipelining and Open Earth Channel Benefit Comparison

SN	Activities	PVC Pipe Lining	Open Earth Channel	Remarks for Pipe
1	Evaporation	Nil	10%	Advantage
2	Infiltration	Nil	5%	Advantage
3	Seepages	Nil	2%	Advantage
4	Transport time	Quick	Very slow	Advantage
5	Wastage of water	Nil	8%	Advantage
6	Rotational issue at farm gate	Good	Fair	Advantage
7	Damaging by flood	Nil	high	Advantage
8	Damaging by wild animal	Nil	high	Advantage
9	Drainage crossing	Not necessary	Necessary	Advantage
10	Spill channel crossing	Not necessary	Necessary	Advantage
11	Farm vehicle crossing	Not necessary	Necessary	Advantage
12	Concrete canal lining	Not necessary	Necessary	Advantage
13	Cost of maintenance	Very low cost	Once in five years high	Advantage
14	Able to irrigate high land through low level	Easy way	Not possible	Advantage
15	Other field crop cultivation	Good	Poor	Advantage
16	Water issuing time period	7 to 8 day	3 to 5 days	psychological feeling
17	Illegally water taking without order	Not possible	Possible	Advantage
18	Water issuing to unauthorized paddy field	Not possible	Possible	Advantage
19	Farmers opinion	Appreciating	Fair	Advantage
20	Construction cost	Low	High (concrete lining)	Advantage
21	Sustainability	Live long	5 to 10 years	Advantage

Source: DAD Vavuniya office

3.12.2 PVC-Pipeline Tank in Vavuniya

Study Team inspected the following tank on 5 March 2020.

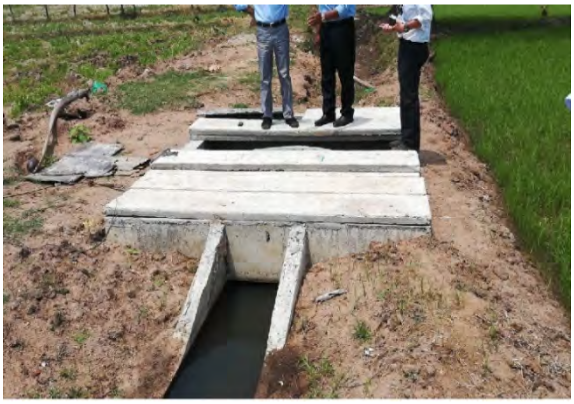
Table 3.12-2 Outline of PVC-Pipeline Tank

Location	Vavuniya district, Coordinates (439058.61m E, 968438.25 m N)
Cascade ID	117
Tank name	Sampalthooddamkulam
Irrigable area	Approximately 30ha
Facility	PVC-Pipeline, D 100 – 15 mm, screening facility, farm turnout

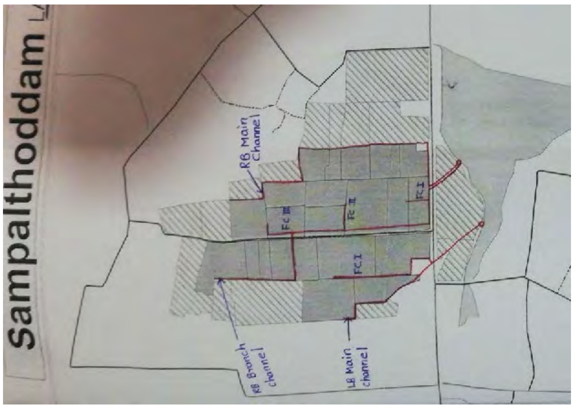
Source: Study Team

PVC Pipeline and Division Valve

Farm Turnout



Screening Facility



Pipeline Layout Plan

Source: Study Team

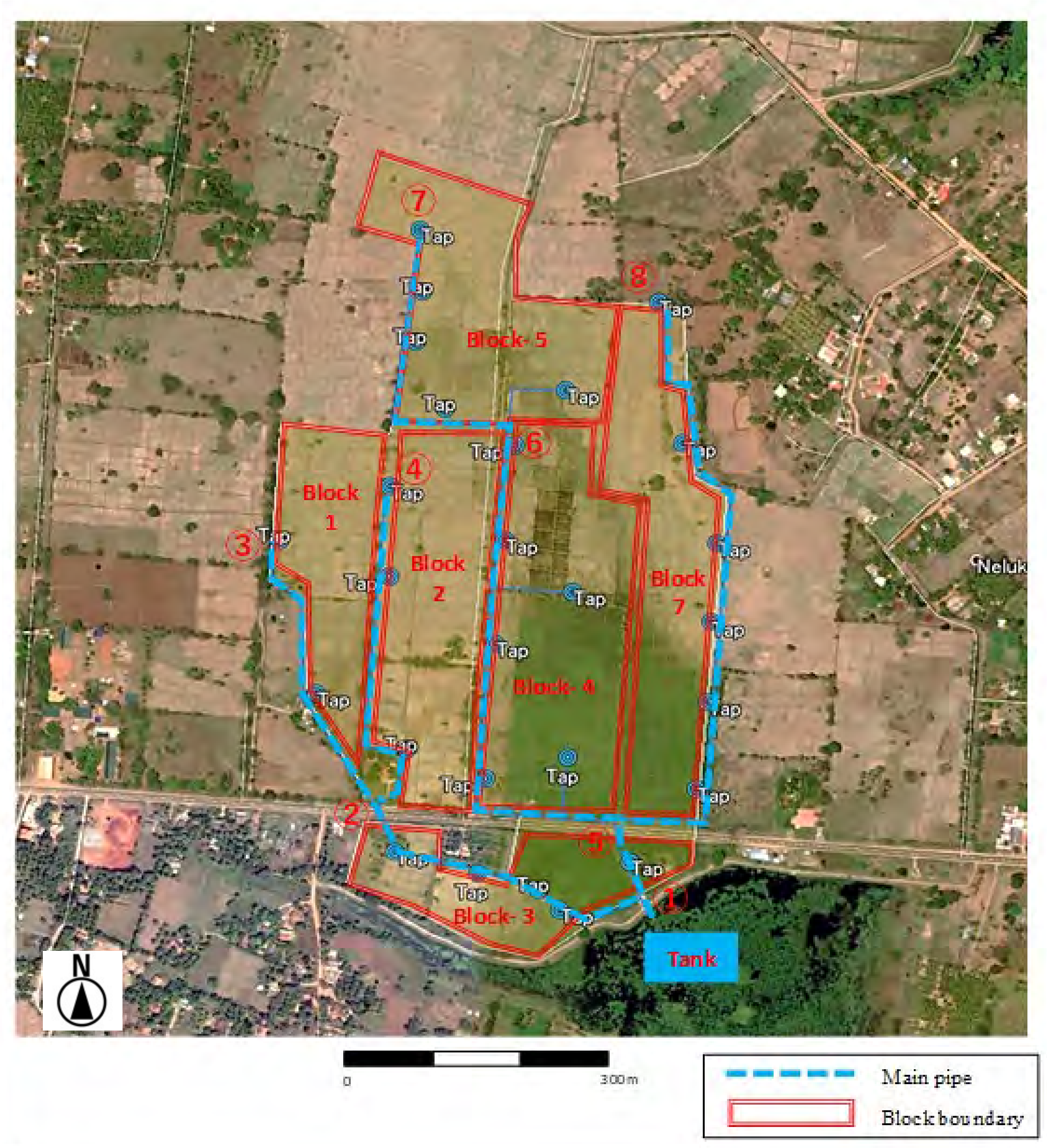
Figure 3.12-2 Survey on Sampalthooddamkulam Tank

3.12.3 Study on the Standardised Pipeline Model

(1) Model Pipeline Layout Plan

A study for the standardised pipeline model was conducted on the basis of existing pipeline system of Sampalthooddamkulam schemes. The following are items to consider.

i) Alignment plan of main pipe and Irrigable area plan follows the existing pipeline system.
ii) One intake facility is to be installed to distribute water all over the area.
iii) One farm turn-out is to be installed in each plot.

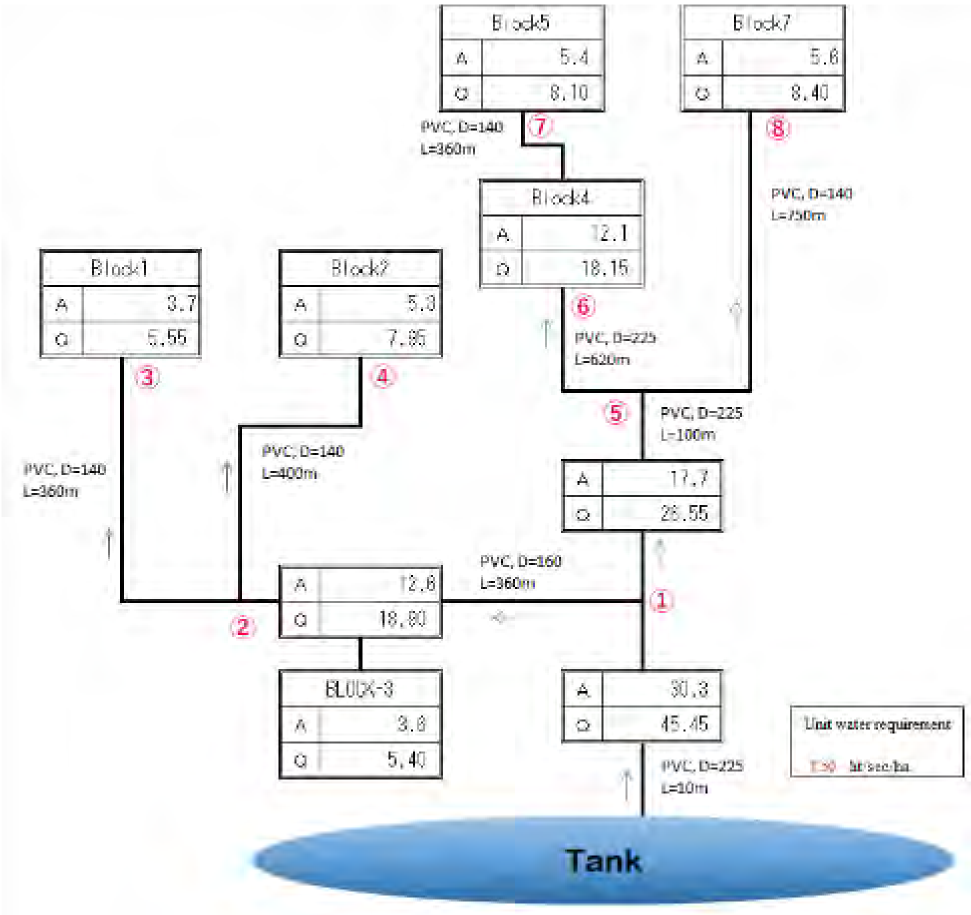


Source: Study Team

Figure 3.12-3 Model Pipeline Scheme Layout Plan

(2) Pipeline System and Water Distribution Plan

The following figure shows the pipeline system and water distribution plan of the pipeline model schemes. The unit water requirement (1.5 L/sec ha) was set, considering the maximum water requirement of the cascade and the example of the Sampalthooddamkulam design.



Source: Study Team

Figure 3.12-4 Pipeline System and Water Distribution Plan

(3) Pipeline Hydraulic Study

The size of PVC-pipeline was set based on the hydraulic calculation result. From the study result, it can be said that at least a 2-m water head, which is equivalent to an elevation gap of 2 m between WSA and the irrigable area, is necessary for a smooth operation of the pipeline system.

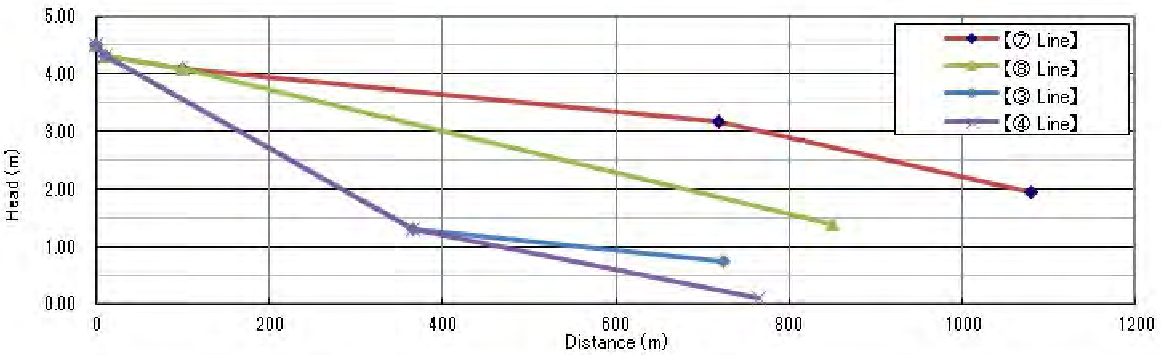
The study condition is as follows:

i) Pipe: PVC
ii) Hydraulic calculation: Hazenulic calculations
iii) Roughness coefficient: 140
iv) Maximum velocity: 2.000 m/**s**
v) Minimum velocity: 0.300 m/**s**
vi) Available head: tank minimum depth 0.5 m + average available head from elevation gap 4.0 m = 4.5 m

Table 3.12-3 Pipeline System Hydraulic Calculation

Line	Length (m)	Water Requirement (m^3/S)	Pipe Diameter (mm)	Internal Diameter (mm)	Average Velocity (m/s)	Hydraulic Gradient (‰)	Head Losses (m)			Dynamic Water Pressure (m)
							Friction	Others	Subtotal	
⑦ Line										4.50
Start to ①	10.00	0.045	225	210	1.31	7.500	0.075	0.007	0.082	4.33
① to ⑤	100.00	0.027	225	210	0.77	2.774	0.277	0.028	0.305	4.08
⑤ to ⑥	620.00	0.018	225	210	0.52	1.373	0.851	0.085	0.936	3.16
⑥to ⑦	360.00	0.008	140	131	0.60	3.072	1.106	0.111	1.216	**1.94**
⑧ Line										4.50
Start	10.00	0.04545	225	210	1.31	7.500	0.075	0.007	0.082	4.33
① to ⑤	100.00	0.02655	225	210	0.77	2.774	0.277	0.028	0.305	4.08
⑤ to ⑧	750.00	0.0084	140	131	0.62	3.286	2.464	0.246	2.711	**1.38**
③ Line										4.50
Start point to ①	10.00	0.04545	225	210	1.31	7.500	0.075	0.007	0.082	4.33
① to ②	365.00	0.0189	160	150	1.07	7.616	2.780	0.278	3.058	1.30
② to ③	360.00	0.00555	140	131	0.41	1.526	0.549	0.055	0.604	**0.75**
④ Line										4.50
Start point to ①	10.00	0.04545	225	210	1.31	7.500	0.075	0.007	0.082	4.33
① to ②	365.00	0.0189	160	150	1.07	7.616	2.780	0.278	3.058	1.30
② to ④	400.00	0.00795	140	131	0.59	2.968	1.128	0.113	1.240	**0.10**

Source: *Study Team*



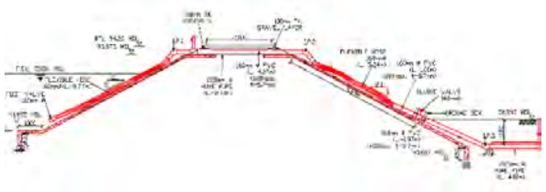
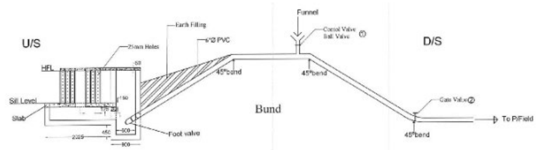
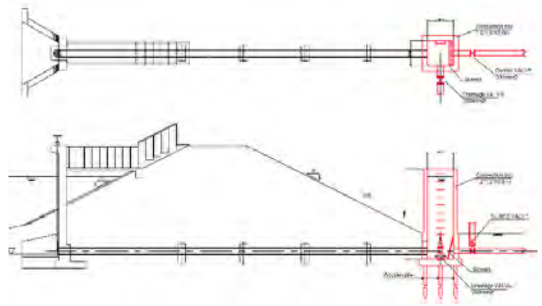
Source: *Study Team*

Figure 3.12-5 Pipelines Dynamic Water Pressure Profile

(4) Intake Facility from Tank

The two types of intake facility structures can be considered to utilise tank water pressure for pipeline systems, as it is shown in the next page. Both types of structures have merits and demerits, and there is no significant difference in the construction cost. Therefore, the selection of intake facility type should be conducted at the time of the detailed design stage, in coordination with relevant organisations.

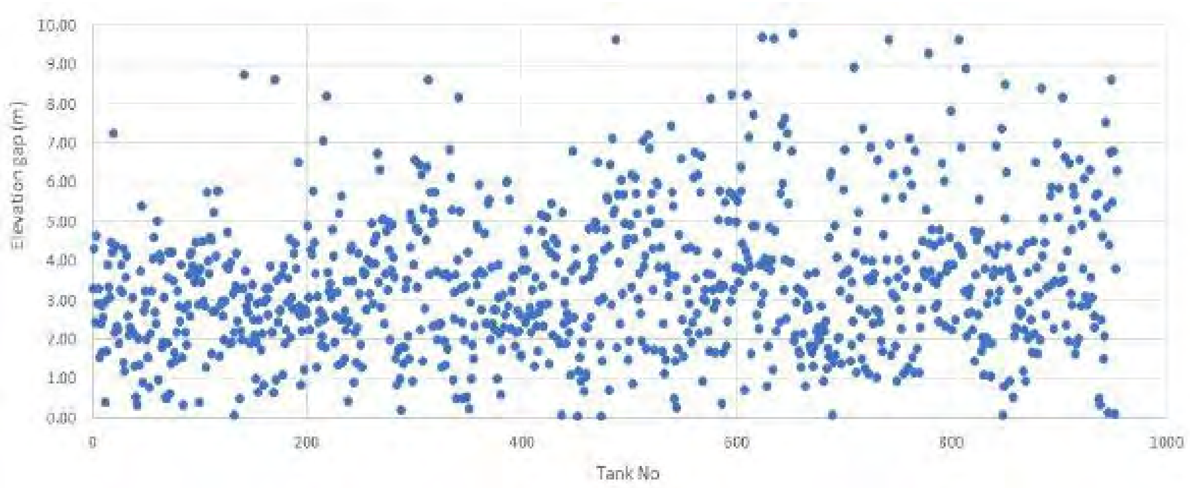
Table 3.12-4 Comparison of Intake Facility Types

Plan	Siphon Type-1（Model case of CSDPP ）	Siphon Type-2 (Vavuniya case)	Connection Box type
Drawing			
Outline	･To start the Intake of Siphon system, Water filling procedure is necessary with valves and a portable pump. ･The syphon system was installed at the model site and it was confirmed that farmers can understand and operate the system.	･Siphon type itself is the same as on the left ･Screening facility is installed to prevent sand and debris from entering into the pipe. ･This idea was tested in Vavuniya.	･Existing Sluice outlet is changed into pipeline connection box. The height of connection box should be higher than FWL. ･Screen is installed in box to prevent sand and debris from entering into the pipe. Valves of box are used in flushing and clearing.
Merit	･Pipeline Intake facility can be installed separately from Sluice without big excavation of tank bund. ･Pressure from tank water level can be utilized to pipeline system.	･The same as on the left	･Water flow control with valve on-off is easy to operate. ･Water for open channel can be divided from connection box, if necessary.
Demerit	･Water filling procedure is necessary to start system ･Screening facility is necessary additionally. ･Water flow control is not easy	･Water filling procedure is necessary to start system ･Water flow control is not easy ･Needs measures for soft ground like piles and soil solidification	･Needs measures for soft ground like piles and soil solidification
Cost	No significant difference for construction cost among types		

Source: Study Team

(5) Elevation Gap between the Water Spread Area and Irrigation Area

As it is mentioned before, the pipeline canal system needs a minimum water head of 2 m to distribute irrigation water all over the scheme area. That means the elevation gap between the tank and irrigable area should be larger than 2 meters. The elevation gap between the tank and irrigable area for 955 tanks in target area was analysed with DEM data and GIS as shown in the following figure. The top 50 tank list by elevation gap for pipeline canal is shown in Attachment 3.12-1.



Source: Study Team

Figure 3.12-6 Elevation gaps between Target Tanks and Irrigable area

The following are findings from the elevation gaps between the target tank and the irrigable.

i) Average elevation gap is 3.57 meters.
ii) Elevation gaps of 78% tanks are larger than 2 meters.
iii) Location of the Tanks which elevation gap is less than 2 meters are scattered around project area. These can be found in most of cascades.
iv) Average elevation gap, which figure is larger than 2 meters, becomes 4.0 meters.

Consequently, 747 tanks out of 955 tanks have the elevation gap more than 2.0 meters. These tanks are candidates for pipeline canal system on condition that a) More than two-third of FO members agree in writing to promote crop diversification and b) FO agrees in writing to bear a full responsibility for operation and maintenance of pipeline canal system.

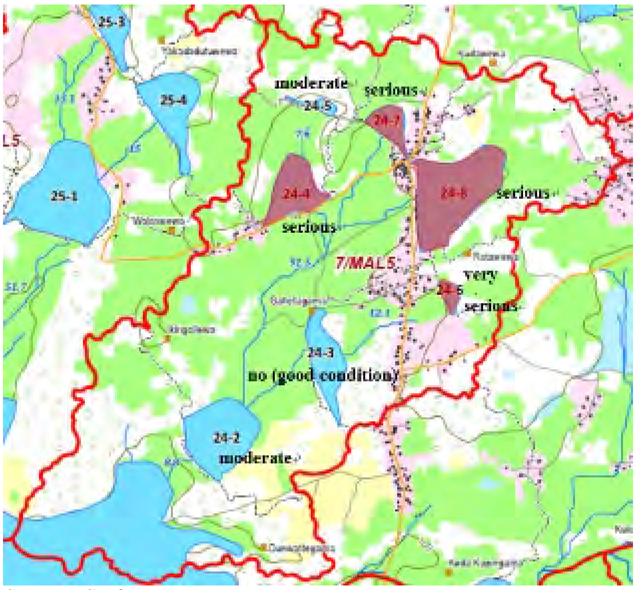
3.13 Partial Desilting Works

3.13.1 Background

Sedimentation in reservoirs is one of the most crucial problems for farmers who live in the dry zone of Sri Lanka. They have largely depended on tank water for their livelihoods for a long time. However, water bodies become shallower year by year as a consequence of sedimentation. According to the Tank Inventory Survey being carried out under CSDPP, it reveals that 19.8% (189 tanks out of 955 tanks) of surveyed tanks have serious sedimentation problems that has led to the reduction in crop production. The figure below shows the typical location of tanks having serious sedimentation problems. It is noted that 64.6% of the 189 tanks are located in the upstream area of the cascades.

Desilting is an effective countermeasure against over sedimentation. Although it is considered that the desilting work is costly, various benefits can be expected by that work. For instance, its benefits are the increase of water storage for irrigation, livestock, fishery, washing, and bathing in addition to groundwater recharge and environmental protection. Therefore, DOA of North Central Province in collaboration with PID and DAD has conducted a hydrological research study to generate low-cost and effective desilting process, which is named as partial desilting.

In this section, the partial desilting of tank beds will be examined as a countermeasure against the current sedimentation problems.



Source: Study Team

Figure 3.13-1 Typical Location of Tanks with Serious Sedimentation

After Removing the Blockage of Inlet by Sedimentation

Overview of the Tank Bed and Sluice

Source: Study Team

Figure 3.13-2 Typical Sedimentation Status of Tank Bed

3.13.2 Partial Desilting of Tank Bund

(1) Concept of Partial Desilting

Partial desilting increases the amount of water stored in the tank by the amount of soil desilted. At the same time, it has an impact on the reduction of evaporation loss and percolation loss by changing the tank bottom cross section affected by sedimentation. When the sedimentation progresses, water spread area is increased and the depth of tank becomes shallow. Consequently, more water decreases by evaporation and percolation. In this sense, the partial desilting reduces tank water losses by changing the tank bed geometry through desilting.

According to historical research of tank management reveals that the periodical desilting work had been implemented by local community members utilising the tank water before the British colonial era. As the result of inventory survey shows, the norm for collaborative desilting work by farmers has been lost, and only a few desilting projects have been implemented by donor agencies and government agencies in recent years. For the sustainable utilisation of the existing tanks for the local agricultural production for the future, it is indispensable to incorporate the desilting work of tanks into rehabilitation projects.

(2) Methodology of Desilting

(a) Procedure

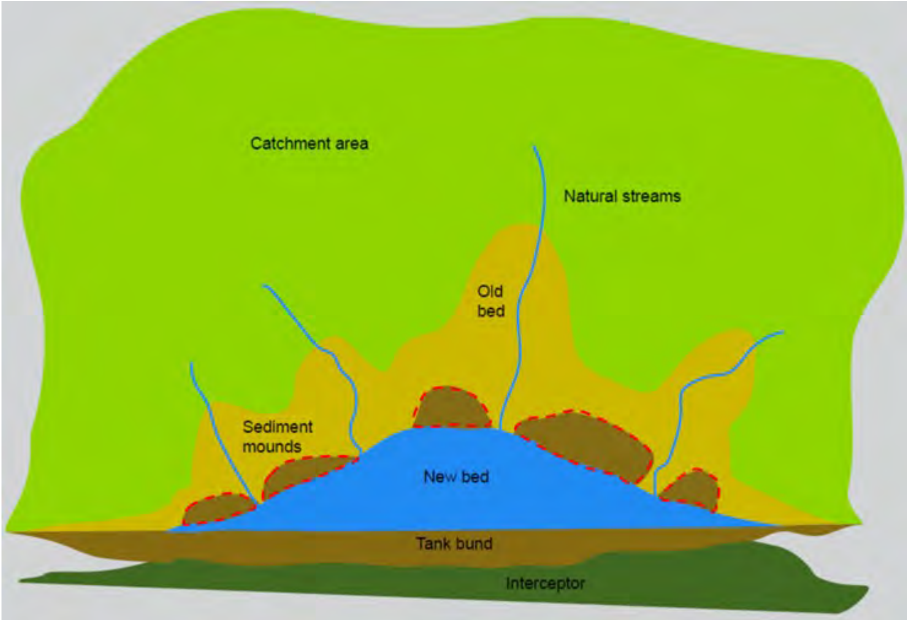
In Sri Lanka, the partial desilting works have been implemented by several projects and organisations such as CRIWMP, CSIAP, DOA, DAD, and PID. The desilting works carried out by the above projects and organisations contain similar work items and procedure based on the concept above.

The work conducts tank bed survey and prepares an Area-Capacity Curve. It also conducts geotechnical investigation to identify the thickness of sediment. Based on these investigation results, an estimate of the volume of sediments and the preparation of maps for demarcating the siltation layer thickness is done. The following are the typical contents of partial desilting works:

- i) Tank bed level survey,
- ii) Tank bed sediment survey,
- iii) Partial desilting design,
- iv) Implementation, and
- v) Impact assessment.

(b) ATreatment Method of Desilted Soil

According to the hydrological research by the DOA, the amount of sediment deposited in minor tanks is between 20 - 30%, and half of this sediment is found within one-third of the tank bed close to the bund. The same capacity can be maintained by removing sediment in this area and heaping it in the upstream tank bed. Using desilted soil, several sediment mounds (island mounds) are built above the FSL line of the tank. These sediment mounds are located without obstructing the natural water flow lines to the tank. Depending on the site conditions, desilted soil can be used to block water leakage at the downstream of the tank bund. The following figure shows the old tank bed area and new tank bed area, and the location of sediment mounds and natural water flows from the catchment area.



Source: IUCN Cascade Development Project Information Brief No.5

Figure 3.13-3 Reformed Tank Bed Area and Sediment Mound after the Partial Desilting

3.13.3 Procedure and Criteria for Selection of Tanks for Desilting Works

Although the partial desilting works have been proven effective, PID and DAD are sceptical to carry out the desilting works for all tanks because of the cost. The desilting works will be done only for selective tanks. There are several conditions given by other projects and organizations for selection of tanks for desilting works. Among others, the Study Team proposes to take two processes for selection of the tanks for the partial desilting works.

(1) Screening

The first process is screening of tanks in accordance with the criteria given in the following table.

Table 3.13-1 Criteria for Screening of Tanks

Screening Process	Criteria for Screening	Data Source
Total number of tanks	955 tanks	-
Step-1 — No → Out; Yes ↓	Is the current sedimentation status of the tank very serious/ serious?	Inventory Data No. 11-13
Step-2 — No → Out; Yes ↓	Does the tank have better inflow and spill? (Select tanks with peak inflow of 10 m^3/s or more)	Flood Analysis
Step-3 — No → Out; Yes ↓	Is the water spread area of the tank less than 35 acres?	Inventory Data No. 5-18
Step-4 — No → Out; Yes ↓	Is the current piping and leakage through the tank bund no/ moderate?	Inventory Data No. 11-13, 11-3
The number of selected tank for the scoring	89 tanks	-

Source: Study Team

(2) Scoring

The tanks selected by the screening process will be prioritised for the implantation of the partial desilting works with score given in the following table. The screened tanks and the scores of each tank are shown in Attachment 3.13-1.

Table 3.13-2 Criteria for Prioritisation of Tanks

Item	Score for Prioritisation			Data Source
	5	3	1	
Command Area (CA in ha)	CA > 20	10 < CA < 20	CA < 10	Inventory Survey No. 5-21
Number of Beneficiary Farmers (BF in number)	BF > 30	15 < BF < 30	BF < 15	Inventory Survey No. 5-23

Source: Study Team

3.14 Emergency Spillway Gate

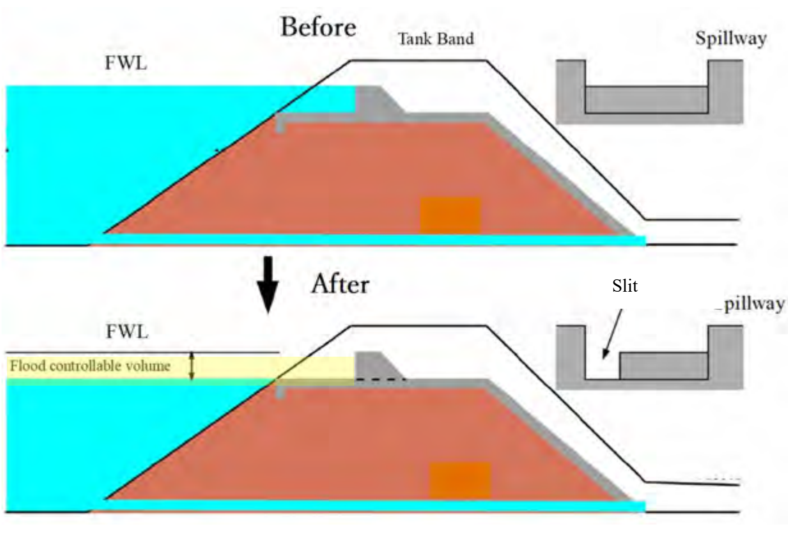
(1) Flood Pre-discharge Facility

With regard to flooding, the risk of large-scale floods, which is longer than the designated return period, could happen more frequently due to climate change.

However, it is not realistic from an economical point of view to spend much to construct a large-scale flood preventing facility for the large number of small tanks. Therefore, inexpensive measures and special techniques are needed, besides the conventional design of the spillway.

Flood pre-discharge system, namely; “spillway wall slit” and “pre-discharge gate”, is recommended to be used in the target area, considering effectiveness, cost, and the capacity of FO.

The system is to lower down the tank water level before floods reach the tank, so that the controllable flood volume of the tank is increased. This is shown in the image of the flood pre-discharge system shown below (a flood pre-discharge system should be combined with accurate weather forecasting).



Source: Study Team

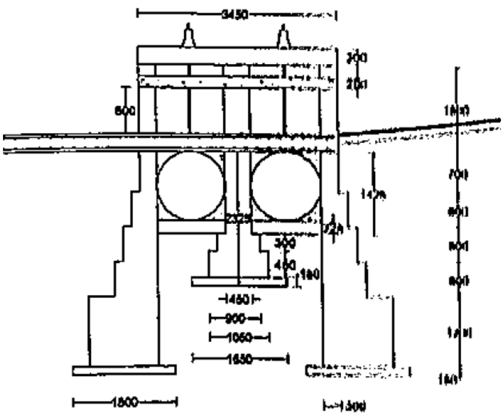
Figure 3.14-1 Image of Flood pre-discharge system

The existing "spillway wall slit" and "pre-discharge gate" system can be seen in the target area, although the number is still small and at the test trial stage (refer to the pictures below for the example of existing facilities).

According to information from PID, one trial "pre-discharge gate system" shown below was introduced in Anuradhapura for the first time, after an experience of heavy floods that caused severe damage to many tanks in 2014/2015. The FO operates the gate to lower down the water level up to 1.0 m before serious floods arrive.

Spillway Wall Slit

Pre-discharge Sluice Gate



Section Drawing of Pre-discharge Sluice Gate (Pipe Dia-1.0 m×2)

Source: Study Team

Figure 3.14-2 Spillway Wall Slit and Flood Pre-discharge Sluice Gate (Ihala Abathale Tank)

(2) Basic Policy for Flood Pre-discharge Facility

The following are the basic policies for flood pre-discharge facilities.

- i) "Spillway wall slit with stoplog" will be a standard mitigation measurement for a flood pre-discharge facility. A "pre-discharge sluice gate" as shown in the above figure is more suitable for a larger scale tank.
- ii) The construction cost of a "spillway wall slit with stoplog" will not be counted separately from the cost of the spillway construction work.
- iii) Soft component activity "improving capacity of FOs in tank level water management" includes relevant activities which will enhance the capacity and consensus building of flood pre-discharge facility operation.

(3) Considering Points at Detail Design Stage

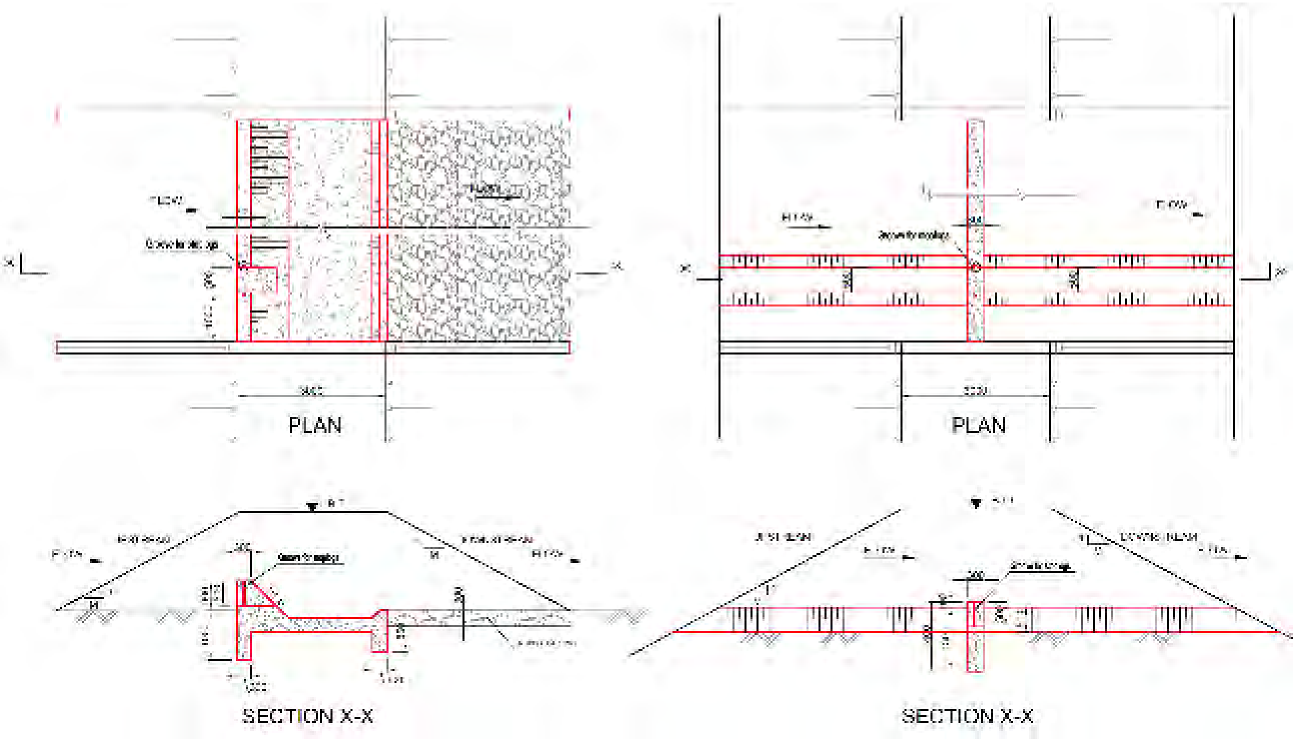
The following are points to be considered at the detailed design stage.

The merit of flood pre-discharge system is decreasing risk of flood damages. However, the demerit is decreasing the irrigation water storage. Therefore, it is important to consider the items below for the smooth operation of a flood pre-discharge system.

- i) To formulate the basic rules and responsibilities to operate and maintain a flood pre-discharge system, like regular clearing, appointing operators in charge, timing of operation, etc.
- ii) To achieve a consensus among beneficiary farmers regarding the conditions in operating the system.
- iii) To acquire an accurate weather forecasting system in cooperation with relevant government organisations.
- iv) To make a compensation system among beneficiary farmers, in case expected flood did not come and tank water storage was decreased.

When it comes to the scale setting of the flood pre-discharge system, the following items should be considered.

- i) Balance between pre-discharge system and down-stream drainage capacity.
- ii) With regard to size of the spillway wall slit in Japan, for example, the width of the stop-log should be less than 0.5 m and the recommendable slit height is 0.5 m, considering human labour work.



Source: Study Team

Figure 3.14-3 Spillway Wall Slit Structure (left: drop type, right: natural type)

3.15 Link Canal

The purpose of the link canal is to manage effectively the limited irrigation water between an upper tank and a lower tank. Two link canals were newly constructed by CSDPP in 2017 as shown in the following table.

Table 3.15-1 Outline of Link Canals

Items	No. 1 Link Canal	No. 2 Link Canal
Cascade	Kiulekada	Naveli kulam
Location	Puliyankulam to Halmillawatiya	Vala Sinna kulam to Panichchan kulam
Type	Open channel with concrete lining	Pipeline with PVC
Design Flow (m^3/s)	0.00925	0.00914
Length (m)	1,085	370
Dimension	Width: 0.30 m, Depth: 0.30 m	Diameter 160 mm
Slope	0.0050 (1/200)	0.0031 (1/330)
Velocity (m/s)	0.40	0.45

Source: Prepared by the Study Team based on CSDPP Final Report

The Study Team surveyed two link canals on 15-16 February 2020. Those link canals are functioning and are being used to manage irrigation water as shown in the following table.

Table 3.15-2 Present Conditions of Link Canals

Items	No.1 Link Canal	No.2 Link Canal
Photograph	 (15th February 2020)	 (16th February 2020)
Conditions	The link canal is being used to manage limited irrigation water from Puliyankulam (upper tank) to Halmillawatya (lower tank) by FO. The effect is to cultivate paddy on schedule by using irrigation water from Puliyankulam (upper tank), in case the irrigation water storage of Halmillawatya (lower tank) is not enough.	The link canal has not been used after CSDPP due to lack of opportunity to manage irrigation water between Vala Sinna kulam (upper tank) and Panichchan kulam (lower tank) because there has been enough rainfall for recent years.

Source: Study Team

There is a practice of link canal in other tanks. The Study Team surveyed Ichchankulama Cascade on 17 February 2020. The irrigation water is managed by using siphon system (pipe) from the upper tank (symbol: 12-4) to the lower tank (symbol: 12-5) as shown in the following table.

Source: Study Team

Figure 3.15-1 Link Canal in Ichchankulam Cascade

Based on the survey of the Study, the link canal is effective because it is functioning and practical. There is necessity in the target area, if conditions of water resources and farmers organisation are satisfied. The link canal is included in the scope of the Study.

CHAPTER 4 SCOPE OF THE PROJECT

4.1 General

4.1.1 General Approach for the Project

Based on Chapter 2 and Chapter 3, the general features of the Project and the fundamental issues for the achievement of the project objectives are summarised as follows:

Project Purpose:
Development and rehabilitation of irrigation infrastructure (tanks, irrigation canals, and link canals) and farm roads in the cascade systems in the target area in order to attain efficient use of water available for irrigation, flood prevention of farm lands and facilities, efficient transportation of agricultural products, and thereby promote agricultural development adaptable to climate change and improve agricultural productivity.

Target Area
Anuradhapura District in North Central Province (NCP)
Vavuniya District in Northern Province (NP)

Related Government Agencies
Executing agency: Ministry of Irrigation (MOI)
Implementation agencies: Department of Irrigation (ID) under the MOI, Provincial Department of Irrigation (PID) in Anuradhapura District, Department of Agrarian Development (DAD) in Vavuniya District.

Fundamental Issue in the Target Area:
The fundamental issue in the target area is that farm income, which is a key contributor to the local economy, is low compared with those of the national, urban, and rural sectors.

The main reasons are summarised as follows:

1) There are serious deteriorations that cannot be overlooked in the irrigation facilities such as the subsidence of embankment, cracking, sedimentation in the tank, intake gate, and non-functional spillway. The PID and the DAD attend some maintenance or rehabilitation works on tank bund and/or related structure every year with their available fund. However, the present irrigation and drainage facilities including farm road are still in poor condition.

2) It is recognised that flood had huge impact on the livelihood of the target area. Due to the recent climate change, the frequency of flood increases, which resulted to serious damage of irrigation facilities and insufficient irrigation water in the damaged tank caused by the drought. The floods also have devastated farmland and affected agricultural production.

3) There are many problems in the agricultural sector, i.e., high dependency on rice farming, low yield of paddy, and low crop intensity in irrigable area due to inadequate supply of irrigation water. The present agricultural situation does not generate adequate net farm income to farmers for further farm investment to initiate intensive agriculture. As a result, technologies may not be updated leading to the decline in crop productivity and deterioration of farm earnings.

Based on the above project outline and fundamental issue of the Project, the project scope has been formulated considering the following general approach:

(1) Firm Facility Development with Proper O&M

In order to achieve the purpose of this Project, firm facilities that support intensive farming are necessary to ensure irrigation water as well as to mitigate drought and flood risk. Although the availability of irrigation water may increase the cropping intensities; simple augmentation will not bring enough profit to the farmers.

Goods and equipment required for the operation and maintenance (O&M) of irrigation and drainage facilities to be rehabilitated/improved under the Project is necessary since small-scale tank irrigation schemes are scattered around the target area and the government’s technical support cannot be delivered on time, the farmers organisation (FO) should identify the risk of collapse of the facilities especially the tank bund, and enable them to attend to the works or manage the works by themselves.

(2) Crop and Farm Income Diversification

To generate adequate net farm income, qualitative changes to the present agriculture are required such as (i) increase in the productivity of ordinal crops, (ii) diversification to high-value crops and crop varieties, and (ii) crop/livestock integration as major strategies for profitable agriculture. It is envisaged that the increase in farm income would enhance welfare of household members and boost up farmers' satisfaction.

(3) Create Added Value on Agriculture Produce

Most of the farmers in the target districts have practiced subsistence farming for a long time. To break away from subsistence farming, farmers need to learn a modern marketing system such as initial processing, order-delivery, traceability, safety assurance, etc., in addition to crop and variety, quality, quantity, and shipping time, through doing real business with the private sector like hotels and supermarkets. It will also contribute and enhance their farm incomes.

It should be noted that the several projects proposed by Project for Formulating Cascade System Development Plan under North Central Province Canal (CSDPP) have been carefully reviewed without North Central Province Canal (NCPC) condition and incorporated a part of those into the project scope in due consideration of urgency and effect.

4.1.2 Summary of the Proposed Project Scope

Based on the above general approaches, the following components are proposed for the Project:

Table 4.1-1 Project Components

Component No.	Description	Target Area
Component 1	Cascade System Development	Subprojects selected from the criteria mentioned in Section 4.2.1
Component 2	Soft Component	Six model cascades (refer to Section 4.3)
Component 3	Project Management and Monitoring	Target area of components 1 and 2
Component 4	Consulting Services	Assist or conduct all activities included in components 1, 2, and 3

Source: Study Team

4.2 Component 1: Cascade System Development

The Component 1 is divided into infrastructure and facility development (called as "Subcomponent 1.1") and procurement of machinery and equipment (called as "Subcomponent 1.2"), according to the content of the work. The contents and selection procedure of each subcomponent are as follows:

4.2.1 Subcomponent 1.1: Infrastructure and Facility Development

(1) Proposed Contents of Subcomponent 1.1

Infrastructure and facility development is the main activity of the Project in order to maximise the use of water and land resources available in the target area; and to improve the productivity and profitability of cascade system agriculture.

The Study Team suggests that the following civil works and facility will be constructed and/or rehabilitated under Subcomponent 1.1:

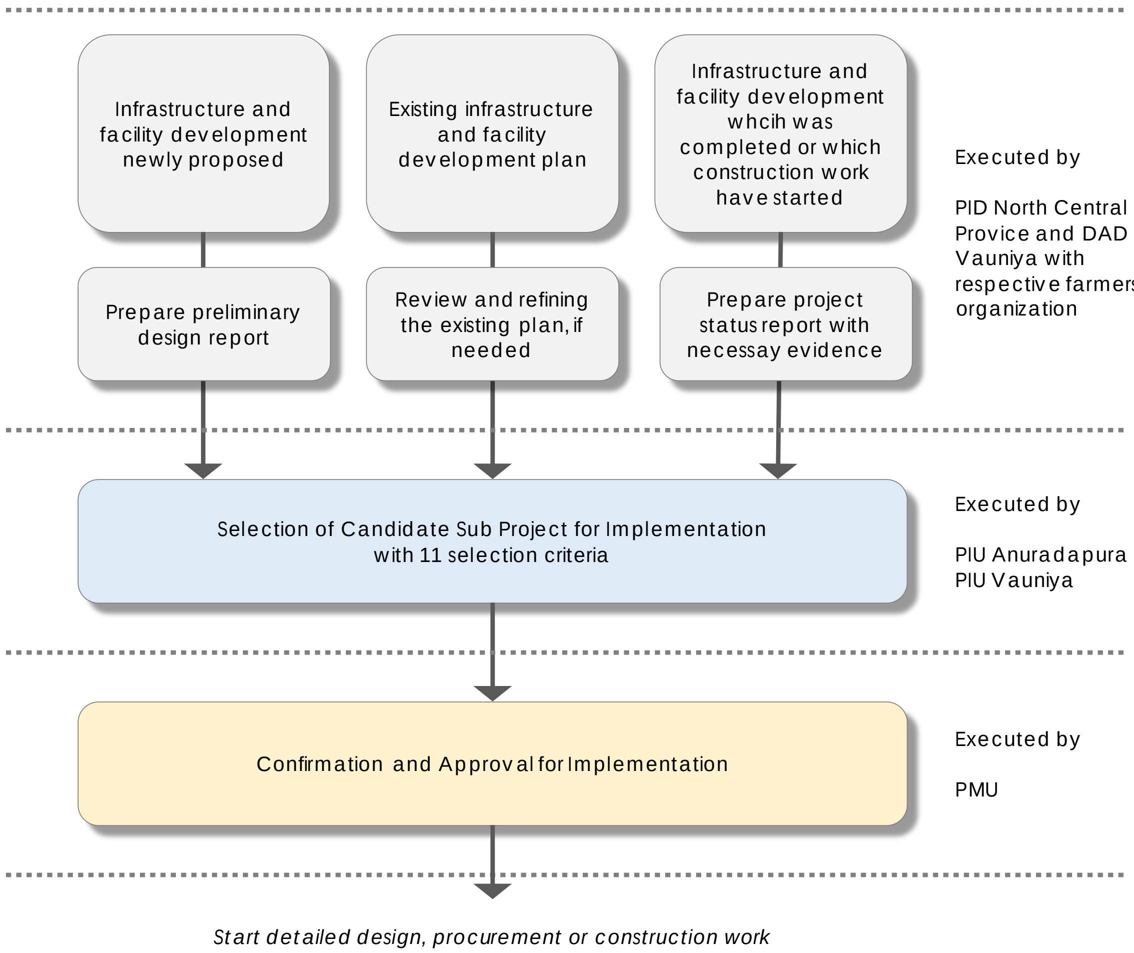
Table 4.2-1 Target Infrastructure and Facilities Development and Rehabilitation Works under Subcomponent 1.1

Item	Description
(1) Civil Works for Infrastructure Development	
Tank Bund	・ Formation of upstream and downstream slopes and provide riprap protection, as required ・ Filling of breached, eroded, and leaked section and construction of toe drain, as required ・ Setting bathing steps for improving farmer's livelihood
Spillway	・ Rehabilitation of eroded downstream bed and both side slopes of the spillway ・ Expansion of width of the spillway ・ Installation of gate on the spillway ・ Construction of emergency spillway, if required
Sluice	・ Reinstallation of inlet gate and/or rehabilitation or reconstruction of inlet and outlet structure ・ Instruction of water level measuring staff gauge and construction of measuring devices in the outlet
Irrigation Canal	・ Repair of irrigation canals that water distribution function is impaired due to aging
Drainage Canal	・ Repair of drainage canals that water discharge function is impaired due to aging
Farm Road	・ Expansion of width of the farm road ・ Gravel pavement
Link Canal	・ New construction of canal connecting upstream and downstream tanks
Desilting	・ Removal of sediment and weeding to improve the storage capacity of the tank
Pipeline	・ Constructed to improve water supply efficiency

Source: Study Team

(2) Procedure for the Selection of Candidate Infrastructure and Facility Development Works

The flow chart for the selection of infrastructure development and rehabilitation works to be implemented under the Project are shown in Figure 4.2-1.



Source: Study Team

Figure 4.2-1 Procedure for the Selection of Subprojects for Infrastructure and Facility Development

The outline of procedures is described as follows:

(a) Preparation and Submission of the Preliminary Design Report

The existing plan or new development and rehabilitation needs in the Tank Cascade System in Anuradhapura and Vavuniya districts for infrastructure and facilities such as irrigation facilities, farm roads, agriculture production, and post-harvest handing will be collected, although discussion with FO leaders and field reconnaissance survey conducted mainly by field staff in PID in the North Central Province (NCP) and DAD in Vavuniya District. The collected infrastructure and facility development and rehabilitation needs or plan will be summarised in the Tank Cascade System basis. The advantages of using the Tank Cascade System as the smallest unit of infrastructure and facility development and rehabilitation are summarised in Table 4.2-2.

Table 4.2-2 Comparison of Infrastructure Development Units

Unit of Sub-project	Advantage	Disadvantage	Evaluation
1. Cascade	· Consistent with the Sri Lankan government's water resources and irrigation development approach · Maximising benefits on a basin basis · Consistent with past development study of CSDPP · Enable to reduce the number of procurement packages	· Takes time to implement the project, including preparatory work and consensus building among stakeholders	· It is the most rational as a subproject unit of the irrigation sector loan.
2. Tank	· Enable to shorten the time for consensus building among the stakeholders and need survey · Enable to implement the project in a shorter period of time, including preparatory work.	· Single reservoir rehabilitation is an old type water resources and irrigation development approach (for example, it cannot cope with large-scale flood in the basin). · Increase procurement operations (bids, etc.) · Increase construction supervision work (progress management, meetings, etc.)	· The subproject unit of the irrigation sector loan is small and procurement work and construction management work become complicated. In addition, a synergistic effect with the upstream and downstream reservoirs cannot be expected as a cascade tank system.

Source: Study Team

After examining the existing plan and collected data, PID of NCP and DAD of Vavuniya will prepare the preliminary design report. The preliminary design report should contain the following information:

Table 4.2-3 Contents of the Preliminary Design Report

Categories	Contents
General	· List of tanks with location map · Name of FOs and number of members
Present Agriculture	· Tank based cultivation area/ irrigated area · Major cropping calendar in each FO/ tank · Number of farmers who practice vegetable/ OFC cultivation/ livestock rearing
Present Condition of Infrastructure	· Basic dimension of tank bund and related structure and condition · Existing canal system and condition · Existing rural road and condition · Other post-harvest facilities
Record of Past Rehabilitation Work	· Year, fund, and major scope
Preliminary Plan	· Proposed cropping calendar · Proposed facility and infrastructure development plan · Estimated cost · Expected benefit · Cooperative setting up for project implementation
Information of Environmental and Social Consideration	· Information on land issue · Information on forest reserve and conservation area · Information on cultural properties and building

Source: Study Team

(b) Selection of Subprojects for Implementation

After receiving the preliminary design report of tank cascade system, the Project Implementation Unit (PIU) will examine whether the proposed plan should be implemented as a subproject under the Project. The proposed selection criteria are shown in Table 4.2-4. The subprojects to be selected must meet the objectives of the Project and be able to produce outcomes efficiently and reliably by implementing agency and FO. For the selection of subprojects, five key perspectives for project success such as (1) Relevance, (2) Effectiveness, (3) Impact, (4) Efficiency, and (5) Sustainability will be considered as principal concepts.

The selection will be conducted by PIU Anuradhapura and Vavuniya, respectively. Whenever necessity arises, PIUs will request PID North Central Province and DAD Vavuniya to provide the additional data and information of the subproject.

Table 4.2-4 Criteria for Selection of Infrastructure and Facility Development Needs

Draft Criteria
(1) Proposed plan should include irrigation development and related works is for minor and medium tank (below 400 ha).
(2) Proposed plan should be consistent with MOI's cascade development policy.
(3) All of targeted infrastructures are FO or government properties or to be handed over to FO or government.
(4) The targeted infrastructure and facility development plan does not overlap with other ongoing or planned government project.
(5) The targeted infrastructure and facility were not rehabilitated for more than five years.
(6) More than 10% of the expected beneficiaries have practiced horticulture crop cultivation and/or mixing farming (growing of crops and raising of livestock).
(7) FO should be established in all of the targeted tanks and is willing to cooperate with the proposed works.
(8) Benefit/Cost (B/C) ratio of the plan shall not be less than 1.0.
(9) Cost per hectare in the subproject shall not be more than LKR 0.7 million.
(10) Proposed works should not require any land acquisition and/or resettlement (unless FO can settle such issues by themselves without government financial support).
(11) If proposed work has been completed or has been started, it should be confirmed with clear evidence that the work was implemented in accordance with the government guidelines

*Note: *1 The tanks are located in the forest reserves, which need to get approval from the Forest Department in advance.*
Source: Study Team

The PIU Anuradhapura and Vavuniya will compile the list of candidate subprojects that pass all the above criteria. The subprojects that fail in the above criteria for screening should not be selected under the Project. The list of candidates must be prepared for PIU Anuradhapura and PIU Vavuniya, respectively. The list with preliminary report will submit to the Project Management Unit (PMU) for confirmation and approval.

(c) Confirmation and Approval of Subprojects for Implementation

After receiving the list of candidates of subprojects with the preliminary design report form each PIU, the PMU will check the contents with support of the project consultant. If the contents of the preliminary design report or evidence for completed project have fulfilled the selected selection criteria, the PMU will give the approval to proceed to the next step.

4.2.2 Subcomponent 1.2: Procurement of Machinery and Equipment

(1) Proposed Contents of Subcomponent 1.2

The machinery and equipment procured in Subcomponent 1.2 will be used to achieve the project purpose of enhance and stabilisation of farmers' livelihood and income. Specifically, it is used for O&M of infrastructure to be developed, improvement of productivity of irrigated agriculture, diversification of income, etc., and those will be owned by FO or government agencies.

The expected contents of the machinery and equipment are summarised as follows:

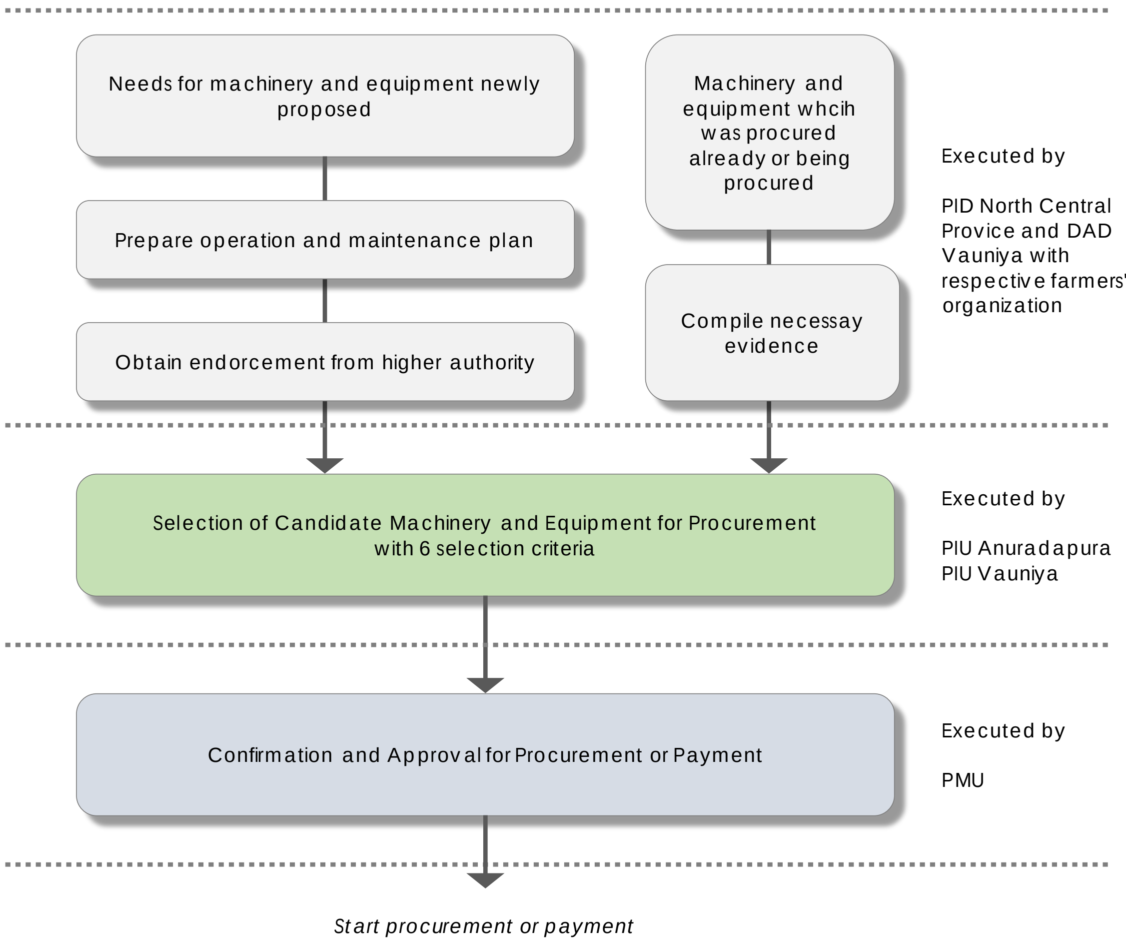
Table 4.2-5 Target Machinery and Equipment to be Procured under Subcomponent 1.2

Item	Description
(1) Machinery and equipment for proper O&M	
O&M tool set for FO	・ Wheelbarrow, shovel, pickaxe, hoe, bucket, watering can, rake, hand rammer, and ground rake
FO office and O&M office equipment for FO	・ FO office ・ Personal computer and software
(2) Machinery and equipment for agriculture production and post-harvesting handling	
Farm machinery	・ Transplanter, weeder, slasher, tractors, etc., and other related items
Post-harvesting	・ Drying yard, storage, packing machine and other miscellaneous items such as weighing machine, moisture meter, etc.
(3) Facilities/goods for farm income diversification	
Livestock	・ Building for dairy cattle, grass chopper and vacuum cleaner for silage, shed and necessary equipment for poultry
Fishery	・ Fish net and other related materials

Source: Study Team

(2) Procedure for the Selection of Machinery and Equipment under Subcomponent 1.2

The flow chart for the selection of machinery and equipment to be procured under the Project are shown in Figure 4.2-2.



Note : PIU : Project Implementation Unit established in the District level
PMU: Project Management Unit established in the Province level
Source: Study Team

Figure 4.2-2 Procedure for the Selection of Machinery and Equipment

The outline of the procedure is described as follows:

(a) Collect Various Needs for Procurement of Machinery and Equipment

The needs for procurement of machinery and equipment related to the irrigation and agriculture development in the target area with necessary information will be collected by the field staff in PID in North Central Province and DAD in Vavuniya District. While collecting the needs for machinery and equipment, the expected users such as FO and government agencies should prepare the O&M plan with clear budgetary arrangement. The proposed contents of the O&M plan are summarised in Table 4.2-6. The list of machinery and equipment with O&M plan should be submitted to the PIU Office in Anuradhapura and Vavuniya, respectively, after endorsement by the higher or supervisory authority. If the respective machinery and equipment have been purchased or are being purchased, PID or DAD should collect and organise documents that provide information on the process of procurement of supplier and details of payment amount.

Table 4.2-6 Contents of the O&M Plan for Machinery and Equipment

Categories	Contents
Machinery and Equipment	・ Name of machinery and equipment ・ Type or specification ・ Estimated price per unit
User Details	・ Name of users/ organisation ・ Address and location to be installed
Purpose for Utilisation	・ Expected output/ outcome (quantity base)
Operational Plan	・ Operational days or time per month, day, year ・ Operational cost year unit and per annum
Maintenance Plan	・ Major maintenance items and activities ・ Maintenance setting up ・ Necessary maintenance cost per year and source of fund

Source: Study Team

(b) Selection of the Machinery and Equipment to be Procured

After receiving the needs for machinery and equipment with necessary data, the PIU will examine whether the proposed machinery and equipment should be procured under the Project. The proposed selection criteria are shown in Table 4.2-7. The procured machinery and equipment should be used to achieve the objectives of the Project and be able to produce outcomes efficiently and should be operated and maintained properly by users.

Whenever necessity arises, PIUs will request PID North Central Province and DAD Vavuniya to provide the additional data and information of the proposed machinery and equipment.

Table 4.2-7 Selection Criteria for the Procurement of Machinery and Equipment

	Draft Criteria
(1)	The proposed machinery and equipment should become FO or government property.
(2)	Proposed machinery and equipment should be used for i) improvement of irrigation efficiency, ii) expansion of irrigated area, iii) improvement of productivity of irrigated agriculture, and/or iv) crop and income diversification for improving the livelihood of the farmers in the target area.
(3)	O&M plan should be prepared by respective FO or department. The plan should be endorsed by the following organisations: ➢ In case of FO property: Assistant Commissioner of Department of Agrarian Development ➢ In case of provincial government property: Chief Secretary ➢ In case of district government property: District Secretary
(4)	Next year's expenses related to the O&M of the proposed machinery and equipment have already been budgeted in the organisation
(5)	The cumulative cost of proposed machinery and equipment should not exceed 10% of cumulative cost of Subcomponent 1.1
(6)	If the procurement of machinery and equipment has been completed or has started, it should be confirmed with clear evidence that the procurement work was implemented in accordance with the government guidelines

Source: Study Team

(c) Confirmation and Approval of Subproject for Implementation

The list of machinery and equipment proposed by each PIU will be submitted to the PMU Office for preparation of procurement plan and approval. After confirming the contents of the O&M plan with basic information, the candidate machinery and equipment will be organised by type and by industry, and a quarterly basis procurement plan will be formulated. The procurement plan will send to MOI for approval. Upon the MOI approval on the procurement plan, the procurement of machinery and equipment will be authorised to be executed under the Project and PMU will proceed to the selection of suppliers.

4.3 Component 2: Soft Component

4.3.1 Target Area and Basic Concept for Component 2 Activity

To increase farm income in the project area, the activity for intensive agriculture and income diversification with proper maintenance of irrigation facility is essential in addition to Component 1 activity. However, there are constraints for farmers to boost farm income diversification because i) the realisation of profitable agriculture requires more labour and capital and ii) the farmers have limited knowledge of irrigated agriculture for other field crop.

Considering the above constraints, the detailed survey results of the Study described in Chapter 3 and the review of projects proposed in CSDPP, the following subcomponents are proposed:

i) Subcomponent 2.1: Institution and Capacity Development
ii) Subcomponent 2.2: Agriculture Development
iii) Subcomponent 2.3: Post-harvest and Marketing Development
iv) Subcomponent 2.4: Livestock Development
v) Subcomponent 2.5: Fishery Development

The activities of the above five subcomponents will be carried out mainly for 18 FOs and farmers in the following cascades (hereinafter called model cascade) in consideration of demonstration effects to the neighbouring cascades. The location map of model cascades is shown in Attachment 4.3-1.

i) Ichchankulam
ii) Siyambalagaswewa
iii) Alagalla
iv) Ithalawatuna Wewa
v) Kiulekada
vi) Naveli Kulam

Since the Project pursues the augmentation in farm income by (1) increase in the productivity of ordinal crops, (2) diversification to market oriented high-value crops and crop varieties, and (3) crop/livestock integration as major strategies for profitable agriculture, the soft component activities should be expanded to the project area. Hence, all activities of the five subcomponents to be conducted in the model cascade shall be expanded to other cascades (subprojects) as inviting and hosting of trainees to the model cascades.

Considering the importance of farmers' autonomous motivation as it is an essential ingredient for sustainable outcome after the completion of the Project, the Project aims at empowering farmers in their endeavour to pursue market-oriented agriculture and to undertake farming as a business in a suitable manner through imparting necessary marketing and production skills to them.

The basic concept and activities are summarised in the following table.

Table 4.3-1 Basic Approach and Programmes for Component 2

Subcomponent	Basic Approach	Programme	Main Target	Implementation Organisation
2.1 Institution and Capacity Development	・ Strengthening periodical maintenance activities in collaboration with cascade management through skills development	2.1(1) Capacity Improvement of FOs and the Relevant Government Officers for Water Management	・ 18 pilot FOs in six model cascades ・ ARPAs	PID, DAD, Consultant
		2.1(2) Promotion of Awareness Campaign of Tank Day	・ 18 pilot FOs in six model cascades	PID, DAD, Consultant
2.2 Agriculture Development	・ Diversification to market-oriented high value crops and varieties ・ Improvement of cultivation practices and effective input for crop diversification	2.2(1) Cultivation of Skills Development with Provision of Quality Inputs	・ 18 pilot FOs in six model cascades	PDOA, Consultant (BRRI, DS, Service Providers as required)
	・ Group and community-based extension approaches to expand extension outreach	2.2(2) Enhancement of Agriculture Extension System	・ 18 pilot FOs in six model cascades	PDOA, Consultant (DS as required)
2.3 Post-harvest and Marketing Development	・ Establishment of agricultural model for high value-added vegetable ・ Promotion of contract cultivation of OFC ・ Construction of value chain of traditional rice varieties	2.3(1) Establishment of the Community Supported Agriculture Model	・ 18 pilot FOs in six model cascades	PDOA, Consultant (Tourism and Hoteliers Association, DS as required)
2.4 Livestock Development	・ Encouragement of youth involvement in livestock production	2.4(1) Stable Feeds Production and Delivery through Entrepreneur Development	・ Farmers in 18 pilot FOs who have already owned cattle	PDAH, Consultant (FO Milk Society as required)
	・ Improvement to integrated livestock farming with fodder cultivation and feeds processing	2.4(2) Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System	・ Farmers in 18 pilot FOs who have already owned cattle and/or back yard poultry	PDAH, Consultant (FO Milk Society as required)
2.5 Fishery Development	・ Maximum use of water, which increases after the rehabilitation of tank bund	2.5(1) Promotion of Inland Fisheries Development in Selective Tanks	・ Pilot FOs where the tank capacity is enough for inland fishery.	NAQDA, Consultant (DS as required)

Note: BRRI is Bathalagda Rice Research Institute
Source: Study Team

4.3.2 Subcomponent 2.1: Institution and Capacity Development

It is proposed to provide the capacity enhancement programs for the farmers and government officers aiming at the proper O&M of the facilities to be improved under the Project.

(1) 2.1(1): Capacity Improvement of FOs and the Relevant Government Officers for Water Management

Capacity development of the existing FOs is necessary based on the following points of view: i) the need for effective and efficient water use, ii) the need for improvement of organisational functions to manage the FO under the cascade system, iii) the need for improvement of the tank level water distribution with improved irrigation system, iv) the need for improvement of the water management in the present situation of water scarcity and drought situation, and v) the need for developing agriculture related collective activities as an FO for profitable agriculture activities.

The Project will encourage expanding women participation in water management and agricultural development activities by way of forming women groups attached to the FOs. These women groups can be utilised not only for the said activities but also for promoting agricultural enterprises such as packing and marketing of value-added products, enhance nutritional value of family food system, and improve saving habits.

The programme for capacity building shall be conducted with the following activities:

Table 4.3-2 Outline Programme of Capacity Improvement of FOs and the Relevant Government Officers for Water Management

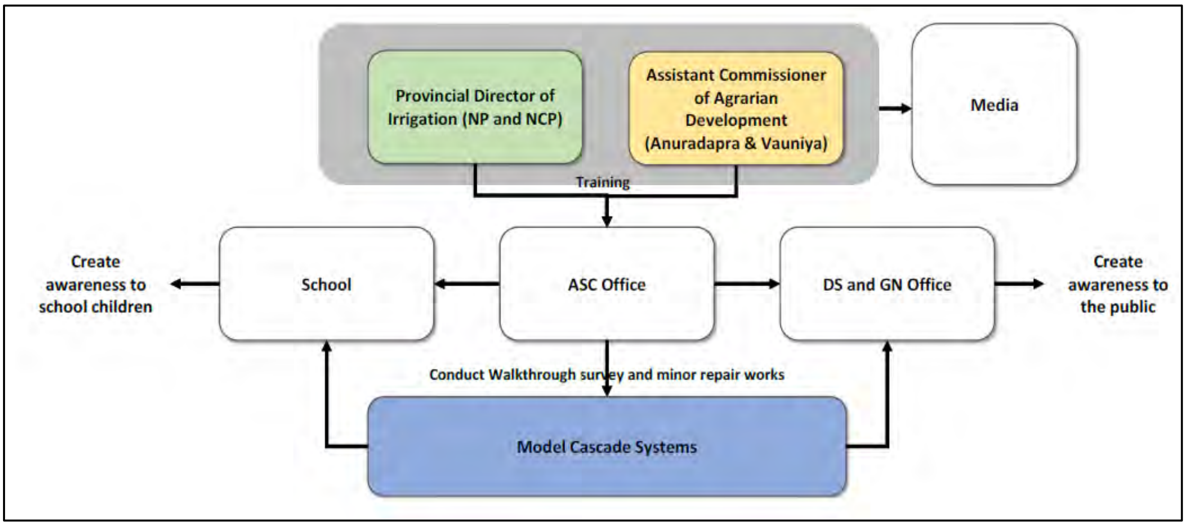
Programme	Types of Training/Activity	Contents/Remarks	Number of Participants
Selection of Pilot FOs	-	-	-
Improvement of Water Management under Tanks	Awareness raising	・ Available water for irrigation ・ Need of efficient use of the limited water	Farmers: 360 (1 day x 20 participants x 18 sites)
	Lecture training on the efficient water use	・ Establishment of management system ・ Improvement in irrigation structures	Farmers: 7,200 (2 days x 20 participants x 18 sites x 5 seasons)
	Training of water master and relevant person	・ Planning of water control and water distribution	Farmers: 200 (2 days x 20 participants x 5 seasons)
	Practical sessions and in-field practice of water management	・ Supply of irrigation water to the field ・ Monitoring and evaluation of water distribution ・ Adjustment on the distribution by the cultivation progress during operation period	Farmers: 200 (2 days x 20 participants x 5 seasons)
	Exposure visit to other projects	・ Visit other government projects ・ Review capacity development activity ・ Share the experience within the model cascade	Farmers: 600 (1 night trip x 6 model cascades x 20 participants x 5 seasons)
Introduction of Irrigation and Crop Planning	Training on irrigation and crop planning	・ Tank level crop planning for better cultivation practice with current water supply	Farmers: 1,800 (1 day x 20 participants x 18 sites x 5 seasons)

Programme	Types of Training/Activity	Contents/Remarks	Number of Participants
	On-field support on irrigation and crop planning practice	・ Conduct water distribution based on the plan ・ Revise the plan for efficient use of limited water	Farmers: 3,600 (2 days x 20 participants x 18 sites x 5 seasons)
Training Needs Assessment for FO's Capacity Building	Capacity Assessment of model cascades	・ Conduct training as required	Farmers: 1,800 (1 day x 20 participants x 18 sites x 5 seasons)
Training of ARPAs	Training for improvement of FO's functions and water management	・ Skills for supporting FO activities (Additional need-based training can be included in institutional support on the development of water management related activities with the FOs)	Farmers: 160 (2 days x 20 participants x 4 times)
Hosting of Trainees from Non-model Cascades	Dissemination of skills and knowledge developed through various trainings in the model cascades	・ Share experiences ・ Discuss problems and solutions among the member farmers at the community hall ・ Field visits for trainees to see for themselves what is going on.	Farmers: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

(2) 2.1(2): Promotion of Awareness Campaign of Tank Day

If FO will be able to identify the risk and attend to the minor repairs of the tanks, O&M of the tanks will be greatly improved. Early detection and early repair of piping holes can prevent the direct damage leading to bund collapse. To maximise the abilities of the farmers in actual risk assessment and disaster preventive measures, the objective of the "Promotion of Awareness Campaign of Tank Day" to generate the movement of encouraging FOs to be a tank guardian, conduct walkthrough survey, and engage in minor repair work on one specific day (so-called as Tank Day) in the year should be accomplished. The conceptual institution arrangement is shown in the table below.



Source: CSDPP Final Report

Figure 4.3-1 Conceptual Institution Arrangement of Tank Day

The activities expected for the “Tank Day” are as follows:

Table 4.3-3 Outline Programme of Promotion of Awareness Campaign of Tank Day

Programme	Type of Training/Activity	Contents/Remarks	Number of Participants
Awareness Trainings	2 days of workshop	▪ Discussion of basic concept ▪ Selection of model cascade ▪ Awareness and training	Farmers: 960 (2 days x 20 participants x 6 model cascades x 4 years)
Implementation of Tank Day	1 day activity	▪ Conduct walkthrough survey ▪ Share the experience	Farmers: 2400 (1 day x 20 participants x 5 FOs x 6 model cascades x 4 seasons)

Source: Study Team

4.3.3 Subcomponent 2.2: Agriculture Development

The basic concepts for agricultural development are i) improvement of productivity of ordinal crops and ii) diversification to market-oriented high value crops and varieties.

Since the national self-sufficiency in paddy has already been achieved, the present priority would be to sustain and stabilise the production level of ordinal crops in the target area. Present average productivity of the crop has remained around 4.66 ton/ha in minor irrigation scheme. With an assured water supply and improved crop husbandry supported by strengthened extension services, it is expected that the average paddy yield in the project area would increase. Other crops in the project area include other food crops (OFCs) (e.g., coarse grain, grain legumes, condiments) and traditional or low country vegetables, which are cultivated during the Maha in the highlands. The cultivated extent under other crops is insignificant in the command area but the yield levels are achievable through assured irrigation water combined with an effective extension service. However, the land extents for cultivation of OFCs and vegetables would, however, depend largely on factors such as willingness and ability of individual farmers, land suitability, crop water requirement, capital investment, farm labour, national deficit in supply and demand, marketing and relative crop income level.

Based on the above concept, the following programmes will be conducted in Subcomponent 2.2:

(1) 2.2(1): Cultivation Skills Development with Provision of Quality Inputs

Nominal and high-value crops are included in the cropping patterns for the target area. Except for paddies, other crops are cultivated under rain-fed conditions in the highlands because most farmers lack previous experience in growing them under irrigation in the command area. The productivity of the nominal crops remains less that those recorded in the major irrigation schemes in the district. With assured irrigation water supply and an effective extension delivery system, it is necessary to promote adoption of improved practices in crop production by the farmers in order to reach the targeted productivity levels.

Before cultivation practice, it is necessary that farmers understand good agricultural practice (GAP) and the importance of production process management for quality control of production. Also, farmers should ensure that the recommended varieties of seeds/planting materials, fertilisers, and agrochemicals are available for the farmers through the input suppliers, the local dealers, and entrepreneurs under buy-back agreements with the farmers, at the required time and in adequate quantities.

For this purpose, the following activities will be conducted:

Table 4.3-4 Outline Programme of Cultivation Skills Development with the Provision of Quality Inputs

Programme	Type of Training/Activity	Contents	Number of Participants
Promotional Seminars on Crop Diversification (Traditional Rice and High Value Crops)	Awareness raising programme	· Basic issues relating to diversification · Major agribusiness entrepreneurs and processors · Purpose, benefits and profitability of contract farming as well as the opportunities and limitations.	Farmers: 1800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons) AI: 100 (1 day x 20 participants x 5 seasons)
Preparation of Action Plan for Crop Diversification	Training for the preparation of action plan	· Selection of crops to be cultivated · Cropping schedule with water supply · Necessary techniques for cultivation and technical trainings to be required · Scheduling of the trainings (Training will be carried out for agricultural instructors (AIs) at first. Then, AIs who will be trained on planning will conduct the training for the farmers)	Farmers: 1800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons) AI: 100 (1 day x 20 participants x 5 seasons)
Promotion of Good Agriculture Practice (GAP)	Training on GAP	· Importance of production process management · Quality control for production (Training on GAP will be conducted for AIs' capacity building, and then AIs will conduct training for farmers on GAP.)	Farmers: 1800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons) AI: 100 (1 day x 20 participants x 5 seasons)
Skills Development	Training for officers / on-site training for farmers at demo farm	i) General subjects: · Land preparation · Nursery management · Basic techniques on cultivation · On-farm irrigation and drainage · Harvesting and post-harvest handling ii) Specific subjects: · Crop agronomy relating to Integrated Pest Management (IPM) · Integrated Plant Nutrition Management (IPNM) including soil testing for fertiliser recommendations (For the effective implementation of trainings, demo farms will be prepared in pilot sites respectively. On-site trainings for each cultivation stage will be conducted at demo farms.)	Farmers: 9,000 (1 day x 5 subjects x 20 participants x 18 Pilot FOs x 5 seasons) AI: 500 (1 day x 5 subjects x 20 participants x 5 seasons)
	Field day for experience sharing	· Share the skills and experiences with other farmers in the Project area at demo farm	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
	Monitoring and evaluation of participants activity	· Share the activity result with other participants · Evaluation of the activity by themselves and revise the action plan for the next season cultivation	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
Provision of Quality Inputs	Demonstration and training of	· Compare seasonal seed requirement · Discuss with suppliers in the state and	Farmers: 100 (1 day x 20

Programme	Type of Training/Activity	Contents	Number of Participants
	materials for provision of quality by suppliers	private sectors ・ Confirm the availability of time and quantities ・ Facilitate supplies through FO/ CMO (Demonstration of those agricultural materials by the suppliers shall be conducted at demo farms in order for the farmers to gain new knowledge and develop linkages with the suppliers.)	participants x 5 seasons)
Hosting of Trainees for Non-Model Cascades	Dissemination of skills and knowledge developed through various trainings in the model cascades	・ Hosting of trainees for non-model cascades to demo farms for extension of the techniques to be learned through the above activities	Farmers: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

(2) 2.2(2): Enhancement of Agriculture Extension System

Effective provision of extension service is deemed crucial for development. Besides the provincial ministries and departments, the Provincial Director of Agriculture (PDOA) collaborative work on extension is centred on the vested duties and services of the central Department of Agriculture (DOA) and Department of Agrarian Development (DAD). Training and capacity development on the crop-related subjects are handled by the PDOA in collaboration with the DOA. Direct transactions with the non-state or private sector are rare. However, the agricultural development activities involve many actors, both from the state and the private sectors such as service providers (materials, machinery, equipment and farm input suppliers), agribusiness enterprises, Paddy Marketing Board, collectors, and dedicated economic centres. It is proposed to establish a collaborative extension platform with all the contributors to the system of which the major private sector partners are listed below.

- Agribusiness entrepreneurs (processors providing crop-based extension)
- Service providers (suppliers of machinery and equipment, farm inputs and market players)
- Private sector establishment specialising in high-value vegetables

In addition to the above, transformation from a paddy-based cropping system to diversified cropping patterns in the irrigated command area requires a concerted effort and work commitment by the farmers themselves. Systematic utilisation of Farmer-to-Farmer (FTF) extension system is recommended as an effective community-based approach. FTF system involves careful selection of suitable lead farmers from the community and provision of comprehensive training on production technologies, sustainable production, and value addition for sharing the acquired knowledge with fellow farmers. The system expands the extension outreach, low cost/cost effectiveness, and promotes an increased participation of local communities.

This activity focuses on the enhancement of basic extension system platform as follows:

Table 4.3-5 Outline Programme of Enhancement of Agriculture Extension System

Programme	Type of Training/Activity	Contents	Number of Participants
Farmer-to-Farmer Extension	Selection of farmer leaders from 18 pilot FOs	・ Conduct meeting to select farmer leader	Farmers: 360 (half-day x 20 participants x 18 Pilot FOs)

Programme	Type of Training/Activity	Contents	Number of Participants
Programme	Training for farmer leaders on how to conduct FTF training	・ Selection of farmer leaders from 18 pilot FOs for FTF training ・ Group formation based on FO and selection of farmer leaders ・ Training for farmer leaders on how to conduct FTF training ・ Conducting FTF training for FOs	Farmers: 360 (1 day x 20 participants x 18 Pilot FOs)
	FTF training for other FOs	・ Conduct FTF training to other FO in the same model cascades by farmer leaders at demo farm	Farmers: 1,800 (1 day x 20 participants x 18 sites x 5 seasons)
Establishment of Collaborative Extension Mechanism	Demonstration and matching seminar	・ Invite the non-state or private sectors partners for demonstration on materials and techniques ・ Matching seminar with the partners for collaboration	ditto
	Exposure visit	・ Conduct exposure visit to private sectors	ditto
	Planning of training on agricultural sectors	・ Agricultural materials ・ Machinery ・ Equipment ・ Farm input	ditto
	Training on agricultural information	・ Agricultural materials ・ Machinery ・ Equipment ・ Farm input	ditto
Enhancement of Agriculture Extension System	Monitoring and evaluation of participants' activity	・ Monitoring and evaluation of activities for FTF extension system and collaborative extension mechanism with non-state or private sectors ・ Improve for further dissemination of those extension systems.	ditto
	Hosting of trainees for non-model cascades	・ Hosting of trainees for non-model cascades to share their experiences to farmers of pilot FOs, ・ Motivate farmers to proceed to crop diversification through the extension systems	Farmers: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

4.3.4 Subcomponent 2.3: Post-harvest and Marketing Development

Cultivation skills and agriculture extension system are proposed in Subcomponent 2.2 for crop diversification but proper agriculture marketing and post-harvest strategies and plans are required to achieve the increase in farm income in the target area. The market-driven approach, which puts priority on consumers' preference, begins with the identification of target consumers. The level of quality required by target consumers is thereafter determined, and the necessary cost to achieve that level of quality is appraised. Noting that "delivery" or the transportation of such goods from producers to consumers, which indicates the time, volume, location, and method, is taken into account as it directly influences the optimisation of cost and quality. On this basis, the concept of the post-harvest and marketing development is formulated to increase agricultural profit for the beneficiaries with the two strategies: i) to improve current conditions and ii) to upgrade or create value-added markets.

Based on the above concept, the following programmes will be conducted in Subcomponent 2.3:

(1) 2.3(1): Establishment of the Community Supported Agriculture Model

After rehabilitation of the cascade irrigation system, value addition to crops and high-value crops can be promoted partly in the irrigated command area from the view of increase in income. For the promotion, the project employs community supported agriculture wherein producers and consumers (tourism, hoteliers association, DS, etc.) mutually create a food chain in the region in order to secure the market and quality at the same time. To do so, the project coordinates the partnership, and supports the quality control of products and outbound logistics. The selected farmers will be assisted to formulate an agreement for partnership which covers the targeted produces, quality, pricing, and delivery methods. The agreement can be formed as a contract which is legally approved.

As for value addition, especially dried paddy can be the important crop for farmers because proper operation of drying and keeping at storage can increase its value. On the other hand, in the last CSDPP the verification programmes for crop diversification were conducted, and several high-value crops were identified, such as cauliflower and beets, that are well adaptable in the target area.

The project will support the operation of drying and stocking of paddy and for crop planning of high-value crops according to the partnership with buyers, through the following activities:

Table 4.3-6 Outline Programme of Establishment of the Community Supported Agriculture Model

Programme	Types of Training/Activity	Contents	Number of Participants
Selection of Pilot FOs	Seminar on selection of trial farmers	・ Conduct meeting to select farmer leader	Farmers: 18 (1 day x 1 participant x 18 Pilot FOs)
	Awareness raising programme	・ Explanation of importance of post-harvesting and marketing	Farmers: 100 (1 day x 20 participants x 5 seasons)
Formulation of the Partnership	Exposure visits to hotel	・ Identify the requirement (crop, quality, order-delivery management, traceability management) of hotels by farmers	Farmers: 360 (1 day x 20 participants x 18 sites)
	Preparation of business planning	・ Prepare the business plan for crop production and outbound logistics	Farmers: 360 (1 day x 20 participants x 18 sites)
	Formulation of agreement between FOs and hotels	・ Formulate the agreement to sale crops directory to FOs and hotels	Farmers: 360 (1 day x 20 participants x 18 sites)
Skills Development	Paddy training	・ Planning, procurement, construction, operation of grain drying, operation of storage for paddy	Farmers: 9,000 (1 day seminar x 5 subjects x 20 participants x 18 Pilot FOs x 5 seasons) AI: 100 (1 day x 20 participants x 5 seasons)
	Vegetable training	・ Post-harvesting handling for vegetables	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons) AI: 20 (1 day x 20

Programme	Types of Training/Activity	Contents	Number of Participants
			participants)
	Training on order-delivery management	・ Delivery service with identification of efficient outbound logistics	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
Establishment of the Model of High Value Vegetable	Monitoring and evaluation	・ The above activities shall be monitored and evaluated periodically, and then improved for further enhancement of the agriculture model.	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
	Hosting of trainees for non-model cascades	・ The farmers of non-model cascades can share their experience with farmers of pilot FOs, where it is expected to motivate farmers to try the model to increase their income.	Farmers: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

4.3.5 Subcomponent 2.4: Livestock Development

Keeping livestock is an important risk reduction strategy and livestock is a noteworthy provider of nutrients, an important capital asset and an important source of income for smallholders. Ruminant livestock provides an important complement to rice farming-based livelihoods in Sri Lanka and can increase the incomes of crop-livestock farmers. At this moment, there is an interest in dairy farming in the crop farming sector, especially from the youth, due to its high-income generation potential that can offset losses due to crop failures and market variability. The significant reason is that landless and farmers with limited land can also participate in dairy farming due to its high flexibility. Furthermore, demand for animal products such as milk is increasing with the rapid economic growth in the country. During the past several decades, a slow transition was observed from meat to milk type farms or from cattle keepers to dairy farmers. With the increase of fresh milk purchasing price, there seems to be a real urgency to the farmer for a rapid transition of this system.

Based on the above concept, the following programmes will be conducted in Subcomponent 2.4:

(1) 2.4(1): Stable Feed Production and Delivery through Entrepreneur Development

The Project expects to establish a system of entrepreneur development, involving motivated young livestock farmer groups that collect and process crop residue. The group would foster the sale of cattle feed to the other member. The group is basically a strong organisation functioning with basic accounting and management procedures in milk related service activities. The sale channels are easily created in the Farm Management Society (FMS) and present accounting systems are also used for transactions on business activities. For this purpose, the young livestock farmers' groups will obtain the training programmes and other supports, as listed below.

Table 4.3-7 Outline Programme of Stable Feed Production and Delivery through Entrepreneur Development

Programme	Types of Training/Activity	Contents	Number of Participants
Selection of Pilot FOs	Selection of farmers in model cascade	・ Selection of farmers who have already owned cattle for income source or home assumption	Farmers: 1800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
Skills Development of Production of Silage	Training for improve management capacity	・ Economic value of crop residue ・ Record keeping	ditto
		・ Processing of crop residue with equipment, machinery, storage and packing	ditto
		・ Improvement of nutritive quality of crop residue	ditto
Enhancement of Entrepreneur Development	Training on initial fund to start silage	・ Explanation of proper livestock management	ditto
	Workshop for other farmers on dairy cattle	・ Farmer-to-farmer dissemination of information on feed production for dairy cattle ・ Motivate other young farmers who are not doing livestock.	ditto

Source: Study Team

(2) 2.4(2): Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System

Detailed and proper how-to of dairy cattle management shall be taught to the farmers. In addition, backyard poultry (egg and day-old chicken) shall be introduced to farmers because it can be an income source. Dairy cattle will also be introduced as well.

It is important for farmers to know the actors of value chain and their demand from the view of marketing. If the farmers can establish the relationship with private sectors, the farmers can obtain information on market demand and advice for quality control as well.

Therefore, both livestock activities shall be conducted in the pilot FOs and the models of dairy cattle and backyard poultry shall be developed through the following activities:

Table 4.3-8 Outline Programme of Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System

Programme	Types of Training/Activity	Contents	Number of Participants
Selection of Pilot FOs	Selection of farmers for dairy cattle activity	-	-
	Selection of farmers for backyard poultry	(The farmers of pilot FOs for backyard poultry shall be selected based on the willingness of the farmers.)	Farmers: 1,800 (1 day x 20 participants x 18 Pilot FOs x 5 seasons)
Skills Development of Livestock	Farmer training on dairy cattle	・ Rearing, feeding, breeding, managing, milking	ditto
	Farmer training on backyard poultry	・ Rearing, feeding, managing, hatching)	ditto
Enhancement of	Exposure visit for farmers	・ Visit the private sectors for collectors of milk, egg, day-old chicken	ditto

Programme	Types of Training/Activity	Contents	Number of Participants
Entrepreneur Development	Planning on action plan based on exposure visit	· Plan the annual action plan in view of marketing for improvement of livestock management	ditto
	Training along the action plan	· Plan the necessary training as required	ditto
Establishment of Livestock Model	Monitoring and evaluation	The above activities shall be monitored and evaluated periodically, and then improved for the establishment of livestock models.	ditto
	Hosting of trainees for non-model cascades	(The farmers of non-model cascades can share the experience with the farmers of pilot FOs, where it is expected to motivate farmers to try the models on dairy cattle and backyard poultry.)	Farmer: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

4.3.6 Subcomponent 2.5: Fishery Development

In some seasonal tanks, inland fishery is conducted by the sub-groups of FOs, and contribution from fishery is paid to FO as the leasing fee of water body. The fee amount sometimes exceeds the total member fee and becomes a major income of FO. After rehabilitation of cascade systems, water in the tanks will be managed in a better way and will retain longer period. This situation will be advantageous to promote the seasonal inland fishery and there is a high demand from FOs and the relevant government agencies.

Based on the above concept, the following programmes will be conducted in Subcomponent 2.5:

(1) 2.5(1): Promotion of Inland Fishery Development in Selective Tanks

The following programme shall be conducted:

Table 4.3-9 Outline Training/Activity of Promotion of Inland Fishery Development in Selective Tanks

Programme	Types of Training/Activity	Contents/Remarks	Number of Participants
Selection of Pilot FOs	Selection of tank from model cascades		-
Skills Development of Inland Fishery	Farmer training	· Training on inland fishery production · Training on management by FO · Training on marketing	Farmers: 1,800 (1 day seminar x 20 participants x 18 Pilot FOs x 5 seasons)
Establishment of Inland Fishery Model	Monitoring and evaluation	Activities for (1) and (2) shall be monitored and evaluated periodically, and then improved for the establishment of inland fishery model.	Farmers: 1,800 (1 day seminar x 20 participants x 18 Pilot FOs x 5 seasons)
	Hosting of trainees for non-model cascades	The farmers of non-model cascades can share the experience with farmers of pilot FOs, where it is expected to motivate the farmers to try the inland fishery model.	Farmers: 2,360 (1 day x 20 participants x (124-6) cascades)

Source: Study Team

4.4 Component 3: Project Management and Monitoring

The Component 3 will be considered essential for ensuring the smooth implementation of the Project. The PMU in consultation with the PIUs will operate, instruct and approve all activities within the Project.

(1) Establishment of PMU and PIUs

Officially deciding the Project with any financial resources, MoI might establish a PMU and PIUs. The required engineers and experts for PMU and PIUs will be employed or dispatched by ID, PID, DAD, and supporting agencies. Details of PMU and PIUs are described in Section 6.2.

Since the establishment of PMU/PIUs is before the procurement of the Consultant, the commencement of PMU/PIUs operation should be supported by ID, PID and DAD. The number of staffs from PID, DAD, ID, and supporting agencies shall be finalised by the MOI in consideration of their routing works.

The following activity will be conducted by PMU and PIUs for smooth implementation of the Project:

(a) Procurement of Office Facilities and Goods

Office facilities and goods for PMU and PIUs will be procured and supplied through supplier(s) under the supervision of PIUs. The tentative list of furniture and equipment for each office and accommodation is shown in the table below. Details for the procurement works are shown in Section 6.5.

Table 4.4-1 Tentative List of Office Furniture and Equipment

Facilities and Equipment	Qty.	Remarks
Renovation of offices for PMU and PIUs	-	-
Computer	9	PMU (2), PIU (PID, DAD) (7)
Printer	4	PMU (1), PIU (PID, DAD) (3)
Tablet PC	7	PIU (PID, DAD) (7)
Photo Copier	3	PMU (1), PIU (PID, DAD) (2)
Survey Equipment	3	PIU (PID, DAD) (3)
Computer	9	PMU (2), PIU (PID, DAD) (7)
Printer	4	PMU (1), PIU (PID, DAD) (3)

Source: Study Team

(b) Procurement of Local Consultant for Survey and Design of the Selected Subproject

PIUs will call the bidding for local consultant for the survey and design of the selected subprojects. Local consultant conducts detailed survey and design based on the approved preliminary design. Details for the procurement works are shown in Section 6.5.

(c) Procurement of Vehicles and Motorbikes

Vehicles and motorbikes for PMU, PIUs, supporting agencies, and the Consultant will be procured through the supplier(s) under the supervision of the PMU. The tentative list of vehicles and motorbikes for PMU, PIUs, and the Consultant is shown in the table below. Details for the procurement works are shown in Section 6.5.

Table 4.4-2 Tentative List of Vehicles and Motorbikes for PMU, PIUs, and the Consultant

Vehicles/ Motorbikes	Qty.	Remarks
Vehicle (4WD or Off-road Type)	7	PMU (1), PIUs (PID, DAD, ID) (5), Consultant (1)
Pick-up Truck	12	PIUs (PID, DAD, ID) (6), Supporting Agencies (NAQDA, PDOA, PDAH) (4), Consultant (2)
Motorbike (125 cc)	66	PIU (DAD, PID, ID) (36), Supporting Agencies (NAQDA, PDOA, PDAH) (18), Consultant (12)

Source: Study Team

(2) Strengthening of PMU and PIUs for Proper Project Management and Monitoring

(a) Preparation and Establishment of Manuals and Systems

For the smooth and proper implementation of the Project, the following manuals and systems will be prepared and established by PMU:

- Operation manual for the project implementation;
- Design criteria for the Project (for preliminary design and detailed design);
- Cost estimate system for the Project (for preliminary design and detailed design); and
- Guidelines for construction supervision and quality control for the Project.

The above manuals and systems shall be authorised by the MOI for the use in the operation and implementation of the Project. During the project implementation, these manuals and systems shall be reviewed and updated by the Consultant from time to time and whenever necessary. Concerned parties shall be informed regarding such updates under the authorisation of the PMU.

(b) Preparation and Planning of Training Programs

For the better understanding of the above manual and system by the concerned parties, the following training programs will be prepared and planned by the Consultant and approved by the PMU:

Table 4.4-3 Training Programs for Manuals and Systems to be Used in the Project

Manual/ System	Target	Timing
Operation Manual for Project Implementation	- PMU and PIUs staff - PID, DAD staff	After authorisation of the manual by PMU
Design Criteria for the Project	- PMU and PIUs staff - PID, DAD staff	After authorisation of the manual by PMU
Cost Estimate System for the Project	- PMU and PIUs staff - PID, DAD staff	After authorisation of the manual by PMU
Guidelines for Construction Supervision and Quality Control for the Project	- PMU and PIUs staff - PID, DAD staff	After authorisation of the manual by PMU
	- The contractors for civil works	Before the commencement of construction works

Source: Study Team

(c) Implementation of Training Programs

The training programs will be implemented by the Consultant as planned above. The refresher trainings will be planned and implemented to refresh the above training outcomes from time to time and whenever necessary.

(3) Monitoring and Evaluation (M&E)

(a) Establish M&E Frameworks

For the proper M&E of the Project activities, frameworks for M&E shall be prepared by PMU with the assistance of the Consultant. The M&E framework may include the following:

- Operation and effect indicators set forth in the loan agreement;
- Criteria for selection of subprojects for M&E;
- Method of sampling and survey to examine the indicators;
- Evaluation criteria; and
- Roles and responsibilities of the concerned agencies.

The above M&E frameworks shall be authorised by MOI for the use in the project works.

(b) Plan and Implement Training Programs

For better understanding of the above manual and system by the concerned parties, the following training program shall be planned and implemented by the Consultant in collaboration with the PMU:

Table 4.4-4 Training Programs for M&E Frameworks

Training Program	Target	Timing
M&E Frameworks	- PMU and PIUs staff, and - PID, DAD staff	After authorisation of the manual by PMU

Source: Study Team

The refresher trainings shall be planned and implemented to refresh the above training outcomes from time to time and whenever necessary.

(c) Implement M&E

The M&E of the project activities, including the environmental and social aspects, shall be implemented based on the M&E frameworks described above 1). Details of frameworks for environmental and social considerations are shown in Chapter 7.

(4) Thematic Study and Action Research

This item might be provisional and outsourced to local consulting firms by PIUs. The themes may be selected by PIUs and approved by PMU, for instances, drone survey, tank water level monitoring system, value chain analysis and crop monitoring system, depending on the actual needs that will arise during the project implementation period.

4.5 Component 4: Consulting Services

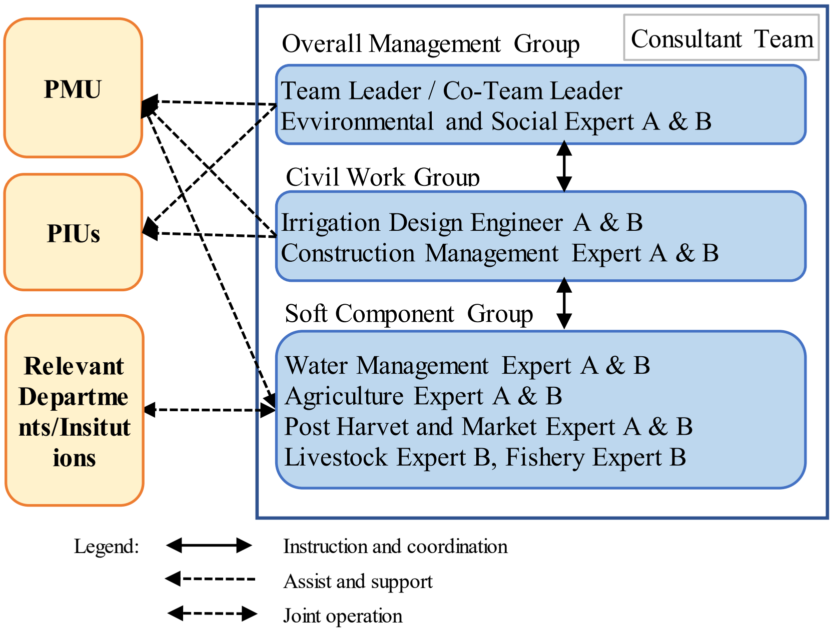
The consulting services would be provided by an international consulting firm (the Consultant) in association with the national consultant/s. The Consultant might be procured by the PMU under the supervision of MOI. For the efficient and proper management and implementation of the Project, the activities of the Consultant are to assist and advise the PMU in overall project management, and PIUs in the efficient and proper management and implementation of the Project, and PID, DAD, ID in necessary advice and technical guidance. In addition, the Consultant will carry out the activities of Component 2 as shown in Chapter 4.3. The scope of consulting services might cover the following:

- Overall project management (Task and Assistance);
- Review of detailed design (Task);
- Procurement (Assistance);
- Construction supervision (Assistance);
- Soft component (Task); and
- Project management and monitoring (Assistance).

The major activities of the Consultant are to assist PMU and PIUs in the following:

Project Management i) Overall project management and coordination among the agencies concerned; ii) Preparation of inception report, monthly, quarterly and annual progress report, service completion report, operation guidelines and other reports specified in draft TOR; iii) Preparation of annual work plan and budget estimate in standard forms; iv) Monitoring and reporting of physical and financial progress of all project activities; v) Project formulation study for future project, if required; vi) Arrangement of overseas trainings; and i) Safety in the project activities including preventive measures for COVID-19; and ii) In case of accidents during the construction, assist PMU to report-the details of such accidents in a proper manner.
Component 1 i) Check and review of detailed design on all civil works; ii) Selection of priority subprojects based on agreed criteria; iii) Procurement for civil works and goods; iv) Construction supervision of all civil works at least once a month including time control, quality control, cost control, finishing the contracts, safety management and settlement of disputes; v) Fund management including checking invoices to be submitted by the contractors and suppliers; and vi) Trouble shooting.
Component 2 vii) Preparation of the training materials and training plans; viii) Implementation of training plans; and i) Monitoring and evaluation of training activities.
Component 3 ii) Strengthen PMU and PIUs for proper project management and monitoring; iii) Implementation of monitoring and evaluation including benchmark survey, management information system (MIS) and environmental monitoring; and iv) Selection of subjects for thematic and action research and give technical advices to PMU.

The organisational structure of the Consultant Team is proposed as follows:



Source: Study Team

Figure 4.5-1 Proposed Organisation Structure of the Consultant Team

The draft terms of reference (TOR) for the consulting services on the Project is shown in Attachment 4.5-1.

CHAPTER 5 COST ESTIMATION

5.1 Basic Conditions of the Project Cost Estimation

The Project cost is tentatively estimated for 124 sub-projects, where the inventory survey conducted by the Study Team as described in Chapter 3.

(1) Composition of the Project Cost

The project cost is composed of the following items:

i) Part of procurement and construction cost

ii) Consulting service cost

iii) Land acquisition cost

iv) Incremental administration cost

v) Value added tax (VAT)

vi) Import tax

vii) Interest during construction

(2) Basic Conditions of the Project Cost Estimation

The basic conditions of the Project cost estimation are shown in the following table. The conditions are set as a sample.

Table 5.1-1 Basic Conditions of the Project Cost Estimation

Non-disclosure information

Source: Study Team

(3) Approaches for the Project Cost Estimation

The Project cost is estimated with the following approaches shown in the table below. –

Table 5.1-2 Approaches for the Project Cost Estimation

Non-disclosure information

Non-disclosure information

Note: (1) OPERATIONAL GUIDELINES ON PREPAREDNESS AND RESPONSE FORCOVID-19 OUTBREAK FOR WORK SETTINGS, 17 April 2020, issued by Ministry of Health and Indigenous Medical Services
Source: Study Team

5.2 Total Cost of the Project

The total cost of the Project is estimated as shown in the following table. The detailed cost is shown in Appendix 5.2-1.

Table 5.2-1 Total Cost of the Project

Non-disclosure information

Source: Study Team

Annual disbursement schedule of the Project is shown in the following table.

Table 5.2-2 Disbursement Schedule of the Project

Non-disclosure information

Source: Study Team

5.3 Breakdown of the Project Cost by Component

(1) Cost for Component 1: Infrastructure and Facility Development

Cost for Component 1 is shown in the following table. The basic design and the unit rate of each work and is shown in Appendix 5.3-1. The cost breakdown of each sub-projects for Subcomponent 1.1 is shown in Study Result 1 in Appendix.

Table 5.3-1 Cost for Component 1: Civil Works

Non-disclosure information

Source: Study Team

(2) Cost for Component 2 Soft Component

Cost for Component 2 is shown in the following table. The cost breakdown and unit rate is shown in Appendix 5.3-2.

Table 5.3-2 Cost for Component 2: Institution and Capacity Development

Non-disclosure information

Source: Study Team

(3) Cost for Component 3 Project Management and Evaluation

Cost for Component 3 is shown in the following table. Details of the cost breakdown is shown in Appendix 5.3-3.

Table 5.3-3 Cost for Component 3: Project Management and Evaluation

Non-disclosure information

Source: Study Team

(4) Cost for Component 4 Consulting Services

Cost for Component 4 is shown in the following table. Details of the cost breakdown and tentative assignment schedule of the Consultant is shown in Appendix 5.3-4.

Table 5.3-4 Cost for Component 4: Consulting Service

Non-disclosure information

Source: Study Team

5.4 Cost Reduction

Cost, time and quality are crucial aspects of the construction project and trade-off among them is an important factor when planning the project. It is well known that there is a trade-off between quality and project cost when formulating the optimal implementation plan. The Study Team examined the possibility of cost reduction within acceptable quality and project implementation period.

For the project implementation, the Study Team proposes the following improvements and measures for the purpose of cost reduction (details are described in Chapter 6):

1) Formulation of optimal construction plan
   - To plan survey and design works by local consulting firm(s) from the first year to start the rehabilitation work from the second year,
   - To prepare an optimal construction plan by local construction firms whereas international construction firms may not have an interest for the Project because of the project nature (small and scattered), and
   - To prepare a simple procurement plan to minimise the time requirement for the Project because of the project nature (large number of contract packages),

2) Appropriate bidding method
   - To apply a local competitive bidding (LCB) for the rehabilitation works to select the responsible and capable local construction firms at lower contract price, and
   - To obligate the use of new construction machineries to be stipulated in the bid documents to avoid delay of the works due to frequent damage of construction machineries.

3) Review of CSDPP implementation plan.
   - To minimise miscellaneous works related to tank irrigation systems (limited to the essential facilities only) by reviewing the rehabilitation works conducted in the model cascades under CSDPP.

4) Appropriate rehabilitation time schedule
   - To prepare a realistic rehabilitation time schedule in due consideration of experience and capacity of the counterpart agencies and local construction firms as well as the limited dry seasons for construction (May to September in general),
   - To plan the rehabilitation time schedule in consideration of regional balance and priority order

of the sub-projects.

Through the above items 1 to 4, the reduction of price escalation can be expected by the early commencement and completion of the construction works as well as early realisation of the project benefits can be expected.

In addition, the cost for operation and maintenance (O&M) can be reduced through the capacity building of Farmers Organisations (FOs), Provincial Department of Irrigation (PID) and Department of Agrarian Development (DAD) field officers.

CHAPTER 6 IMPLEMENTATION PLAN OF THE PROJECT

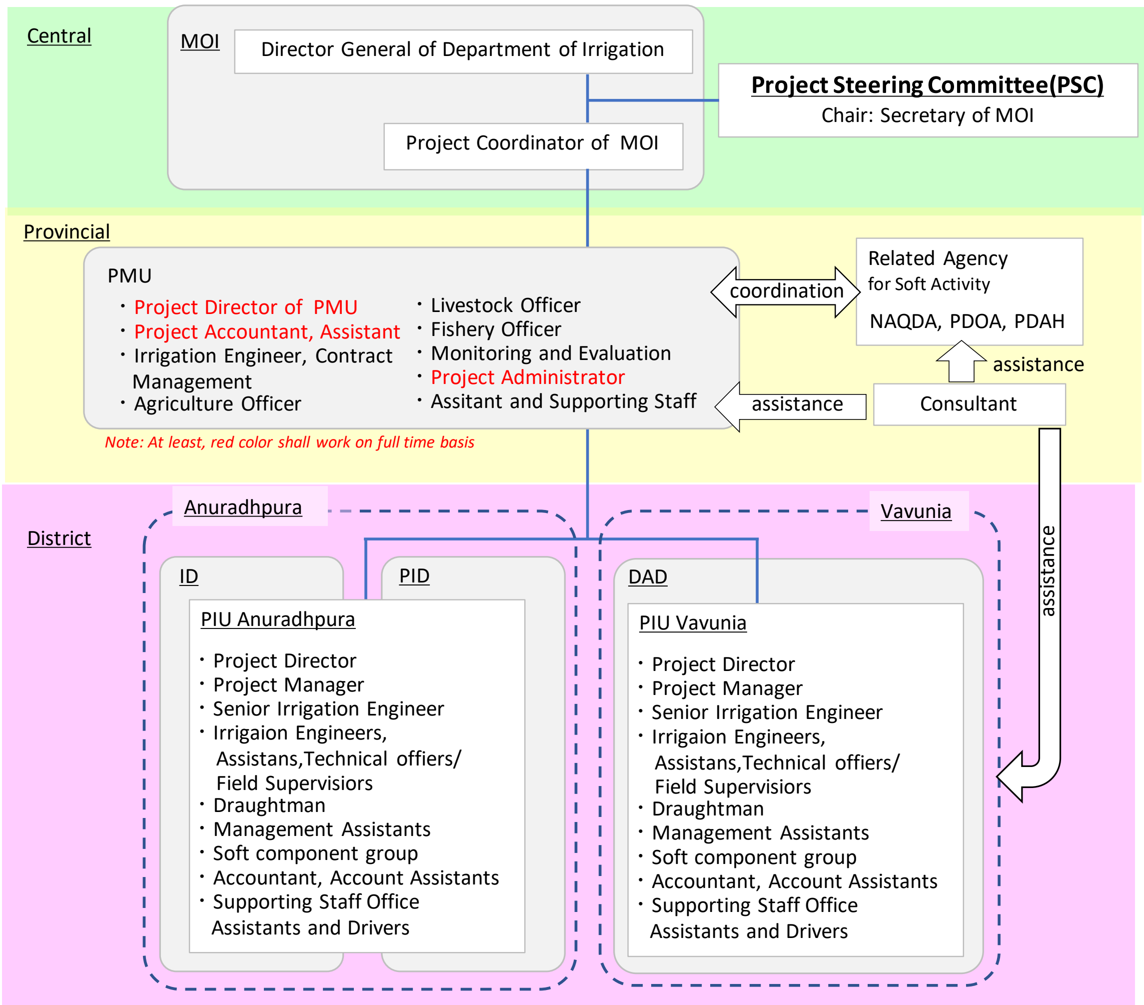
6.1 General

This chapter deals with the implementation plan of the Project, which consists of the project organisational structure, implementation procedure, implementation schedule, procurement plan, fund management, quality control, contract management, and safety management for the construction works.

6.2 Project Organisational Structure

6.2.1 Project Organisation for Implementation Stage

The executing agency is the Ministry of Irrigation (MOI). The MOI will set up the project organisation for the implementation as discussed below. The overall project organisation structure proposed for the implementation stage is shown in Figure 6.2-1. The project organisation structure will consist of the Project Management Unit (PMU) at the project level, the Project Implementation Unit (PIU) each in Anuradhapura and Vavuniya, with the national level Project Steering Committee (PSC).

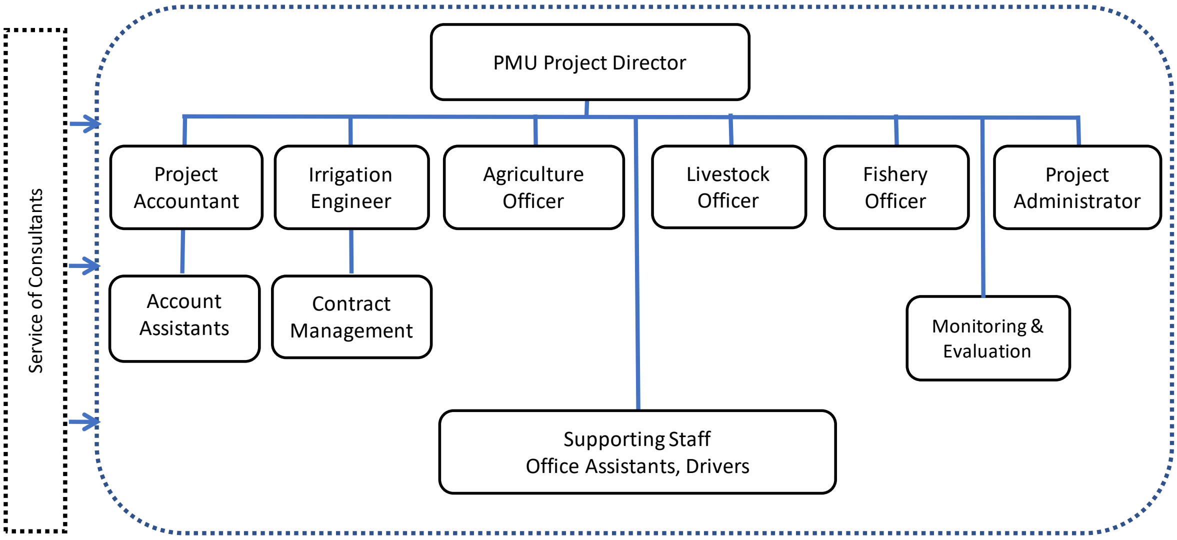


Source: Study Team

Figure 6.2-1 Overall Project Organisation Structure

(1) Project Management Unit (PMU)

The PMU at the project level will be newly established at the provincial council of North Central Province. The PMU is responsible for the overall project management including approval on several activity plans proposed by PIUs, fund management, progress monitoring and evaluation, problems and solutions, and coordination with relevant government departments and institutions with support from the Consultant. The proposed organisation of PMU will be as follows. The MOI shall make the necessary arrangement to depute officers to PMU.



Note: At least, the Project Director, Project Accountant, Project Administrator shall work on a full-time basis.
Source: Study Team

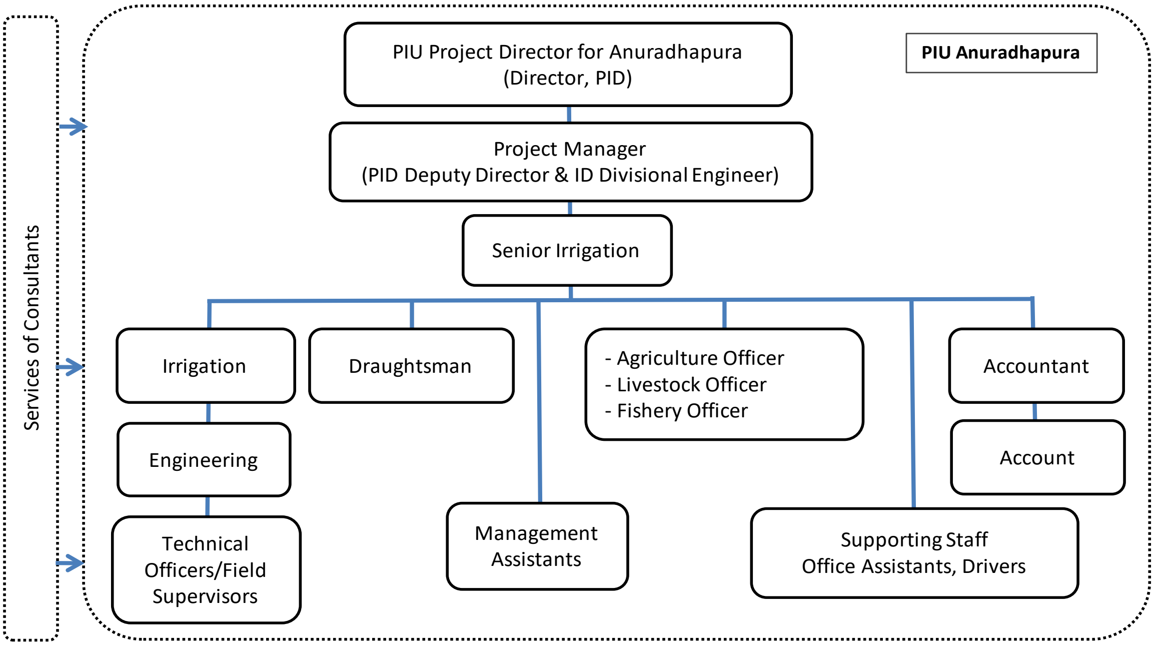
Figure 6.2-2 Organisation Structure of PMU at the Project Level

The major tasks of the PMU are summarised below but not limited to:

i) Overall project management;
ii) Procurement of the Consultant;
iii) Procurement of vehicles, office furniture and equipment required for the proper management and monitoring works;
iv) Preparation of annual financial forecast and submit it a lender for the concurrence;
v) Confirmation and approval on the subprojects proposed by PIU;
vi) Confirmation and approval on survey and design manual, cost estimate system and guideline for construction supervision submitted by PIU;
vii) Confirmation and approval on the contract for local consultant/s for the detailed design works of the selected subprojects submitted by PIU;
viii) Confirmation and approval on the contracts for infrastructure and facility development for the selected subprojects submitted by PIU;
ix) Confirmation and approval on the contract for procurement of machinery and equipment submitted by PIU;
x) Confirmation and approval on the training programs, training materials and evaluation reports for soft component submitted by the Consultant through PIU;
xi) Financial management for loan budget and government budget;
xii) Coordination among the departments/institutions concerned to the Project activities;
xiii) Recommendations on the required approval by MOI, committees, and/or a lender ;
xiv) Preparation of the guidelines and manuals required for the smooth implementation of the Project;
xv) Monitoring and evaluation of the Project activities; and
xvi) Preparation of the quarterly project status reports and completion reports at project level and submit those to a lender.

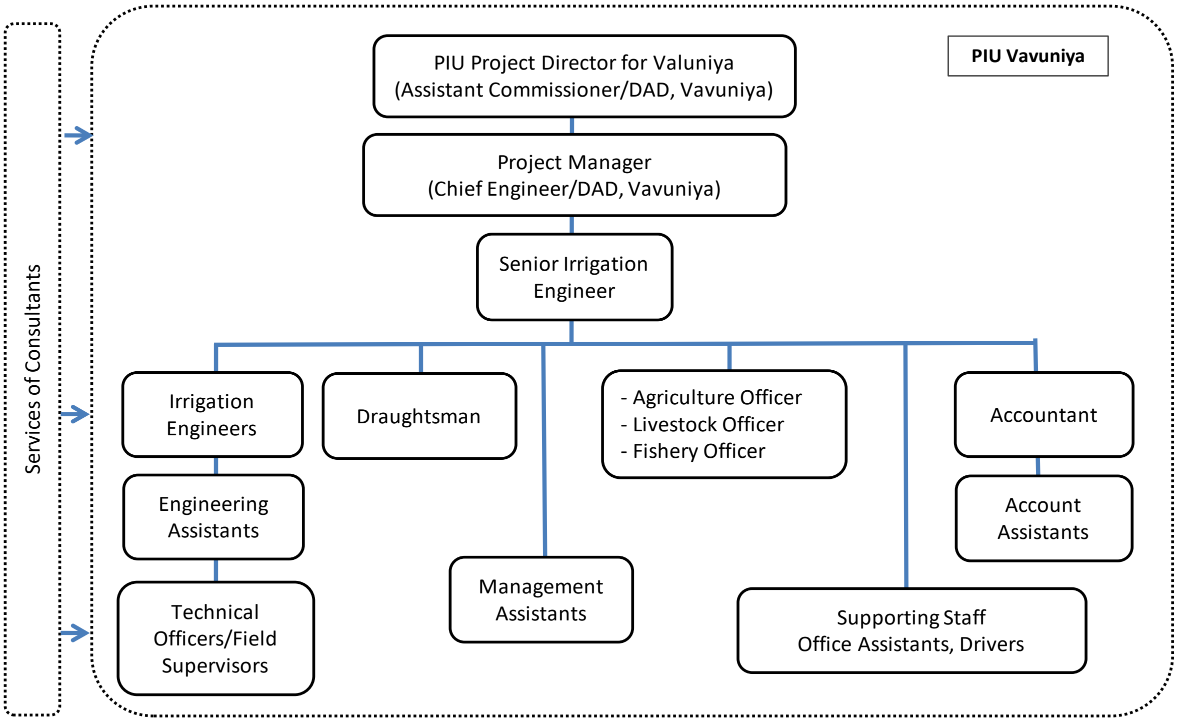
(2) Project Implementation Unit (PIU)

The Project Implementation Unit (PIU) will be established at the Provincial Department of Irrigation (PID) Office for Anuradhapura District and the Department of Agrarian Development (DAD) Office for Vavuniya District. The PIUs will be responsible for the implementation of various activities with support from the Consultant. The proposed organisation of PIU will be as follows. The MOI shall make the necessary arrangement to assign officers to respective PIUs exclusively for the Project.



Source: Study Team

Figure 6.2-3 Organisation Structure of PIU Anuradhapura



Source: Study Team

Figure 6.2-4 Organisation Structure of PIU Vavuniya

The major tasks of the PIUs are summarised below but not limited to:

- Selection of subprojects based on the agreed criteria;
- Preliminary design of the subprojects for final confirmation;
- Preparation of survey and design manual, cost estimate system and guideline for construction supervision and submit those to PMU for approval;
- Bidding of local consultant/s including preparation of bid documents for detailed design works of the selected subprojects after the PMU's approval;
- Supervision of detailed design works for the selected subprojects;
- Bidding of civil works including preparation of bid documents for the selected subprojects after the PMU's approval;
- Construction supervision of subprojects at the district level;
- Selection of machinery and equipment based on the agreed criteria;
- Bidding of suppliers for procurement of machinery and equipment after the PMU's approval;
- Supervision of the procurement works;
- Check and review of annual training plan to be submitted by the Consultant and submit it to PMU for approval;
- Supervision of training activities;
- Coordination among the government departments concerned at the district level;
- Monitoring and evaluation of all activities at the district level and report to PMU; and
- Preparation of the subproject status and completion reports at the district level and report those to PMU.

(3) National Level Project Steering Committee

The national level PSC will be established at the MOI to make important decision, to monitor and evaluate the work progress, and to coordinate for supporting works among the agencies concerned at the national level. <u>The secretary of the MOI will chair the committee and call the meeting every three months</u>. A project coordinator will be appointed from the members of the PSC and he/she will devote efforts to coordinate between the MOI and PMU. The PSC members are proposed as shown below.

Table 6.2-1 Proposed Members of the National Level Project Steering Committee

Members	Position
Relevant State Ministries	Secretaries
Ministry of Irrigation (MOI)	Add. Secretary
Department of Irrigation	Director General
Department of Agriculture	Director General
Department of Agrarian Development (DAD)	Commissioner General
Water Management Division, DAD	Head
Animal Production and Health	Director General
National Aquatic Resources and Research and Development Agency (NAQDA)	Director General
Department of External Resources (ERD)	Director
Department of National Planning (NPD)	Director
North Central Province (NCP)	Chief Secretary
Northern Province (NP)	Chief Secretary
PIU Anuradhapura	Director, PID (Anuradhapura)
PIU Vavuniya	Assistant Commissioner, DAD (Vavuniya)
Project Consultants	Team Leader
Others	Others named by the chairperson

Source: Study Team

6.2.2 Project Organisation for Operation and Maintenance Stage

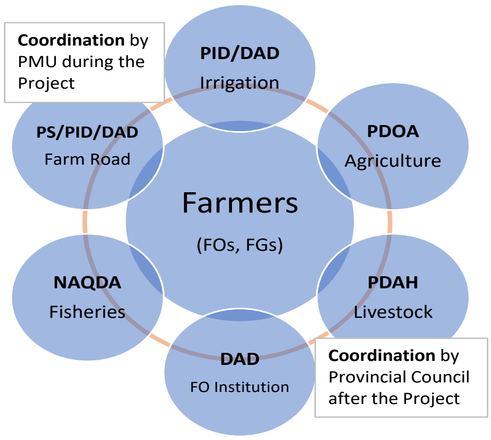
The project organisation for the operation and maintenance (O&M) stage in principle is same as those for the implementation stage.

Table 6.2-2 Responsible Agencies for O&M

Operation and Maintenance	Anuradhapura District	Vavuniya District
Major irrigation schemes	ID (MOI)	ID (MOI)
Medium irrigation schemes	ID (MOI), PID	PID
Minor irrigation schemes	PID	DAD
Farm roads	Pradeshiya Sabha (PS), PID	Pradeshiya Sabha (PS), DAD
Farmers' organisation (FO)	DAD	DAD
Agriculture extension services	PDOA	PDOA
Livestock	PDAH	PDAH
Fisheries	NAQDA	NAQDA

Source: Study Team

The PMU will monitor and evaluate the overall O&M activities and make necessary coordination among the departments and agencies concerned during the project period.



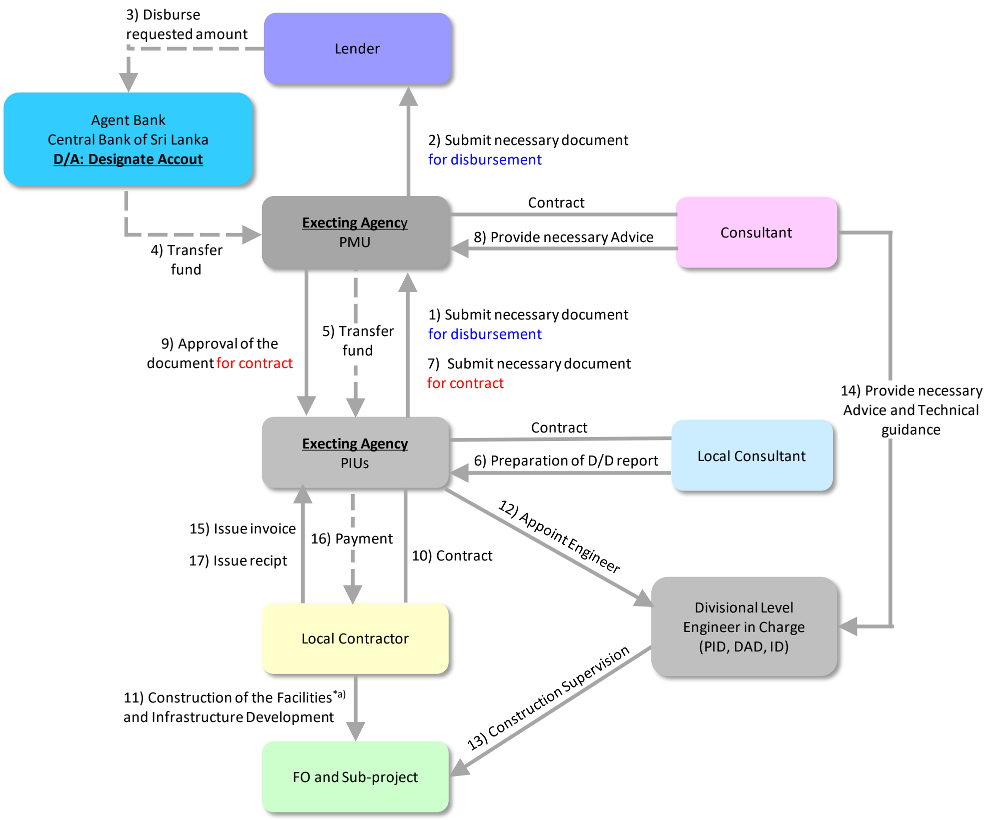
Source: Study Team

Figure 6.2-5 Organisation Structure for the O&M Stage

6.3 Implementation Procedure

6.3.1 Subcomponent 1.1: Infrastructure and Facility Development

The implementation procedure of Subcomponent 1.1: Infrastructure and Facility Development is shown in Figure 6.3-1 that is an example of borrowing from donors.



Source: Study Team

Figure 6.3-1 Implementation Procedure of Subcomponent 1.1

The implementation procedure of Subcomponent 1.1 will be as follows. The detailed fund flow is shown in the following Section 6.6.

1) PIUs prepare financial forecast and inform the required amount and submit it to PMU.
2) PMU submits the request for disbursement to a lender.
3) A lender disburses the requested amount to the nominated agent bank.
4) Agent bank transfers the fund to PMU project A/C after converting the fund in international currency to LKR.
5) PMU transfers the fund to PIUs project A/C.
6) The detailed design report of the subproject approved by MOI is prepared by the local consultant procured by PIU.
7) PIU submits the necessary document including the detailed design report to PMU. PMU reviews it.
8) At that time, the Consultant reviews and provides necessary advice to PMU.
9) PMU approves the start of the construction of subproject to PIU.
10) PIU procures the local contractor.
11) The local contractor implements the construction of the infrastructure and facilities.
12) PIU appoints the engineer for the construction supervision from divisional level engineer in charge in PID, DAD, ID.
13) The engineers appointed by PIU carry out the construction supervision.

14) The consultant provides the advice and the technical guidance to the engineer in charge of supervision.
15) Contractor issues the invoice for the works to PIUs.
16) PIUs pay the invoiced amount to Contractor.
17) Contractor issues the receipt for the works to PIUs.

Under Subcomponent 1.1, the activities of (1) detailed design works, (2) procurement of contractor(s), (3) civil works for rehabilitation and/or construction of irrigation facilities including the FO's offices and agriculture-related facilities will be carried out after getting the PMU's approval on subprojects as described in Chapter 4.

The suggestions and remarks for the implementation of these activities are described below.

(1) Detailed Design Works

After getting the PMU's approval on the subprojects, the PIUs will procure a local consultant firm for the detailed design work. For the first stage group, the respective PIU should complete the survey and detailed design without the assistance of the Consultant since the Consultant will be procured under Component 4 by PMU during this period. From the second stage group, the Consultant shall assist the PIUs in the detailed design.

The following are suggested for the implementation of detailed design works:

i) It is suggested that the following activities be commenced immediately after the loan agreement and completed by the end of the first year:
    - Survey and design manual for the rehabilitation works,
    - Cost estimate system, and
    - Guidelines for construction supervision and quality control.
ii) The detailed design works that are carried out based on the survey, design criteria, and cost estimate system prepared by PIUs and approved by PMU are to be implemented under Component 1.

(2) Preparation of Package Plan

After the PMU's approval on the detailed design report, the PIU shall consider a package plan for each subproject in every stage (every year).

The contract packaging of subprojects will be determined based on locations, work quantities, and cost of subproject. It is noted that the financial limit of the registered construction companies and the management capacity of PID and Department of Agrarian Development (DAD) should be considered in packaging plan for smooth bidding and efficient implementation of the subproject. Detailed procedures of the package plan are shown in Section 6.5.1.

(3) Bidding and Procurement of Contractor

Based on the results of the detailed design works, contractors will be procured for the civil works and facilities by respective PIUs. To reduce the number of contracts for the PMU and PIU smooth operation, the contract shall include the construction and/or rehabilitation of the civil works and facilities.

The facilities, which are constructed or procured by the contractor under the supervision of PIUs, will be provided to FOs so that they can operate and maintain such facilities by themselves. Detailed procedures of the procurement are shown in Section 6.5.1.

(4) Civil Works for Rehabilitation and Construction of Infrastructure and Facility

(a) Construction Supervision

To monitor the progress of the construction works and discuss the issues at the site, the following regulator special construction meetings should be held for proper construction supervision:

Table 6.3-1 Regular and Special Construction Meeting

Name	Timing	Chairman	Co-chairman	Member	Main Agenda
Monthly construction meeting	Monthly	Irrigation Engineer (PIU)	Assistant Engineer (PIU)	- Consultant - Contractor - FO	- Progress, quality, and safety - Decisions for required actions such as special meeting, warning letter, variation order, extension of time, contract amendment, etc.
Weekly construction meeting	Weekly	Irrigation Engineer (PIU)	Assistant Engineer (PIU)	- Consultant - Contractor - FO	- Progress, quality, and safety - Discussion for required actions such as special meeting, warning letter, variation order, extension of time, contract amendment, etc.
Special meeting	As required	Project Director (PIU)	Irrigation Engineer (PIU)	- Consultant - Contractor - FO	- Specific issues for discussion (delay of the works, low quality of the works, etc.)

Source: Study Team

(b) Quality Control

Supervision of the quality control done by the contractors will be the responsibility of the engineering assistants at the field level under the guidance of an irrigation engineer (subproject manager) in the PIU. The quality of construction works should be controlled based on the check list for construction supervision and quality control for the Project to be developed by the Consultant under Component 4. It is suggested that the PIU instructs the contractors at the pre-construction meeting that the quality of the construction works should be controlled based on such check list.

Based on the monitoring and evaluation through the above construction meetings, whenever necessary, warning and penalty to be imposed upon the contractors should be strictly applied in accordance with the relevant clauses of the specifications and conditions of the contract.

Additionally, for the proper monitoring of the quality control activities, it is recommended to instruct the contractor to submit “Quality Assurance of the Works” at the beginning of the construction and “Monthly Quality Report” in a timely manner. Details for the quality control are described in Section 6.8.

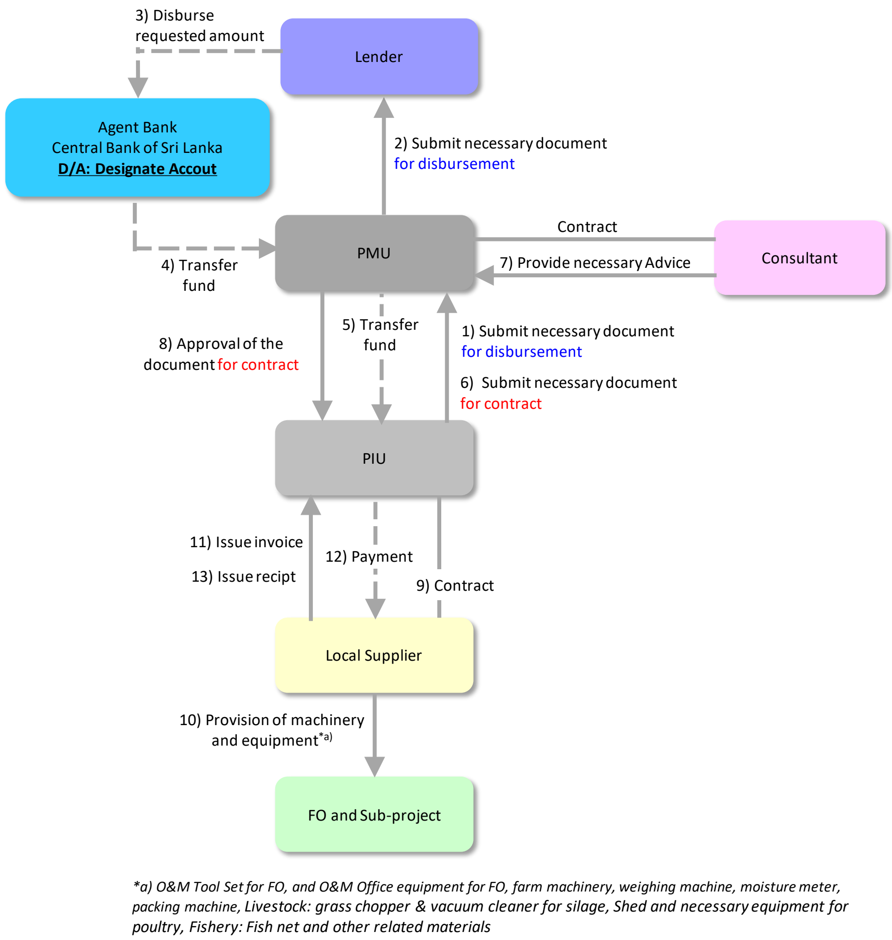
(c) Safety Control

The following safety control activities should be carried out to avoid serious accidents:

- Submission of “working safety plan” by the Contractor and approval by PIU;
- Weekly and monthly safety patrol by the contractor and the PIU assistant engineer;
- Reporting of results of weekly and monthly safety patrol and discussions for proper safety manners to be taken by the contractors in the weekly and monthly meetings (recorded as minutes of meeting); and
- Description of the above activities in weekly and monthly reports submitted by the contractors. Details for the safety control are shown in Section 6.9.

6.3.2 Subcomponent 1.2: Provision of Machinery and Equipment

The implementation procedure of Subcomponent 1.2: Provision of machinery and equipment is proposed as shown in the following figure.



Source: Study Team

Figure 6.3-2 Implementation Procedure of Subcomponent 1.2

The implementation procedure of Subcomponent 1.2 will be as follows. The detailed fund flow is shown in the following Section 6.6.

1) PIUs prepare financial forecast and inform the required amount and submit it to PMU.
2) PMU submits the request for disbursement to a lender.
3) A lender disburses the requested amount to the nominated agent bank.
4) Agent bank transfers the fund to PMU project A/C after converting the fund in international currency to LKR.
5) PMU transfers the fund to PIUs project A/C.
6) PIU will examine whether the proposed machinery and equipment should be procured based on the selection criteria. PIU prepares the request list and necessary documents quarterly and submits them to PMU.
7) At that time, the Consultant provides necessary advice to PMU.
8) PMU approves to procure machinery and equipment.
9) PIU contracts to procure the machinery and equipment through the local supplier.
10) The local supplier provides the machinery and equipment to FO and subproject.
11) The local supplier issues the invoice for machinery and equipment to PIUs.
12) PIUs pay the invoiced amount to the local suppliers.

13) The local supplier issues the receipt for the O&M machinery and equipment to PIUs.

Under Subcomponent 1.2, the activities of procurement of machinery and equipment for O&M, agricultural production, and farm income diversification will be carried out.

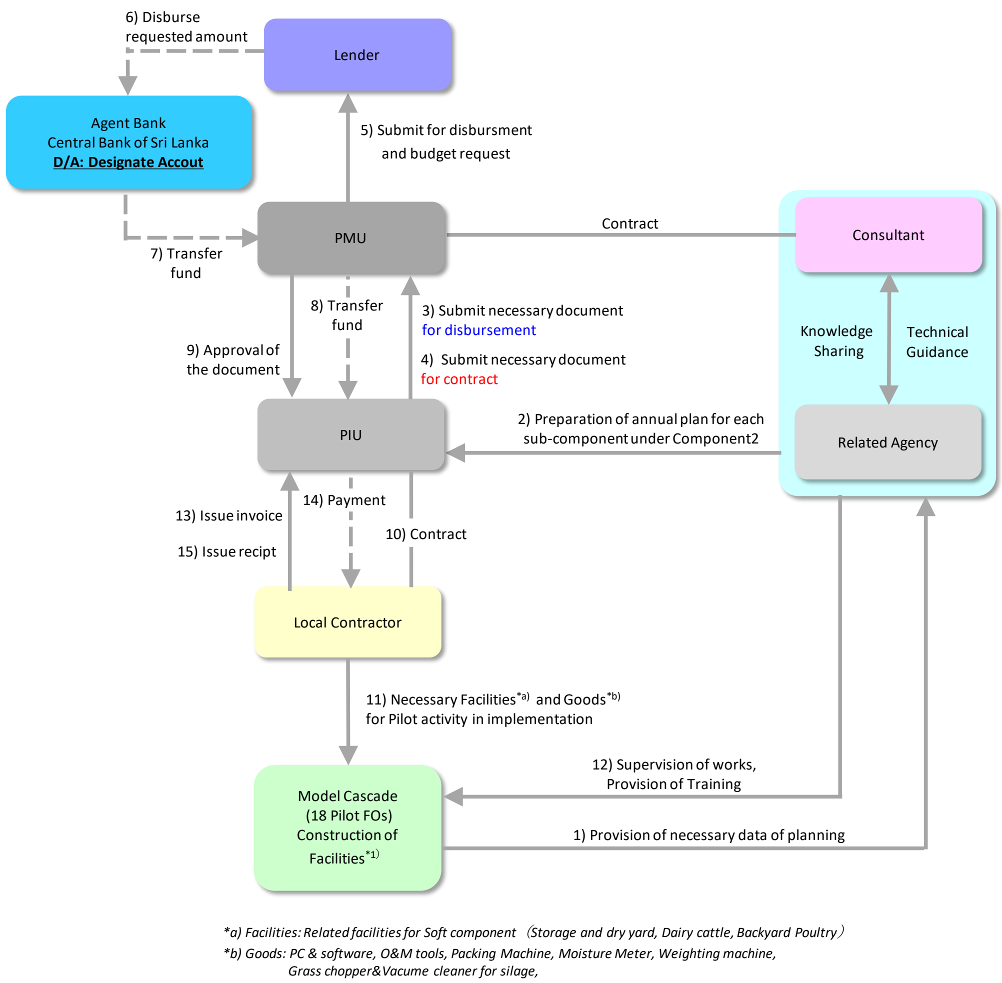
The requests for procurement of machinery and equipment will be accepted as needed from the beginning of the second year, a procurement list will be prepared based on the requests by the PIU on a quarterly basis, and necessary documents will be prepared and submitted to PMU. After the PMU approval, the PIU will place an order to the supplier who selected by tender, and the equipment will be distributed to each subproject.

The machinery and equipment to be procured under the Subcomponent 1.2 are as follows but not limited to:

Personal computer and software, O&M tools, packing machine, moisture meter, weighting machine, grass chopper and vacuum cleaner for silage, farm machinery, and other necessary for proper O&M, agricultural production, and farm income diversification.

6.3.3 Component 2: Soft Component

Various training activities under the Component 2: Soft Component will be carried out for 18 pilot FOs (three each in the model cascades). The Consultant will implement the soft component activities in collaboration with the supporting agencies responsible for the specific fields as shown in Figure 6.3-3 below. The detailed fund flow is shown in the following Section 6.6.



Source: Study Team

Figure 6.3-3 Implementation Procedure of Component 2

The activity of soft component is not only the training but also the procurement of related facilities and goods necessary for soft component. The implementation procedure of Subcomponent 2 will be as follows. The detailed fund flow is shown in the following Section 6.6.

1) Eighteen pilot FOs provide necessary data for planning to the Consultant and related agency.
2) The Consultant and the related agency prepare the annual plan (include procurement plan of the related facilities and goods for soft component) for each subcomponent under Component 2, and submit them to the PIU.
3) At the same time, the PIUs prepare the financial forecast and inform the required amount and submit it to PMU.
4) PIUs prepare and submit the necessary documents regarding the training plan to PMU.
5) PMU submits the request for disbursement to a lender.
6) A lender disburses the requested amount to the nominated agent bank.
7) Agent bank transfers the fund to PMU project A/C after converting the fund in the international currency (e.g. USD, EUR, JPY) to LKR.

8) PMU transfers the fund to PIUs project A/C.
9) At the same time, PMU approves the plan of annual training activities and procurement of the facilities and goods.
10) PIU contracts to procure the facilities and goods for the pilot activity through the local contractor.
11) The local contractor constructs the necessary facilities and supplies the goods to 18 pilot sites.
12) The Consultant and the related agency carry out the supervision for the construction of facilities during construction period and conduct the several training for FOs.
13) The local contractor issues the invoice for necessary facilities and goods to PIUs.
14) PIUs pay the invoiced amount to the local suppliers.
15) The local contractor issues the receipt for the works to PIU.

The suggestions and remarks for the implementation of these activities are described below.

(1) Selection of Pilot FO

The pilot FOs are selected from six model cascades in consideration of area balance, soil pattern, water availability, ethnic balance, etc. After the discussion with concerned FOs and supporting agency, the Consultant will select the candidate FOs and inform to PIUs for getting the approval of PMU.

(2) Preparation of Annual Plan for Each Program

The Consultant will prepare the annual plan every year for each program in collaboration with the supporting agencies, which include schedule, cost, responsibilities of stakeholder in charge, expected participants, material and equipment required for training or activities. Annual plan shall be submitted to PIUs for getting the PMU's approval.

(3) Preparation of Training Material for Each Program

For the various trainings proposed for each subcomponent, the training manual shall be prepared by the Consultant in collaboration with the supporting agencies.

(4) Implementation of Programs

The Consultant will implement the training programs for the pilot FOs from the second year of this Project in parallel to the infrastructure and facility development of model cascades to be commenced in the second year (first stage group). As described in Section 4.3, the model cascades should be set as top priority for the early attainment of the project purpose.

(5) Dissemination of Pilot FO Model to Other FOs

The outcome of five subcomponents to be conducted to the pilot FOs shall be disseminated to other FOs in other cascades (subprojects) by means of inviting and hosting trainees from other FOs to the pilot FO sites. The invitees should be selected from the FO leaders or other representatives within the subprojects, where the Subcomponent 1.1 activities (civil works and facilities) are completed and the improved irrigation facilities are available for intensive farming.

(6) Procurement of Contractor for Training Facilities/Goods

The following training facilities and goods are necessary to promote farm income diversification:

Table 6.3-2 Training Facilities/Goods for Component 2

Subcomponent	Material Name
1. Institutional and Capacity Development	None
2. Agriculture Development	Goods for land preparation, levelling, nursery, harvesting and processing organic manure, fertiliser, weedicide, and pesticide
3. Post-harvest and Marketing Development	Drying yard, storage, weighing machine, moisture meter and packing machine
4. Livestock Development	Grass chopper, vacuum cleaner, and other equipment for silage Shed for dairy cattle and backyard poultry, equipment for dairy kit
5. Fishery Development	Fish net and other materials

Source: Study Team

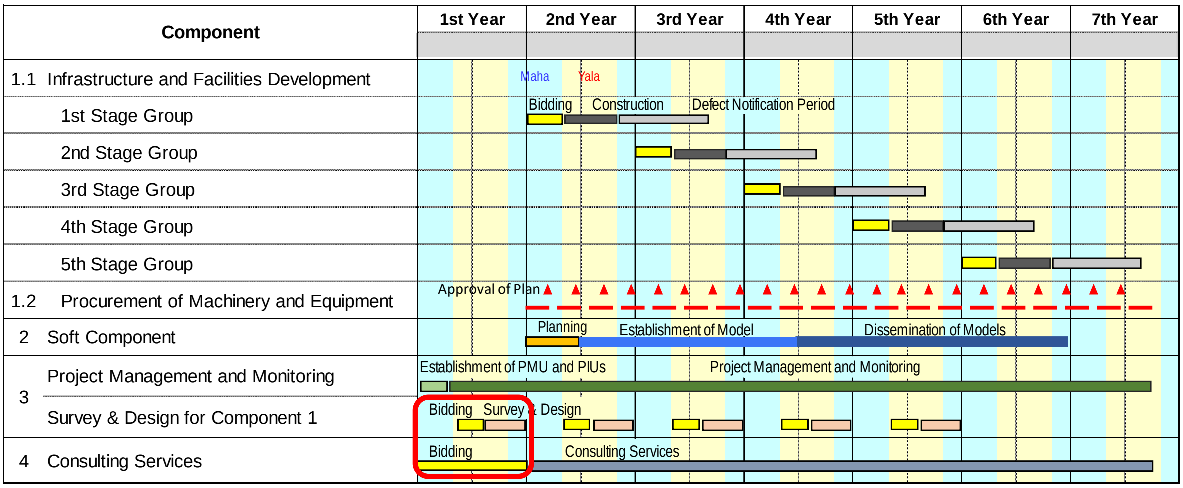
(7) Handing Over Training Facilities/Goods to FO

After the implementation of the training programs, an agreement for handing over the facilities and/or equipment will be concluded between the PIU and the pilot FOs, while the responsibilities of O&M for the facilities and/or goods will be transferred to FOs accordingly.

6.4 Implementation Schedule

6.4.1 Overall Implementation Schedule

The Project assumes to be a sector loan-type project including the numbers of subprojects scattered over Anuradhapura District and Vavuniya District. The tentative overall implementation schedule of the Project is shown in the following Figure 6.4-1.



The survey and design precede the consulting services

Source: Study Team

Figure 6.4-1 Tentative Overall Implementation Schedule

The total implementation period of the Projectcould be set at seven years including one year for procurement of the consulting services, five years for infrastructure and facility development, and five years for soft component.

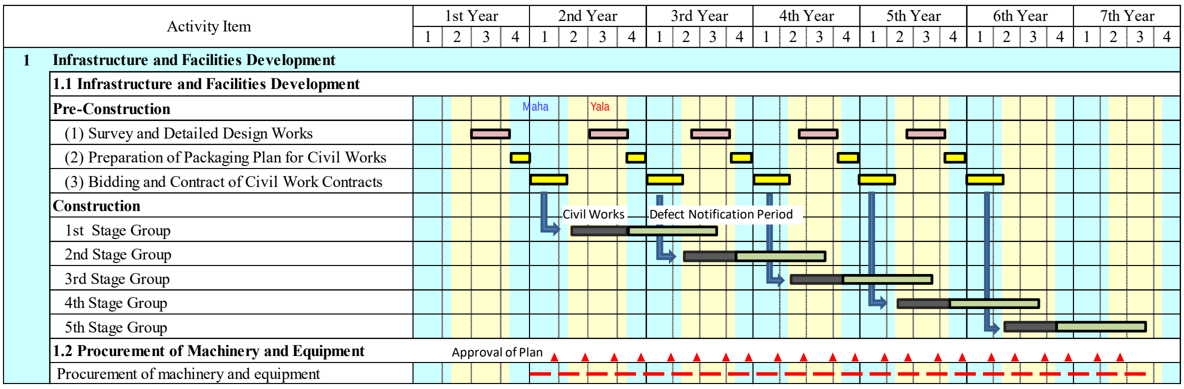
As described in Chapter 4, it is proposed to adopt a stage-wise implementation for the Project. The review result of implementation schedule, which is prepared by CSDPP is shown in Attachment 6.4-1. Infrastructure and facility development works could commence at the second year for the subprojects in the first stage group. It should be noted that the total number of subprojects to be implemented by the Project may be changed by the total budget and time for implementation.

In parallel with the infrastructure and facility development works, Component 2: Soft Component activities will be implemented. Six subprojects (refer to Section 4.3.1), where the Component 2 will be implemented, will be selected as a part of the first stage subprojects for smooth implementation of Component 2.

Additionally, the progress and outcomes of these activities will be monitored and evaluated under Component 3. All these activities will be implemented with the assistance of the Consultant to be employed under Component 4.

6.4.2 Component 1: Cascade System Development

The following Figure 6.4-2 shows the proposed implementation schedule of the Component 1: Cascade System Development (Subcomponent 1.1: Infrastructure and Facility Development and Subcomponent 1.2: Procurement of Machinery and Equipment).



Source: Study Team

Figure 6.4-2 Component 1: Cascade System Development

6.4.3 Component 2: Soft Component

The activities for the soft components will start at the middle of the second year with a total period of five years. The implementation schedule of the soft components has been prepared assuming the following conditions. For the stage of the dissemination of model, the field trainings will be organised at the selected six cascades, inviting the representatives of FOs in the neighbouring cascades.

Planning	:	6 months (from July to December) in 2nd year
Establishment of model	:	24 months (from January to December) in 3rd and 4th year
Dissemination of model	:	30 months (from January to December) in 5th to 7th year

The trainings and other activities will be planned based on the following assumption:

Institution and Capacity Development:

- ✓ Trainings for operation mainly in the wet seasons and maintenance in the dry season

Agriculture Development:

- ✓ Trainings for improvement of farming technologies mainly in the wet season

Post-harvest and Marketing Development:

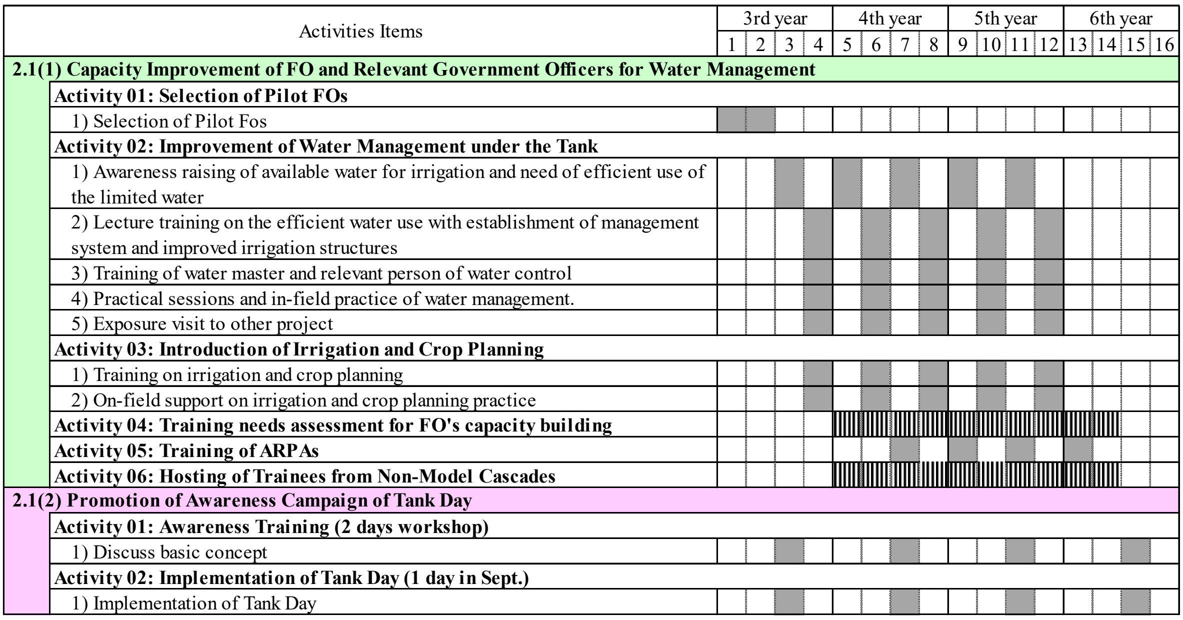
- ✓ Trainings for improvement of post-harvest and marketing mainly after the wet season

Livestock and Fishery Development:

- ✓ Trainings mainly in the wet season

(1) Subcomponent 2.1: Institution and Capacity Development

The following figure shows the proposed implementation schedule of Subcomponent 2.1 "Institution and Capacity Development". As shown in the figure, these activities start from the third year of the Project and would last for four years.



Source: Study Team

Figure 6.4-3 Subcomponent 2.1 Institution and Capacity Development

(2) Subcomponent 2.2: Agriculture Development

The following figure shows the proposed implementation schedule of Subcomponent 2.2 "Agriculture Development". The activities start from the second year of the project and would last for five years.

Activities Items	2nd year				3rd year				4th year				5th year				6th year			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2.2(1) Cultivation Skills Development with Provision of Quality Inputs																				
Activity 01: Promotion Seminars on Crop Diversification (Traditional Rice and High- Value Crops)																				
1) Awareness raising programme for officers on crop diversification																				
2) Awareness raising programme for farmers on crop diversification																				
Activity 02: Preparation of Action Plan for Crop Diversification																				
1) Training for officers on preparation of action plan																				
2) Training for officers on preparation of action plan																				
Activity 03: Promotion of Good Agriculture Practice (GAP)																				
1) Training for officers on GAP																				
2) Training for farmers on GAP																				
Activity 04: Skills Development																				
1) Training for Officers (nursery, irrigation, cultivation, harvesting, post-harvesting handling)																				
2) On-site training for farmers at demo farm (nursery, irrigation, cultivation, harvesting, post-harvesting handling)																				
3) Field day for experience sharing to other farmers at demo farm																				
4) Monitering and evaluation																				
Activity 05: Provision of Quality Inputs																				
1) Demonstration and trainig of materials for provision of quality by suppliers																				
Activity 06: Hosting of trainees for non model cascades																				
1) Hosting of trainees for non model cascades																				
2.2(2) Enhancement of Agriculture Extension System																				
Activity 01: Farmer to Farmer (FTF) Extension Programme																				
1) Selection of farmer leaders from 18 pilot sites for FTF training																				
2) Training for farmer leaders on how to conduct FTF training																				
3) FTF training for other FOs of the same cascade by farmer leaders at demo farm																				
Activity 02: Establishment of Collaborative Extension Mechanism																				
1) Demonstration for farmers on materilas and techniques from private sector and matching seminar with farmers																				
2) Exposure visit for farmers to private sectors																				
3) Planning on training on materials, techniques and information of private sectoers																				
4) Training on materials, techniques and information of private sectoers																				
Activity 03: Enhancement of Agriculture Extension System																				
1) Monitoering and evaluation																				
2) Hosting of trainees for non model cascades																				

Source: Study Team

Figure 6.4-4 Subcomponent 2.2 Agriculture Development

(3) Subcomponent 2.3: Post-harvest and Marketing Development

The following figure shows the proposed implementation schedule of Subcomponent 2.3 "Post-harvest and Marketing Development". The activities start from the second year of the project and would last for five years.

Activities Items	2nd year				3rd year				4th year				5th year				6th year			
	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2.3(1) Establishment of the Community Supported Agriculture Model of High Value Vegetable																				
Activity 01: Selection of Pilot sites																				
1) Seminar on selection of trial farmers with awareness raising programme for importance of post-harvesting and marketing																				
2) Awareness raising programme for importance of post-harvesting and marketing																				
Activity 02: Formulation of the Partnership																				
1) Exposure visit and identification of requirement (crop, quality, order-delivery management, traceability management) of hotels by farmers																				
2) Preparation of business planning for crop production and outbound logostocs																				
3) Formulation of agreement between CMO/FOs and hotels																				
Activity 03: Skills Development for Post-harvesting with Required Quality																				
1) Training for officers (Planning, Procurement, Construction, Operation of grain drying, Operation of storage for paddy)																				
2) Training for officers (Post-harvesting handling for vegatbles)																				
3) Training for farmers (Planning, Procurement, Construction, Operation of grain drying, Operation of storage for paddy)																				
4) Training for farmers (Post-harvesting handling for vegatbles)																				
5) Training on Order-Delivery Management																				
Activity 04: Establishment of the Model of High Value Vegetable																				
1) Monitoering and evaluation																				
2) Hosting of trainees for non model cascades																				

Source: Study Team

Figure 6.4-5 Subcomponent 2.3 Post-harvest and Marketing Development

(4) Subcomponent 2.4: Livestock Development

The following figure shows the proposed implementation schedule of Subcomponent 2.4 "Livestock Development". The activities start from the second year of the project and would last for five years.

Activities Items	2nd year				3rd year				4th year				5th year				6th year			
	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2.4(1) Stable Feed Production and Delivery through Entrepreneur Development																				
Activity 01: Selection of Pilot Site																				
1) Selection of Pilot Site		■																		
Activity 02: Skills Develoment of Production of Silage																				
1) Training on economic value of crop residue			■				■				■				■				■	
2) Training on processing of crop residue with equipment, machinery, storage and packing				■				■				■				■				■
3) Training on improvement of nutritive quality of crop residue					■				■				■				■			■
Activity 03: Enhancement of Entreprenuer Development																				
1) Training on Initial Fund to Start Silage			■				■				■				■				■	
2) Workshop for other farmers on dairy cattle			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
2.4(2) Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System																				
Activity 01: Selection of Pilot Site																				
1) Selection for backyard poultry		■																		
Activity 02: Skills Develoment of Livestock																				
1) Training on dairy cattle (each stage of production: Rearing, Feeding, Breeding, Managing, Milking)			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
2) Training on backyard poultry (each stage of production: Rearing, Feeding, Managing, Hatching)			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
Activity 03: Enhancement of collaboration with private sectors for value chain system																				
1) Exporsure visit for farmers to private sectors (collecters of milk, egg, dayold chicken)			■				■				■				■				■	
2) Planning on action plan based on exporsure visit				■				■				■				■				■
3) Training along to action plan				■	■			■	■			■	■			■	■			■
Activity 04: Establishment of Livestock Model																				
1) Monitoering and evaluation			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
2) Hosting of trainees for non model cascades			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥

Source: Study Team

Figure 6.4-6 Subcomponent 2.4 Livestock Development

(5) Subcomponent 2.5: Fishery Development

The following figure shows the proposed implementation schedule of Subcomponent 2.5 "Tank Fishery Development". The activities start from the second year of the project and would last for five years.

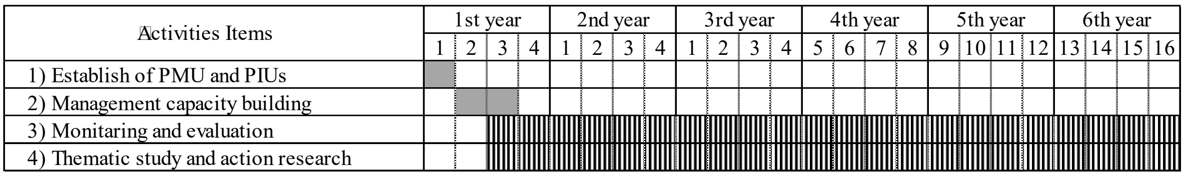
Activities Items	2nd year				3rd year				4th year				5th year				6th year			
	1	2	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2.5(1) Promotion of Inland Fishery Development in Selective Tank																				
Activity 01: Selection of Pilot Site																				
1) Selection of Pilot Site		■																		
Activity 02: Skills Develoment of inland fishery																				
1) Training on inland fishery production			■				■				■				■				■	
2) Training on management by FO				■				■				■				■				■
3) Training on marketing					■				■				■				■			■
Activity 03: Establishment of Inland Fishery Model																				
1) Monitoering and evaluation			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
2) Hosting of trainees for non model cascades			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥

Source: Study Team

Figure 6.4-7 Subcomponent 2.5 Fishery Development

6.4.4 Component 3: Project Management and Monitoring

The following figure shows the proposed implementation schedule of Component 3 "Project Management and Monitoring". As shown in Figure 6.4-1, most of the preparatory works for Component 3 shall be completed in the first year. Since certain implementation of these preparatory works will be crucial for the smooth and efficient implementation of the Project, it is recommended that a lender provides specific inputs and support to assist the PMU and PIUs in the implementation of the said activities.



Source: Study Team

Figure 6.4-8 Component 3 Project Management and Monitoring

6.4.5 Component 4: Consulting Services

Immediately after the conclusion of the loan agreement, PMU will start the procurement of the Consultant. The ICB procedure and Quality Cost Based Selection (QCBS) will be suggested for the procurement (refer to Section 6.5.4). Generally, it takes about one year for the procurement of the Consultant. The consulting services last for six years as shown in Figure 6.4-1.

As discussed in Section 6.4.1, PMU will be requested to achieve various activities in the first year. Therefore, it is suggested that GOSL and a lender discuss and consider the possible measures to accelerate and expedite the procurement process of the consulting services considering the importance of the early mobilisation of the Consultant.

6.5 Procurement Plan

The following procurement will be done during the implementation of the Project:

Table 6.5-1 Procurement Type of the Project

Item	Description
Civil Works/Facilities	・ Infrastructure development works (e.g. tank bund, spillway, sluice, irrigation canal, drainage canal, farm road, link canal, desilting, and pipeline) (Subcomponent 1.1) ・ Facilities for proper O&M (e.g. FO office), agriculture production and post-harvesting (e.g., drying yard, storage), farm income diversification (e.g., building for dairy cattle) (Subcomponent 1.1) ・ Training facilities for soft component activity (goods for land preparation, levelling, nursery, harvesting and processing, organic manure, fertiliser, weedicide and pesticide, drying yard, storage, weighing machine, moisture meter and packing machine, grass chopper, vacuum cleaner and other equipment for silage, shed for daily cattle and backyard poultry, equipment for daily kit, fish net and other materials) (Component 2) *(To reduce the number of contracts for PMU and PIU smooth operation, the contract shall also include the procurement of relevant goods)*
Goods	・ Machinery and equipment for proper O&M (e.g. O&M tool set for FO, and O&M office equipment for FO), agriculture production and post-harvesting (e.g. farm machinery, weighing machine, moisture meter, packing machine), farm income diversification (e.g. livestock: grass chopper and vacuum cleaner for silage, shed and necessary equipment for poultry, fishery: fish net and other related materials) (Subcomponent 1.2) ・ Vehicles and motorbikes for PMU, PIUs and supporting agencies (Component 3) ・ Computer, copy machine, scanner, desk, chair, etc., for PMU and PIUs (Component 3)
Training	None
Consultant	・ International consultant for consulting service (Component 4) ・ Local consultant(s) for survey and detailed design of subprojects (Component 3) ・ Individual consultant(s) and/or expert(s) for the project management (Component 3), if any

Source: Study Team

6.5.1 Procurement Plan for Civil Work/Facilities

(1) Standard Bid Documents

Procurement of works, goods, and services will be carried out in accordance with the guideline of lender. However, it is recommended to use the national competitive bidding (NCB) since the international competitive bidding (ICB) is not attractive for foreign firms by nature or scope of the Project and NCB is commonly used for such a project in Sri Lanka.

In Sri Lanka, the procurement method is principally based on the “Standard Bidding Document (SBD) Procurement of Works, Second Edition January 2007” prepared by the Institute for Construction Training and Development (ICTAD). The Construction Industry Development Authority (CIDA) was established under the Construction Industry Development Act No. 33 of 2014. Since then, the tasks performed by ICTAD have been succeeded by CIDA. The SBD document, largely based on the World Bank Standard Bidding Document for Small Contract, was prepared for use by both the ICB and by the NCB, according to SBD Procurement of Works. The applicability of the ICTAD SBD for Procurement of Works is shown in Table 6.5-2.

Table 6.5-2 Applicability of ICTAD SBD Procurement of Works

ICTAD/SBD /No	Standard Bidding Document	Recommended for Use on the Contract (LKR in Million)	Remarks
ICTAD/SBD/03	Procurement of Works for Minor Contracts	Up to 10	-
ICTAD/SBD/01	Procurement of Works	10 to 100	For works of higher values, which are not in complex nature
ICTAD/SBD/02	Procurement of Works for Major Contracts	More than 100	For contracts of a lesser value, which are in complex nature
ICTAD/SBD/04	Procurement of Works for Design and Build Contracts	-	For works/contracts where the contractor is responsible for the design and construction of the works on the specified approvals obtained from the Employer
ICTAD/SBD/06	Procurement of Works for Shopping Procedure (under preparation)	Up to 5	-
ICTAD/SBD/07	Procurement of Works for Construction Related Plant (under preparation)	-	For use when procuring construction related plant such as air-condition system, elevators, large generators, etc., where substantial installation is involved

Source: SBD Procurement of Works ICTAD/SBD/01, Second Edition, January 2007, Page vi,

The bidding procedure and standard bidding documents currently applied and utilised for the procurement works under PID and DAD cover all the above procurement works required for the Project. Especially for the smooth confirmation by the authorities concerned, it is recommended to adopt the above bidding procedure and standard bidding documents with the modifications and adjustments required for the Project and/or a lender.

(2) Workflow and Responsible Organisation

The workflow and responsible organisations/officers for the implementation of the Project are shown in Table 6.5-3 for pre-construction activities.

Table 6.5-3 Responsible Organisation and Officer for Pre-Construction Activities

Process	Survey and Design (Step 1)	Check and Review of Design (Step 2)	Technical Sanction (1) (Step 3)	Administrative Sanction (Step 4)	Tender (2) (Step 5)	Contract Signing (Step 6)
(A) Minor Tank Irrigation						
Responsible Organisation/s	Local Consultants	PIU (PID and DAD)	PIU (PID and DAD)	PIU (PID and DAD)	PIU (PID and DAD)	PIU (PID and DAD)
Responsible Officer/s	-	Engineering Section	Chief Engineer	Director of PID, Assistant Commi. of DAD	Senior Engineer	Senior Engineer
(B) Medium Tank Irrigation						
Responsible Organisation/s	Local Consultants	PIU (ID)	PIU (ID)	PIU (ID)	PIU (ID)	PIU (ID)
Responsible Officer/s	-	Engineering Section	Chief Engineer	Director of Irrigation	Senior Engineer	Senior Engineer

Note: (1) The Project Consultant will assist the responsible organisation in the technical review and sanction.
(2) Tender Evaluation Committee (TEC) is organised for the evaluation.
Source: Study Team, prepared based on hearing from C/P

The average time requirement for pre-construction activities is given in the following as a reference.

Table 6.5-4 Standard Time Requirement for Pre-Construction Activities

Process	Survey and Design (days)	Check and Review of Design (days)	Technical Sanction (days)	Administrative Sanction (days)	Tender (days)	Tender Evaluation (days)	Contract Award/Sign (days)
(A) Minor	Variable	1 to 5	1	1	21	3	1
(B) Medium	Variable	5	3	3	21	3	1

Source: Study Team, prepared based on hearing from PID and DAD

(3) Contract Packaging

Considering the financial limit of the registered construction companies and the management capacity of PID and DAD, it is suggested to divide the subproject into several contract package taking into account the following points. This packaging of subprojects and procurement works will be carried out in each stage.

Table 6.5-5 Points to be Considered in Contract Packaging

Items	Description
Contract Price	・A contract price for construction package will be in between LKR 10 million and LKR 150 million, which is equivalent to grades C6 to C4 contractors.
Contract Period	・Each construction package will be completed within one year. Special attention shall be paid for construction in the Maha cultivation. ・The bidding process for NCB is usually executed from January to April in order to commence the works in the beginning of May.
Contract Method	・The contract for minor and medium tank irrigation schemes shall be made separately as its management entity is different; minor schemes by PID/DAD, and medium schemes by ID or PID. ・Administrative boundaries shall be taken into consideration in preparing the packages. In case that the tanks are located in two or more Divisional Secretariat (DS) areas, the contractor will visit different DS offices to get permission, for instance, for transportation of material such as sand and gravel. Therefore, one package shall cover the tanks belonging to one DS area, as far as possible.

Items	Description
	・ Particularly for medium tank irrigation schemes, one package shall cover the tank/s managed by a Divisional Irrigation Engineer to avoid several management issues, as much as possible. He/she will manage the construction supervision, and if necessary, coordinate with FOs during the construction.
Others	・ It is further noted that a well-planned awareness session shall be conducted for FOs and local communities in advance to make them aware about the construction program and get their participation for the purpose of successful implementation of the Project.

Source: Study Team

The Study Team tentatively estimated the number of contract package by subproject as shown in Attachment 6.5-1.

6.5.2 Procurement Plan for Goods

For the project operation, the following goods including machinery and equipment will be procured under the Project. The smooth procurement of these goods is necessary for proper O&M, agricultural production, farm income diversification, as well as timely commencement of the Project.

i) Procurement of Machinery and Equipment: farm machinery, packing machine, etc. (Component 1.2)
ii) Establishment of PMU/PIU: office equipment, transportation equipment, etc. (Component 3)
iii) O&M equipment: Automatic water level gauging systems, etc. (Component 3)

The Standard Bidding Documents (SDB) for the Procurement of General Goods, National Competitive Bidding (NPA/Goods/SBD 01) published by the National Procurement Agency, Sri Lanka will be applicable for the goods and equipment available in Sri Lanka. It depends on the availability of procurement items in Sri Lanka. The supplier shall have his/her sales office/agent registered in Sri Lanka for the aftercare of items to be procured under the Project.

6.5.3 Procurement Plan for Training

There is no procurement for training in Component 2 since soft component activities will be carried out under the consulting services. The Consultant will organise the soft component activities in collaboration with the PIUs and the departments and institutions responsible for the specific fields.

6.5.4 Procurement Plan for Consultant

There would be three types of consulting services to be provided under the Project: i) an international consulting firm for project management and implementation, ii) a local consulting firm for detailed design of subprojects, and iii) individual consultants to the PMU on a contract basis for project management and monitoring, if any.

(1) International Consultant for Consulting Service

It is recommended to follow the guideline of a lender; but the Study team has suggested to procure the Consultant by the ICB Procedure and Quality Cost Based Selection (QCBS) so far.

(2) Local Consultant and Individual Consultants

The Procurement Manual 2018, the Selection and Employment of Consultants, published by the National Procurement Commission, Sri Lanka will be recommended for the procurement of local consulting firms and/or individual consultants.

The authority of Consultant Selection Committees (CSCs) for contract award recommendation/ determination is shown in Table 6.5-6, which would be applicable for international and national competitive biddings.

Table 6.5-6 Authority of Consultant Selection Committees for Contract Award Recommendation/Determination

Authority	Nationally Publicise	Internationally and Nationally Publicise
A. Consulting Firms (QCBS, QBS, FBS or LCS)		
Cabinet Appointed Consultant Selection Committee (CCSC)	Greater than or equal to LKR 100 M.	Greater than or equal to LKR 200 M.
Ministry Consultant Selection Committee (MCSC)	Greater than or equal to LKR 20 M and less than LKR 100 M	Greater than or equal to LKR 50 M and less than LKR 200 M
Department Consultant Selection Committee (DCSC) or Project Consultant Selection Committee (PCSC)	Less than LKR 20 M	Less than LKR 50 M
B. Individual Consultants		
Cabinet Appointed Consultant Selection Committee (CCSC)	Greater than or equal to LKR 15 M.	Greater than or equal to LKR 25 M.
Ministry Consultant Selection Committee (MCSC)	Less than LKR 15 M	Less than LKR 25 M
Department Consultant Selection Committee (DCSC) or Project Consultant Selection Committee (PCSC)	Less than or equal to LKR 5 M	Less than or equal to LKR 10 M
Chief Accounting Officer (CAO)	Less than or equal to LKR 3 M	Less than or equal to LKR 5 M
Accounting Officer (AO) / Project Director (PD)	Less than or equal to LKR 1 M	Less than or equal to LKR 3 M

Notes: QCBS=Quality Cost Based Selection, QBS= Quality Based Selection, FBS= Selection under A Fixed Budget, LCS= Least Cost Selection

Source: Procurement Manual 2018, Selection and Employment of Consultants, published by the National Procurement Commission, Sri Lanka

Before the contract is awarded, approval from the Chief Accounting Officer (CAO) of the respective ministry should be obtained for recommendation/determination made by the CSC except for CCSC, which needs the approval of the cabinet of ministers.

6.6 Fund Management

Once a loan agreement of the Project becomes effective with a lender, the project accounts will be created in the Central Bank of Sri Lanka (CBSR), PMU, and PIUs, respectively. As stated in Section 6.5, civil works, facilities, goods, trainings, and consulting services would be procured in the Project.

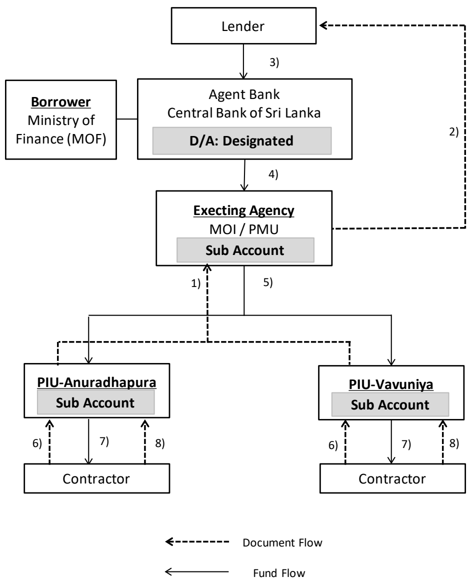
It should be noted the disbursement procedure be finalised by discussions between a lender and MOI during project appraisal.

6.6.1 Civil Works/Facility

The fund management for the civil works/ facility is illustrated in Figure 6.6-1, and the fund flow and the document flow are briefly as follows:

1) PIUs prepare financial forecast and inform the required amount and submit it to PMU.

2) PMU submits the request for disbursement in the international currency (e.g. USD, EUR, JPY) to a lender for lender portion.
3) A lender disburses the requested amount nominated as lender portion into Government A/C at the Central Bank of Sri Lanka (CBSL).
4) CBLS transfers the PMU's project A/C after converting the fund in an international currency (e.g. USD, EUR, JPY) to LKR.
5) PMU transfers the fund for lender portion at the PMU project A/C to the PIUs project A/C.
6) Contractor issues the invoice for the works including value-added tax (VAT) and income tax (IT).
7) PIUs pay the invoiced amount to the Contractor.
8) Contractor issues the receipt for the works to PIU.



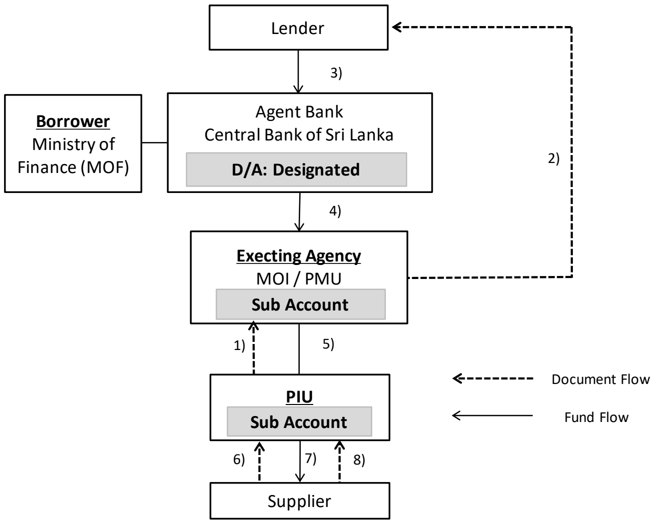
Source: Study Team

Figure 6.6-1 Fund Management for Civil Works/Facility

6.6.2 Goods

The fund management for the procurement of goods including machinery and equipment is illustrated in the following figure, and the fund flow and the document flow are briefly as follows:

1) PIUs prepare financial forecast and inform the estimated amount for the procurement of goods and submit it to PMU.
2) PMU submits the request for disbursement in the international currency (e.g. USD, EUR, JPY) to a lender for lender portion.
3) A lender disburses the requested amount nominated in an international currency (e.g. USD, EUR, JPY) as lender portion into Government A/C at CBSL.
4) CBSL transfers PMU’s project A/C after converting the fund in the international currency (e.g. USD, EUR, JPY) to LKR.
5) PMU transfers the fund for both lender portion at the PMU project A/C to PIUs project A/C.
6) Supplier issues the invoice for goods including VAT and IT to PIUs.
7) PIUs pay the invoiced amount to the supplier.
8) Supplier issues the receipt for the goods to PIU.



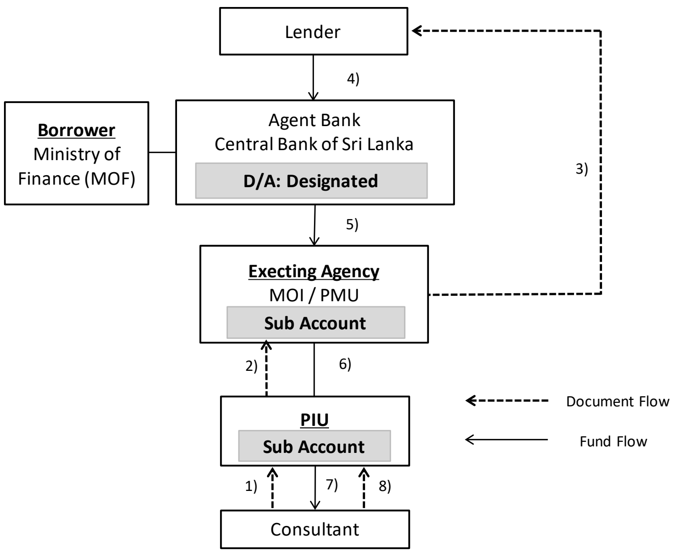
Source: Study Team

Figure 6.6-2 Fund Management for Goods

6.6.3 Trainings

These activities would be implemented by the Consultant in collaboration with the supporting agencies responsible for the specific fields. The fund management of trainings will be as follows:

1) The Consultant prepares the financial forecast and informs the required amount for the trainings and submits it to the PIU.
2) PIU submits it to the PMU after thorough review.
3) PMU submits the request for disbursement in an international currency (e.g. USD, EUR, JPY) to a lender for lender portion.
4) A lender disburses the requested amount nominated in an international currency (e.g. USD, EUR, JPY) as lender portion into the Government A/C at CBSL.
5) CBSL transfers the PMU's project A/C and, at the same time, PMU to convert the fund in an international currency (e.g. USD, EUR, JPY) to LKR.
6) PMU transfers the fund for lender portion at the PMU project A/C to respective PIU A/C.
7) PIU transfers the fund for the lender portion at the PIU project A/C to the Consultant A/C.
8) Consultant issues the receipt for the trainings to PIU.



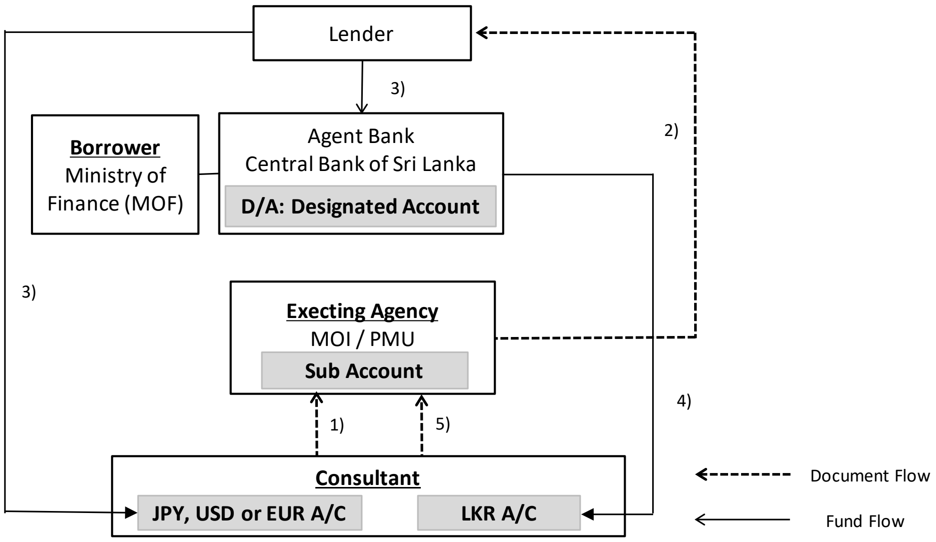
Source: Study Team

Figure 6.6-3 Fund Management for Training

6.6.4 Consulting Services

The fund management of consulting services is illustrated in the following figure, and the fund flow and the document flow are briefly as follows:

1) The Consultant issues the invoice for consulting services[1] to PMU.
2) PMU submits the request for disbursement in an international currency (e.g., USD, EUR, JPY) to funder. In case of invoice denominated in LKR, PMU to convert LKR to the international currency in the request for disbursement.
3) A lender disburses the requested amount directly to the consultants account in case of the invoice denominated in an international currency (e.g., USD, EUR, JPY). In case of invoice denominated in LKR, a lender to disburse the converted requested amount into the Government A/C at CBSL.
4) CBSL converts to LKR and transfers to the Consultant’s LKR account.
5) Consultant issues the receipt for the services to PMU.



Source: Study Team

Figure 6.6-4 Fund Management for Consultancy Services

6.7 Contract Management

The Engineer (PIUs) is responsible for the contract management under the Project. The Consultant will assist the Engineer in contract management of civil works whenever requested.

The contract management is the process of managing contract creation, execution, and analysis to maximise operational and financial performance of an organisation, while reducing financial risk. The contract management is broadly divided into three periods as shown in the figure below.

[1] *In case of consulting services contract with international consulting firm, tax to be imposed to the consultant is exempted based on the Exchange of Notes between the lender and the Government of Sri Lanka*

Pre-Contract Period	Construction Period	Defects Notification Period
Issue of the Tender Documents Submission of the Tender Signing of the Contract Agreement	Commencement Date Test on Completion Issue of Taking-Over Certificate	Issue of Performance Certificate

Source: Study Team

Figure 6.7-1 Typical Sequence of Principal Events during Contract

The following table summarises the contractual claims, which have been submitted by the contractors in the past projects. To implement the Project smoothly in accordance with the implementation schedule, it needs to organise construction supervision teams including a capable and experienced engineer for contract management in PIUs.

Table 6.7-1 Major Claims during Contract Period (Samples)

Major Cause of Claims	Description
1) Delay in tendering (Pre-contract period)	It requires adjustment of unit prices and price escalation in case of a lengthy delay in tendering or repeated tendering due to the reasons at the Employer side.
2) Lack of possession of site (Construction period)	Land acquisition of construction sites is a major cause of claim by the contractor. The Employer shall acquire the lands necessary for the construction works at least before the commencement of works.
3) Delayed drawings (Construction period)	The Engineer must issue construction drawings for site setting-out by the contractor and approve the contractor's working drawings within the specified time. The delayed drawings are subject to claim by the contractor.
4) Delayed payments (Construction period)	There are several reasons for delayed payments, for instances, time-taking for confirmation of work volume by the Engineer, delay in issuing the payment certificate by the Employer.
5) Unforeseeable ground conditions (Construction period)	It often happens that the actual foundation (geology) of dams and structures differ from the designed. It will bring about variation and subsequently claimed for extension of time by the contractor.
6) Variation (Construction period)	Variation orders for design are often issued by the Engineer due to unforeseeable ground conditions, wrong information of benchmarks (coordinates and elevation), changes of construction methods and materials, etc. It usually needs a time to negotiate for new unit prices.
7) Force majeure (Construction period)	It is principally identified as being an "exceptional" event or circumstance, beyond the party's control, and something that it could not have reasonably provided against before entering into the contract; for example, wars, rebellion, terrorism, civil war, riots, earthquakes, typhoons, volcanic activities, and also the COVID-19 pandemic.
8) Extension of time (Construction period)	The above causes (2 to7) are subject to extension of time for construction. It is often associated with cost increase. The Engineer shall make fair and square evaluation based on the Contract when claimed by the contractor.

Source: Study Team

6.8 Quality Control

The Consultant will assist the Engineer (PIUs) in the quality control of construction works. In the construction supervision, a priority shall be placed on quality control in construction of the project facilities, particularly the following:

i) Headworks (tank bund, sluice, and spillway): To repair based on the project specifications and the ICTAD Standards and communicate with PIUs for their guidance.
ii) Canals: To prepare hydraulic particulars (HPs) strictly based on the site conditions.
iii) Farm roads: To repair the embankment with gravel in accordance with the project specification.
iv) Earthwork: Selection of adequate soils and proper compaction with certain specifications.
v) Concreting: Proper mixing (weight base) and strict curing work.
vi) Structures: Analysis of works by equipment on compaction works and concrete mixing at the site.

In the initial stage, the Consultant will prepare the check list for the construction supervision including quality control and guide PMU/PIUs on how to use the check list.

The check list will include the following subjects:

(1) Setting out and Survey Reference Controls

Before starting the construction works, the Consultant will assist the Engineer (PIUs) in checking (temporary local) benchmarks for vertical and horizontal controls, inclusive of additional benchmarks, which will be established by the contractors for the convenience of construction. Further checking of the accuracy of all contractors' stakeouts is important. Any deviations or inaccuracies, which may be noted in the surveying works, will be settled between the Engineer and the contractors with assistance of the Consultant.

(2) Site Inspections

The Consultant will assist the Engineer (PIUs) in carrying out site inspections of the works at least once a week in order to ensure quality of the works performed by the contractors, in accordance with the technical specifications and sound engineering practices. The Engineer, with support of the Consultant, if necessary, will give the instructions or orders to the contractors whenever needed, or in case of foreseeable troubles or events.

(3) Field and Laboratory Tests

In the course of construction works, various kinds of tests will be performed at the fields and in laboratories. The tests for quality control will be elaborated in the technical specifications of the contract documents. The Consultant will assist the Engineer (PIUs) in reviewing the test items and recommend modification/improvement, if necessary. The tests for embankment and concrete works shall be made to ensure proper quality of the works.

6.9 Safety Management for the Construction Works

The safety management refers to establish a safe and health-conscious working environment in order to achieve the goal of "ensuring human safety". Special measures for COVID-19 shall be taken according to the government rules and guidelines. The establishment of such an environment should minimise the negative impact on the environment and/or society of the countries, and consequently, improve efficiency and productivity. The Engineer (PIUs) is responsible for the safety management under the Project. The Consultant will assist the Engineer in safety management, if requested.

6.9.1 Construction Safety Issues

Safety is the top priority for the construction works. In the Project, the following accidents are conceivable:

- i) Traffic accidents on construction sites and public roads will happen during transportation of construction materials.
- ii) Accidents involving construction machinery will occur in loading materials and moving at sites.
- iii) Works in tanks will bring about submersion of workers and construction machinery under water especially during rainy seasons and at the time of heavy rainfalls.
- iv) Emergent and unforeseeable accidents will happen during construction works due to carelessness of operators and workers.
- v) Cluster of COVID-19 positives will happen at the construction sites.

These safety risks shall be carefully studied and clarified in the design stage and measures to prevent the occurrence of these risks will be taken in the construction stage by the stakeholders (The Employer, Engineer, contractors, workers, and Consultant) concerned.

6.9.2 Safety Management

Basic policies for safety management are as follows:

Table 6.9-1 Basic Policies for Safety Management

Basic Principle	Description
1) Safety is a top priority	All project stakeholders shall put top priority on safety and use their best endeavours to eliminate the occurrence of accidents.
2) Elimination of causes	The Contractor shall identify every possible danger in each process of construction work, and examine, analyse, and eliminate the causes of such danger and take appropriate action to ensure the safe execution of the work.
3) Thorough precautions	The Contractor shall give consideration in advance to inherent the risk of accidents in each stage of construction work, review appropriate measures to cope with such risks, and commence work once these preventive measures have been implemented.
4) Thorough compliance with relevant laws and regulations	Compliance with relevant laws and regulations shall be complied with.
5) Thorough prevention of public accidents	All project stakeholders shall implement safety management measures taking the interests of third parties duly into consideration in order to prevent public accidents.
6) Thorough implementation of PDCA cycle for safety management	PDCA for Safety Management shall be complied with.
7) Thorough sharing of information	All project stakeholders shall share all safety-related information they possess in a manner and at times as appropriate in the circumstances.
8) Thorough participation of all project stakeholders	All project stakeholders shall actively participate in activities related to safety management at the construction sites.

Source: Study Team

The Contractor shall prepare and implement two plans for the safety management for construction work sites in compliance with relevant laws and regulation in Sri Lanka, namely, the "Safety Plan" and "Method Statements on Safety”. The Contractor shall prepare the Safety Plan in the pre-construction stage. The Contractor shall, however, prepare the Method Statements on Safety in the construction stage. The PDCA for safety management shall be the cycle of "Plan, Do, Check, Act" with "Plan" being the process of establishing the Safety Plan and its Method Statements on Safety. The Engineer, with support of the Consultant, will review the "Safety Plan" and "Method Statements on Safety” to be submitted by the Contractor, and the Engineer will approve those, if satisfactory.

(1) Safety Plan

The Contractor shall prepare the Safety Plan and submit it to the Engineer (PIUs) for his/her approval in the pre-construction stage as per the contract documents.

The Safety Plan shall be composed of i) basic policies for safety management, ii) internal organisational structure for safety management, iii) promotion of the PDCA cycle, iv) monitoring, v) safety education and training, vi) voluntary safety management activities, vii) sharing information, and viii) response to emergencies and unforeseen circumstances.

(2) Method Statement on Safety

The Contractor shall prepare a Method Statements on Safety and submit it to the Engineer (PIUs) for his/her approval during the construction stage as per the contract documents.

The Contractor shall formulate the Method Statements on Safety for each type of work based on the design or documents implementing the design in order to undertake work, maintain a safe working environment, and prevent any unsafe action by workers accurately and efficiently. The Contractor shall incorporate the following items in the Method Statements on Safety: i) construction plant and machinery, ii) equipment and tools, iii) materials, iv) necessary qualifications and licences, v) the order of command for the works, vi) work items, vii) procedure for the execution of the works, viii) foreseeable risks, and ix) precautionary measures.

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS, GENDER MAINSTREAMING AND CONFLICT PREVENTION

7.1 Environmental and Social Considerations

7.1.1 Environmental and Social Conditions in the Project Area

(1) General Topography and Geographical Features

Anuradhapura District lies entirely in the dry zone in the northern half of the country between 80.4037° east longitude and 8.3114° north latitude. The average elevation of the district is between 328 ft. and 340 ft. The topography of the district is gently undulating. Therefore, the tanks in the district have undulating terrain with well-developed drainage systems in a dendritic form, which is a unique feature to form cascaded tank systems. Valley bottoms are almost flat and have formed a floor for irrigated terraced paddy farming. The crest positions of the terrain are often occupied by forest vegetation on rock out crops and mid-aspect of the land catena is generally utilised for Chena (shifting cultivation) and homestead farming. Presence of many water bodies, remarkable mountains along with number of small hills are among the key geographic features of Anuradhapura District.

Vavuniya District falls within the northern half of the dry zone between 80.4971° east longitude and 8.7514° north latitude. The topography of the districts is gently undulating. The elevation of the district is around 326 ft. The topography becomes more distinct in the south east where prominent ridges occur representing the highest elevations in the district. There are no major or perennial river systems within Vavuniya District. However, there are number of small- to medium-scale 32 seasonal streams, all of which are active only during monsoonal rainy periods. Additionally, the district contains many small- and medium-sized tanks.

(2) Land Use

Anuradhapura is the largest among all the districts in Sri Lanka. The land area of the district covers 11% of the whole countries' land surface while the area of inland water bodies distributed within the district is highest compared with other districts. From the total of 7,179 km^2 (717,900 ha) of the district land, 6,664 km^2 represented by land and 515 km^2 by inland water bodies.

According to the available information, the major component of the land extent consists of forest which is 29.37% of the total land. Secondly, an extent of 23.76% covers with grass scrub/Chena, and thirdly, with paddy cultivation which is 21.44%. The details of the land use pattern in Anuradhapura District are given in the following table.

Table 7.1-1 Land Use Pattern in Anuradhapura District (2018)

Nature of Land	Area (ha)	Percentage (%)
Forest	210,827.00	29.37
Home gardens	95,424.00	13.29
Paddy lands	153,920.75	21.44
Perennial crops	10,442.00	1.45
Major crops (Tea, Rubber, Coconut)	1,865.00	0.26
Other field crops (Seasonal crops)	14,298.94	1.99
Large inland waters	52,241.00	7.28
Abandoned land	207.31	0.03
Built up land	7,071.00	0.98
Scrub/Chena	170,598.00	23.76
Other	1,005.00	0.14
Total	717,900.00	100.00

Source: District Land Use Planning Office, Department of Census and Statistics

Vavuniya District covers an area of 1,967 km^2 (196,700.96 ha) and claims 3% of the area of the island. The total area includes 1,861 km^2 of land and 106 km^2 of inland water bodies.

According to the available information from the Department of Census and Statistics (DCS), major component of the land extent consists of forest, which is 49.71% of the total land. Secondly, an extent of 15.21% is covered with home gardens, and thirdly, with paddy cultivation, which is 14.12%. The details of the land use pattern in Vavuniya District are given in the following table.

Table 7.1-2 Land Use Pattern in Vavuniya District (2018)

Nature of Land	Area (ha)	Percentage (%)
Forest	97,777	49.71
Home gardens	29,918	15.21
Paddy lands	27,778	14.12
Perennial crops	215	0.11
Major crops (Tea, Rubber, Coconut)	0	0.00
Other field crops (Seasonal crops)	14,912	7.58
Large inland waters	12,212	6.21
Abandoned land	388	0.20
Built up land	1,237	0.63
Scrub/Chena	11,824	6.01
Other	439	0.22
Total	196,700	100.00

Source: District Land Use Planning Office, Department of Census and Statistics

(3) Hydrogeological Situation

The hydrology and water resources of Anuradhapura District have very distinctive features, which align with agriculture and settlement patterns in the region. The hydrology of the area is mainly governed by seasonal streams, cascade systems, man-made reservoirs and associated irrigation canals. The main sources of storage of surface water are small to medium tanks and man-made reservoirs that have been constructed across the valleys in the area. From the total land area of the district, which is 7,179 km^2, inland water bodies represent 515 km^2.

Due to relatively limited thickness of the overlying soil mantle and hard-underlying bedrock of the area, approximately 40% of the annual rainfall is lost as surface run-off. Therefore, storage of underground water is not possible except in very limited amounts in locations where the underlying rocks are fractured or fissured. Further, the total annual evaporation from a free water surface of area is 1,750 mm, which exceeds the total annual rainfall ranges between 850 mm and 1,900 mm. Therefore, water in the streams and main rivers is gone during the dry weather which is from May to November. This will result in insufficient storage of water in village tank cascades for irrigation during the Maha season and drying some of the village tanks during the Yala season.

During the dry season, the main sources of water supply for domestic needs are the open dug wells located on high ground, which is just below the small village tanks. The depth of the ground-water table varies from 5 m to 8 m and mainly “hard water” is found in dug wells of the district. Therefore, people in the area are reluctant to use well water for drinking purposes. Water for animal husbandry and cultivation of few extents of land during the Yala season are obtained from the tanks.

The irrigation system of the district consists of main tanks such as Kala wewa & Balalu wewa, Thisa wewa, Nuwera wewa, Abhaya wewa, Nachchaduwa, Mahkandarawa, Huruluwewa, Villachchiya, Rajangana, Padaviya, etc., and 85 middle-scale irrigations with 2,974 small lakes. The minor tanks in the district are managed by the Department of Agrarian Development (DAD) while major and medium tanks are managed by the Irrigation Department (ID) or Provincial Irrigation Department (PID). Four major river basins along the main rivers and their major tributaries in the district include Kala oya, Malwathu oya, Yan oya, and Ma oya.

In Vavuniya District, there are one major tank, 23 medium tanks, and 674 minor irrigation tanks including 26 anicuts. The water resources mainly depend on rainfall as there are no perennial rivers. However, there are a number of small- to medium-scale seasonal streams, all of which are active only during the monsoonal rainy periods. Kanakarayan Aru, Chamali Aru, Kiul Aru, Chamalankulam Aru, Per Aru, Kal Aru and parts of Malwathu oya are the main river systems flowing through the district. These river systems show a remarkable variability in discharge the during dry and wet seasons.

The Parangi Aru originates in Vavuniya District, north of the town of Vavuniya as Per Aru and runs through north western direction. Its immediate catchment goes up to the Mamaduwa Reservoir, which is a medium irrigation reservoir. In Palaimodai, the Turumpamoddai Aru joins the river on the right side, afterwards this river is referred to as Manal or Paranki Aru and further downstream of the Paranki Aru, the Periyakatte Aru enters from the left side and the river discharges into about 35 km north-east of Mannar. The catchment of the Parangi Aru is located in the northern dry zone and its area is 832 km^2. The average discharge volume of Per Aru Reservoir to the sea is 312 MCM per year based on the Hydrological Studies for the Per Aru Reservoir in Vavuniya in 2011. The catchment of the Parangi Aru is bounded by the basins of the Pali Aru and Chamalakulam Aru in the north, the Kanagararayan Aru and Ma oya in the east and the Kal Aru, a tributary of the Malwathu oya, and Nay Aru in the south.

The Kanagarayan Aru also lies in the Vavuniya District, around Puliyankulam, north east of the town of Vavuniya and ends with Kilinochchi Chundikulam Lagoon through Mullaitivu. Length of this river is 86 km and total catchment area is 906 km^2. The river first flows in north western direction in Mankulam and its course changes to a strictly northern direction through Mullative District. The major scheme in this river basin is Iranamadu Tank and there are two other medium schemes, namely Kanagarayan

Kulam and Chemamadu Kulam. There are also 64 minor tanks in the Kanagarayan Aru river basin. The capacity of Iranamadu scheme is 106,500 Ac. ft., Chemamadu is 2,560 Ac. ft. and Kanagarayan Kulam is 1,100 Ac. ft. Near the village of Kokkuvil, the river discharges into the Iranamadu Tank and continues to the coast through Jaffna District until it finally meets the Jaffna Lagoon.

(4) Landscape and Ecosystem of Cascade Systems

Source: Presentation material on Cascade Irrigation Systems for Rural Sustainability held on 9th December 2010 at SLFI, Colombo, P.B. Dharmasena

Figure 7.1-1 Village Tank System in the Dry Zone of Sri Lanka

Current cascade systems in the Study area were created in ancient times and designed to best utilise rainwater. There are more than 15,000 small tanks spread in the northern central dry zone of Sri Lanka. They are not randomly located and distributed: they are located in the form of distinct cascade that are positioned within the small watersheds. A cascade is made up of 4 to 10 of individual small tanks[1]. Figure 7.1-1 above shows a typical village tank system in a dry area of Sri Lanka. The tank, paddy fields, watershed, canals, and village are integrated as they blend into the natural environment, forming a unique ecosystem. The forest ("Mukalana") located upstream of the irrigation tank is jointly owned by the village, and it is preserved strictly by controlling logging of trees and expansion of agricultural land. Since ancient times, only non-timber forest products such as medicinal herbs for Ayurveda have been sustainably utilised. However, the most important role of “Mukalana” was to purify the rainwater and to raise the groundwater level by gradually releasing the water during the dry season to the irrigation tank. Rainwater is caught in “Mukalana” and “Chena” land flows into “Godawala”. It is a small tank that traps sediment flow into the tank and provides water to animals. Then water flows into the tank. There is a forest called "Gasgommana" in the immediate upstream area of the irrigation tank. It plays a role of regulating the amount of water by absorbing when water level is high, preventing strong wind, lowering temperature, and a buffer zone between wild animals and humans. Large trees are observed, and it is a habitat for various type of fish. Just below the tank bund (outside), a zone with various vegetation called "Kattakaduwa" is preserved. This has a role of preventing salt and ferric ions from

[1] Kapila Peiris, “Ecosystem based Indigenous Water Management”, National Science Foundation, 2008.

entering paddy fields. Farmers have used this part by planting various trees for the various purposes, including fuel, medicine, home and agricultural tools, food, etc. Each part in the village tank system has its own unique function to effectively maintain and utilise rainwater as well as serves as a habitat for diverse flora and fauna, migratory birds and sustainable human activities, which has a great contribution to preserve biodiversity.

(5) Air Quality

Recent information on air quality including atmospheric characteristics such as dust in the air, carbon monoxide, nitrogen dioxide, sulphur dioxide, etc., of the Study area are not available. However, according to available information in 1999 by Central Environmental Authority (CEA), the concentration of ambient air quality parameters in Anuradhapura District are well below the National Ambient Air Quality Standards (NAAQS) as shown in the following table.

Table 7.1-3 Air quality Measurements as of 1999 in Anuradhapura

Parameter Value	Value	NAAQS
CO	3 ppm	9 ppm
PM_{10}	45 μgm^{-3}	350 μgm^{-3}
NO_2	0.01 ppm	0.08 ppm
SO_2	0.02 ppm	0.03 ppm

Source: Environmental Atlas (2005), CEA; ISBN: 9559012312, Gazette of the Democratic Socialist Republic of Sri Lanka, 850/4 (20 December 1994)

According to the field air quality measurements of an environmental impact assessment (EIA) study for Vavuniya Per Aru Reservoir carried out in 2011, the measured air quality levels were well below the permissible ambient air quality levels stipulated in the CEA as shown in the following table.

Table 7.1-4 Air Quality Data Obtained in October 2011 Parameter Concentration (micro g/m^3)

	SPM	PM_{10}	SO_2	NO_2
CEA Permissible Level	300	100	80	100
Sample 1	51	12	11	<10
Sample 2	26	6	<10	<10
Sample 3	27	10	<10	<10

Source: ITI Report No. SS 1113385 on Air Quality Assessment (2011) for Dry Zone Urban Water and Sanitation Project - for Vavuniya Per Aru Reservoir

Exhaust emissions from vehicles might increase the levels of carbon monoxide, lead and certain other pollutants especially within the main town limits of Vavuniya and Anuradhapura districts. However, absence of heavy industries, low level of vehicle operation and presence of significant green cover vegetation suggest that atmospheric condition of the study area is clean and within acceptable levels.

(6) Noise and Vibration

Based on the noise level measurement of an EIA study carried out for Yan oya Reservoir Project in November 2011 indicated that measured noise level in the areas were within the acceptable levels (45-50 dB) during daytime but slightly higher (46-48 dB) during night time.

The noise level measurement of four selected locations for the EIA study on the “Proposed Surface Water Extraction Project from Reservoir across Per Aru in Vavuniya District, 2011” recorded that measured noise level in the areas were within the acceptable range (32-46 dB) during day time and night time (33-43 dB) as shown in the following table.

Table 7.1-5 Noise Measurements for Per Aru Surface Water Extraction Project in Vavuniya

GPS Locations	Noise Level			
	Day Time		Night Time	
	ENL dB(A)	RBL dB(A)	ENL dB(A)	RBL dB(A)
401153.17mN 165720.97 mE	38	34	43	39
401634.88 mN 164911.33 mE	41	36	43	40
402196.58 mN 164158.48 mE	46	42	43	42
402465.09 mN 166646.69 mE	33	32	37	33

Source: ITI Report SS 1113352 on existing noise levels (2011)

There are no records of vibration levels or continual vibration generation activities in the Study area.

(7) Water Quality

The quality of surface water at five locations (tanks) were tested in the Study as the baseline. The result was summarised in the following table.

Table 7.1-6 Result of Water Quality Test of the Five Project Target Tanks

Item	Vavuniya Tank (ID: 111-7)	Gonu Hathdwnawa maha Wewa (ID: 96-5)	Mora Wewa (ID: 82-16)	Lulnewa Wewa (ID: 22-5)	Mada Wewa (ID: 19-3)	National Tolerance Standard
pH	7.8	8.0	8.0	7.7	7.2	6.0 – 8.0
Turbidity (NTU)	6	8	10	3	4	N/A
Suspended Solid (mg/L)	25	4	3	12	5	50
BOD (mg/L)	10	12	10	14	4	30
COD (mg/L)	108	130	140	166	138	250
Electric Conductivity	0.777	0.357	0.394	1.256	0.661	N/A
Oils and Greases (mg/L)	ND	4.0	1.8	ND	ND	10
Phenolic Compounds	ND	ND	ND	0.6	ND	1
Heavy Metals (Cadmium, Lead, Mercury, etc.) (mg/L)	ND	ND	ND	ND	ND	Cd: 0.1 Pb: 0.1 Hg: 0.0005
Pesticides (29 chemical substances) (mg/L)	ND	ND	ND	ND	ND	0.005
E-coli (/100ml)	100	700	100	700	1800	N/A

Source: Study Team field study

The results of the Study revealed that the baseline values of the five tank-water are all within the standard limits for the surface water stipulated in the National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water). The details of the analysis are shown in Attachment 7.1-1.

(8) Soil[2]

Reddish brown earth and low humic gley soil association is the most commonly distributed soil in the Anuradhapura District. Reddish brown earth soil is better drained and occupies the upper parts of the undulations that almost exclusively make up the landscape in the district, which is 92%. It is highly fertile, therefore, supporting a high level of agricultural activity. Poorly drained low humic gley soil covers the lower parts of the same undulations and is often found in the less well drained areas. There are also narrow bands of alluvial soils alongside the rivers and streams. The soil is highly fertile due to the presence of these three soil types in the district. Red- yellow latro soils are also found in the northern part of the district, and the area is more fertile with better ground-water potential.

The main soil types in Vavuniya District are reddish brown earth, low humid clays and alluvial soil. Reddish brown earths and low humic gley soils are seen in undulating terrain and cover almost 92% of the soil in the district. Other soil types including alluvial soil of variable drainage and texture consists of 4%, Rock knob plain with 2%, Erosional remnants and Soildized solonetz and solonchaks with 1% from each. These soils are highly fertile and support a high level of agricultural activity, especially for paddy and dry land crops, Chena cultivation as well as scrub and dry forest trees.

The quality of the soil in the five locations (command area of the five target tanks, same as the water quality testing sites) was tested in the study as the baseline. The result was summarised in the following table. The results of the study revealed that chromium and lead as well as chemicals associated to the pesticides were found in the soil of the command area of five tanks. The details of the analysis are provided in Attachment 7.1-2.

[2] Analysed based on the map of Distribution of Soil Types in Sri Lanka, by Land Use Division, Irrigation Department, 1988.

Table 7.1-7 Result of Water Quality Test of the Five Project Target Tanks

Item	Vavuniya Tank (ID: 111-7)	Gonu Hathdwnawa maha Wewa (ID: 96-5)	Mora Wewa (ID: 82-16)	Lulnewa Wewa (ID: 22-5)	Mada Wewa (ID: 19-3)
Cadmium (as Cd) (mg/kg)	ND	ND	ND	ND	ND
Chromium (as Cr)	12.0	23.6	12.5	15.6	8.5
Lead (mg/kg)	4.1	2.3	2.5	4.0	3.4
Mercury (mg/kg)	ND	ND	ND	ND	ND
Arsenic (mg/kg)	ND	ND	ND	ND	ND
Phenolic Compounds (mg/kg)	Naphthalene: 0.12	ND	ND	Benzo [a] pyrene: 1.10 Benzo [e] pyrene: 1.31 Indeno [1.2.3-cd] anthracene: 3.34	ND
Oils and Greases (mg/kg)	ND	4.0	1.8	ND	ND
Pesticides (29 Chemical substances) (mg/kg)	Metribuzin: 0.1 Diazinon: 0.1 Carbofuran: 0.4 Diuron: 0.07 Fenitrothion: 0.09	ND	ND	Diazinon: 0.9 Carbofuran: 0.5 Fenitrothion: 0.1	Metribuzin: 0.2 Carbofuran: 0.7 Diuron: 0.1 Fenitrothion: 0.8
PCB (mg/kg)	ND	ND	ND	ND	ND

Note: ND: Not Detected
Source: Study Team field study

(9) Bottom Sediments

The bottom sediments of the tanks are supplied from the surrounding land. Thus, chemical compounds of the sediment in a given tank are ought to be affected by the catchment area as well as upper-stream tanks and command area. Therefore, sediments in a tank could reflect the chemical inputs and anthropogenic influence from within the cascade systems.

The bottom quality of the five locations (five target tanks, same as the water quality testing sites) was tested in the study as the baseline. The result was summarised in the following table. The results of the study revealed that almost none of heavy metals, poly aromatic hydrocarbons, chemical compounds used in the pesticides and PCB were detected from the sediments of these five tanks, despite the tank water and/or soil of the command area contained some of these items. Only oil and grease were found from the bottom sediments. The details of the analysis are shown in Attachment 7.1-3.

Table 7.1-8 Result of Bottom Sediments Test of the Five Project Target Tanks

Item	Vavuniya Tank (ID: 111-7)	Gonu Hathdwnawa maha Wewa (ID: 96-5)	Mora Wewa (ID: 82-16)	Lulnewa Wewa (ID: 22-5)	Mada Wewa (ID: 19-3)
Heavy Metals (Cadmium, Chromium, Lead, Mercury) (mg/kg)	ND	ND	ND	ND	ND
Arsenic (mg/kg)	ND	ND	ND	ND	ND
Phenolic Compounds (mg/kg)	ND	ND	Naphthalene: 1.52	ND	ND
Oils and Greases (mg/kg)	111.9	57.1	51.5	72.9	28.0
Pesticides (29 chemical substances) (mg/kg)	ND	ND	ND	ND	ND
PCB (mg/kg)	ND	ND	ND	ND	ND

Note: ND: Not detected
Source: Study Team field study

(10) Environmentally Protected and Sensitive Areas

In Sri Lanka, environmentally protected and sensitive areas are identified in the Gazette Extra Ordinary No. 772/22 of 24th June 1993 and subsequent amendments, National Heritage Wilderness Act No. 3 of 1988, and Forest Ordinance No. 6 of 1907 and amendments. Areas include 61 sanctuaries, 3 strict nature reserves, 7 nature reserves, 26 national parks, one elephant corridor and various forest reserves. The maps of the protected areas in Anuradhapura District and Vavuniya District are attached in Attachments 7.1-4 and 7.1-5.

(a) National Parks, Sanctuaries and Other Areas

There are several protected and sensitive areas near the target cascades in Anuradhapura and Vavuniya districts. These include Horowpothana National Park, Padaviya Sanctuary (Padaviya Important Bird Areas) and Mahakanadarawa Wewa Sanctuary. There are no strict nature reserves, nature reserves, and elephant corridor in the Study area.

(b) Reserved Forest

There are quite a few reserved forests and proposed reserved forests in the cascade area both in Anuradhapura and Vavuniya districts as shown in the maps in Attachments 7.1-4 and 7.1-5. However, the boundaries of these forests are not precise and do not necessarily match the current land use. Only field officers of FD can reveal by the field survey if the area is inside or outside the protected forest areas, according to the FD.

(c) Wetlands

There is no Ramsar wetland in the Study area. According to the National Wetland Directory, there are five national wetlands in Anuradhapura District shown in the following table. In Vavuniya District, there is no wetland listed in the National Directory.

Table 7.1-9 List of Wetlands in Anuradhapura District and their Current Status

	Name of Wetland	Overall Threat Status
1	Kalawewa Tank	Low
2	Nachchaduwa Tank	Moderate
3	Nuwarawewa Tank	Moderate
4	Padaviya Tank	Low
5	Wahalkada Tank	Low

Source: National Wetland Directory of Sri Lanka, Central Environmental Authority, 2006

(11) Cultural Heritage and Archaeological Sites

Sri Lanka has six archaeological UNESCO World Heritage Sites, but none of these overlaps with the Study area. There are 24 archaeological sites identified by the Department of Archaeology in Anuradhapura District as shown in the following table, but none of them falls withinside the cascade systems. There are small cultural sites, such as shrines and statues, scattered throughout both districts, and some are in the cascades area.

Table 7.1-10 Archaeological Sites in Vavuniya and Anuradhapura Districts

No.	Map No.	Site Name	No.	Map No.	Sites Name
Vavuniya District					
1	1	Unknown	2	2	Unknown
Anuradhapura District					
1	6	Isebessagama	13	110	Pahala Divulwewa
2	8	Palippothana	14	114	Thammennewa
3	12	Kedewa	15	115	Ethalvidda Wewa
4	13	Kirigalwewa	16	117	Puhulwewa
5	14	Diviyaudabendawewa	17	121	Kurukuragama
6	16	Kuda Vilachchiya	18	122	Dachchihalmillewa
7	17	Ethdathkalla	19	124	Kalpe
8	48	Ranpathwila	20	127	Medawachchiya Junction
9	49	Kokmaduwa	21	130	Panwella
10	50	Upuldeniya	22	131	Mahawewa
11	51	Konwewa	23	132	Konwewa
12	52	Himbutugollewa	24	136	Ihalagama

Source: Prepared by the Study Team based on the Environmental Sensitive Areas Maps by CEA

(12) Biological Environment of the Project Target Areas and Existing Vegetation and Flora and Fauna

Biogeographically, the Study area lies within the low country dry zone. Floristically, it is under the dry and arid lowlands floristic zone. Tropical dry mixed evergreen forests ((Manilkara Community, Mixed Community (Chloroxylon-Vitex-Berrya-Schleichera series)), tropical thorn forests (Manilkara-Chloroxylon-Salvadora-Randia series), Damana and Villu Grasslands, flood-plain wetlands, riverine and gallery forests are typical natural vegetation formations in the dry and arid lowlands floristic zone. Tropical dry mixed evergreen forests or dry zone forests and tropical thorn forests can be observed in the protected areas in the Study area as well as catchment area of tanks and some highlands in the command area of the tanks. Riverine and gallery forests can be observed beside rivers and streams as a thin belt along the rivers or streams. However, most of the riverine and gallery forests that in the command area of tanks are disturbed due to human activities. Sometimes, gallery forests can be observed in the riparian periphery of the small tanks, which are commonly called as Thavalla or Thavulla forests in Sinhala. Sometimes, gallery forests can also be observed in the immediate downstream of the tank bund due to seepage water. Flood-plain wetlands can be observed in the food plains of large rivers and riparian periphery of the small tanks. Damana and villu grasslands are rare in the Study area. In addition to above, forest plantations, abandoned lands, rocky outcrops can be observed in the area.

According to "the National Red List 2012 of Sri Lanka: Conservation Status of the Fauna and Flora", distribution of the endemic and threatened species of the main fauna groups and flora in the Anuradhapura and Vavuniya districts are listed in the following table[3].

Table 7.1-11 Distribution of Threatened Species of the Main Fauna Groups and Flora in Anuradhapura and Vavuniya Districts

Item 1	Freshwater Fish			Amphibians			Reptiles		
	CR(1)	EN(2)	VU(3)	CR	EN	VU	CR	EN	VU
Anuradhapura	1(1)*	3 (2)	4 (3)	0	0	3 (2)	2 (2)	5 (3)	8 (3)
Vavuniya	1 (1)	1 (0)	0	0	0	0	0	0	1 (0)

Item 1	Birds			Mammals			Total
	CR	EN	VU	CR	EN	VU	
Anuradhapura	0	1 (0)	6 (0)	0	12 (1)	12 (1)	57 (18)
Vavuniya	0	3 (1)	5 (2)	0	0	0	11 (3)

Item 2	Flora			
	Total Species	Threatened Species	Endemic Species	Threatened Endemic Species
Anuradhapura	956	236	100	47
Vavuniya	218	41	9	5

*Note: (1) CR: Critically Endangered, (2) EN: Endangered, (3) VU: Vulnerable, * the numbers inside the parentheses indicate endemic species.*
Source: The National Red List 2012 of Sri Lanka: Conservation Status of the Fauna and Flora, GOSL

Out of the 956 total recorded flora species in Anuradhapura District, 236 species are threatened, 100 species are endemics, and the threatened endemic are 47 species. Anyhow, some of the threatened or endemic or threatened endemic species can be found only in some isolated hills in Anuradhapura District (Ritigala). Therefore, such numbers are less in the Study area since such isolated hills are not in the Study area. Similarly, endemic and threatened fauna species also are less as such isolated hills are not in the Study area.

A more detailed information on existing fauna and flora in the Study area is summarised in Attachment 7.1-6.

(13) Involuntary Settlement and Land Acquisition

No land acquisition in the project is expected. Thus, no involuntary settlement will occur.

(14) Indigenous People

Indigenous people are known as "Vedda" in Sri Lanka with indigenous ancestry. It is estimated that there are a total of 7,350 to 7,500 families, which is less than 0.005% of the Sri Lankan national population, according to the Ministry of Culture and Arts[4]. Settlements of indigenous people have been restricted mainly to the Ampara, Batticaloa, Trincomalee, Polonnaruwa, Anuradhapura, Badulla and Moneragala

[3] It should be noted that the numbers are not necessarily definite. During 2012 red listing process, species distribution maps were prepared by extracting past records and due to prevailing war in the Northern Province not much past records were found in Vavuniya District, hence, the total number of species in Vavuniya District came to low value.
[4] "Socio-Anthropological Research Project on Vedda Community in Sri Lanka", Ministry of Culture and the Arts, 2011.

districts in Eastern, Uva and North Central provinces. However, there is no Vedda communities within the Study area. Settlements of indigenous people have been restricted mainly to the Ampara, Batticaloa, Trincomalee, Polonnaruwa, Anuradhapura, Badulla and Moneragala districts in Eastern, Uva and North Central provinces. However, there are no Vedda communities within the Study area.

(15) Other Natural, Social and Economic Environment in the Project Area

The current situation of the natural environment such as climate as well as social and economic environments such as demography, economy, irrigation and rural infrastructure, institutions and organisations, gender, etc. is summarised in Chapter 2 of this report.

7.1.2 National and Regional Government Organisations

(1) Organisations for Environmental Protection

The Central Environmental Authority (CEA) under the Ministry of Environment is Sri Lanka's most relevant entity on environmental considerations. It is responsible for the management of the environment and natural resources of the country, "providing leadership in order to ensure national commitment for sustainable development for the benefit of the present and future generations"[5]. The Environment Management and Assessment Division is responsible for Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) process. The Environment Management and Assessment Division is responsible for the EIA and initial environmental examination (IEE) process.

The CEA also operates provincial and district offices that handle most compliance and enforcement functions. At the provincial level, the provincial councils have the power to make statutes applicable within the province in respect to subject areas specified under the constitution. For example, the North Western Province has set up statutes for environmental protection on its own in 1990. Other local authorities like Municipal Councils, Urban Councils and Pradeshiya Sabhas also have the power to formulate subsidiary legislation.

(2) Organisations for Environmental Conservation

The Ministry of Wildlife and Forest Conservation is the major government organisation that undertakes environmental conservation in Sri Lanka.

Under the Ministry, the Department of Wildlife Conservation (DWC) is responsible for protection of wildlife resources throughout the entire country. DWC also has the legal authority to establish and manage network of wildlife protected areas (WLPAs), national parks, nature reserves and wildlife of wilderness areas in Sri Lanka.

The Forest Department (FD) is another department whose role is maintaining forest reserves and wildness areas. More than half (55%) of the forest and wildlife in Sri Lanka is managed and protected by FD, while the rest falls under the DWC's purview.

7.1.3 Important Legislations and Policies Concerning Environmental and Social Considerations

A summarised list of important legislations and national policies concerning environmental and social considerations is shown in Table 7.1-12 and Table 7.1-13 below.

[5] The Ministry of Environment website.

Table 7.1-12 Key Legislations Concerning Environmental and Social Considerations

Legislations	Contents
Constitution of Sri Lanka	Article 18 stats that "It is the duty of every person of Sri Lanka to protect nature and conserve its riches". Also, Article 27 (14) states that" The state shall protect, preserve and improve the environment for the benefit of the community"). The 13th amendment to the constitution created new institutions at the provincial level for environmental protection and management. Each provincial government has legislative and executive powers over environmental matters (Articles 154 (A), 9, 19 and (III) 17). Using such provincial legislative and executive powers, the North Western Provincial (NWP) Council has established the North Western Provincial Environmental Authority to supervise and monitor environmental activities in the North Western Province of Sri Lanka. Only the NWP has established its own environmental authority.
National Environmental Act, No.47 of 1980, and amendments in Act No. 56 of 1988, Act No. 53 of 2000	The NEA is the umbrella environmental protection legislation. It provides an environmental framework for protection, management and enhancement of the environment.
Forest Ordinance No. 6 of 1907 and amended up to 2009	The law for conservation, protection and management of forests and forest resources.
Fauna and Flora Protection Ordinance No. 02 of 1937, amended 2009	The act provides protection and conservation of the fauna and flora of Sri Lanka and their habitats. This act specifies that any development activity that takes place within the one mile of the boundary of a National Reserve declared under the ordinance require an EIA/IEE.
Mines and Minerals Act 1973	All resources required for construction must be procured from quarries or burrow sites having a valid mining license.
Felling of Trees Control Act No. 9 of 1951 and amended through Act No. 30 of 1953	It prescribes the permissions from the Divisional Secretary in case some trees must be removed.
National Water Supply and Drainage Board Law No. 2 of 1974	The Act deals with prevention of pollution of rivers, streams and other water sources and regulates the supply and distribution of safe drinking water.
Irrigation Ordinance No. 32 of 1946	The ordinance deals with environmental aspects of water and land use in irrigation agriculture.
Paddy Lands Act of 1958	The Department of Agrarian Services was established in order to encourage farmer participation in minor irrigation development. Cultivation Committees were also established under this Act.
Agriculture Productivity Law of 1972	Responsibility of minor irrigation development was transferred back to the Irrigation Department. Agricultural Productivity Committees (APC's) were established for the development of irrigated agriculture.
Agrarian Development Act No. 46, 2000	An act provides for, matters relating to landlords and tenant cultivators of paddy lands, for the utilisation of agricultural lands, for the establishment of agrarian development councils, for the establishment of a land bank.
Agrarian Services Act No. 59 of 1991	Farmers' organisations (FO's) were given legal authority to undertake irrigation contracts under this act.
National Aquatic Resources Research and Development Agency Act 1981	The act addresses the management, regulation, conservation and development of fisheries and aquatic resources.
Control of Pesticide Act No. 33 of 1980 and Amendments	It provides for the licensing of pesticides; to regulate the import, packing, labelling, storage, formulation, transport, sale, use, etc.
Soil Conservation Act No. 25 of 1951 and Amendments	It was designed to conserve soil resources, mitigate soil erosion and protect land against damage by floods and droughts.
Plant Protection Ordinance No. 35 of 1999	The ordinance makes better provision against the spread of weeds, pests, and diseases injurious to, or destruction of, plants, and for the sanitation of plants.

Legislations	Contents
National Heritage Wilderness Act No. 3 of 1988	Identifying and protecting important wilderness areas in the country.
Land Acquisition Act, No. 9 of 1950 and 1956	It makes provision for the acquisition of lands and servitudes for public purposes.
Crown Lands (State Land) Ordinance No. 8 of 1947 and Amendments	This ordinance deals with the power of the state to sell, lease, grant or otherwise dispose of state lands for management and control.
Land Settlement Ordinance No. 20 of 1931	An ordinance to amend and consolidate the law relating to land settlement.
Flood Protection Ordinance No. 04 of 1924, No. 22 of 1955	An ordinance for protection of areas subjected to damage from floods. This includes declaration of flood areas, preparation of schemes for flood protection and other rules and regulations regarding flood in the country
The Urban Development Authority, Law, No. 41 of 1978	Urban Development Authority Law to provide for the establishment of UDA to promote integrated planning and implementation of economic, social and physical development of certain areas as may be declared by the minister to be urban development areas and for matters connected with the relevant project activities. UDA provides technical support to local councils who require assistance in developing plans. It has the authority to develop plans when local authorities fail to do so. The UDA monitors urban areas and develops land use policies for designated development areas.
Antiquities Ordinance No. 9 of 1940 (and Subsequent Amendments)	The act regulates the subprojects located near any archaeological reserves. In areas so designated under the Antiquities Ordinance, an Archaeological Impact Assessment (AIA) may be required for new projects, at the discretion of the Director General of Archaeology (Section 47 and 43A of the Antiquities Ordinance. Extraordinary Gazette No. 1154/14 dated 4th October 2000.)
Water Resources Board Act, No. 29 of 1964 and (Amendment) Act, No. 42 of 1999	The act control, regulation and development (including conservation and utilisation) of water resources; prevention of pollution of rivers, streams and other water resources; formulation of national policies relating to control and use of water resources.
Town and Country Planning Ordinance No. 13 of 1946 and The Town & Country Planning (Amendment) Act, No. 49 of 2000	This regulates the National Physical Plan which includes transport as main aspect, and the proposed project related activities should be included for the purposes of this ordinance
Buddhist Temporalities Ordinance No. 19 of 1931	This act provides necessary assistance to administer and protect the property of Viharas, Intervention to settle disputes that arise regarding property of Viharas and making recommendation to release money to be paid as compensation in respect of property of Vihara acquired by the government for any similar development like the proposed project.
Cemeteries and Burial Grounds Ordinance No. 9 of 1899 and Amendments	The act regulates any disturbance, removal of burial, monuments and use of such areas for other developments and such activities related to the proposed project must be given proper concern
Land Development (Amendment) Act, No. 9 (1995), No. 20 of 1996	The act provides for the systematic development and alienation of state land in Sri Lanka.

Source: Prepared by the Study Team from various documents and webpage.

Table 7.1-13 Major Environment and Resettlement Policies

Policies	Contents
National Environment Policy - 2003	It aims to promote sound management of environment balancing social and economic development and environment integrity, assuring environmental accountability.
National Forestry Policy - 1995	The objective is to provide clear directions for safeguarding the remaining natural forests in order to conserve biodiversity, soil and water resources.
The National Policy on Wildlife Conservation - 2000	It shows the government commitment to conserve wildlife resources through promoting conservation, maintaining ecological processes and life sustaining systems, managing genetic diversity and ensuring sustainable utilisation of biodiversity.
National Watershed Management Policy - 2004	Policy aims to conserve, protect, and rehabilitate, sustainability use and manage the watersheds, managing their environment characteristics.
Cleaner Production Policy - 2004	It tries to incorporate the cleaner production concept and practices into all development sectors of the country.
National Biosafety Policy - 2005	It sets the overall framework for developing and practicing adequate safety measures in order to minimise possible risks to human health and the environment.
National Air Quality Management Policy - 2000	It aims to maintain good air quality to reduce morbidity due to air pollution and in turn reduce national health expenditures.
National Policy on Wetlands – 2005	It identifies the National Wetlands and gives effect on National Environment Policy and other relevant national policies.
National Policy on Sand as a Resource for the Construction Industry - 2006	It defines the commitment of the government to effectively manage the construction-sand resource for the benefit of present and future generations.
National Policy on Elephant Conservation - 2006	The policy was developed to ensure long-term survival of the elephant in the wild in Sri Lanka through mitigation of human-elephant conflict.
National Policy on Solid Waste Management	It aims to ensure integrated, economically feasible and environmentally sound solid waste management practices at the national, provincial and local authority level.
National Involuntary Resettlement Policies of 2001 and amendment in 2009	It addresses resettlement issues. The NIRP requires that a comprehensive plan should be prepared when 20 or more families are affected.

Source: Prepared by the Study Team

7.1.4 Environmental Standard

Environmental Standard for Air Quality, Emission Standard, Waste Quality and Noise identified in National Environmental (Noise Control) Regulations No. 1 1996 are summarised in Attachment 7.1-7.

7.1.5 EIA/IEE Process

In Sri Lanka, EIA was introduced for the first time in 1981 under the Coast Conservation Act. The act required carrying out EIA for projects located within "coastal zones". The EIA was formally brought into practice for prescribed projects since 1988 through legal provisions under the National Environmental Act (Amendment), No. 56 of 1988. The prescribed projects are listed in the Gazette No. 772/22, dated 24th June 1993; No. 859/14 dated 23td February 1995; No. 1104/22 dated 5th November 1999 and No. 1108/1 dated 29th November 1999. The project proponent or project implementing agency should conduct an IEE or EIA for the prescribed project and obtain an environmental clearance before starting the project. The Environmental Management and Assessment Unit of CEA is in charge of processing, implementing and approving the EIA or IEE.

According to the “PART 1: SECTION (i) – GENERAL Government Notification of 772/22 under Section 23 Y”, rehabilitation of minor tank works is not included in the "prescribed projects"; and therefore, the implementation of EIA or IEE is not required, unless it is implemented in the sensitive areas.

The sensitive areas identified in GENERAL Government Notification of No. 772/22 include the following:

i) Within 100 metres from the boundaries of or within any area declared under:
  - the Forest Ordinance (Chapter 451) of 1981;
  - whether or not such areas are wholly or partly within the Coastal Zone as defined in the Coast Conservation Act, No. 57 of 1981.

ii) Within the following areas whether or not the areas are wholly or partly within the Coastal Zone:
  - any erodible area declared under the Soil Conservation Act (Chapter 450);
  - any flood area declared under the Flood Protection Ordinance (Chapter 449) and any flood protection area declared under the Sri Lanka Land Reclamation and Development Corporation Act, No.15 of 1968 as amended by Act, No. 52 of 1982;
  - 60 metres from the bank of a public stream as defined in the Crown Lands Ordinance (Chapter 454) and having a width of more than 25 metres at any point of its course;
  - any reservation beyond the full supply level of a reservoir;
  - any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (Chapter 188);
  - any area declared under the Botanical Gardens Ordinance (Chapter 446)

iii) In these regulations unless the context otherwise requires:
  - ‘Hazardous waste’ means any waste that has toxic, corrosive, flammable, reactive, radioactive or infectious characteristics.
  - ‘Reservoir’ means an expanse of water resulting from man-made constructions across a river or a stream to store or regulate water. Its ‘environs’ will include that area extending up-to a distance of 100 metres from full supply level of the reservoir of all islands falling within the reservoir.

7.1.6 Components in the Proposed Development Plan

A total of four components were proposed in the development plan. Component 1 is a civil work component for the infrastructure rehabilitation while Component 2 is supporting activities/components in order to enhance the incomes of beneficiary farmers in the Study area. The infrastructure and facility development are applicable to the selected sub-projects; however, Component 2 is implemented only in the model cascades.

The following table summarises these four components. Details of the four components are explained in Chapter 4.

Table 7.1-14 Proposed Project Activity in Cascade Systems Development Plan

No.	Component	Short Name	Programme Name	Content
Component 1: Cascade System Development				
1.1	Infrastructure and Facility	-	-	Rehabilitates and constructs irrigation and drainage facilities of 124 cascade systems in the Study area. The work includes rehabilitation of

No.	Component	Short Name	Programme Name	Content
	Development-			tank band reshaping, repair/re-construction of sluices, improvement of spillways, and provision of bathing steps. Also, formation of irrigation canals and improvement of farm road (gravel) are planned. Those facilities will enable to conduct proper and efficient water distribution in the Study area.
1.2	Procurement of Machinery and Equipment	-	-	Procures machinery and equipment useful for proper O&M, enhancement of agricultural production and fam income diversification in the Study area.
Component 2: Soft Component				
2.1	Institution and Capacity Development	(1)	Capacity Improvement of FOs and the Relevant Government Officers for Water Management	Strengthens existing farmer organisation's (FO) capacity for better water management.
		(2)	Promotion of Awareness Campaign of Tank Day	Promotes stakeholders' awareness on the importance of maintenance of irrigation facilities and disaster management by conducting campaigns.
2.2	Agricultural Development	(1)	Cultivation Skills Development with Provision of Quality Inputs	Provides farmers with skills and high-quality inputs for high value crops, OCFs and new varieties production.
		(2)	Enhancement of Agriculture Extension System	Establishes a firm agriculture extension system platform to increase agriculture productivity and production.
2.3	Post-harvest and Marketing Development	(1)	Establishment of the Community Supported Agriculture Model	Supports to design the most suitable cropping pattern of several high value crops in the Study area through, formation of the partnerships with hotels, provision of technical support, providing training, and establishment of business model.
2.4	Livestock Development	(1)	Stable Feed Production and Delivery through Entrepreneur Development	Establishes a system of entrepreneur development for motivated young livestock farmer groups collecting and processing maize crop residue and selling those as cattle feed to the members.
		(2)	Development of Models for Dairy Cattle and Backyard Poultry under Value Chain System	Establishes the models of dairy cattle and backyard poultry through the pilot activities in parallel with 2.4(1).
2.5	Fishery Development	(1)	Promotion of Inland Fishery Development in Selective Tanks	Promotes seasonal inland fisheries in selected tanks.

Source: Study Team

7.1.7 Scoping

The main objective of this section is to make a provisional identification of environmental and social impacts based on the proposed project components listed above and overall environmental and social conditions in and around the Study area. The results of the potential impacts from the project are preliminarily presented and analysed in this section with respect to the following aspects:

i) Pollution control measures;

ii) Natural environment;
iii) Social environment; and
iv) Others.

The impacts were evaluated using the following rating scale and criteria:

A-: Significant negative impact A+: Significant positive impact

B-: Some negative impact B+: Some positive impact

C: Impacts are not clear, need more investigation

D: No impacts or impacts are negligible, no further study required

The result of scoping for environmental and social impact assessment is shown in the following table. Scoping was conducted at two phases, i.e., construction phase (C) and operation phase (O).

It should be noted that both land acquisition and involuntary resettlement are not expected in the Project.

Table 7.1-15 Results of Scoping for Environmental and Social Impact Assessment

Issues	Phase	Possible Impacts	Evaluation
Pollution Control			
Air Pollution	C	Dust and exhaust gas will be generated by land clearing and excavation works for the rehabilitation of irrigation structures and farm roads. However, impacts will be quite limited because this happens only at a limited time of construction and outside the housing zones. (by 1)	D
	O	No impacts on air are expected.	D
Water Pollution	C	Soil from excavation work may cause water turbidity, and concrete residue from civil work may contaminate the water; however, the impact of these will be limited. (by 1)	B-
	O	Training for proper application of high-quality inputs in crop diversification will reduce the risk of water pollution. (by 2.2(1))	B+
Solid Waste	C	Various solid wastes, mainly green waste, soil excavation waste, demolition /construction waste will be generated. (by 1)	B-
	O	No impact from solid waste is expected.	D
Soil Contami-nation	C	There may be contamination of fuel oils from construction vehicles, if they are not maintained properly. However, it will be very limited. (by 1)	B-
	O	Proper application of high-quality inputs in crop diversification will reduce the risk of soil pollution. (by 2.2(1), 2.3(1))	B±
Noise and Vibration	C	Noise and vibration by the construction and rehabilitation works may occur. However, impacts will be limited because this happens outside the housing zones. (by 1)	D
	O	The slight increase of road traffic in the village areas for the transportation of agriculture products may affect the noise levels, but this is not significant. (by 2.2(1))	D
Ground Subsidence	C/O	There is basically no ground subsidence likely to occur.	D
Offensive Odours	C	Exhaust gases from construction vehicles may cause undesirable odour. However, impacts will be quite limited because this happens outside. Odour will dissipate. (by 1)	D
	O	There is basically no offensive odour likely to occur.	D
Bottom Sediment	C	Desilting of sediment from tank bottom for rehabilitation of tanks could cause the impacts on bottom sediment. However, this is a positive impact, restoring original ecosystem of tanks. (by 1)	B+

Issues	Phase	Possible Impacts	Evaluation
	O	Basically, there is not much impact on bottom sediment to occur.	D
Natural Environment			
Protected Areas	C	There are some protected areas including National parks and Reserved Forests in the Study area. Close examination is necessary. However, the projects should not give serious adverse impacts as it is only a rehabilitation and inside the long existing tank cascade area.	B-
	O	Direct adverse impacts on protected area are not expected. The project may provide better environment for aquatic creatures and birds year around.	B+
Flora, Fauna and Biodiversity	C	Only limited clearance of vegetation for construction in the areas is expected. Disturbance of activities of animals and insects by construction, such as limiting access to water, may be occur during the construction period although it is only for a limited period. (by 1)	B-
	O	No impact is expected.	D
Hydrological Situation	C	Reducing the tank water during the construction period may affect the hydrology of the cascade system, although it would be during the Yala season and only short-term, and not much impact is expected. (by 1)	D
	O	The efficiency of water distribution system will be improved, and hydrological situation will be improved (by 1).	B+
Topography and Geographical Features	C/O	This project is a restoration and rehabilitation of existing tanks and roads, and the impact of topography and geology is not expected. .	D
Poverty	C	Part of construction of irrigation restoration and inter-tank water channels may be implemented by farmers' participatory method. This will give a positive impact on poor farmers' income. (by 1)	B+
	O	Enhanced agriculture, livestock and fishery production will likely increase farmers' income, which contribute to alleviating poverty and vulnerability. (All)	B+
Indigenous People and Ethnic Minorities	C/O	There is a risk for conflict between ethnic, religious and social status of the groups by building tension or feeling of unfairness if enough consideration is not given (by 1, 2.1(1)) There is no indigenous people living in the area.	B-
Local Economy such as Employment and Livelihood, etc.	C	Construction work of infrastructure will be contracted out to local companies, and local labours will be employed. This will give a positive impact on local economy. (by 1)	B+
	O	Enhanced agriculture production and marketing will likely increase farmers' income. Diversification of agriculture products and processing industries will activate local economies and increase employment. (by All)	B+
Land Use and Utilisation of Local Resources	C	Some parts of nearby farmland may be used for construction sites and facilities. However, it is temporal. (by 1)	D
	O	Agriculture in the peripheral areas will also be promoted. Maize crop residue will be utilised, and inland fishery is promoted, which will lead to more effective use of land and local resources. (by 2.2(1), 2.4(2), 2.5(1))	B+
Water Use	C	Farmers cannot have access to water for agriculture during construction period. However, it is temporal, and impacts are minimum. (by 1)	D
	O	Efficiency of water usage will be improved by the rehabilitated	B+

Issues	Phase	Possible Impacts	Evaluation
		water distribution facility with planned water distribution system. (by 1, 2.1(1), 2.2(1), 4, 2.5(1))	
Social Environment			
Existing Social Infra-structures and Services	C/O	Existing infrastructure is upgraded. (by 1). More active involvement of FOs as well as local government institutions is expected. (by All)	B+
Social Institutions	C	New relationship with farmers of neighbouring tanks in the same cascade system and government institutions/officers will be created through planning. (by 1)	B+
	O	The relationship with other actors will be newly generated in the process of diversification of agriculture. Social capital and social organisation are supposed to be broaden and strengthened. Power dynamism in the communities may change. (by All)	B+
Mis-distribution of Benefit and Damage/ Local Conflict of Interest	C	Some construction works for restoration of the tanks may be contracted out to communities and farmers. Employment procedure and opportunities should be fair to avoid local conflict among farmers. (by 1)	B-
	O	In any intervention, there are risks that could induce local conflicts. Institution and capacity development component will promote establishment of sound and fair cascade water management bodies, which will be the key to avoid local conflict. (by 2.1(1))	B+
Cultural Heritage	C/O	Although Anuradhapura District has many historical and cultural heritage sites, the Study area does not overlap with these heritage sites and will not cause any physical damages or indirect damages such as changes of landscape, to any of the notified sites. (overall)	D
Landscape	C/O	There will be some changes in landscape during construction. However, landscape in the area will be improved when traditional cascade system will be restored. (by 1)	B+
Gender	C	Tanks are used not only for agriculture purposes but also for domestic use such as washing clothes, basing, etc., in which women play major roles. Women's participation in planning and consultation processes of rehabilitation of irrigation system need to be secured, particularly, women in vulnerable condition. Also, equal employment as well as compensation opportunities for the female labours in construction should be secured (by 1).	B-
	O	Priority may be put on the male farmers in the Project activities. Women's participation in decision-making process and project activities may be limited, particularly women in vulnerable condition. (by All)	B-
Children's Rights	C	No usage of child labours is expected to occur. (by 1)	D
	O	No impact on children's rights is anticipated.	D
Infectious Diseases such as HIV/AIDS, etc.	C/O	The tank rehabilitation work is not large-scale, and influx of construction workers is not expected. No impact on infectious diseases is expected. (by 1)	D
Working Condition	C	A risk on occupational health and safety due to construction works and operation of heavy machines. Poor working and living conditions may be given to workers. (by 1)	B-
	O	No activity that causes negative impacts on farmers is expected.	D
Accidents	C	Transportation of construction vehicles or operation of heavy	B-

Issues	Phase	Possible Impacts	Evaluation
		machine will increase the risk of accidents at the surrounding area and within the construction site during construction and rehabilitation period in some extent. (by 1)	
	O	No activity that increases accidents is expected.	D
Other			
Cross-border Effects	C	Some small rivers and medium tanks that are not in the Study area but connected to the target cascade systems may be affected, like having turbid water during construction and rehabilitation period, although it is limited and not significant (by 1).	D
	O	Some spill over positive effect on neighbouring areas of agriculture, livestock and fishery promotion may be possible. (2.1(1), 2.1(2), 2.2(1), 2.2(2), 2.3(1), 2.4(2), 2.5(1))	B+

Source: The Study Team

7.1.8 Survey Result

(1) Pollution such as air pollution, water pollution, soil contamination, solid waste may be caused by the infrastructure construction

Implementation of "Cascade System Facility Development Project (1)" including rehabilitation of tank band, spill ways and farm roads may cause some pollution listed below during the construction period:

i) Air pollution due to dust and exhaust gas from civil works for the rehabilitation of irrigation structures and farm roads where the houses are located near the tank or farm roads.
ii) A solid waste such as branches and leaves of trees generated by vegetation clearance, earth waste by dredging, concrete debris from old tank parts, etc.
iii) Residential waste and human waste from the labour camp.

Although water pollution from the agro-chemicals by the agricultural components in the operational phase will be limited, and the impact will not be significant, water quality of the tank should be monitored as it is one of the most important resources for the residents and environment. As the baseline value, the water quality tests were conducted in the field. The samples are taken from one tank each from the total of five cascades[6]. The test result is summarised in the following table. The detailed result of the test is presented in Section 7.1.1 (7) above.

[6] See above section 7.1.1 (7) to (9).

Table 7.1-16 Result of Water Quality Test of Five Target Tanks

Items	Test Results
Water Quality	The baseline values of the five tank-water are all within the standard limits for the surface water stipulated in the National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water).

Source: Study Team

(2) Protected Areas

There are environmentally protected areas and reserved forests located in the Study area both in Anuradhapura District and Vavuniya District as listed in Table 7.1-17. The geographical relationship between these protected areas and each target tank area was examined, using the geographical information system (GIS). The result is shown in Table 7.1-18.

Table 7.1-17 Environmentally Protected Areas in the Target Areas

Protected Areas	Anuradhapura	Vavuniya
National Parks	Horowpothana	N/A
Sanctuaries	Mihinthale, Mahakanadarawa Wewa, Padaviya Wewa	N/A
National Wetland	Kalawewa tank, Nachchaduwa tank, Nuwarawewa tank, Padaviya tank, Wahalkada tank	N/A
Forest Reserves	Wedakanda, Isenbessagala, etc.	Nainamadu, Irampaikulam, Maha Irankaikulam, etc.
Proposed Forest Reserves	Medawachchiya, Hinna, Semawa, Ethakaduwa, etc.	Periyakattikulam, Puliyankulama, etc.
Important Bird Areas	Padabiya	N/A

Source: Prepared by the Study Team based on the information from DWC

Table 7.1-18 Potential Numbers of Target Tank Systems that Overlaps with Protected Areas

Item	Horowpothana National Park	Forest Reserves (incl. Proposed)
Number of Tanks around the Tank Area & Command Area Overlap	0	33 (13)
Number of Tanks that Only Catchment Forest Area Overlap	14 (4)	44 (19)

Note: The numbers inside the parenthesises indicate the number of cascade systems.
Source: Study Team

It was found that there are 33 tank systems in 13 cascades of which surrounding area and command area seemingly overlap within the reserved forests. Also, there are 14 tanks in four cascades of which catchment forest area overlap with a part of the Horowpothana National Park, and 44 tanks in 19 cascades of which catchment forest area seemingly overlaps as the reserved forest[7].

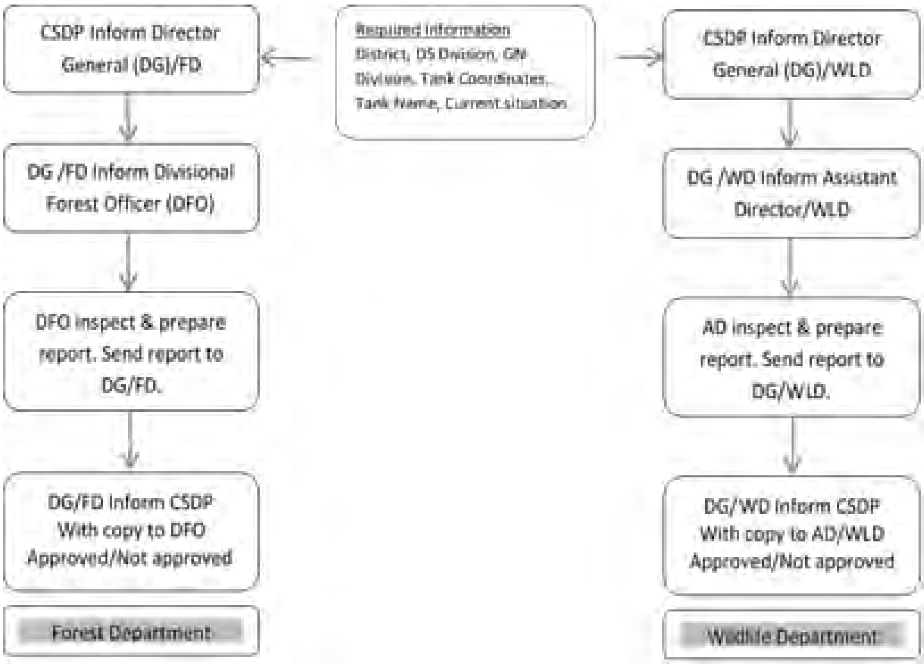
The discussions with the Forest Department (FD), Department of Wildlife Conservation (DWC), Department of Irrigation (ID), Provincial Department of Irrigation (PID) and Department of Agrarian Development (DAD) cleared the issue.

i) In case that tank systems (tank, tank band, command area, resident area, farm road, etc.) are overlapping with the protected areas, and they have been actively used.
   - Working minor tank systems are under the purview of PID and DAD, and FD and DWC

[7] The list of these tanks is attached in Attachment 9.1-8.

do not require the permission for rehabilitation of existing system.

- However, concurrence is needed before the construction starts. The forest officer and DWC officer in the field will examine the site and give permission. The diagram of general procedure for applying permission is shown in the following figure. The diagram of general procedure for applying permission is shown in the following figure.



Source: Study Team

Figure 7.1-2 General Procedures for Applying Permission from FD and DWC

ii) In case that only catchment area of the tanks is identified as protected area.

- No permission is needed from FD or DWC as there will be no Project activities there.
- However, it is important to inform both departments, and take enough considerations should be given in order not to disturb the animals and plants in the forest.

It is necessary to contact field FD offices when the Project starts and take above procedures to receive the concurrences for the tanks seemingly overlap with the protected forest areas. Also, it is important to inform FD and DWC about the construction plans of tanks of which catchment areas seemingly overlap with the protected forest or the Horowpothana National Park.

As for the Padaviya Important Bird Area (IBA), which was originally suspected overlapping with many cascade boundaries. However, it was confirmed with the senior officers of the Field Ornithology Group of Sri Lanka (FOGSL) which is the partner organisation of BirdLife International who identified and recommended the area as the IBA that Padaviya IBA is equivalent to the Padaviya Sanctuary area, and do not overlap with the Project target cascade boundaries.

(3) Fauna, Flora and Biodiversity

Main impacts on biodiversity are likely generated during the construction period: fauna and flora that live in the tank area will be disturbed due to clearance of some of the plants for rehabilitation work. Also, there will be loss of access to the tank water during construction period. Especially during the Yala season, fish and birds living around the tank will be affected as water from the irrigation tank is removed for construction, although this would be temporary.

As for the biodiversity, discussions with the ecological specialists ensured that some of the threatened, endemic or threatened endemic species can be only found in some isolated hills in the area. So, the project activities, which take place in the farm area would not affect the biodiversity very much. Nevertheless, extra caution should be taken in order not to give adverse impact on fauna and flora in the area.

(4) Animal-Human Conflict vs. Needs for Conservation

Although this area is not identified as an Elephant Corridor, it is estimated that there are about 600 elephants in Anuradhapura District and Wilpattu National Park, according to the Department of Wildlife Conservation of Anuradhapura. Large herds of elephants can destroy wide areas of crops, such as rice and maize, in a single night. A study shows that an average farmer in elephant-affected areas loses over USD 200 annually from crop damage[8]. But damage is not only on the crops. They often harm minor tank systems. Damage on the tank bund is observed in the Study area. Some areas are protected by electric fencing, which is considered to be most effective at present but very expensive at the same time. Farmers cannot do much about it by themselves. In addition, according to farmers, peacocks and monkeys are causing serious damages to the paddy yield and affecting the production. One reason for that is the decrease of predators for peacock; overprotection of them by eliminating foxes. No detail information on damages is found. In both cases, the farmers in the Study area are facing the dilemma between conservation of wild animals and protecting their production.

(5) Local Conflict of Interest regarding Water Distribution: Difference in Location (Upper Stream vs. Lower Stream), Size, Ethnic Groups, Social Status, etc.

Water management is a very sensitive matter, in particular in the Yala season in the dry zone, and local dissension could be induced among farmers if careful consideration on water distribution and management system is not given. As mentioned in the following section in this Chapter, there are some tanks and cascades that communities of different ethnic groups such as Muslim and Sinhala or Sinhala and Tamil are mixed, and the farmers use different languages. In such a case, in general, often the opinions of minorities are easily ignored. In addition, differences in the location in the cascade, e.g., upstream versus downstream or size of FO /community also contribute to the power and interest struggle among communities. Even in the current FO, which is formed by farmers operating only one tank, disputes related to water management sometimes occur, and there are many cases where intervention of the ASC officers is required to settle the issue. Sufficient consideration must be given to this issue because discord between FOs /communities not only hampers good management and effective water management but also induces instability in the area. The Institutional Development Plan, in particular "Capacity Development of FOs" will address this issue.

(6) Gender

Participation of women in the development activities and decision-making process is low in rural Sri Lanka due to lack of capacity, cultural and social background, and limited information and opportunities given to them. Currently, there are very few female FO representatives (office bearer). Also, as for participation in decision making, usually husbands, not wives often participate in the FO meetings on behalf of each family. In particular in the Muslim FOs, female participation is almost zero. Female

8 "An assessment of the human-elephant conflict in Sri Lanka", Ceylon Journal of Science (Bio.Sci.). Vol 39(1). 21-33, Santiapillai, C.,et.al. (2010).

members have less opportunities to participate in decision making, getting information, and getting services or support from the government. Actions are taken to address these issues in the Project.

7.1.9 Impact Assessment

The results of the assessment of impacts from the Project with their ranking are presented in the following table.

Table 7.1-19 Impacts of the Project

Items	Result of Scoping		Result of Survey		Possible Impacts
	C	O	C	O	
Pollution Control					
Air Pollution	D	D	B-	D	C: Dust and exhaust gas will be generated by traveling of construction vehicles and heavy machineries near the residential area. O: No impacts on air are expected.
Water Pollution	B-	B+	D	D	C: Soil from excavation work may cause water turbidity, and concrete residue from civil work may contaminate the water; however, the impact of these will be negligible. O: Training for proper application of high-quality inputs in crop diversification will reduce the risk of water pollution. Yet, the monitoring should be implemented as it is one of the important resources for farmers not only for agriculture but also for the living.
Solid Waste	B-	D	B-	D	C: Various solid wastes, mainly green waste, soil excavation waste, demolition /construction waste will be generated. O: No impact from solid waste is expected.
Soil Contami-nation	B-	B+	D	D	C: There may be contamination of fuel oils from construction vehicles, if they are not maintained properly. However, it will be very limited area and negligible. O: Proper application of high-quality inputs in crop diversification will reduce the risk of soil pollution. Yet, monitoring is recommended as the soil has some heavy metals.
Noise and Vibration	D	D	D	D	C: Noise and vibration by the construction and rehabilitation works may occur. However, impacts will be limited because this happens outside the housing zones. O: No impact is expected.
Ground Subsidence	D	D	D	D	C/O: There is basically no ground subsidence likely to occur.
Offensive Odours	D	D	D	D	C: Exhaust gases from construction vehicles may cause undesirable odour. However, impacts will be quite limited because this happens outside. Odour will dissipate. O: There is basically no offensive odours likely to occur.
Natural Environment					
Bottom Sediment	B+	D	B+	D	C: Desilting of sediment from tank bottom will bring about improvement of the capacity, better water utilization, and restoring original ecosystem of tanks. Although this will be implemented only in limited number of tanks, impact for the communities will be positive. O: There is basically not much impact on bottom sediment to occur.
Protected Areas	B-	B+	B-	B+	C: There are 33 tanks of which surrounding area is identified as reserved forests in the Study area. However, the projects

Items	Result of Scoping C	Result of Scoping O	Result of Survey C	Result of Survey O	Possible Impacts
					should not give serious adverse impacts to these forests as only rehabilitation of existing tanks systems is planned. However, confirmation with FD is a must. O: Direct adverse impacts on protected area are not expected. On the contrary, the rehabilitated tank system will provide better environment for creatures.
Flora, Fauna and Biodiversity	B-	D	B-	D	C/O: Only limited clearance of vegetation in the areas is expected. Disturbance of activities of animals and insects by construction, such as limiting access to water, may occur during the construction period although it is only for a limited period.
Hydrolo-gical Situation	D	B+	D	B+	C: Reducing the tank water during the construction period may affect hydrology of the cascade system, though it would be during the Yala season and only short-term, and not much impact is expected. O: The efficiency of water distribution system will be improved, and hydrological situation will be improved
Topography and Geographical Features	D	D	D	D	C: This project is a restoration and rehabilitation of existing tanks and roads, and the impact of topography and geology is not expected. O: No plans for land acquisition or resettlement are expected.
Landscape (Soil)	D	D	B-	D	C: Soil excavation for construction from unpermitted site or no recovery of the site may happen. O: No changes in landscape.
Social Environment					
Poverty	B+	B+	B+	B+	C: Part of construction of irrigation restoration and inter-tank water channels may be implemented by farmers' participatory method. This will give a positive impact on poor farmers' income. O: Enhanced agriculture, livestock and fishery production will likely increase farmers' income, which contribute to alleviating poverty and vulnerability.
Indigenous People and Ethnic Minorities	B-	B-	B-	B-	C/O: There is a risk of neglection of opinions of minorities. Conflict between ethnic, religious and social status of the groups may be induced by building tension or feeling of unfairness if enough consideration is not given. There are no indigenous people living in the area.
Local Economy such as Employment and Livelihood, etc.	B+	B+	B+	B±	C: Construction work of infrastructure will be contracted out to local companies, and local labours will be employed. This will give a positive impact on local economy. O: Although only at five locations, when the link canals are created in the cascades, farmers of upper tank and lower tank may cause tension regarding water utilization. Enhanced agriculture production and marketing will likely increase farmers' income. Diversification of agriculture products and processing industries will activate local economies and increase employment.
Land Use and Utilisation of Local Resources	D	B+	D	B+	C: Some part of nearby farmland may be used for construction sites and facilities. However, it is temporal. O: Agriculture in the peripheral areas will also be promoted. Maize crop residue will be utilised, and inland fishery is promoted, which will lead to more effective use of land and local resources

Items	Result of Scoping		Result of Survey		Possible Impacts
	C	O	C	O	
Water Use	D	B+	D	B+	C/O: Farmers cannot have access to water for agriculture during construction period. However, it is temporal and impacts are minimum. (by 1)
Existing Social Infrastructures and Services	B+	B+	B+	B+	C/O: Existing infrastructure is upgraded. More active involvement of FOs as well as local government institutions is expected.
Social Institutions	B+	B+	B+	B+	C/O: New relationship with farmers of neighbouring tanks in the same cascade system and government institutions/officers will be created through planning. The relationship with other actors will be newly generated in the process of diversification of agriculture. Social capital and social organisation are supposed to be broaden and strengthened. Power dynamism in the communities may change.
Mis-distribution of Benefit and Damage/ Local Conflict of Interest	B-	B+	B-	B+	C: Some construction works for restoration of the tanks may be contracted out to communities and farmers. If employment procedure and opportunities are not fair, local conflict of interest may occur among farmers. O: In any intervention, there are risks that could induce local conflicts. Institution building and capacity strengthening components will promote sound and fair cascade water management bodies, which will be the key to avoid local conflict.
Cultural Heritage	D	D	D	D	C: Although Anuradhapura District has many historical and cultural heritage sites, the Study area does not overlap with these heritage sites and will not cause any physical damages or indirect damages such as changes of landscape, to any of the notified sites. O: There is no impact on cultural heritage.
Gender	B-	B-	B-	B-	C: Women's participation in planning and consultation processes of rehabilitation of irrigation system may be ignored, particularly women in vulnerable condition. Women may be discriminated in employment as well as compensation as construction labours. O: Priority may be put on the male farmers in the Project activities. Women's participation in decision-making process and project activities may be limited, particularly women in vulnerable condition.
Children's Rights	D	D	D	D	C: No usage of child labours is expected to occur. O: No impact on children's rights is anticipated.
Infectious Diseases such as HIV/AIDS, etc.	D	D	B-	B-	C/O: The tank rehabilitation work is not large-scale, and influx of construction workers is not expected. However, enough precaution should be taken to prevent infectious diseases including COVID-19 when conducting any activities.
Working Condition	B-	D	B-	D	C: A risk on occupational health and safety due to construction works and operation of heavy machines. Poor working and living conditions may be given to workers. O: No activity that causes negative impacts on farmers is expected.
Accidents	B-	D	B-	D	C: Transportation of construction vehicles or operation of heavy machine will increase the risk of accidents at the surrounding area and within the construction site during

Items	Result of Scoping C	Result of Scoping O	Result of Survey C	Result of Survey O	Possible Impacts
					construction and rehabilitation period in some extent. O: No activity that increases accidents is expected.
Other					
Cross-border Effects	D	B+	D	B+	C: No impact is expected beyond the boundaries. C: Some spill over positive effects on neighbouring areas of agriculture, livestock and fishery promotion may be possible.

Note: C: Construction Phase, O: Operational Phase, B-=Negative impacts are expected to some extent, B+: Positive impacts are expected to some extent, D: No or very limited impacts are expected
Source: Study Team

7.1.10 Summary of Impacts

The following table provides a component level summary of the negative impacts.

Table 7.1-20 Overview of Anticipated Negative Impacts

Project Component	Infrastructure and Facility Development	-	Soft Component 2.1(1)	2.1(2)	2.2(1)	2.2(2)	2.3(1)	2.4(1)	2.4(2)	2.5(1)
Phase	C	O	O	O	O	O	O	O	O	O
Air Pollution	B-	-	-	-	-	-	-	-	-	-
Solid Waste	B-	-	-	-	-	-	-	-	-	-
Landscape (Soil)	B-	-	-	-	-	-	-	-	-	-
Protected Areas	B-	-	-	-	-	-	-	-	-	-
Flora, Fauna and Biodiversity	B-	-	-	-	-	-	-	-	-	-
Ethnic Minorities/Conflict of Interest	B-	B-	-	-	B-	B-	B-	B-	B-	B-
Gender	B-	B-	B-	B-	B-	B-	B-	B-	B-	-
Infectious Diseases	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
Working Condition	B-	-	-	-	-	-	-	-	-	-
Accidents	B-	-	-	-	-	-	-	-	-	-

Note: C: construction phase, O: operational phase, B-: Some negative impact
Source: Study Team

7.1.11 Comparison to the No-Project Alternative

An alternative plan was considered in the early stage of planning of the Project. In addition to environmental and social impacts to be generated by the implementation of the Project, other aspects such as effective use of irrigation water; economic effect; disaster risk; and impacts on society and organisation, are evaluated in comparison with an alternative, which is “the Project is not implemented (zero option)”. The following table shows the results of the comparison of these two cases.

Table 7.1-21 Compared Impacts of the Project with No-Project Alternative

Item	With the Project	Without the Project
Impacts on Environment	・ Some temporal pollution on water and solid waste as well as disturbance to the nature may be caused by the construction works ・ Provision and training of proper application of better-quality chemical fertilizers and pesticides could reduce water and soil contamination	・ Deteriorating tank facilities will be left un-rehabilitated, and they will malfunction, or some may be destroyed forever ・ Paddy field stays unproductive or lost forever ・ Some tank areas will turn into a jungle, landscape will change, and livelihood will be lost
Impacts on Disaster Prevention	・ Rehabilitation of the tank bund, spillway and other irrigation facilities will enhance tanks' discharge and drainage capacities and reduces risks of damages on the tanks as well as on agriculture produce caused by heavy rains and flooding ・ Improve tolerance toward flood and drought due to better water management inside a cascade.	・ There is a high risk of damages on tank bund, farm roads, culvert, and spillway as well as discharge of sediments by heavy rain. Furthermore, the domino effect may cause damage to downstream tanks and residential areas. ・ Low drainage capacity may cause flood in the farmland
Impacts on Society	・ Established better water management facilities and system as well as supporting activities in the Project will increase the agriculture productivity and income. ・ In addition, mutual understanding among stakeholders in the Study area will be enhanced, which will lower the risk of conflict and contribute to the stability of the area	・ Decrease of farmers' farm income ・ Increase of flood damage
Others	・ Food security in the region will increase	

Source: Study Team

Implementing the Project is far more beneficial than the "no project" alternative, from conservation of the environment, social, and disaster prevention standpoints.

7.1.12 Mitigation Measures

The mitigation measures are prepared to reduce all negative impacts that could be generated by implementation of the Project. These measures are indispensable for environmental and social sustainability of the cascade systems and prosperity of the people in the Study area. The following table provides a summary of the mitigation measures. Their strict application is required.

Table 7.1-22 Environmental and Social Issues and Mitigation Measures

Items	Identified Potential Negative Impact	Proposed Mitigation Measures	Cost
Construction Phase			
Air Pollution	Dust and exhaust gas will be generated by traveling of construction vehicles and heavy machineries near the residential area.	・ Use tarpaulins to cover sand and other loose materials when transported by trucks ・ Conduct air quality monitoring near the residential area as mentioned in the monitoring plan	N/A

Items	Identified Potential Negative Impact	Proposed Mitigation Measures	Cost
Waste	Various solid wastes, mainly green waste, demolition /construction waste will be generated.	▪ The contract document of the Project (1) shall include preparation of waste management plan during construction as a condition	N/A
Landscape (Soil)	Soil excavation for construction from unpermitted site or no recovery of the site may happen	▪ Ensure that the contractors comply with requirements. The contract document of the Project (1) shall include a clause indicating that "soil to be used for the rehabilitation works has to be taken from the designated place and excavated soil has to be restored after the construction work as directed by DAD or PID". ▪ Strict monitoring and intervention by the PMU are necessary.	N/A
Protected Area	Tank area may be inside the reserved forest	▪ Consult with FD and DWC of field offices to get clearance.	N/A
Fauna, Flora and Bio-diversity	Disturbance of activities of animals and insects by construction, such as limiting access to water, may occur during the construction period	▪ Minimize removal of vegetation as much as possible. ▪ An off-limit area of the construction workers will be put in place to prevent disturbance of the ecosystem around the construction site. ▪ The contract document of the Project (1) shall include a clause, which will follow the environmental regulations. ▪ Implement construction work efficiently to finish it as planned in order to minimize the burden the on eco-system	N/A
Ethnic Minorities, Gender, Mis-distribution of Benefit / Local Conflict of Interest	Opinion of women and minorities may not be well reflected in the plan Unequal employment opportunities and compensation for women or ethnic minority for construction work, which also may cause local conflict of interest	▪ The contract document of the Project (1) shall include a clause for no-discrimination policy toward ethnic minorities and women. ▪ Set meeting time when women are not busy with household chores or hold women-only meetings and allow them to bring their children to the meeting. ▪ Fair distribution of information among all stakeholders shall be ensured.	N/A
Infectious Disease	Risk of COVID-19 and other infectious disease	▪ The contract document of the Project (1) shall include a clause stating it is mandatory for the contractors to take precautions and education programs to workers.	N/A
Working Condition	Risk of occupational health and safety due to construction works and operation of the heavy machines. Poor working and living conditions may be given to workers	▪ The contract document of the Project (1) shall include the clauses of the following. ▪ Provision of working environment for workers, including provision of appropriate dormitories, sanitation, compensation, etc. ▪ Setting up the adequate health care facilities and first aid within the construction site.	N/A
Accident	Transportation of construction vehicles or operation of heavy machine will increase the risk of accidents at the surrounding area and within the construction site	▪ Provide information and guidance on construction activities and safety to the farmers and residents. ▪ The contract document of the Project (1) shall include the clauses of the following: ➢ Safety for workers, including provision of appropriate clothing, gear, etc.	N/A

Items	Identified Potential Negative Impact	Proposed Mitigation Measures	Cost
	to some extent	➢ Maintenance and management of construction vehicles and equipment. ➢ Installation of signboards and safety fences.	
Operational Phase			
Infectious Disease	Risk of COVID-19 and other infectious disease	▪ Enough precaution shall be taken for the gathering such as meetings, trainings, and technical demonstrations. ▪ Information on disease prevention shall be incorporated in the training program.	N/A
Ethnic Minorities	Risk for neglect of opinions of the minorities.	▪ All different languages that are used by different communities shall be equally applied in the documentation, information delivery and discussions.	N/A
Gender	Priority may be put on the male farmers in the project activities. Women's participation in decision-making process and project activities may be limited	▪ Training courses shall be incorporating provision of childcare, flexible hours, etc., for female farmers so that they can participate. ▪ Special attention and high priorities to the female-headed farmer households shall be given.	N/A

Source: Study Team

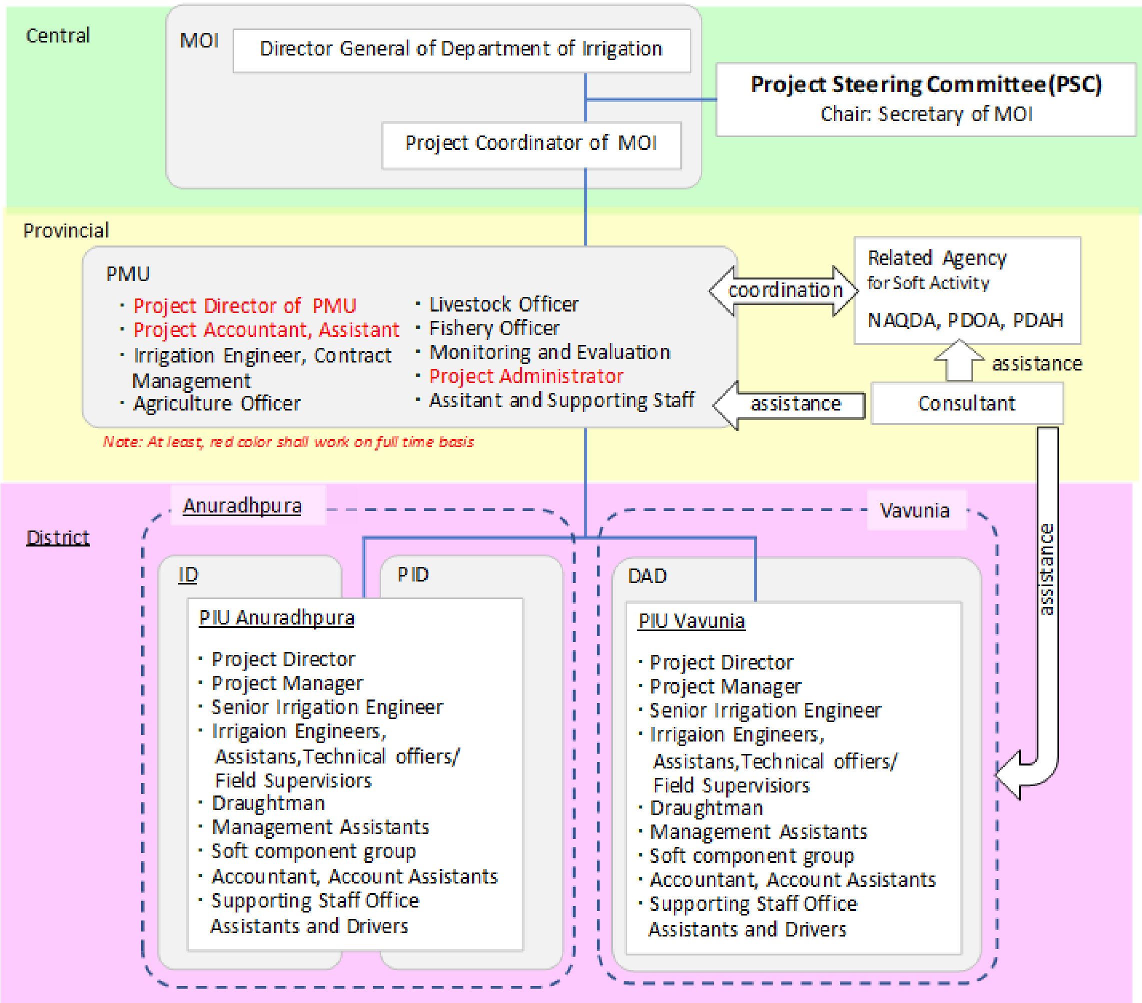
7.1.13 Monitoring Plan

It is very important to make efforts to contain and minimize any negative impacts that may be generated by the implementation of the Project through periodic monitoring. The following section explains the suggested monitoring arrangements.

(1) Monitoring Arrangements

The suggested implementation structure of environmental monitoring is shown in the following table.

The Project Level Management Unit is primarily responsible for environmental monitoring. During the Project period, the environmental and social safeguard consultant who has skills and experience in environmental management will implement the monitoring. In addition, issuance of penalties and fines for noncompliance and violations could be their task. The Consultants coordinate and liaise with Project Level Management Unit, receiving periodical monitoring reports, supervise the contractors' activities, give advice and directions related to environmental issues, during construction period. Actual tasks in the field are managed and implemented by the Project Implementation Units (PIUs) in Anuradhapura and Vavuniya districts, in cooperation with the consultant and local contractors. The roles of the safeguard consultants also include communicating with project stakeholders such as government agencies, reporting monitoring results and issues to the Project Coordinator /Co-Project Director and a lender, taking actions to solve the issues raised by the consultant, contractors, and PIUs.



Source: Study Team

Figure 7.1-3 Overall Project Organisational Structure

(2) Monitoring Program

The following table summarises a monitoring program during the construction and operational phases. The monitoring form is attached in Attachment 7.1-9.

Table 7.1-23 Monitoring Program

Issues	Monitoring Items	Responsibility	Venue	Frequency
In the Construction Phase				
Permission from the FD	Permission from FD	PMU, PIU	N/A	Before the commence-ment of construction
Air Pollution	Air Quality	PMU, PIU Contractor	Near the residential Area	Monthly
Solid Waste (debris and bio-waste from the tank rehabilitation, waste from labours' camp)	Status of collection, Segregation of wastes and treatment	PMU, PIU Contractor	Construction site, labour camp	Monthly
Fair Employment (Misdistribution of benefit, local conflict of	Employment and compensation procedure and status,	PMU, PIU Contractor	Construction site	Monthly

Issues	Monitoring Items	Responsibility	Venue	Frequency
interest, minority, gender, children's rights, working condition)	complaints from workers / farmers			
Working Environment and Sanitation	Safety and sanitary condition of the camp, provision and furnishment of safety gear	PMU, PIU Contractor	Construction site, labour camp	Bi-monthly
Accidents	Number of accidents, implementation of safety measures, including signs, fences, etc.	PMU, PIU Contractor	Construction site	Monthly
In the Operational Phase				
Water Pollution by Agrochemicals	pH, colour, turbidity, heavy metal, salinity, <u>residual</u> agro-chemicals(1)	PMU, PIU, FO	Tank water	Yearly
Soil Contamination by Agrochemicals	Heavy metal, <u>residual</u> agro-chemicals, salinity	PMU, PIU, FO	3 points inside the command area	Bi-yearly
Biodiversity	Change in inhabitation of fauna and flora as well as biodiversity	PMU, PIU (DWC, FD), FO	Inside the cascade system (tanks, catchment area, command area, hamlet, etc.)	Yearly
Animal Damage	Damage status	PMU, PIU DWC, FO	Inside the cascade boundary and peripheral areas	Regular basis
Gender	Participation of female members to training opportunities, decision making, etc.	PMU, PIU, FO	N/A	Regular basis

Note: (1) Since advanced technology and equipment are necessary for detecting residual of agricultural chemicals, monitoring is carried out to the extent possible, considering the situation of the site.
Source: Study Team

7.1.14 Stakeholder Meeting

Public consultation meetings offer an opportunity to people to participate in the decision-making process leading to project design, development and its implementation. Five stakeholder meetings were held as shown in the following table. In the meetings, overall information on the Project, anticipated environmental and social impacts that the Project could bring about, mitigation measures to be taken, and monitoring plans were presented and discussed in order to collect the opinions and comments from the stakeholders.

Table 7.1-24 List of Stakeholder Meetings

No.	Date	Venue			Number of Participants
		District	Village	Cascade Name	
1	October 8, 2020	Vavuniya	Alagalla	Alagalla	15 (12 males and 3 females)
2	October 9, 2020	Vavuniya	Omanthai	Naveli Kulam	17 (all males)
3	October 10, 2020	Anuradhapura	Puliyankulam	Kiulekada	14 (7 males and 7 females)
4	October 14, 2020	Anuradhapura	Siyambalagas-wewa	Siyambalagas-wewa	12 (11 males and 1 female)
5	October 17, 2020	Anuradhapura	Ichchankulam	Ichchankulam	11 (10 males and 1 female)

Note: The result of stakeholder meetings is presented in Attachment 7.1-10.
Source: Study Team

7.1.15 Checklist

Checklist is attached in Attachment 7.1-11.

7.1.16 Conclusion and Recommendation on the Environmental and Social Considerations

The Project assumes to be a sector loan type project, in which multiple sub-projects would be selected at the project implementation stage. Therefore, the sub-projects have not yet been selected and thus an environmental impact assessment has not been conducted before theproject approval.

The study finds that there are risks of causing negative impacts on some social and environmental issues by implementation of the Cascade System Development Plan. Nevertheless, these negative impacts will be relatively minor and could be avoided or minimised by undertaking mitigation measures and implementing strict monitoring. In addition, implementation of the Project would result in better outcomes than the “no-project” alternative. It is essential to undertake mitigation measures and ensure monitoring to minimize the adverse environmental and social impacts.

7.2 Gender Mainstreaming

7.2.1 Sri Lanka’s National Gender Policy

The constitution of Sri Lanka guarantees equal rights without discrimination on sex. The country is also signatory to key United Nations Conventions and International Human Rights Treaties that have committed to protect and empower women. In fact, the country has moved forward towards gender equality in particular education and health sectors. For example, the school enrolment rates of girls are not inferior to the level as boys’ in all levels. In 2018, the girls’ school enrolment rates for the primary, secondary and tertiary were 99.62%, 102.63% and 23.44% while the boys’ rates were 102.63%, 98.04%, and 15.8%, respectively[9]. Women are also generally well served by the country’s healthcare system. However, gender issues are complex, and gender inequality still persists in many aspects in Sri Lanka.

The National Policy for women was drafted by the Ministry of Women Ministry of Women & Child Affairs and Social Security[10] in 2019 in order to establish a framework to guide and standardise the

[9] The communities between Sinhalese and Muslim tend to have less problems.
[10] At the time of drafted, it was the State Minister of Women and Child Development, Pre-schools and Primary Education, School Infrastructure and Education Services.

development of laws, policies, programs and mechanisms in gender mainstreaming in Sri Lanka. It aims to ensure equal rights and opportunities for women by encouraging participation and eliminating all forms of discrimination against women. Strategic areas are Education and Information and Communications Technology (ICT), Health and Wellbeing, Law and Administration of Justice, Labour, Media, Environment, Political Participation, Women, Peace and Security and Enabling Policy and Institutional Framework. Although it does not specify directions and recommendations in agriculture sector, rural women are one of the priority targets groups in the policy in 2019 in order to establish a framework to guide and standardize the development of laws, policies, programs and mechanisms in gender mainstreaming in Sri Lanka. It aims to ensure equal rights and opportunities for women by encouraging participation and eliminating all forms of discrimination against women. Strategic areas are Education and Information and Communications Technology (ICT), Health and Wellbeing, Law and Administration of Justice, Labour, Media, Environment, Political Participation, Women, Peace and Security and Enabling Policy and Institutional Framework. Although it does not specify directions and recommendations in agriculture sector, rural women are one of the priority targets groups in the policy.

7.2.2 Gender Policy related to Agriculture Sector

The draft Overarching Agriculture Policy, by the Ministry of Mahaweli, Agriculture, Irrigation and Rural Development[11] in 2019 recognises the gender gap in representation of women (and youth) in both economic and political aspects. The policy puts a priority in increasing the participation of women (and youth) in a more competitive and commercially oriented agriculture. It also identifies gender-related issues in agriculture sector, including lack of access to resources such as land, water, capital and markets for female farmers. In order to address those issues, skills development through education and training for female farmers will be promoted. Also, regulatory and institutional environment will be adjusted to improve the access to the resources for women (and youth), the policy identifies. The Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), a research and training institution under the Ministry of Agriculture, provides trainings specialized for female farmers. The topics of the training includes leadership, empowerment strategy, agricultural entrepreneurship. in 2019 recognizes the gender gap in representation of women (and youth) in both economic and political aspects. The policy puts a priority in increasing the participation of women (and youth) in a more competitive and commercially oriented agriculture. It also identifies gender-related issues in agriculture sector, including lack of access to resources such as land, water, capital and markets for female farmers. In order to address those issues, skills development through education and training for female farmers will be promoted. Also, regulatory and institutional environment will be adjusted to improve the access to the resources for women (and youth), the policy identifies. The Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), a research and training institution under the Ministry of Agriculture, provides trainings specialized for female farmers. The topics of the training includes leadership, empowerment strategy and agricultural entrepreneurship.

[11] It is the Ministry of Agriculture at the time of writing the draft report.

7.2.3 Gender-oriented Actions by Other Development Partners' in Similar Projects

There are two similar projects implemented with the assistance by development partners in the project areas. One is Climate Smart Irrigate Agriculture Project (CSIAP) by the World Bank and another is Climate Resilient Integrated Water Management Project (CRIWMP) assisted by UNDP. Both projects set gender-mainstreaming in the project framework and the activities addressing gender issues are summarised below.

(1) The World Bank: Climate Smart Irrigated Agriculture Project (CSIAP)

The project document states that "gender mainstreaming and social inclusion is a focus area of CSIAP". Although the contribution from women to farming operations is over 38%, they tend to have limited access to agricultural assets and services. The project seeks to increase women's access to agriculture extension services and smart technologies. The Gender Action Plan (GAP) was identified in order to avoid giving negative impact on women's already unfavourable situation. GAP will ensure that at least 30% of the project benefits are received by women, and some of the activities are especially targeting women. Such activities included in GAP are: (a) assessing what extension services and smart technologies are suitable for women and result will be incorporated into the policy and training modules; (b) tailoring programs suited for women and setting quota for women for the participation in leadership and skill development training; (d) creating enable environment for women to participate, by providing childcare support, flexible working houses, etc.; and (e) develop structures and processes that bridge gaps in access to women's agricultural assets, especially land ownership, credit schemes and market linkages.

(2) UNDP: Climate Resilient Integrated Water Management Project (CRIWMP)

The project sets vulnerability criteria and put high priorities on women-headed households and disabled women in dry zone as social isolation and poverty are inevitable for this group. The project will invest in interventions that directly impact on women's well-being and livelihood options. The project activities include the following: a) providing capacity building opportunities for women through knowledge and technical training programs for Agrarian Service Centres (ASCs), Community -based Organisations (CBOs), and FOs in water distribution, and irrigation facility improvement; b) involving women in infrastructure repairing opportunities and decision making processes, such as FO planning; c) including women into agriculture practice and knowledge management opportunities as the primary beneficiary of ASC activities; d) conduct training (bookkeeping, maintenance of water supply facilities, etc.) so that women groups / women's organisations can be responsible for sustainable drinking water supply schemes as water supply enterprises; e) training women's groups to monitor precipitation and water levels in tanks (flood and drought monitoring); and f) make climate advisories available in the fields of home garden cultivation. Project will benefit over 350,000 women (about 50% of the target beneficiaries).

7.2.4 Gender Roles and Issues in the Study Area

(1) Labour and power relationship

Women play significant roles in agriculture in Sri Lanka. These women's roles are determined based on social and cultural norms and practices as well as family situation. According to the farmers in the Study area, there is a division of labour in farm activities. Canal cleaning, band cleaning, machine-using, application of inputs, external negotiations, decision making, etc., are considered as men's work and usually taken cared by male farmers. On the other hand, work done inside the home premises like taking care of home garden and livestock, preparing tea and lunches for FO joint work are basically the responsibility of women.

A field survey was conducted to verify above information. The following table shows the degree of involvement of both female and male farmers of different religions in agriculture-related activities in the Project target cascades. Female farmers are more involved in manual activities and requires daily attention in general. There is no large difference between Sinhalese women and Tamil women in the degree of involvement, and both are involved in variety of activities. Muslims farmers have clearer gender roles and division of labour: Female Muslim farmers are involved in very limited activities and no involvement in participation in the meetings.

Table 7.2-1 Gender Differences in Involvement in Agriculture-related Activities

No.	Activities	Sinhala		Tamil		Muslim	
		Male Farmers	Female Farmers	Male Farmers	Female Farmers	Male Farmers	Female Farmers
1	Irrigation channel cleaning	5.0	2.7	5.0	2.5	5.0	1.0
2	Bund cleaning	5.0	2.8	5.0	2.6	5.0	1.0
3	Care of intake and outlet	5.0	2.1	5.0	1.7	5.0	1.0
4	Minor Irrigation facility repairing	5.0	2.0	5.0	1.7	5.0	1.0
5	Ploughing and levelling by machines	5.0	1.7	5.0	1.2	5.0	1.0
6	Hand levelling	5.0	2.4	5.0	2.2	5.0	1.0
7	Making drainage system	5.0	1.9	5.0	1.6	5.0	1.0
8	Preparation for sowing	5.0	2.7	5.0	2.2	5.0	1.0
9	Sowing seeds	5.0	2.6	5.0	1.9	5.0	1.0
10	Irrigation	5.0	2.7	4.9	3.4	5.0	1.0
11	Applying weedicides, pesticides and fertilizer (by machine)	5.0	1.6	4.5	1.2	5.0	1.0
12	Weeding by hand	2.6	4.5	3.8	4.5	2.7	2.7
13	Manual harvesting	2.4	4.8	3.0	3.8	2.3	2.7
14	Preparing tea, snacks, meals during group activities	1.9	5.0	2.7	5.0	1.7	5.0

No.	Activities	Sinhala		Tamil		Muslim	
		Male Farmers	Female Farmers	Male Farmers	Female Farmers	Male Farmers	Female Farmers
15	Drying rice	4.9	4.6	4.7	3.6	4.7	2.7
16	Packing rice	5.0	4.5	4.9	3.5	4.7	2.7
17	Selling products to trader	5.0	1.8	4.7	2.1	5.0	1.0
18	Taking care of home garden	3.3	3.4	3.9	4.6	3.7	3.3
19	Taking care of livestock, if any	3.8	2.6	4.0	4.0	N/A	N/A
20	Milking of cows or buffaloes, if any	3.9	2.7	4.2	4.3	N/A	N/A
21	Taking care of poultry	3.1	3.2	3.7	4.7	3.0	2.0
22	Participation in FO meetings	5.0	2.9	4.7	2.7	5.0	1.0
23	Participation in Kanna Meetings	5.0	2.7	4.9	2.5	5.0	1.0

Note: (1) 39 sample farmers (20 males and 19 females of three races /religions) at six different cascades are interviewed regarding the involvement in agricultural-related activities of both genders. The degree of involvement is subjectively rated as the following standard by the sample farmers. 1: not at all involved, 2: very limited involvement, 3: fairly involved, 4: extensively involved, and 5: predominately involved. Average is shown in the table.

Source: Study Team

The following table shows the decision-making power (%) of both genders in different ethnicity in paddy farming in Sri Lanka. Men take a major role in decision-making among Tamil and Muslim families, while men and women together make decisions in Sinhalese families.

Table 7.2-2 Ethnic Groups and Decision-making Power (%) on Paddy Farming

Item	Ethnicity	Male	Female	Both
Paddy Farming	Sinhalese	11	6	83
	Tamil	43	9	48
	Muslim	73	0	27

Source: Prepared by the Study Team based on the Study by T. Jeyaruba, et.al. (2013)

Participation of women in development activities and decision-making processes tends to be still low in rural Sri Lanka because female farmers encounter the following constraints: 1) the lack of capacity (knowledge and skills) in order to participate; 2) cultural and social background; and 3) limited information and opportunities given to them. Women themselves lack understanding of the importance of participation in the activities, leadership, and correct mind set and often see themselves as "sub-ordinate". Participation in meetings or activities is considered "obligation" rather than "entitlement", and only one person from the household, in many cases, the man who has decision-making power in the family, attends. Even if women farmers attend, they are just there to watch the discussion taking place in order to fulfil their obligation or avoid risk[12], and follow the decisions. In addition, information about activities is often transmitted only to the head of the households (generally men), and follow the

[12] "An Assessment of Female Participation in Minor Tank Irrigation System in Sri Lanka", IWMI and University of Twente, 2001.

decisions. In addition, information about activities is often transmitted only to the head of the households (generally men).

(2) Female-Headed Households

When women are the head of the family, they have to fulfil all responsibilities of FO joint works in addition to their individual farming activities by themselves. Usually, they are pardoned from heavy labour work and assigned to relatively light work, but the burden is still heavy. They also have obligations to attend the Kanna and FO meetings. However, they hardly speak during the meetings. On the other hand, male single-family heads are exempted from preparing tea and meals in FO joint work.

According to the National Census of 2012, the information obtained from WDOs in the target districts (as of 2020) and Vavuniya Development Plan (as of 2018) showed that there are FHHs exist in the target DSDs in both Anuradhapura and Vavuniya districts[13] as shown Table 7.2-3 and Table 7.2-4. There is no information how many of them are farmers and encountering above difficulties; however, attention and consideration is needed for FHHs in planning and implementing agricultural activities in the Project. as shown Table 7.2-3 and Table 7.2-4. There is no information how many of them are farmers and encountering above difficulties; however, attention and consideration are needed for FHHs in planning and implementing agricultural activities in the Project.

Table 7.2-3 Female-Headed Households in Anuradhapura and Vavuniya Districts as Compared with the National Average (2012)

Item	Anuradhapura District	Vavuniya District	Sri Lanka
Female-Headed Households	60,730	9,905	1,270,293
Total Households	170,626	41,894	5,251,155
Ratio (%)	26.2%	23.6%	24.2%

Source: Prepared by the Study Team based on the Sri Lanka Census of Population and Household 2012, Department of Census and Statistics.

Table 7.2-4 Female-Headed Households in Target DSD

District / DSD[14]	Female-headed Households
Anuradhapura District	
Kebithigollewa	1,259
Kahatagasdigiliya	2,047
Horowpathana	733
Rambewa	1,809
Medawachchiya	2,474
Mihintale	1,231
Tirappane	1,305
Galenbidunuwewa	2,031
Sub-total	12,889
Vavuniya District	
Vavuniya	3,854
Vavuniya South	904

[13] A study conducted in 2013 gave analysis that the majority of FHHs in Anuradhapura were in Kebithigllewa Division due to the conflict, but it seems no longer the case as shown in Table 9.2-4.

[14] Anuradhapura District has a total of twenty-four DSDs, and Vavuniya District has four DSDs.

District / DSD[14]	Female-headed Households
Vavuniya North	694
Vengalacheddikulam	1,584
Sub-total	7,036

Source: Prepared by the Study Team based on the information from the Anuradhapura District Women Development Officer and Vavuniya District Development Plan 2018-2022.

(3) Women's Participation in Farmer Organisations

According to the information obtained from ASCs in the Study area, there are almost zero female presidents of the FOs. However, about 20% occupies secretary or treasurer positions in the FOs. Secretary jobs include record keeping and member registrations, and it is considered that women are better at these activities than men. Previous study revealed that the average gender ratio (male to female) of FO members is 56.6 to 23.1 in Anuradhapura District and 59.1 to 27.3 in Vavuniya District. Normally, one family member, mostly male, are registered as member of FO, but there are cases that both husband and wife become members and represent in the FO. All members supposed to have equal right.

As it is broadly discussed, women’s opinions may not be well reflected in the decisions of FO meetings, but it is not that women are ignored. It is due to 1) low participation of women in the meeting and 2) they hardly express their opinions at the meeting.

In recent years, there are some female divisional officers (DOs) and Agriculture Research & Development Assistants (ARPAs), but special efforts and considerations have not been made to solve the issues and reflect women’s opinions by those female officers, according to the farmers.

(4) Access to the Resources

The Country Gender Assessment of Agriculture and the Rural Sector in Sri Lanka, published by the Food and Agricultural Organization (FAO) in 2018, spotlights gender issues that rural women who engaged in agriculture encounter inadequate gender policies and programs to address these issues. Despite women make up a large part of the agricultural labour force, there are a number of gender disparities in access to resources, markets and skills training, all of which are critical for agricultural production and livelihoods. One of the most serious constraints is the access to land. The Sri Lanka’s Land Development Ordinance and other customary laws as well as cultural practices are limiting women’s land ownership. The lack of land ownership also limits women’s ability to obtain agricultural assets, services and benefits. For example, if farmers are not landowners, they are not registered with the agrarian service centres or irrigation organisations, thus, they have no formal access to government provided services and water, unless they are married to a landowner. This situation seriously affects their agricultural productivities as well as livelihoods. Yet gender mainstreaming policies, strategies and programs had not existed in the agriculture sectors, the assessment says.

According to one of the WDOs in the Study area, this becomes a serious problem for unmarried female farmers who were cultivating her mother’s land. When her mother suddenly dies, the right to use their land will be passed on to her brothers, not hers, under the current law, therefore, she could no longer continue farming the land. The same situation could be applicable to about 90% of farmland in the Study area.

7.2.5 Actions to be Taken

Actions to be taken to address major gender issues within the project framework are suggested in the following table. These actions will maximize the benefits of the project and ensure that women will receive an equal portion of these benefits through their participation and involvement in decision making in the project activities.

Table 7.2-5 Gender Issues, Needs and Actions to be Taken in the Project Framework

Gender Issues and Needs to be Addressed in the Project	Actions
Cultural and social background leave gender issues in the Study area unrecognized or not addressed.	Assign an officer who has expertise in gender considerations in PIUs' positions and add "to ensure gender consideration in project implementation" to her/his TOR (Component 4) Monitor the following actions in the project implementation.
Most of the cases, only one family member, the husband becomes a FO member and participates in the Kanna and FO meetings, where decisions are made. Often information discussed in the meetings is not shared with wives, which let them to miss the opportunities for receiving training, services, etc.	Utilise ITC technologies for information sharing among FO members, including using mobile phones. (2.1(1))
Female farmers are put in subordinate positions and assigned mainly for manual and routine activities, which do not require skills. Female farmers stay unskilled and have low productivities.	Include female farmers as participants in skills and knowledge training for water management, agriculture production and marketing (2.1(1), 2.2(1), 2.2(2), 2.4(2)).
Women farmers have to take care of domestic works, taking care of children beside farm works, which limit their access to knowledge and markets.	Tailor the training courses incorporating provision of childcare, flexible hours, etc., for female farmers so that they can participate. (2.1(1), 2.2(1), 2.2(2), 2.4(2)).
The lack of land ownership also limits women's ability to access to other resources, including inputs, markets, extension services, public irrigation water, etc.	Set quotas for female farmers for participation in project activities when appropriate. (2.2, 2.3, 2.4 programs)
There are almost no female FO head, and the numbers of FO female secretaries and treasures are limited.	Provide technical and administrative trainings as well as guidance to the FO female members to fulfil some of these positions and responsibilities in FO. (2.1(1))
There are some female-headed farmer households in the Study area. They have relatively heavy burden to fulfil their responsibilities.	Give special attention and high priorities to the female-headed farmer households to provide opportunities for extension services and training. (2.1(1), 2.2(1), 2.4(2)).

Source: Study Team

7.3 Conflict Prevention

Sri Lanka is made up of multiple ethnic groups, and conflicts among these groups have been often a problem. Farmers in the Study area are also composed of multiple ethnic groups, namely: Sinhalese, Tamils and Sri Lankan Moore whose religion is Islam (it is called Muslims), and it is very important to consider this aspect in planning and implementing the Project.

The Project attempts to discuss between FOs that accommodate and effectively utilise limited water resources between up-stream and down-stream tanks that may be managed by the FOs whose members consists of different ethnic groups. Water distribution is a very sensitive matter for farmers, and could become a trigger of conflict if handled improperly. In order to avoid potential conflict, the risks and issues are analysed, and counter actions ought to be taken, and all the farmers in the target cascades, regardless of their ethnicity or social categories, should feel they receive fair share of benefit from the Project.

In this section, potential risks and issues of conflict that exist in the field and actions to be taken to avoid potential conflict are re-analysed. Then, activities incorporated in the Project framework for conflict prevention are summarised.

7.3.1 Cascades with Mixed Ethnicity

Field interviews with the FOs were conducted and information about composition of ethnicity of the FO members of the cascades were collected. The following table shows cascade ID numbers with mixed ethnicity in the Study area.

Table 7.3-1 Mixed Ethnicity Cascades in the Target Areas

Ethnicity	Tamils and Sinhalese			Sinhalese and Muslims			Tamils and Muslims Mix	Tamils, Sinhalese and Muslims
Majority	Tamils	Sinhalese	Equal	Sinhalese	Muslim	Equal	Tamils	Sinhalese
Vavuniya	56, 58, 59, 60	55, 120	116	-	-	-	117	111
Anuradhapura	-	-	-	22, 30, 80, 85, 97	13, 38, 94	37, 83	-	-

Source: Prepared by Study Team based on the field survey

There are a total of 19 cascades that have mixed ethnic communities, i.e., nine cascades in Vavuniya District and ten in Anuradhapura District. Most of them are mix of Sinhalese and Tamil or Sinhalese and Muslim. There is one cascades that has three ethnic groups in Vavuniya District.

7.3.2 Potential Risks and Issues

Previous study analysed that there are several risks and issues (related to difference of ethnicity) of conflict exist in the target communities. Main risks and issues are 1) underlining scepticism toward different ethnic groups; 2) belonging to different jurisdictions; and 3) other related factors including caste, size, political affiliations, etc.; and 4) Un-established conflict resolution method.

(1) Underling scepticism toward different ethnic groups

In general, some farmers of downstream community doubt that the community of the upper tank accommodate water. This scepticism is enhanced when they belong to different ethnic communities. Even though they have had a good relationship and presently have no negative feelings towards each other, they seem to have concern on ethnic differences although different combination of ethnicities or history may affect the level of risks[15]. Tension is high when it comes to the distribution of water. The

[15] The World Bank webpage: https://data.worldbank.org/indicator.

most critical issue is to which community the selected water controller belongs. Tension is high when it comes to the distribution of water. The most critical issue is to which community the selected water controller belongs.

(2) Belonging to different jurisdictions

There are cascades covered by two ASC divisions in different DS divisions, one of which is Tamil dominant area, and the other is Sinhalese dominant area, speaking different languages. In these case, communication and coordination will be an issue. Usually, FOs in the neighbouring ASCs hardly communicated with each other.

(3) Other factors

It was recognised that the following factors could induce conflict. When they are combined with ethnic differences, problem may be even aggravated.

(a) Caste

There is an opinion that caste is a more serious issue than ethnicity, based on the current situation of FO management. Members of high caste groups tend to dominate in terms of position and decisions.

(b) Size

Some power relations amongst FOs were observed especially between larger FOs and small inactive FOs. Larger FOs opinions tend to dominate the discussion in the inter-FOs meetings.

(c) Political affiliations

Existence of politically powerful landowners can cause political intervention in water management of the cascade.

(d) Upper Stream vs. Lower Stream

When the upper stream tank and the lower stream tank in the cascade are connected by a link canal, water in the upper tank ought to be shared with the lower tank. The water distribution has to be managed by farmers of both tanks. However, the farmers of the upper stream tank may have stronger power and dominant in the water management, which may cause tension and mistrust between farmers.

(4) Unestablished conflict resolution method

Problem solving procedure is not clearly established. All the FOs solve their problem internally through discussions and mutual understanding based on their social relations. Some serious problems they cannot solve, mostly water distribution and problems in maintenance works, are brought up to the ARPA or DO. For farmers prefer involving a certain authority to intervene as they do not have enough confidence of solving the problems.

The discussions with the officers and farmers in the Study area revealed that there have not been many changes made in above situation since the previous study was conducted. These risks and issues mentioned above still exist and the possibility of internal conflict cannot be denied in the cascade with mixed communities.

7.3.3 Suggested Actions to Mitigate Risks and Issues in the Project Framework

In order to avoid occurrence of conflict, the actions to be taken to mitigate these risks and issues as well as activities to be conducted in the Project framework are summarised in the following table.

Table 7.3-2 Suggested Actions to Mitigate Risks and Issues in the Project Framework

Risks and Issues	Actions to be Taken	Actions Addressed in the Project
Underling scepticism toward different ethnic groups	Create a water management system that assure fair distribution of water.	▪ The Project itself tries to create an effective and efficient water management infrastructure. ▪ The water masters will be trained and he/she will be equipped with appropriate skills for fair distribution of water. ▪ Training for strengthening FOs' capacity for water management will be provided.
	Encourage behavioural change of farmers through collaboration in the FOs' activities as well as providing awareness programs and interaction opportunities	▪ Awareness programs for understanding the management system, training programs for consensus building and conflict management will be conducted for FOs. ▪ All different languages that are used by different communities will be equally applied in the documentation, information delivery, and discussions. Currently, Sinhalese language is dominant.
Unestablished Conflict Resolution Method	Officers in-charge should be provided with training opportunities on conflict management and inclusion of minority and socially underprivileged people.	▪ Awareness raising, training programs for conflict resolution, etc. will be provided for DAD officers including DOs and ARPAs. ▪ Support for the field officers will be continuously provided by conducting FOs activities and follow-up trainings, especially for handling the risk factors that may induce conflicts.
	Conflict management training to enhance capacity of conflict resolution for FOs should be provided.	▪ Awareness and training programs on conflict management will be provided to FOs.
Belonging to Different Jurisdictions	Substantial involvement of government authority to support cascade management system is critical.	▪ Support system for sound cascade management will be established and support will be provided to DAD and concerned government offices. ▪ Coordination among ARPAs, ASCs, and with other government agencies administrative boundaries be enhanced.
	Fulfil the positions of ARPAs who support FOs especially in Vavuniya.	▪ The training will be provided to ARPA in which will enhance ARPA's support capacity. Also, the Project encourage concerned government offices to fill-in the vacant positions.

Source: Study Team

CHAPTER 8 PROJECT EVALUATION

8.1 General

The project evaluation was tentatively conducted, assuming that the Project is going to be a sector loan type project, which consists of project benefits, project effects, operation and effect indicators, risk management, adaptation measures for climate change, and economic evaluation, based on the implementation plan discussed in Chapter 4.

8.2 Project Benefits

The benefits of the Project come from agriculture and flood mitigation.

8.2.1 Irrigation Benefits

(1) Crop Diversification

The benefit from irrigation water supply is the increment of net production income of crops derived from crop diversification from paddy to grain legumes, condiments and vegetable, even though the command area of 28,172 ha mentioned in Chapter 5 would not be changed as compared between "without" and "with project condition". Crop intensities at the cultivated area without project condition and with project condition are shown in Table 8.2-1.

Table 8.2-1 Estimated Cropping Intensity at the Cultivated Area

	Cropping Pattern			
	Irrigation Type	**Crop**	**Cultivated Area (%)**	**Cultivated Area (ha)**
Without Project Condition				
Maha	Irrigated	Paddy	58%	16,340 ha
	Rainfed	Paddy	42%	11,832 ha
Yala	Inadequately irrigated	Paddy	25%	7,043 ha
TOTAL			**125%**	**35,215 ha**
With Project Condition				
Maha	Irrigated	Paddy	45%	12,677 ha
		Black gram	4%	1,127 ha
		Chili	4%	1,127 ha
		Eggplant	4%	1,127 ha
	Rainfed	Paddy	43%	12,114 ha
Yala	Irrigated	Green gram	4%	1,127 ha
		Chili	2%	563 ha
		Big onion	2%	563 ha
		Eggplant	3%	845 ha
	Inadequately irrigated	Paddy	14%	3,944 ha
TOTAL			**125%**	**35,215 ha**

Source: Study Team
Note: Other Field Crops (OFCs) are planned to be cultivated with project condition.

Without project condition, there are irrigated paddy and rainfed paddy in both seasons, although water supply from cascade systems is not sufficient, namely, inadequate, and the yield cannot be said satisfying.

On the other hand, with project condition, Other Field Crops (OFCs) would be cultivated partly by sufficient irrigation instead of paddy since cascade systems would be improved.

(2) Crop Budget

Economic crop budget of two irrigation types of paddy and seven Other Filed Crops (OFCs) with and without project conditions were prepared for estimation of irrigation benefit considering the current situation of agriculture in the project area and the following conditions.

i) Crop budget is prepared for the Maha season (paddy-irrigated, paddy-rainfed, black gram, chilli, eggplant), and the Yala season (green gram, chilli, big onion, eggplant), refer to Table 8.2-2. Without project condition, cultivated crop is only paddy-irrigated since water supply from cascade system is limited. However, with project condition, as result of water balance analysis, cropping intensity at 12% of OFCs in the Maha and 11% of OFCs in the Yala can be cultivated with water supply from improved cascade system;

ii) Back data of crop budget of non-trade crops (except paddy) is basically provided by the Department of Agriculture (DOA). However, some data do not show data of Anuradhapura area but nationwide data. Therefore, the crop budget for the Project was considered with actual situation of local market interviewed with DOA. Crop budget of non-trade crops is prepared based on the following sources,
- Cost of cultivation of agricultural crops, 2019/20 Maha (Provisional), Socio Economic and Planning Centre, DOA
- Cost of cultivation of agricultural crops 2019 Yala (Provisional), Socio Economic and Planning Centre, DOA
- Agriculture Technology Guide, 2020, DOA
- Current information from interview with DOA Vavuniya

iii) Back data of crop budget of trade crop (paddy) are prepared from the data of the World Bank or Socio Economic and Planning Centre, DOA, Sri Lanka. Details are shown in Attachment 8.2-1. Crop budgets of chili and big onion are estimated with information of DOA as same as non-trade crops since the price fluctuation of market price is dynamic and they could be harvested at a higher price than traded prices.

iv) Prices of agro-commodities are converted from wholesale price to farm gate price by deducting marketing cost as shown in Table 8.2-2;

v) Cost of chemical fertiliser and pesticide/ weedicide are estimated based on the subsidy and Value-added Tax (VAT); and

vi) Crop budgets are converted to economic prices based on above mentioned financial prices;

The summary of crop budget for major crops is summarized in Table 8.2-2. A detailed table of the crop budget is shown in Attachment 8.2-2.

Table 8.2-2 Summary of Economic Crop Budget

Season	Irrigation Type	Crop	(A) Gross Income 1) Unit Price (LKR/kg)	2) Unit Yield (kg/ha)	A. Total Gross Income (LKR/ha)	(B) Production Cost 1) Labour (LKR/ha)	2) Material (LKR/ha)	3) Machinery (LKR/ha)	B. Total Cost (LKR/ha)	Net Income (LKR/ha)
Without Project Condition										
Maha	Irrigated	Paddy	51	4,500	229,500	56,160	83,866	46,530	186,556	42,944
	Rainfed	Paddy	51	3,200	163,200	47,520	62,358	46,530	156,408	6,792
Yala	Inadequately irrigated	Paddy	51	2,880	146,880	56,160	83,866	46,530	186,556	-39,676
With Project Condition										
Maha	Irrigated	Paddy	51	5,600	285,600	57,600	106,485	46,530	210,615	74,985
		Black gram	282	1,750	493,500	122,400	82,504	26,696	231,600	261,900
		Chilli	132	10,000	1,320,000	499,680	238,622	21,150	759,452	560,548
		Eggplant	49	22,000	1,078,000	455,040	245,277	21,150	721,467	356,533
	Rainfed	Paddy	51	3,200	163,200	47,520	62,358	46,530	156,408	6,792
Yala	Irrigated	Green gram	223	1,750	390,250	113,760	68,182	25,850	207,792	182,458
		Chilli	132	11,500	1,518,000	518,400	238,807	21,150	778,357	739,643
		Big onion	94	20,000	1,880,000	600,480	173,775	21,150	795,405	1,084,595
		Egg plant	49	23,000	1,127,000	483,840	245,460	21,150	750,450	376,550
	Inadequately irrigated	Paddy	51	2,880	146,880	56,160	83,866	46,530	186,556	-39,676

Source: Study Team

(3) Irrigation Benefit

As reported "without" and "with" cropping pattern in the project area and crop budget, annual project benefit is estimated. Economic benefit from irrigation development is estimated at LKR 3,255 million per year as summarised in Table 8.2-3. Detailed calculation of economic irrigation benefit is shown in Attachment 8.2-3.

Table 8.2-3 Summary of Economic Crop Budget

Condition	Annual Total Benefit LKR in Million
Without	503
With	3,758
Incremental Benefit	**3,255**

Source: Study Team

Increase of annual benefit is estimated to be at 20%, 40%, 60%, 80% and 100% in each year from one year after the work start of component-1 according to the work progress. Calculation of total increase of annual benefit is shown in Table 8.2-4.

Table 8.2-4 Summary of Economic Crop Budget

Year	Annual Disbursement for Construction	Increase of Annual Benefit									
	Ratio	2	3	4	5	6	7	8	9	10	11
2	18.1%	3.6%	7.2%	10.8%	14.4%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%
3	28.9%	0.0%	5.8%	11.6%	17.3%	23.1%	28.9%	28.9%	28.9%	28.9%	28.9%
4	21.7%	0.0%	0.0%	4.3%	8.7%	13.0%	17.4%	21.7%	21.7%	21.7%	21.7%
5	19.4%	0.0%	0.0%	0.0%	3.9%	7.7%	11.6%	15.5%	19.4%	19.4%	19.4%
6	11.4%	0.0%	0.0%	0.0%	0.0%	2.3%	4.6%	6.9%	9.2%	11.4%	11.4%
7	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.6%
Total	100%	3.6%	13.0%	26.7%	44.3%	64.2%	80.6%	91.2%	97.5%	99.9%	100%

Source: Study Team

8.2.2 Flood Mitigation Benefits

(1) Definition of Effect

The definition of effect is to reduce flood damage including agriculture and infrastructure by rehabilitating tanks in the candidate sub-projects. The quantitative effect of flood damage is shown in the following numerical expression.

Quantitative effect = Flood damage without the Project – Flood damage with the Project

The flood damage with the Project is assumed zero in the condition of once per eight to ten years because tank bund including spillway will be rehabilitated totally.

(2) Damage Without the Project

There are three conditions to identify inundation areas by flood as shown in the following table. The inundation area analysed by using geographic information system (GIS) is shown in Attachment 8.2-4.

Table 8.2-5 List of Condition to Identify Inundation Areas by Flood

Condition 1	3 m(1) below from top of tank bund
Condition 2	Within catchment of downstream tank
Condition 3	Exceedance probability of rainfall is once per eight to ten years.

Note: (1) Average height of tank bunds based on the detailed survey by CSDPP
Source: Study Team

Flood damage impacts for the short-listed sub-projects (in case of all tank damaged) are calculated as shown in the Attachment 8.2-5. The flood damage extends to irrigation canal, farm road, loss of paddy field, public facility, house, road (main, secondary, others), and railway. Loss of paddy field, public facilities, houses, roads (main, secondary, others), and railway are calculated by using GIS. Irrigation canals and farm roads in the command area are assumed totally damage.

Base on the Rehabilitation of Water Irrigation Flood Damages 2014/2015 (PID), the rainfall was the eight to ten-year probability of exceedance. In case of ten-year probability of exceedance, it is assumed that 552 tanks out of 955 tanks are damaged as shown in the following table.

Table 8.2-6 Flood Damage of Short-listed Sub-projects

Items		Quantity
Tank (bund)	(nos.)	552
Irrigation Canal	(km)	392.4
Farm Road	(km)	380.2
Public Facility	(nos.)	16
House	(nos.)	10,126
Main Road	(km)	60.9
Secondary Road	(km)	113.3
Other Road	(km)	618.1

Source: Study Team

The unit flood damage is assumed based on the Rehabilitation of Water Irrigation Flood Damages 2014/2015 (PID). In the results of analysis, the exceedance probability of the 2014/2015 rainfall is equals to per eight to ten years. The unit flood damage is calculated in once per ten years as shown in the following table.

Table 8.2-7 Unit Flood Damage

Facility	Unit Damage	
Tank (bund)	0.32	LKR in million/nos.
Irrigation Canal	0.11	LKR in million/km
Farm Road	0.10	LKR in million/km
Loss of Paddy Harvest	0.41	LKR in million/nos.
House	0.044	LKR in million/house
Main Road	0.10	LKR in million/km
Secondary Road	0.10	LKR in million/km
Other Road	0.10	LKR in million/km

Source: Study Team

The total damage cost of the short-listed sub-projects is assumed by multiplying the quantity of the flood damage and the unit flood damage as shown in the following table. The total damage cost when all 955 tanks get flood damage is shown in Attachment 8.2-6.

Table 8.2-8 Total Flood Damage of Short-listed Sub-project

Facility	Damage Cost LKR in Million
Tank (bund)	176.64
Irrigation Canal	43.03
Farm Road	38.02
Loss of Paddy Harvest	226.32
House	441.30
Main Road	6.12
Secondary Road	11.35
Other Road	61.81
Sub-Total	1,004.58
Cost Escalation	18.38%
Occurrence Probability	5%
Total (per year)	59.46

Source: Study Team

8.3 Effects of the Project

In this section, the effects of the project implementation are divided into quantitative and qualitative effects, which are discussed below.

8.3.1 Quantitative Effects

The following are implemented as key activities under the Project: 1) rehabilitation and improvement of tank cascade irrigation systems including farm roads, 2) institution and capacity development mainly for operation and maintenance, 3) agriculture development, 4) post-harvest and marketing development, 5) livestock development, and 6) fishery development. The combined effect of the implementation of these activities is to increase the farm income of beneficiary farmers in the project area.

The summary and quantitative effects of each activity are shown in the following table.

Table 8.3-1 Quantitative Effects of the Project

Project Activities	Summary of Effects	Quantitative Effects
1) Infrastructure Development	・Rehabilitation of old tank facilities will reduce the flood damage to the tank bunds and areas downstream of the tank. ・Rehabilitation of aging tank and irrigation facilities will improve irrigation efficiency.	・Reduction in inundation area and flood damage ・Increase in annual crop intensity of OFCs ・Increase in unit yield of rice and OFCs
2) Institution and Capacity Development	・Development of institution and capacity of Farmer Organisations (FOs) will make active participation in O&M activities. ・CMOs will be established and strengthen as a unit for development activities.	・Increase in collection rate of operation and maintenance (O&M) fees ・Increase in registered cascade management organisations (CMOs)
3) Agriculture Development	・Improved farming practices for rice and high-value OFCs will be promoted by trained Agriculture Research & Development Assistants (ARPAs) and Agricultural Instructor s (AIs). ・Quality inputs such as seeds/seedlings, fertilisers and agrochemicals will be provided in time. ・Improvement of agriculture extension system through group/farmer to farmers, ICT tools and collaboration with private sector.	・Increase in annual crop intensity ・Increase of OFC cultivation area, yield and production ・Increase of annual farm incomes
4) Post Harvest and Marketing Development	・Post-harvesting operations for drying paddy will be improved with provision of drying yard and storage. ・Post-harvesting operations for high-value OFCs will be improved properly. ・Partnership agreement with buyers with their requirement will be promoted for contract-based selling.	・Increase of selling prices of paddy and OFCs
5) Livestock Development	・Stable feed production and delivery through entrepreneur development will be improved for dairy production. ・Development model for dairy cattle and backyard poultry will be established through pilot activities.	・Increase of milk production ・Increase of egg and day-old chicken production
6) Fishery Development	・Fisheries farming skills and system will be improved and promoted in selective tanks.	・Increase of fish catches

Project Activities	Summary of Effects	Quantitative Effects
7) Pipeline canal (Pilot basis)	・Irrigation efficiency will be improved by replacing earth canal by pipelines.	・Increase in cultivation area with irrigation
8) Partial desilting in tank reservoir (Pilot basis)	・Partial desilting of sediment in tank reservoir will increase the storage capacity of the tank.	・Increase in storage capacity of the tanks

Source: Study Team

8.3.2 Qualitative Effects

The qualitative effects of the project are assumed as shown in the following table.

Table 8.3-2 Qualitative Effects of the Project

Project Activities	Summary of Effects	Qualitative Effects
1) Infrastructure Development	・Rehabilitation of aging tank and irrigation facilities will enhance water use efficiency. ・Rehabilitation of farm roads will improve access from field to home and market, vice versa. ・Post-harvest loss will be reduced by rehabilitation of farm roads.	・Enhancement of water use efficiency ・Improvement of farm work efficiency
2) Institution and Capacity Development	・Establishment and strengthening of CMOs will improve water use efficiency within a cascade system. ・Capacity development of FOs will contribute to better O&M of tank irrigation facilities. ・FOs will become capable to undertake the government support programs.	・Improvement of O&M ・Activation of FOs and CMOs
3) Agriculture Development	・Crop diversification from rice to high value OFCs will be promoted to increase farm income. ・Traditional rice varieties will be promoted instead of ordinal rice varieties.	・Change in farming system ・Improvement of agriculture extension system
4) Post Harvest and Marketing Development	・Market linkage of farm products with hotel industry will increase farm income. ・Dry and storage of rice will increase farm income by selling at higher price. ・Value chain of not only traditional rice but also OFCs will contribute to better farm incomes.	・Value-addition and reduction in post-harvest losses
5) Livestock Development	・Milk and by-products will bring additional income to farmers and/or nutrition (protein) improvement of family members by home consumption. ・Eggs and by-products will contribute to additional incomes to farmers and/or nutrition (protein) improvement of family members by home consumption. ・Expenditures for milk and eggs can be reduced by self-production.	・Additional incomes by selling milk and eggs ・Nutrition improvement by home consumption of milk and eggs ・Saving cash expenditure for milk and eggs.
6) Fishery Development	・Fishery concession can be expected to raise FOs' incomes. ・Fresh and cheap fishes will improve nutrition (protein) take of local peoples.	・Additional fund for FOs ・Nutrition improvement of local peoples
7) Pipeline canal (Pilot basis)	・Time and cost for delisting and weeding in earth canal will be reduced by pipeline canal.	・Reduction in O&M cost

Project Activities	Summary of Effects	Qualitative Effects
8) Partial desilting in tank reservoir (Pilot basis)	・ Retention period of tank water will be increased. ・ Desilting material can be used for several purposes (fertile farmlands, produce bricks and block, etc.)	・ Fish farming ・ FOs income generation

Source: Study Team

Other than the above, the following qualitative effects would be expected by the Project.

Table 8.3-3 Other Qualitative Effects Expected from the Project

Summary of Effects	Qualitative Effects
Activities for enhancement of project management and monitoring capacity of PMU/PIUs will be implemented under Component 3 of the Project. Technical assistance will also be provided to PMU/PIUs by consulting services under Component 4 of the Project. This will contribute to the enhanced implementation capacity of PMU/PIUs (technical, and operational aspects).	Enhancement of implementation capacity of Project Management Unit (PMU) and Project Implementation Units (PIUs)
Activities for agriculture development will be implemented under Components 2 of the Project. This will contribute to the improvement of the capacity of Provincial Director of Agriculture (PDOA) for the extension activities and cultivation techniques of farmers.	Improvement of capacity of PDOA for extension activity
Activities for the capacity enhancement of farmers' organisations and capacity enhancement of operation and maintenance (O&M) will be under Component 2 of the project. This will contribute to the enhancement of the capacity of FOs/CMOs in irrigation O&M.	Enhancement of the capacity of FOs/CMOs in irrigation O&M
The Project includes livestock and fishery development on a pilot basis under Components 2. This will contribute to the improvement of the capacity of Provincial Department of Animal Production and Health (PDAPH) and National Aquatic Resources and Research and Development Agency (NAQDA) for the extension activities and advance farming techniques of farmers.	Demonstration effect to other projects in the dry zone in Sri Lanka
The Project includes installation of emergency spillway gate, pipeline canal, partial desilting on a pilot basis as adaptation measures for climate change.	Demonstration effect to other projects in the dry zone in Sri Lanka
Development plan for the future project after completion of North Central Province Canal (NCPC) will be planned under the Project as part of the consulting service, if required.	Ensuring consistency and continuity of irrigation development under the NCPC project

Source: Study Team

8.3.3 Contribution to Sustainable Development Goals (SDGs) and Post-COVID-19

As stated in Section 2.2, the Government of Sri Lanka (GOSL) has put a development priority on SDGs for harmonising the economic, social and environmental dimensions in the country. The Project could contribute more or less to SDGs achievement as shown in the table below.

Table 8.3-4 Contribution to SDGs Expected from the Project

No.	Goal	Contribution of the Project
1	No Poverty	Enhancement of farm income
2	Zero Hunger	Improvement of food security and nutrition of farm families by traditional rice production, crop diversification, livestock and fishery development
5	Gender Equality	Participation of women in FO's activities
8	Decent Work and Economic Growth	Increase in employment opportunities for young people in the rural area through promotion of agricultural business

10	Reducing Inequality	Reduction in regional economic disparity through enhancement of farm income and employment
13	Climate Action	Increase in climate change resilience with improved tank irrigation facilities
16	Peace, Justice, and Strong Institutions	Further promotion of ethnic harmony between Sinhala and Tamil rural societies

Source: Study Team

From the end of March to the beginning of June 2020, GOSL officially imposed curfew on and off against outbreak of COVID-19. As a result, many people faced difficulties in their daily life due to interruption in distribution of commodities including farm inputs and outputs. In consideration of such situation, the Project has been designed to build countermeasures such as local food production and consumption, food storage and distribution through various agriculture development activities.

8.4 Operation and Effect Indicators

To measure, monitor, and evaluate, the project effects, operation and effect indicators of the Project and their target values are set. The target year of the indicators is about two years after the completion of the Project. The selected indicators have important relevance to the project objectives and components.

8.4.1 Operation Indicators

The following operation indicators are proposed for project monitoring and evaluation:

Table 8.4-1 Proposed Operation Indicators of the Project

	Operational Indicator	Current (2020)		Target (2030)	
A.	**Agriculture**				
1)	Cultivated area by c crops, - Paddy	(Maha)	28,172 ha	(Maha)	24,791 ha
		(Yala)	7,043 ha	(Yala)	3,944 ha
	Cultivated area by crops, - OFCs	(Maha)	0 ha	(Maha)	3,381 ha
		(Yala)	0 ha	(Yala)	3,099 ha
2)	Improved rate of cascade systems		3%		97%
B.	**Flood Mitigation (1)**				
1)	Improved rate of spillway (widening extension)		33%		100%
2)	Improved rate of tank bund (heightening extension)		29%		100%

Note: (1) Given from the capacities of spillway and tank against 1/25 year flood discharge
Source: Study Team

There are indicators related to the direct output of the Project. These indicators are also proposed as operational indicators, since the Project assumes to be a sector loan type project and it is important to evaluate whether the target development has been achieved for the funds invested. Key operational indicators would be "cultivated area" for agriculture, "improved rate of cascade systems" for irrigation, and "improved rate of spillway capacity of tank" for flood mitigation.

8.4.2 Effect Indicators

The following effect indicators are proposed for project monitoring and evaluation:

Table 8.4-2 Proposed Effect Indicators of the Project

	Effect Indicator	Current (2020)		Target (2030)	
A	**Agriculture**				
1)	Annual crop intensity	(Maha)	Paddy-irrigated : 58% Paddy-rainfed: 42%	(Maha)	Paddy-irrigated: 45% OFCs: 12% Paddy-rainfed: 43%
		(Yala)	Paddy-inadequately irrigated : 25%	(Yala)	OFCs: 11% Paddy-rainfed: 14%
2)	Annual unit yield (1)	(Maha)	Paddy-irrigated: 4.5 ton/ha Paddy-rainfed: 3.2 ton/ha	(Maha)	Paddy-irrigated: 5.6 ton/ha OFCs (average): 11.3 ton/ha Paddy-rainfed: 3.2 ton/ha
		(Yala)	Paddy-inadequately irrigated: 2.9 ton/ha	(Yala)	OFCs (average): 14.0 ton/ha Paddy-inadequately irrigated: 2.9 ton/ha
3)	Increase of annual net farm income (economic price)	LKR 503 million		LKR 3,758 million	
B	**Flood Protection**				
1)	Annual flood damage cost by 10 years return period (economic price)	LKR 56 million		LKR 0	

Source: Study Team
Remark: (1) Annual unit yields are estimated with collected information and data from DOA basically and adjusted according to local situation.

Annual crop intensity and cultivated area of crops are also proposed as effect indicators since the project objective includes "improvement of efficiency of irrigated farming". The current value of each indicator set is tentative, because of a sector loan project, based on the interview with FOs in six model cascades. The target value of annual crop intensity and unit yield of paddy and OFCs are set at the level which ensures economic viability based on the result of economic evaluation for the Project.

8.4.3 Monitoring Method and Structure for Operation and Effect Indicators

Data on the above operation and effect indicators need to be continuously monitored during and after the Project. It is proposed to have a monitoring method and system for each indicator, including specific data collection methods shown in the following table.

Table 8.4-3 Monitoring Method and System for Operation and Effect Indicators

No.	Indicator	Cascades to be Monitored	Responsible Organization	Timing of Data Collection	Data Source
A. Operation Indicators					
1	Cultivated area by crops, - Paddy	All cascades	PMU/PIU the Consultant	Every cultivation season	Annual work plan
2	Cultivated area by crops, - OFCs	All cascades	PMU/PIU the Consultant	Every cultivation season	Annual work plan
3	Collection rate of O&M fees of FOs	All cascades	PMU/PIU the Consultant	Every cultivation season	Annual work plan
4	Established rate of cascade management organisation	All cascades	PMU/PIU the Consultant	Every cultivation season	Annual work plan
5	Improved rate of spillway capacity of tank	All cascades	PMU/PIU the Consultant	Annually	Annual work plan
B. Effect Indicators					
1	Crop intensity	Sample cascades	PMU/PIU the Consultant	Before the completion of the Project	Project end evaluation survey report
2	Unit yield - Paddy	Sample cascades	PMU/PIU the Consultant	Before the completion of the Project	Project end evaluation survey report
3	Unit yield - OFCs	Sample cascades	PMU/PIU the Consultant	Before the completion of the Project	Project end evaluation survey report
4	Increase of annual net farm income	Sample cascades	PMU/PIU the Consultant	Before the completion of the Project	Project end evaluation survey report
5	Annual flood damage cost by 10 years return period	The cascades concerned	PMU/PIU the Consultant	When floods occur	PMU report

Source: Study Team

This monitoring method and system will be finalised and implemented under project component (4) project management: monitoring and evaluation (M&E). Preparation of M&E framework will be prepared based on the above table, at the beginning of implementation stage of the Project.

8.5 Risk Management

The risks anticipated in the implementation of the project are discussed in this section.

8.5.1 Approach to Risk Management

"Risk" is defined as the possibility that an event will occur and adversely affect the achievement of an objective. According to the concept of risk management, risk is generally classified as the probability of occurrence and the impact (magnitude) of loss when it occurs. Based on the classification, treatments for risks shall be considered, such as avoidance, reduction (optimise, mitigation), sharing, retention, etc. The purpose of risk management is to identify potential problems before they occur so that risk-handling activities may be planned and implemented.

In the Project, "loss" is considered to be a "decrease of development effect". Factors that reduce the development effect are called risks, such as decrease of the project benefit, increase of project cost, unachieved development target of the project, project cancellation or suspension, and their multiple occurrences.

Treatment for risks is generally classified as follows:

Table 8.5-1 Treatment for Risks

Impact	Probability: High	Probability: Low
High	Avoidance of the risk (to avoid activity itself with the risk)	Sharing of the risk (to transfer the risk to others, e.g., insurance)
Low	Reduction of the risk (to reduce probability and impact of risk before occurring)	Retention of the risk (not to take action for the risk)

Source: Study Team

As mentioned above, the concept of risk management aims to treat critical and major risks based on the above categories, considering the costs associated with the treatment of risks. Risk identification and assessment shown below is done based on the concept of risk management.

8.5.2 Identification and Assessment of Risks

The risks of the Project are identified and assessed in the following categories: 1) stakeholder risk, 2) executing agency risk, and 3) project risk. The identified major risks in each risk category and the assessment results are shown in the following table.

Table 8.5-2 Identification and Assessment of Major Risks of the Project

Major Risks	Risk Assessment	Risk Treatment
1. Stakeholder Risk		
Risk of project cancellation or suspension resulting from change in the development priority of the new government Appraisal stage / Implementation stage	Probability: Middle Impact: High	・To hold regular high-level policy meeting at the time of the next fiscal year's budget request (Responsible organisation: a lender) ・To monitor the policy trends of the new government of Sri Lanka and the position of the Project in the development plan so as to take actions before the risks occur. (Responsible organisations: Department of Irrigation (ID)/Ministry of Irrigation (MOI), a lender).
2. Executing Agency Risk		
2.1 Capacity risk Risk of decrease in benefit, increase in cost, unachieved development target and delay of the Project resulting from the lack of technical and operational experience of ID/MOI. Appraisal stage / Implementation stage	Probability: Middle Impact: Middle	・To appoint consultants to support PID and DID for the project management, survey and design, and construction supervision as part of the project components. (Responsible organisation: ID/MOI, a lender) ・To plan appropriate project components, project organisation structure and implementation schedule in consideration of the lack of technical and operational staff in Provincial Department of Irrigation (PID) and Department of Agrarian Development (DAD). ・To support ID/MOI by a lender for project implementation before the consultants mobilise. (Responsible organisations: a lender)
2.2 Governance risk Risk of delay of the project resulting from the improper decision-making process of related organisations including PSC. Appraisal stage / Implementation stage	Probability: Low Impact: Middle	・To clarify the decision-making system (authority and responsibility) before starting the Project. ・To make an appropriate improvement proposal to ID/MOI by a lender or the consultant during the implementation period, if there is a problem with decision-making system. (Responsible organisations: ID/MOI, a lender, the consultant)
2.3 Fraud & corruption risk Risk of increase of cost and unachieved development target, delay of the project resulting from fraud in procurement of the Project. Appraisal stage / Implementation stage	Probability: Low Impact: Middle	・To adopt the current procurement system of ID/MOI for the Project. ・To monitor properly the procurement by the consultants. (Responsible organisations: ID/MOI, the consultant)

Major Risks	Risk Assessment	Risk Treatment
3. Project Risk		
3.1 Design risk Risk of delay in the implementation of the Project in case that procurement plan is not properly designed in considering of technical and management capacity of PID and DAD, availability of capable and responsible local contractors in addition to the nature of the Project Appraisal stage / Implementation stage	Probability: Middle Impact: Middle	・To appoint a consultant to support PID and DAD in the procurement procedure. ・To apply the advance procurement to minimise the time for the concurrence. (Responsible organisation: ID/MOI, a lender, the consultant)
3.2 Program/donor risk Risk of overlapping between the target cascade systems and environmentally sensitive areas resulting from unclear boundaries. Appraisal stage / Implementation stage	Probability: Low Impact: Low	・To make field investigation with the government authorities at the beginning of the Project if the boundaries are not clear. (Responsible organisation: PMU, the consultant)
3.3 Delivery quality risk Risk of decrease of benefits resulting from improper operation and maintenance (O&M) activities by FOs and CMOs. Appraisal stage / Implementation stage	Probability: Middle Impact: Middle	・To include activities for strengthening of O&M by FOs and CMOs as a project component. (Responsible organisation: a lender, the consultant) ・To provide continuous support for strengthening of O&M capacity of FOs and CMOs. (Responsible organisation: Project Monitoring Unit (PMU), Project Implementation Unit (PIU), the consultant)

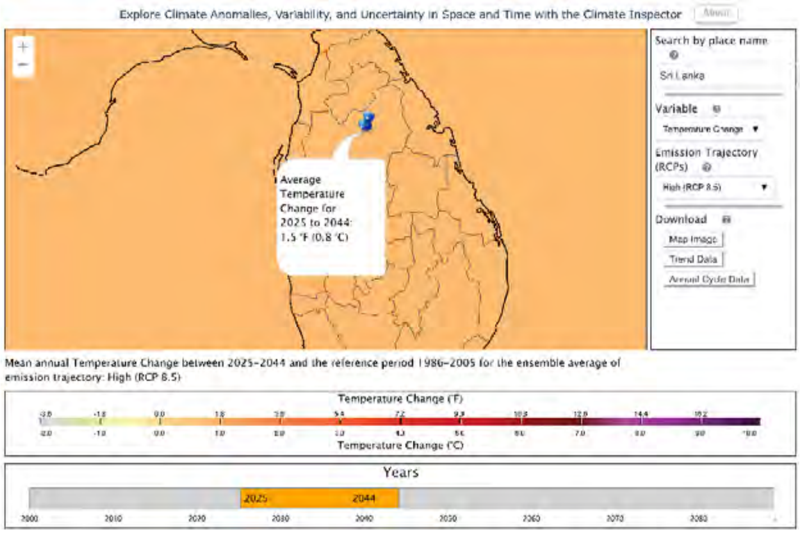
Source: Study Team

As shown above, the relatively critical risks are assumed to be (1) the risk of project cancellation or suspension resulting from change in the development priority of new government and (2) the risk of delay in project implementation resulting from the lack of staff in PID and DAD to implement the Project. It is especially important to take actions to prevent the occurrence of these risks including appropriate support to ID/MOI by a lender. The result of the risk identification and assessment is also shown in Attachment 8.5-1 in the form (Risk Management Framework).

8.6 Adaptation Measures for Climate Change

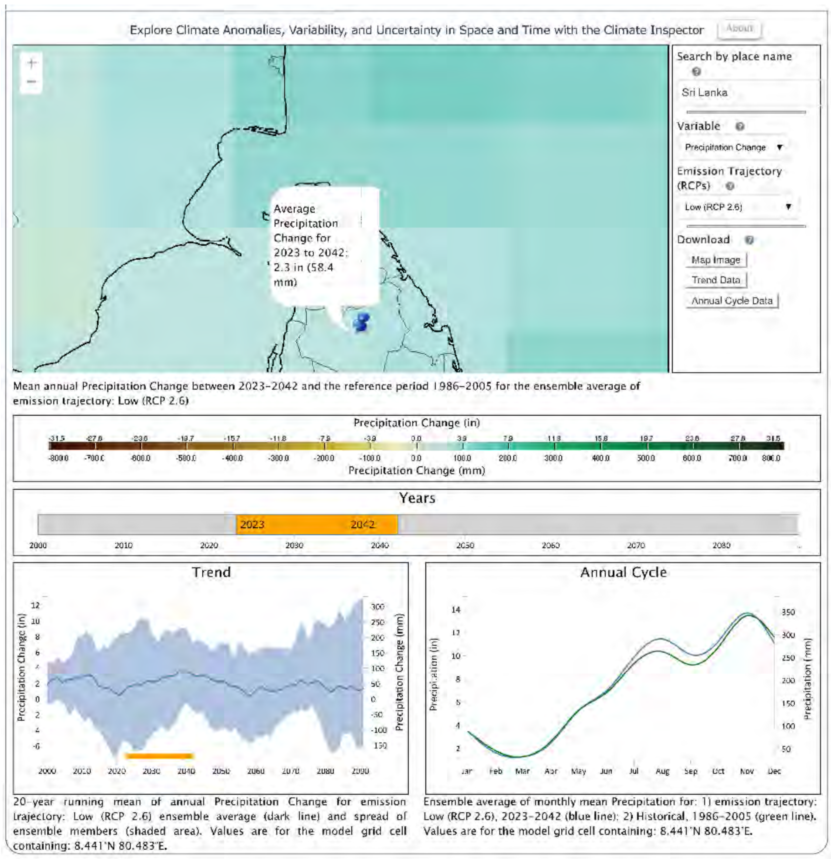
8.6.1 Climate Change Impact

According to the simulation result of Climate Inspector (National Centre for Atmospheric Research, NCAR), it is expected that the average annual temperature (Year 2025-2044) would increase by about 0.8˚C. As for annual average precipitation, it is expected to increase by about 60 mm in North-Central region of Sri Lanka, and especially in August, where it is expected to increase most by about 10% in monthly base as shown in the following figures.



Source: NCAR

Figure 8.6-1 Climate Change Simulation (Temperature)

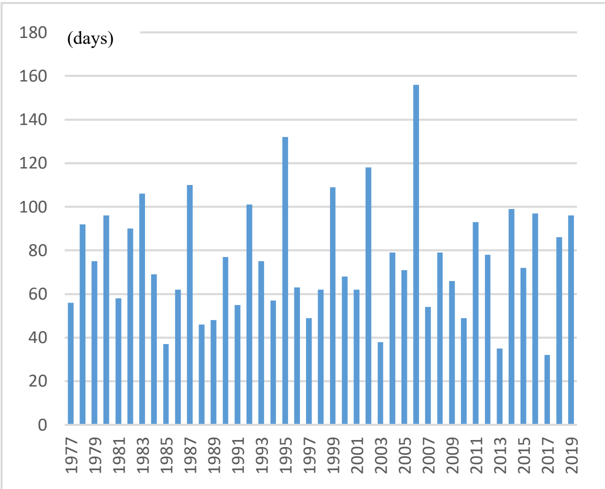


Source: NCAR

Figure 8.6-2 Climate Change Simulation (Precipitation)

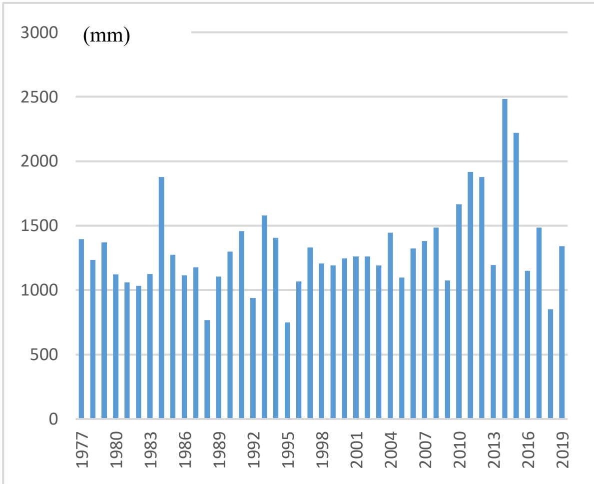
Irrigation water requirement was forecasted to increase by 15% to 18% in Anuradhapura, considering various climate change factors (2007, De Silva). With regard to flooding, it can be said that the precipitation in 2014 and 2015, which caused serious damage, was much higher than general years and it would be related to the effect of recent climate change. However, the drought condition is recognised to be still getting serious due to current climate changes at least from the viewpoint of “Successive no-rain days (1977-2019)" and "Annual precipitation (1977-2019)" shown in the following graph. On the other hand, C/P organisations officials and farmers have observed that rainfall pattern is changing and the localisation with extreme rainfalls is getting worse recently, although these changes are not easy to prove scientifically.

Under these circumstances, trial actions to improve irrigation water use efficiency such as piping of open canals, linking of tanks with some canals and diversion of water to other catchment area, have been started by DAD and others recently.



Source: Study Team

Figure 8.6-3 Successive No-rain Days



Source: Study Team

Figure 8.6-4 Annual Precipitation

8.6.2 Action Plan for Climate Change

As stated in Section 2.2, climate change is a key issue in Sri Lanka, especially in agriculture and water resources sectors. The Government of Sri Lanka has developed action plans for climate change resilience as adaptation measures as stated in Table 8.6-1

Table 8.6-1 Action Plan for Climate Change in Agriculture Related Sectors

Sector	Priority Actions
Food Security	・Develop tolerant varieties (paddy, OFC, horticulture) and breeds (dairy cattle and poultry) to heat stress, drought and floods and resistant to diseases and pest attacks ・Develop and promote water efficient farming methods (e.g. on-farm rainwater harvest, micro irrigation, use of return flow, crop diversification) ・Adjust cropping calendars according to climate forecasts ・Intensive management of livestock (e.g. artificial insemination, silage, fodder production, confinement rearing) ・Develop systems for timely issuance and dissemination of climate information to farmers (e.g. short-term and long-term weather forecasts, early warning system) ・Enhance food storage capacity, buffer stock and management ・Develop research institute capacity for conducting research on tolerant varieties/breeds and climate resilient farming methods
Water Resources	・Develop and implement watershed management plans for critical watershed areas (e.g. participatory cascade management) ・Increase the efficiency of use and reduce losses of irrigation water (e.g. rainwater harvesting, micro irrigation, conjunctive use of surface and groundwater, improvement of existing reservoirs and tanks)

Sector	Priority Actions
	・Assess the current practices of water management for climate resilience and identify ways to improve them (e.g. wise use of climate resilient indigenous practices) ・Identify and map areas vulnerable to droughts and flood hazards and prepare disaster risk management plans ・Design rational intra-basin and trans-basin strategies to harness periodic surpluses of water in storage facilities
Export Agriculture Sector (mainly fruits and spices)	・Introduce new cultivars/clones tolerant to heat, drought and flood and resistant to disease and pest attacks ・Promote improved nursery and plant management practices and sustainable cropping systems to increase the climate resilience of plantations and crops ・Conduct research studies on climate change impacts on export agriculture crops ・Identify and collect information on areas most vulnerable to disasters and prepare hazard vulnerability maps for all crops ・Develop research institutes' capacity for conducting research on climate change impacts on export agriculture crops

Source: National Adaptation Plan for Climate Change Impacts in Sri Lanka: 2016 – 2025 published by Climate Change Secretariat. Ministry of Mahaweli Development and Environment

These action plans have been incorporated in several projects in Sri Lanka, such as Climate Smart Irrigated Agriculture Project (CSIAP) and Climate Resilient Integrated Water Management Project (CRIWMP).

8.6.3 Adaptation Measures for Climate Change

The vulnerability and adaptation measures for climate change in irrigation and drainage sub-sector by the Project can be expected briefly as shown in Table 8.6-2.

Table 8.6-2 Climate Risk Assessment for the Project

Category	Current Situation in the Project Area	Adaptation Measures
Hazard	Project sites are located in the dry zone of Sri Lanka (Section 2.5.1)	Tank cascade systems (a kind of water harvesting structure)
	Frequent occurrence of flood (Section 2.5.2)	Rehabilitation of spillway and tank band as per the design *Provision of emergency spillway gate (on pilot basis)*
	Frequent occurrence of drought (Section 2.5.2)	Rehabilitation of irrigation canal system *Introduction of pipeline canal (on pilot basis)*
Exposure	Agriculture is major income source of local people. (Section 2.3.2)	Promotion of livestock and fishery
	Average land holding size is getting smaller. (Section 2.4.3)	Group farming
	Majority of farmers are engaged in traditional farming. (Section 2.4.3)	Improvement of farming technologies and farm inputs
Impact	Infrastructure (tank irrigation facilities, farm roads, etc.) has been often damaged due to floods. (Section 2.5.2)	Rehabilitation of tank irrigation facilities
	Farm incomes are on a subsistence level. (Section 2.4)	Promotion of high value crops
Vulnerability	Tank irrigation facilities are getting malfunctional due to aged deterioration. (Section 2.4.1)	Rehabilitation of tank irrigation facilities
	Capacity of tank reservoirs is getting smaller due to sedimentation. (Section 3.13.1)	Introduction of partial desilting work (on pilot basis)

Category	Current Situation in the Project Area	Adaptation Measures
	Major crop is paddy. (Section 2.4.3)	Crop diversification
Climate Risk	Agriculture production is largely depending on climate condition.	(Water allocation from NCPC)

Source: Prepared by the Study Team

The Project itself is a kind of adaptation measure for climate change. In addition, the following adaptation measures are proposed to be implemented on needs basis under the Project. Details of these measures are discussed in Section 3.12, 3.13, and 3.14.

Table 8.6-3 Adaptation Measures for Climate Change by the Project

Adaptation Measures	Expected Effects
Pipeline Canal	・Improve irrigation efficiency (no seepage and evaporation losses in canal) ・Minimise ineffective water distribution caused by continuous irrigation in open canals ・Promote crop diversification from rice to high valued crops ・Reduce in canal maintenance works (no weeding and no desilting)
Partial Desilting	・Increase storage capacity ・Reduce water spread area of reservoirs/tanks ・Reuse desilted material for improving soils fertility, brick/block making, construction, etc.
Emergency Spillway Gate	・Reduce flood damage by pre-releasing water in reservoirs/tanks especially in the wet season ・Give a sense of safety to farmers as contingency measure

Source: Study Team

The Climate Resilient Integrated Water Management Project (CRIWMP) currently being operated by the United Nations Development Programme (UNDP) in Sri Lanka has received a grant from Green Climate Fund (GCF)[1] for the part of project costs. Once the effectiveness of the above measures be confirmed through the pilot projects, it is proposed to apply GCF grant for the dissemination of the adaptation measures for the entire project area under the future project.

8.7 Project Evaluation

8.7.1 Economic Evaluation

(1) Method of Economic Evaluation

Economic evaluation is carried out to access the economic viability of the short-listed sub-projects. In order to evaluate the short-listed sub-projects, indicators such as the economic internal rate of return (EIRR), cost-benefit ratio (B/C), and net present value (B-C) are calculated by estimating the cash outflow (costs) and inflow (benefits) on annual basis over the project life with a certain discount rate by discount cash flow method (DCF method). The EIRR is a discount rate at which the present value of the in and out cash flows become equal. This rate shows the return to be expected from the Project as expressed in the following equation:

$$\sum_{t=0}^{n} B_t \,/\, (1+r)^t \;-\; \sum_{t=0}^{n} C_t \,/\, (1+r)^t \;=\; 0$$

where Ct is Cost, B is Benefit, t is Year, n is Project Life (year), and r is Discount Rate (EIRR).

[1] The Green Climate Fund (GCF), https://www.greenclimate.fund/about

The sensitivity analysis is also carried out to evaluate the viability of the short-listed sub-projects against possible adverse change in the future.

The financial internal rate of return (FIRR) is not calculated because FIRR is an indicator to access the financial sustainability of the implementation agency with direct return from project activities, such as airport, water supply project, etc.

(2) Basic Assumption of Economic Evaluation

The indicators for economic evaluation of the short-listed sub-projects are estimated with the following conditions and assumptions:

i) The project life is assumed to be 30 years.

ii) All prices and costs are expressed in economic prices of local currency (LKR). The other currencies are converted to the local currency (LKR) by using the following exchange rates as of August 2020 for the estimation:

iii) USD1.00 = JPY 106, USD1.00 = LKR 185, LKR 1.00 = JPY 0.573

iv) A discount rate of 10% is applied for calculation of B/C and B-C based on the rate used for other irrigation projects in Sri Lanka (Report of Climate Smart Irrigated Agriculture Project, World Bank, 2019 and Report of Integrated Watershed and Water Resources Management Project, World Bank, 2020).

v) All financial prices are converted to economic prices by using the prices and factors as follows. Transfer payment (taxes and subsidies), land acquisition, compensation, price escalation, and interest during construction are excluded for calculation of economic project cost/benefit.

vi) As the traded commodity, the economic price of rice (Cost Insurance and Freight (CIF) price) is estimated based on the price in "World Bank Commodities Price Data (The Pink Sheet), Annual Average from January to December 2019 in USD, September 2, 2020".

vii) On the other hand, crop budgets of chili and big onion are estimated based on the information provided by DOA as same as non-trade crops since the price fluctuation of market price are dynamic and they could be harvested at higher price than traded prices.

viii) Among the traded commodities, chemical fertiliser is calculated by excluding subsidies from the market price. Pesticide and weedicide are calculated without VAT.

ix) Other goods were regarded as non-traded goods. The financial price was converted to the economic price using the standard conversion factor (SCF) of 0.94. The SCF is calculated from the export/import statistical data in 2016 and 2017 of Sri Lanka since the latest data in 2018 to 2019 is not available. The basis for the calculation is as follows:

Table 8.7-1 Calculation of Standard Conversion Factors

Items (USD in thousand)	2016	2017	Average of 2016 and 2017
a) Imports Value (USD in thousand)	19,500,757.05	21,316,199.95	20,408,479
b) Exports Value (USD in thousand)	10,545,893	11,741,037	11,143,465
c) Customs and other import (USD in thousand)	1,958,077	1,994,682	1,976,380
d) Taxes on export (USD in thousand)	14,469	16,138	15,303
e) = a + b	30,046,650	33,057,237	31,551,944
f) = (a + c) +(b - d)	31,990,258	35,035,781	33,513,020
SCF = e / f	**0.939**	**0.944**	**0.940**

Source: Study Team based on the statistical data from World Integrated Trade Solution (WITS), https://wits.worldbank.org/

x) The shadow wage rate (SWR) is calculated from average employment rate of Sri Lanka in 2015 to 2019 (SWR=0.96).

xi) For estimation of the project economic cost, only incremental cost is counted. The sunk cost is not included in the economic cost.

(3) Project Economic Cost

Based on the financial cost described in Chapter 5, the economic project cost is estimated using the abovementioned conversion method to the economic price. Conditions and assumptions for the estimation of the short-listed sub-projects economic cost are as follows:

i) The project economic cost includes civil works for the improvement of tank, irrigation facilities, and farm road, pilot project of pipeline and partial desilting work, and soft components.

ii) The costs for the livestock development and fishery development are excluded from the project economic cost for calculation of EIRR since the developments will be implemented on pilot basis in the selected sub-projects in the shortlist.

iii) The local currency portion of the short-listed sub-projects cost is converted using the following factors:

- Equipment : SCF = 0.94
- Materials : SCF = 0.94
- Unskilled Labour : SWR = 0.96

The economic cost is shown in the following table.

Table 8.7-2 Economic Cost of the Project

Non-disclosure information

Source: Study Team

Based on the disbursement schedule of financial cost, the cash flow table of economic cost is prepared as shown in the following table.

Table 8.7-3 Disbursement Schedule of Economic Project Cost (Unit: LKR in Million)

Non-disclosure information

Source: Study Team

Details of economic cost of the short-listed sub-projects are shown in Appendix 8.7-1.

(4) Operation & Maintenance and Replacement Cost

(a) Operation & Maintenance Cost (Economic Price)

Annual incremental O&M cost is estimated as shown in the following table. The difference between O&M cost without project condition and O&M cost with project condition is the economic annual incremental O&M cost. Annual O&M cost is assumed to be at 1% of total direct cost of Infrastructure Development zone 1 to 5 including preliminary, general item and miscellaneous, based on the appropriate O&M cost calculated by PID. O&M cost to be required will be increased year by year according to the project implementation schedule. Details of the annual incremental O&M cost are shown in the following table.

Table 8.7-4 Economic O&M Cost

Non-disclosure information

Source: Study Team
Note: Conversion factor is 0.94 (SCF)

(b) Replacement Cost (Economic Price)

The following replacement cost is expected in 10 years and 20 years after the completion of Infrastructure Development Zones 1 to 5, considering the economic life of infrastructure based on types of construction works in the Project.

Table 8.7-5 Economic Replacement Cost

Non-disclosure information

Source: Study Team
Note: Conversion factor is 0.94 (SCF)

(5) Economic Benefit

Based on the project implementation plan, the annual incremental economic benefit is calculated. Assumptions and conditions for estimation of the project benefit are as follows:

i) The major economic benefit of the Project is derived from crop diversification: increase of cropping intensity and unit yield of not only paddy but also OFCs to be introduced newly. This benefit is estimated by converting the difference between the agricultural output of without and with project conditions to monetary value.

ii) The crop diversification will come from the combined effects of improvement of tank and irrigation facilities and farm roads, pilot projects and soft component activities. It is assumed that the annual yield OFCs will increase from zero to 90 ton/ha due to crop diversification by the implementation of the Project through its planned activities.

iii) The economic crop budget is estimated by converting the financial crop budget shown in Section 8.2.1 using the conversion factors.

iv) The benefits generating from the livestock development and fishery development are excluded from benefits for economic evaluation of the Project since they are planned as pilot activities.

v) The benefit from flood mitigation effect could be expected by the planned activities as well as irrigation benefit from crop diversification.

The annual incremental benefit derived from crop diversification and flood mitigation is estimated as shown in the following table. Details of the annual incremental benefit are shown in Appendix 8.7-1.

Table 8.7-6 Economic Benefit of the Project

Non-disclosure information

Source: Study Team

(6) Result of Economic Evaluation

Based on the assumptions and conditions described so far, the indicators for economic evaluation are calculated as shown in the following table. The cash flow table for the calculation is shown in Attachment 8.7-1.

Table 8.7-7 Calculation Result of the Indicators for Economic Evaluation

Non-disclosure information

Source: Study Team

[redacted]

A sensitivity analysis is also carried out to evaluate the soundness of the tentative short list of sub-projects against unexpected adverse changes, such as cost overrun and decrease of benefit in the future. The result of analysis is shown in the following table.

Table 8.7-8 Result of Sensitivity Analysis

Non-disclosure information

Source: Study Team

8.7.2 Project Evaluation

The viability of the Project was evaluated from the following viewpoints. The evaluation results for each item are shown in the following table.

Table 8.7-9 Result of Evaluation of the Project

	Viewpoints	Outline of the Evaluation Result
1)	Consistency with national policies and development plan	・ As shown in Section 2.3, the purpose of the Project is consistent with the national/sector policy and development plan in Sri Lanka. Therefore, the relevance of the project implementation is high.
2)	Necessity and urgency of the Project	・ As shown in Section 2.8, it is judged that the necessity and urgency of the Project are high in view of revitalisation of old and damaged minor tank irrigation facilities, promotion of crop diversification, and climate change resilience.
3)	Project scope	・ As shown in each section of Chapter 4, the soft components for the enhanced development effects are proposed appropriately according to the current situation in addition to the components of the rehabilitation of tank irrigation facilities and farm roads. It also includes components to enhance capacity of FOs and CMOs for sustainable irrigation O&M in a participatory manner. Therefore, it is judged that the project scope is proposed appropriately.
4)	Project implementation structure	・ As shown in Section 6.2, the project implementation structure at each level is proposed according to the project characteristics, e.g., a large number of short-listed sub-projects are scattered over two districts. The committees (PSC, PCC, DCC) for decision-making in the Project are also considered as part of the project implementation structure. Therefore, it is judged that the project organisation structure is proposed appropriately.
5)	Project implementation schedule	・ As shown in Section 6.4, the project implementation schedule is proposed based on rainfall pattern in the project area in addition to the technical and operational capacity of the implementation agency. Therefore, it is judged that the project implementation schedule is proposed appropriately.

	Viewpoints	Outline of the Evaluation Result
6)	Technical soundness	・ As discussed in Chapter 4, regarding the technical aspects, the Project in principle will apply simple technology for infrastructure development and improved technology for agriculture development prevailing in Sri Lanka. Accordingly, it is judged that the appropriate technology has been selected based on the local situation and the capacity of the project stakeholders.
7)	Climate change resilience	・ As discussed in Section 8.6, the Project itself is an adaptation measure for climate change judging from the climate risk assessment. Moreover, pipeline canal and partial desilting emergency spillway gate proposed on a pilot basis would enhance the climate change resilience. The Project could contribute to reduce the vulnerability of farmers to climate change.
8)	Economic viability	・ As shown in Section 8.7.1, EIRR as result of economic evaluation for the Project can be expected to be sufficient due to benefits from farm income increment by crop diversification and flood mitigation, and cost reduction considered in Chapter 3. Therefore, it is judged that the economic viability of the Project would be ensured.
9)	Environmental, social and gender consideration	・ As shown in Chapter 7, the result of environmental and social consideration shows that the project does not have large negative impacts. Gender issues are also considered in the project preparation. Therefore, it is judged that the Project has no large problems with regards to the environmental and social aspects.
10)	Risk management	・ As shown in Section 8.5, through the risk assessment, major risks are identified, and the countermeasures for the risks are considered.
11)	Sustainability	・ As shown in Chapter 4, the project components include the capacity development of the implementation agency and beneficiaries. Therefore, the project has high sustainability in the future.

Source: Study Team

Attachment

Attachment 2.4-1: FO Financial Situation

SN.	Cascade/ASC	FO name	Main Income Sources (Rs)/year/2020 Sept							O&M Fee Collection				Major Expenditures (Rs)/Year/2020 Sept					Account Balance Rs./2020
			MS Fee	O&M Fee	Fine	Contract	Fishery	Water Master	Other	Rate %	Who	When	How	Office Bearers	Water Master	Facility Maintena.	Meeting Tea	Other	
1	**Alagalla**/Madukanda	Alagalla	14,000	7,000	0	65,000	60,000	60,000	0	100	Treasurer	Seasonal	Cash	0	60,000	4,500	4,000	5,000	350,000
2		Ekamuthu	3,600	4,000	0	25,000	32,000	6,000	0	100	Treasurer	Seasonal	Cash	0	6,000	0	2,000	2,500	400,000
3		Periya Koormarasan kulam	42,000	48,000	0	100,000	20,500	50,000	0	100	Treasurer	Seasonal	Cash	0	50,000	15,000	2,500	2,000	355,000
4	**Nevelikulam**/Omanthai	Arasankulam	0	0	0	0	0	0	0					0	0	0	0	0	0
5		Mahilankulam	4,800	27,000	0	32,000	0	35,000	0	100	Treasurer	Seasonal	Cash	0	35,000	0	3,200	3,000	79,019
6		Irampaikulam	6,500	12,000	4,000	60,000	150,000	25,000	0	100	Treasurer	Seasonal	Cash	0	25,000	0	0	0	147,036
7		Periyavilanthikulam	13,680	68,500	0	20,000	41,000	27,000	0	100	Treasurer	Seasonal	Cash	0	27,000	0	0	0	666,199
8		Konthakarankulam	28,000	48,600	0	17,500	65,000	15,000	0	100	Treasurer	Seasonal	Cash	0	15,000	0	0	0	285,697
9		Valasinnakulam	10,000	30,000	0	75,000	0	50,000	0	100	Treasurer	Seasonal	Cash	0	50,000	2,000	7,000	11,000	168,105
10		Omanthai	8,500	29,000	0	22,500	40,000	30,000	0	100	Treasurer	Seasonal	Cash	0	30,000	8,000	0	3,000	190,704
11	**Kiulekada**/Kebithigollawa	Perakum	4,800	not collect	0	70,000	50,000	0	0					2,000	0	0	500	1,000	120,000
12		Gonuhathdenawa	14,400	not collect	0	20,000	200,000	0	3,000					0	0	0	0	0	152,000
13		Goviudana	6,600	not collect	0	50,000	0	0	0					0	0	7,000	0	0	166,000
14		Ekamuthu	3,120	not collect	0	15,000	0	0	0					0	0	3,000	0	0	90,000
15	**Ichchankulama**/Galenbindunuwewa.	Karakolawewa	9,500	not collect	0	40,000	27,500	0	0					0	0	0	0	0	174,000
16		Ihalakainathama	9,600	not collect	0	250,000	75,000	0	0					0	0	10,000	3,000	0	362,230
17		Pahalakainathama	10,200	not collect	0	35,000	0	0	0					0	0	75,000	0	0	349,730
18		Ambagahawewa	3,000	not collect	0	0	125,000	0	0					0	0	0	0	0	266,190
19		Madeena	8,000	not collect	0	50,000	0	0	0					2,000	0	0	4,500	3,000	200,000
20	**Siyambalagaswewa**/Kallanchiya	Parakum	2,880	not collect	0	70,000	40,000	0	0					0	0	0	0	5,000	120,000
21		Sakthi/Kandawa	7,620	not collect	0	35,000	50,000	0	0					0	0	50,000	1,000	1,000	354,856
22		Dilenatharu	900	not collect	0	0	0	0	0					0	0	0	500	0	53,971
23	**Ithalawatunawewa**/ Konwewa, Kahatagasdigiliya	Alaman	not collec	not collect	0	33,000	265,000	0	0					0	0	17,000	0	0	425,000
24		Sramasakthi	2,200	not collect	0	90,000	25,000	0	0					0	0	11,000	0	1,000	510,000
25		Prarthana	7,000	not collect	5,000	100,000	75,000	0	0					0	0	0	1,000	2,000	500,000
26		Ruwan	2,000	not collect	0	5,000	0	0	0					0	0	3,000	0	9,000	80,000
27		Pubudu/Thallaththawa	6,000	not collect	0	5,000	30,000	0	0					800	0	3,500	0	7,000	111,000
28		Gemunu	3,000	not collect	0	20,000	0	0	0					0	0	2,500	0	8,500	24,000
29		Pubudu/Thaliyaketuwewa	3,600	not collect	0	60,000	0	0	0					0	0	2,500	0	0	82,000
30		Ekamuthu/Hamillawa	3,000	not collect	0	15,000	0	0	0					0	0	1,000	0	0	18,500
31		Parakum/Pattilappuwa	7,500	not collect	0	43,000	70,000	0	6,000					1,500	0	5,000	0	0	300,000

Source: DAD and FOs

Note-

a). A significant difference can be observed between Anuradhapura and Vavuniya on O&M Fee collection and Water Master payment.

b). Water Master payment is collected by FO and pay it to Water Master in Vavuniya District, meanwhile it is directly paid to Water Master by farmers in Anuradhapura District.
Water Master payment is paid in cash or in kind (Paddy).

c). There is no regular O&M fee collection in Anuradhapura District. Most of the works are done on voluntary basis or need base collection.

Attachment 3.1-1: List of 124 Cascade System

Cascade ID	Cascade Name	Symbol	River Basin	SWS	District	DSD	Zone	Minor Scheme		Medium Scheme		Total (855 Target Tanks)	
								Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command area (ha)
2	Bora Wewa	11/MAL2	South MAL	Maminiya Oya	Anuradhapura	Thirappane	3	3	40.88	0	0.00	3	40.88
3	Pairimaduwa Wewa	12/MAL2	South MAL	Maminiya Oya	Anuradhapura	Thirappane	3	5	96.62	1	92.00	6	188.62
4	Galwaduwagama	10/MAL2	South MAL	Maminiya Oya	Anuradhapura	Galenbindunuwewa	3	2	24.29	0	0.00	2	24.29
5	Abagaha Wewa	12/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Galenbindunuwewa	3	3	99.19	0	0.00	3	99.19
6	Periya Kulam	11/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Thirappane	3	2	76.92	0	0.00	2	76.92
7	Kon Wewa	10/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Thirappane	3	2	119.43	0	0.00	2	119.43
8	Pahala Halmillewa	9/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	3	85.83	0	0.00	3	85.83
9	Tharanogolllawa	8/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	2	23.35	0	0.00	2	23.35
10	Siyabalabedigaswewa	7/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	1	12.15	0	0.00	1	12.15
11	Mahagal kulam	6/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale, Thirappane	3	7	145.85	0	0.00	7	145.85
12	Ichchan Kulam	13/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Galenbindunuwewa, Mihinthale	3	7	218.70	0	0.00	7	218.70
13	Katukaliyawa	14/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	10	118.63	0	0.00	10	118.63
14	Kasamaduwa	15/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	4	90.69	0	0.00	4	90.69
15	Ittiktiya	16/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	4	76.92	0	0.00	4	76.92
16	Galmaduwa	17/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	5	85.82	0	0.00	5	85.82
17	Palugas Wewa	18/MAL4	South MAL	Upper Kanadara Oya	Anuradhapura	Mihinthale	3	17	275.68	0	0.00	17	275.68
18	Mekechchawa	3/MAL5	South MAL	Upper Weli Oya (Maha Kanadara Oya)	Anuradhapura	Galenbindunuwewa, Kahatagasdigigiliya, Mihinthale	3	29	615.49	0	0.00	29	615.49
19	Abagahawela	2/MAL5	South MAL	Upper Weli Oya (Maha Kanadara Oya)	Anuradhapura	Kahatagasdigiliya, Mihinthale	3	7	181.13	0	0.00	7	181.13
20	Ethawetuna Wewa	1/MAL5	South MAL	Upper Weli Oya (Maha Kanadara Oya)	Anuradhapura	Mihinthale	3	2	14.98	0	0.00	2	14.98
21	Ella Wewa	4/MAL5	South MAL	Upper Weli Oya (Maha Kanadara O	Anuradhapura	Kahatagasdigiliya	3	12	335.63	1	152.00	13	487.63
22	Ranpathwila Wewa	5/MAL5	South MAL	Upper Weli Oya (Maha Kanadara O	Anuradhapura	Kahatagasdigiliya	3	25	638.66	1	116.00	26	754.66
23	Kukulawa Wewa	6/MAL5	South MAL	Upper Weli Oya (Maha Kanadara O	Anuradhapura	Kahatagasdigiliya	3	3	42.05	0	0.00	3	42.05
24	Konketupothana	7/MAL5	South MAL	Upper Weli Oya (Maha Kanadara O	Anuradhapura	Rambewa	3	7	130.25	0	0.00	7	130.25
25	Gekarawa Wewa	8/MAL5	South MAL	Upper Weli Oya (Maha Kanadara O	Anuradhapura	Rambewa	3	4	65.58	0	0.00	4	65.58
26	Kongollawewa	8/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	6	117.41	0	0.00	6	117.41
27	Nika Wewa	10/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	3	18.22	0	0.00	3	18.22
28	Mekicha Wewa	9/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	2	12.96	0	0.00	2	12.96
29	Kuda Wewa	11/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	3	58.70	0	0.00	3	58.70
30	Rathmalgaha Wewa	12/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	4	113.76	0	0.00	4	113.76
31	Kudagama Wewa	13/MAL12	South MAL	Lower Weli Oya	Anuradhapura	Rambewa	3	2	72.88	0	0.00	2	72.88

Cascade ID	Cascade Name	Symbol	River Basin	SWS	District	DSD	Zone	Minor Scheme		Medium Scheme		Total (855 Target Tanks)	
								Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command area (ha)
32	Tibiri Wewa	3/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Kahatagasdigiliya, Rambewa	4	20	248.02	1	80.97	21	328.99
33	Gonawa Ihala Wewa	2/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Rambewa	4	3	24.70	0	0.00	3	24.70
34	Gonawa Wewa	1/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Rambewa	4	3	41.70	0	0.00	3	41.70
35	Kapirilgama Wewa	4/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Rambewa	4	19	340.08	2	388.65	21	728.73
36	Siyabalagaswewa	5/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Rambewa	4	9	105.67	1	95.14	10	200.81
37	Thalgaha	6/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Rambewa	4	5	63.57	1	141.70	6	205.27
38	Walketu Wewa	7/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Medawachchiya, Rambewa	4	3	44.01	1	170.04	4	214.05
39	Dumminnegama	8/MAL6	Middle MAL	Kudahathu Oya	Anuradhapura	Medawachchiya	4	2	64.77	0	0.00	2	64.77
40	Lidawewa	2/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	3	44.13	0	0.00	3	44.13
41	Pihibiyagollawa	7/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Rambewa	4	23	564.95	1	85.02	24	649.97
42	Kirimetiyawa	6/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Rambewa	4	6	136.25	0	0.00	6	136.25
43	Ralapanawa	5/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya, Rambewa	4	7	105.26	0	0.00	7	105.26
44	Kardan Kulam	4/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	2	84.61	0	0.00	2	84.61
45	Diulgas Wewa	3/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	2	7.29	0	0.00	2	7.29
46	Gagurane Pathaha	8/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Rambewa	4	9	243.03	0	0.00	9	243.03
47	Kirigollewa	9/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	16	459.77	1	108.09	17	567.86
48	Kudagama Wewa	10/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	14	396.46	1	340.08	15	736.54
49	Kuda Wewa	11/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	4	75.30	0	0.00	4	75.30
50	Madawachchiya Wewa	12/MAL7	Middle MAL	Sangilikanadara Oya	Anuradhapura	Medawachchiya	4	28	560.04	2	207.69	30	767.73
51	Parana Halmillewa	4/MAL8	Middle MAL	Upper Kal ara	Anuradhapura	Medawachchiya	4	20	468.18	1	105.26	21	573.44
52	Kidewaran Kulam	5/MAL9	Middle MAL	Boo Oya / Ulukkulama	Anuradhapura	Medawachchiya	4	19	460.31	1	155.60	20	615.91
53	Thibiri Wewa	3/MAL8	Middle MAL	Upper Kal ara	Anuradhapura	Medawachchiya	4	2	53.44	0	0.00	2	53.44
54	Dutuwewa	6/MAL8	North MAL	Upper Kal ara	both (mainly Anu)	Medawachchiya	5	1	47.37	0	0.00	1	47.37
55	Alagalla	7/MAL8	North MAL	Upper Kal ara	both (mainly Vav)	Vavuniya North, Vavuniya South	5	5	157.00	0	0.00	5	157.00
56	Nochchikulam	8/MAL8	North MAL	Upper Kal ara	both (mainly Vav)	Vavuniya North, Vavuniya South	5	13	557.12	0	0.00	13	557.12
58	Irataperiya Kulam	9/MAL8	North MAL	Upper Kal ara	both (mainly Vav)	Vavuniya North, Vavuniya South	5	17	314.21	1	203.60	18	517.81
59	Kurundan Kulam	10/MAL8	North MAL	Upper Kal ara	Vavuniya	Vavuniya South	5	2	29.72	0	0.00	2	29.72
60	Kandapuran Kulam	11/MAL8	North MAL	Upper Kal ara	Vavuniya	Vavuniya North, Vavuniya South	5	3	62.00	0	0.00	3	62.00
61	Karuweppan Kulam	12/MAL8	North MAL	Upper Kal ara	Vavuniya	Vavuniya North	5	6	52.48	0	0.00	6	52.48
62	Suduventapulavu	13/MAL8	North MAL	Upper Kal ara	Vavuniya	Vengalacheddikulam	5	2	35.87	0	0.00	2	35.87
63	Ihalagal Kulam	10/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	1	4.05	0	0.00	1	4.05
64	Eluwan Kulama	9/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	2	41.30	0	0.00	2	41.30
65	Meegaswewa	8/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	3	41.29	0	0.00	3	41.29
66	Kannimaduwa Wewa	7/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	4	128.34	0	0.00	4	128.34
67	Pahala Nittawa	6/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	2	29.96	0	0.00	2	29.96
68	Puliyan Kulam	5/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	5	86.13	0	0.00	5	86.13

Cascade ID	Cascade Name	Symbol	River Basin	SWS	District	DSD	Zone	Minor Scheme		Medium Scheme		Total (855 Target Tanks)	
								Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command area (ha)
69	Ella Wewa	4/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	3	85.47	0	0.00	3	85.47
70	Olukolagala Wewa	3/Y2	Yan Oya	Huruluwewa	Anuradhapura	Galenbindunuwewa	1	2	48.58	1	103.73	3	152.31
71	Punchihammillawa	2/Y2	Yan Oya	Huruluwewa	Anuradhapura	Kahatagasdigiliya	1	2	42.51	0	0.00	2	42.51
73	Hettuwewa	7/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Kahatagasdigiliya	1	4	138.46	0	0.00	4	138.46
74	Kon Wewa	6/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Kahatagasdigiliya	1	3	100.40	0	0.00	3	100.40
75	Ithalwatuna Wewa	5/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Kahatagasdigiliya	1	9	205.10	2	210.52	11	415.62
76	Maha Hammillewa	4/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Kahatagasdigiliya	1	27	446.80	1	106.00	28	552.80
77	Moragahadigiliya	3/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Horowpothana	1	9	213.76	2	225.91	11	439.67
78	Pemorakewa	2/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Horowpothana	1	19	491.06	1	193.52	20	684.58
79	Patanaya	1/Y4	Yan Oya	Mid Yan Oya	Anuradhapura	Horowpothana	1	4	69.23	0	0.00	4	69.23
80	Nilla Wewa	2/Y5	Yan Oya	Horowpothana	Anuradhapura	Horowpothana	1	36	710.22	3	416.54	39	1126.76
82	Ralapanawa	1/Y5	Yan Oya	Horowpothana	Anuradhapura	Horowpothana	1	12	185.81	2	204.45	14	390.26
83	Hammillawa	1/Y6	Yan Oya	Wahalkada	Anuradhapura	Horowpothana	1	11	368.11	1	101.21	12	469.32
84	Dutu Wewa	5/Y6	Yan Oya	Wahalkada	Anuradhapura	Horowpothana	1	2	110.18	1	121.45	3	231.63
85	Kapugollewa Ela	2/Y6	Yan Oya	Wahalkada	Anuradhapura	Horowpothana	1	6	224.99	2	256.00	8	480.99
86	Wagollakada	3/Y6	Yan Oya	Wahalkada	Anuradhapura	Horowpothana	1	2	68.81	1	171.66	3	240.47
87	Maha Wewalkadawala	9/MA1	Ma Oya	Mora Oya	Anuradhapura	Kahatagasdigiliya, Rambewa	2	29	883.84	1	101.21	30	985.05
88	Walahawidda Wewa	10/MA1	Ma Oya	Mora Oya	Anuradhapura	Horowpothana	2	6	218.00	0	0.00	6	218.00
89	Ulpathagama Wewa	11/MA1	Ma Oya	Mora Oya	Anuradhapura	Horowpothana	2	1	40.49	1	182.00	2	222.49
90	Ulpotha	12/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	1	15.79	0	0.00	1	15.79
91	Kiriketu Wewa	13/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	2	58.30	0	0.00	2	58.30
92	Mahatikka Wewa	15/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	8	210.67	1	175.00	9	385.67
93	Elapattewa	14/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	7	165.16	0	0.00	7	165.16
94	Gallewa Wewa	16/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	3	130.77	1	162.00	4	292.77
95	Ihala Thammennawa	8/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	12	224.34	1	84.00	13	308.34
96	Kiulekada Wewa	7/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	10	202.02	1	102.00	11	304.02
97	Ayiyatige Wewa	6/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	20	404.04	2	236.00	22	640.04
98	Palupuliyam Kulama	5/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	7	137.89	0	0.00	7	137.89
99	Ithalwiddawa Wewa	4/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	10	196.06	1	109.31	11	305.37
100	Mahanettiyawa	3/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	4	132.83	0	0.00	4	132.83
101	Olugaskada	2/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	9	436.09	1	108.00	10	544.09
102	Sinhaya Ulpotha	10/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	1	16.20	0	0.00	1	16.20
103	Pahala Herath Mamillewa	1/MA1	Ma Oya	Mora Oya	Anuradhapura	Kebithigollewa	2	2	35.30	0	0.00	2	35.30
104	Medagama Wewa	9/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	1	22.67	0	0.00	1	22.67
105	Kunchuttuwa	7/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	3	135.63	0	0.00	3	135.63
106	Puliyan Kulama	8/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	7	83.42	0	0.00	7	83.42
107	Maha Ralapanawa	6/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	5	125.33	0	0.00	5	125.33
108	Migakada Wewa	5/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	2	74.08	0	0.00	2	74.08
109	Viharahalmillawa	2/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	2	39.41	0	0.00	2	39.41
110	Nikawewa	1/MA2	Ma Oya	Mukunu Oya	Anuradhapura	Kebithigollewa	2	1	18.01	0	0.00	1	18.01
111	Puthuk Kulam	5/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	14	328.93	3	425.00	17	753.93
112	Putuk Kulam	4/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	5	128.26	0	0.00	5	128.26

Cascade ID	Cascade Name	Symbol	River Basin	SWS	District	DSD	Zone	Minor Scheme		Medium Scheme		Total (855 Target Tanks)	
								Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command Area (ha)	Nos. of Tanks	Command area (ha)
113	Periya Kulam	3/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	1	46.00	0	0.00	1	46.00
114	Kollamutamadu Kulam	2/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	5	97.10	0	0.00	5	97.10
115	Chinna Kulam	1/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	6	233.80	0	0.00	6	233.80
116	Parandikallu	6/PAR1	PAR and MGA	Upper Parangi Aru	Vavuniya	Vavuniya	5	23	509.65	1	87.00	24	596.65
117	Periyakada	6/PAR4	PAR and MGA	Periyakattu Aru	Vavuniya	Vavuniya	5	12	355.00	1	105.00	13	460.00
118	Kidachchuri	7/PAR4	PAR and MGA	Periyakattu Aru	Vavuniya	Vavuniya	5	2	96.00	1	161.87	3	257.87
119	Mullaik Kulam	8/PAR4	PAR and MGA	Periyakattu Aru	Vavuniya	Vavuniya	5	2	48.20	0	0.00	2	48.20
120	Karunkalisinna Kulam	7/PAR1	PAR and MGA	Upper Parangi Aru	both (mainly Vav)	Vavuniya South	5	7	178.08	2	202.00	9	380.08
121	Marutan Kulam	3/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	9	210.01	1	103.00	10	313.01
122	Naveli Kulam	4/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	13	259.29	0	0.00	13	259.29
123	Kasawapulaiyan Kulam	5/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	2	48.16	0	0.00	2	48.16
124	Alankulam	6/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	3	57.67	0	0.00	3	57.67
125	Podun Kulam	7/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	4	108.41	0	0.00	4	108.41
126	Palaimoddalk Kulam	8/PAR2	PAR and MGA	Thurumpamaddi Aru	Vavuniya	Vavuniya	5	1	54.66	0	0.00	1	54.66
127	Chamalan Kulam	7/MGA1	PAR and MGA	Upper Kanakarayan Aru	both (mainly Vav)	Vavuniya	5	7	179.11	1	242.95	8	422.06
128	Periyapuliyan Kulam	6/MGA1	PAR and MGA	Upper Kanakarayan Aru	Vavuniya	Vavuniya	5	9	270.69	1	121.00	10	391.69
	Total	**124**						**900**	**20911.88**	**55**	**7260.17**	**955**	**28172.05**

Source: Study Team

Attachment 3.2-1: Site Inspection of STEIN Canal



Left Bank canal of Kiulekada Ihara wewa

Non-disclosure information due to portrait protection

Right Bank Canal of Puliyankulam



Left Bank Canal of Kakayar Puliyan kulam

Source: Study Team

Attachment 3.3-1: Cracks of the Tanks Rehabilitated by CSDPP

(1) Puliyankulam (Kiulekada Cascade) in Anuradhapura District

Source: Study Team

(2) Halmillawatiya (Kiulekada Cascade) in Anuradhapura District

Source: Study Team

(3) Kiulekada Ihara Wewa (Kiulekada Cascade) in Anuradhapura District

Source: Study Team

(4) Galkadawewa (Kiulekada Cascade) in Anuradhapura District

Source: Study Team

(5) Vala sinna kulam (Naveli kulam Cascade) in Vavuniya District

Source: Study Team

(6) Panichan kulam (Naveli kulam Cascade) in Vavuniya District

Source: Study Team

Attachment 3.3-2: Result of Plaster Survey on Cracks of the Tanks Rehabilitated by CSDPP

Halmillawatiya, No.1, h=8 cm

Halmillawatiya, No.2, h=-cm

Halmillawatiya, No.3, h=60 cm

Halmillawatiya, No.4, h=40 cm

Puliyankulam, No.1, h=100 cm

Puliyankulam, No.2, h=110 cm

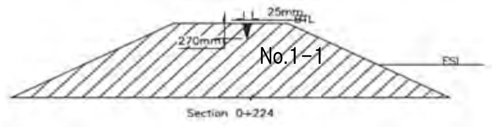
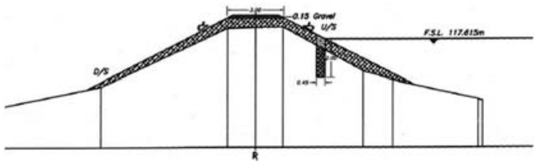
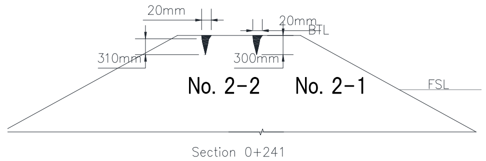
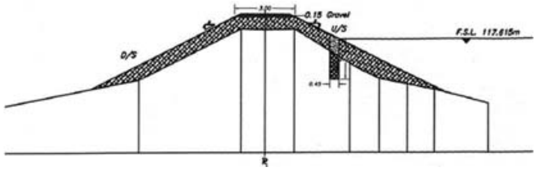
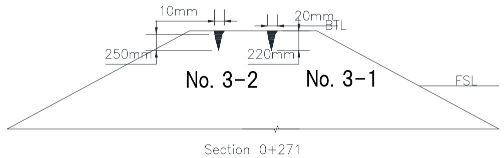
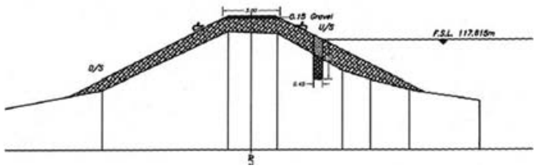
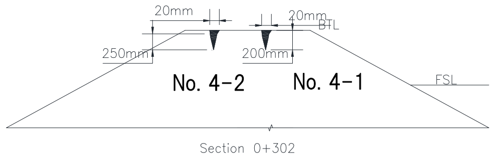
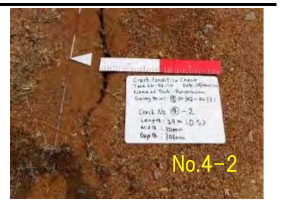
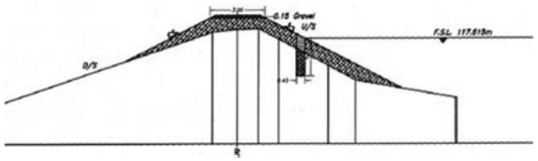
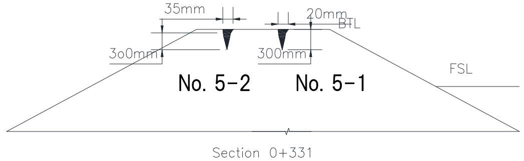
Puliyankulam, No.3, h=70 cm

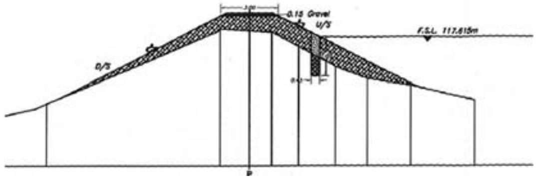
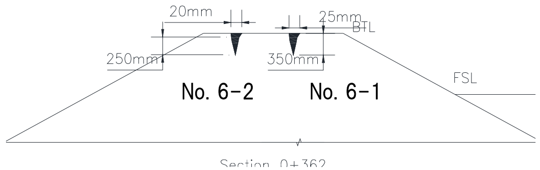
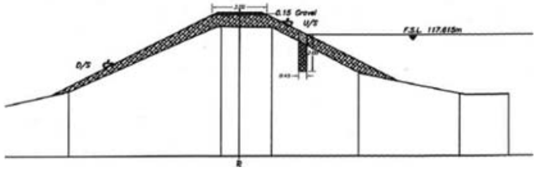
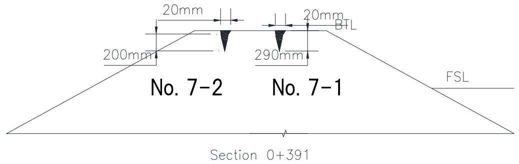
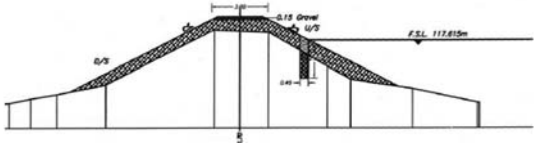
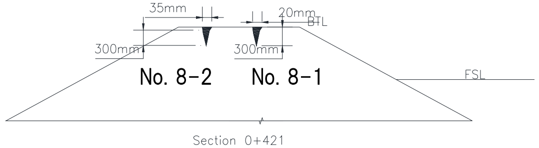
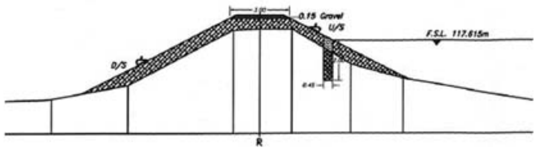
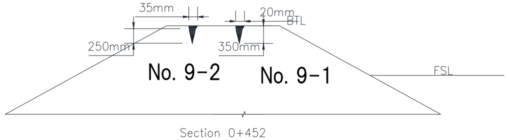
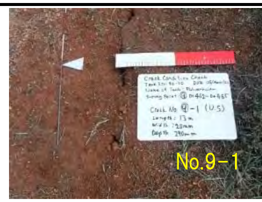
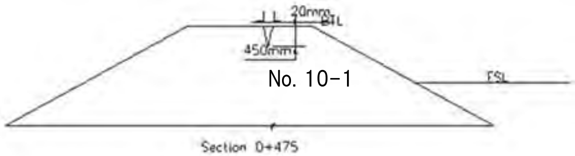
Puliyankulam, No.4, h=50 cm

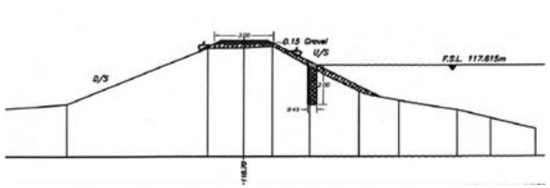
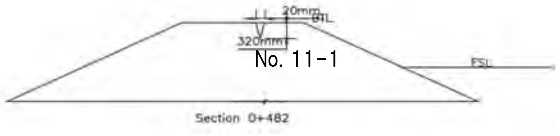
Puliyankulam, No.5, h=68 cm

Source: Study Team

Attachment 3.3-3: Cross Section Sketch and Photographs of Cracks at Puliyankram Tank

Chainage	Design Drawings	Crack Sketch	Photographs	
0+224	-			-
0+241				
0+271				
0+302				
0+331				

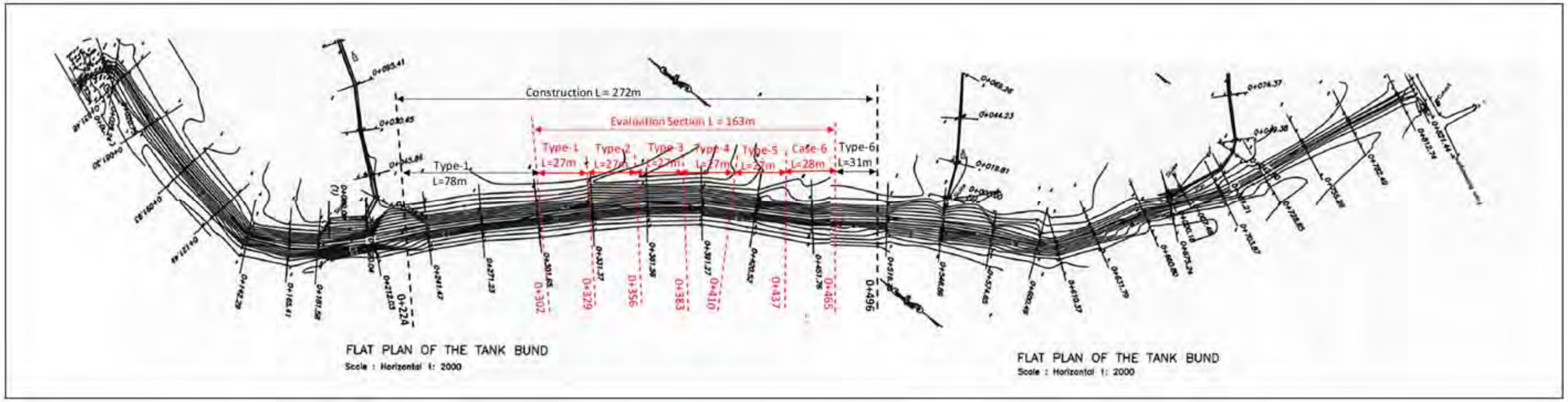
Chainage	Design Drawings	Crack Sketch	Photographs	
0+362				
0+391				
0+421				
0+452				
0+475	-			-

Chainage	Design Drawings	Crack Sketch	Photographs
0+482			 -

Source: Study Team

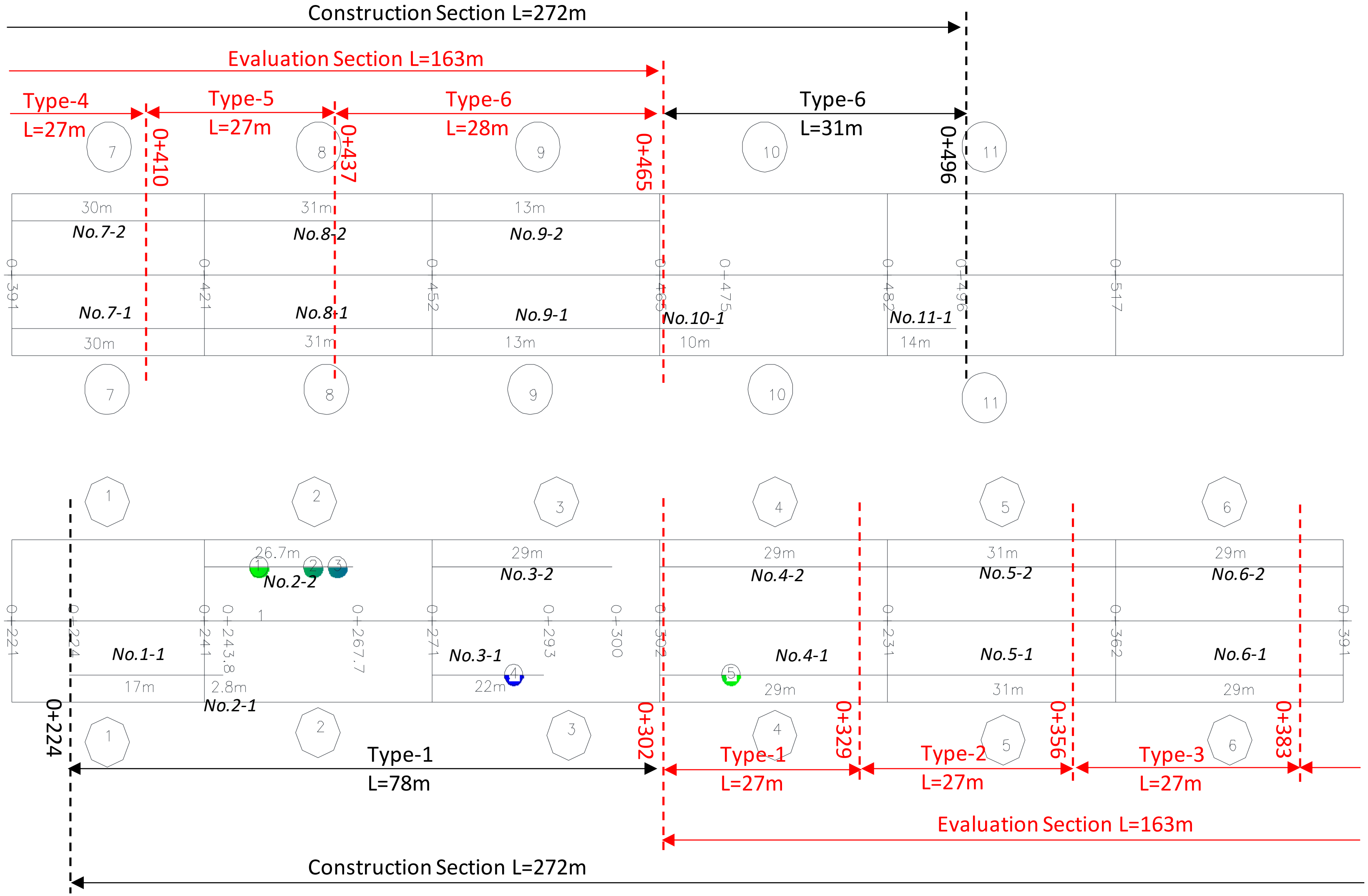
Attachment 3.3-4: Sub-section of Trial Construction at Puliyankram

Tank (1) General Drawing of Sub-section for Trial Construction



Source: *Study Team*

(2) Detail Drawing of Sub-section for Trial Construction

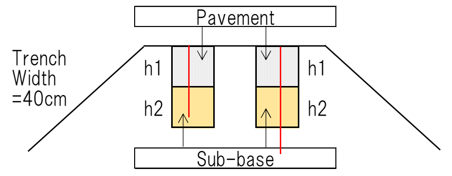


Source: *Study Team*

Attachment 3.3-5: Comparison of Trial Construction Countermeasures

Dimension

Standard Drawing



Dimension Table

Type		Type-1	Type-2	Type-3	Type-4	Type-5	Type-6
Pavement	Depth h1 (cm)	15	15	15	15	15	15
	Material	Gravel	Gravel	Gravel	Gravel	Gravel	Gravel
Sub-base	Depth h2 (cm)	15	15	30	30	75	75
	Material	Clay : Sand (1 : 2)	Clay : Gravel (1 : 2)	Clay : Sand (1 : 2)	Clay : Gravel (1 : 2)	Clay : Sand (1 : 2)	Clay : Gravel (1 : 2)
Construction Method		by farmer	by farmer	by contractor	by contractor	by contractor	by contractor

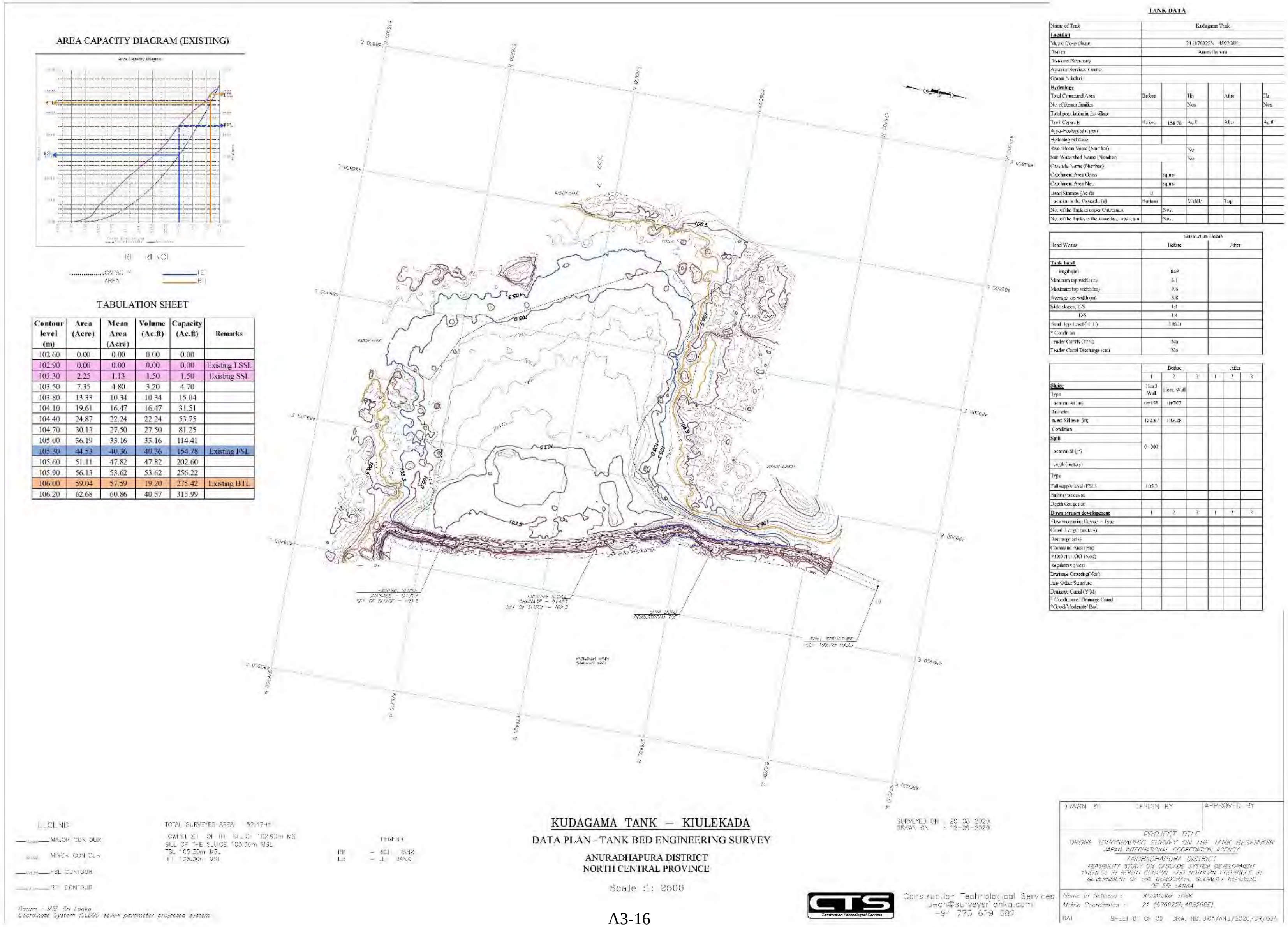
BOQ (per m)

Items	Description of Works	Unit	Rate (LKR)	Quantity						Remarks
				Type-1	Type-2	Type-3	Type-4	Type-5	Type-6	
Excavation										
C 2.1.1	Gravel Trench Excavation as Manual and Stacking at Site	m^3	1,581.00	0.12	0.12					
C 2.1.2	Earth Trench Excavation as Manual	m^3	1,384.00	0.12	0.12					
C 2.2.1	Gravel Trench Excavation as Machinery and Stacking at Site	m^3	192.00			0.12	0.12	0.12	0.12	
C 2.2.2	Earth Trench Excavation as Machinery	m^3	192.00			0.24	0.24	0.60	0.60	
Sub-total		LKR		355.80	355.80	69.12	69.12	138.24	138.24	
Filling										
C. 2.3.1	Barrow Clay Soil and Strcking at Site	m^3	2,709.00	0.04	0.04	0.08	0.08	0.20	0.20	
C. 2.3.2	Purchasing and Providing Sand at Site	m^3	6,500.00	0.08		0.16		0.40		
C. 2.3.3	Barrow Gravel and Stacking at Site	m^3	900.00		0.08		0.16		0.40	
C 2.3.4	Providing Grevel to Prepaire Top surface	m^3	900.00	0.12	0.12	0.12	0.12	0.12	0.12	
C 2.4.1	Filling and Compaction of Clay sand 1:2 Mixing	m^3	967.00	0.12		0.24		0.60		
C 2.4.2	Filling and Compaction of Top Gravel Layer	m^3	967.00	0.12	0.12	0.12	0.12	0.12	0.12	
C 2.5.1	Filling and Compaction of Clay Gravel 1:2 Mixing	m^3	967.00		0.12		0.24		0.60	
Sub-total		LKR		968.44	520.44	1,712.84	816.84	3,946.04	1,706.04	
Total (LKR per m)		LKR		1,324.24	876.24	1,781.96	885.96	4,084.28	1,844.28	

Source: Study Team

Attachment 3.4-1: Drawing of 5 Tanks by Drone Survey

(1) Kudagama tank in Kiulekada cascade



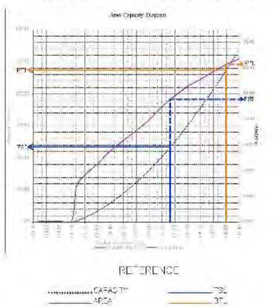
TABULATION SHEET

Contour level (m)	Area (Acre)	Mean Area (Acre)	Volume (Ac.ft)	Capacity (Ac.ft)	Remarks
102.60	0.00	0.00	0.00	0.00	
102.90	0.00	0.00	0.00	0.00	Existing LSSL
103.30	2.25	1.13	1.50	1.50	Existing SSL
103.50	7.35	4.80	3.20	4.70	
103.80	13.33	10.34	10.34	15.04	
104.10	19.61	16.47	16.47	31.51	
104.40	24.87	22.24	22.24	53.75	
104.70	30.13	27.50	27.50	81.25	
105.00	36.19	33.16	33.16	114.41	
105.30	44.53	40.36	40.36	154.78	Existing FSL
105.60	51.11	47.82	47.82	202.60	
105.90	56.13	53.62	53.62	256.22	
106.00	59.04	57.59	19.20	275.42	Existing BTL
106.20	62.68	60.86	40.57	315.99	

Source: Study Team

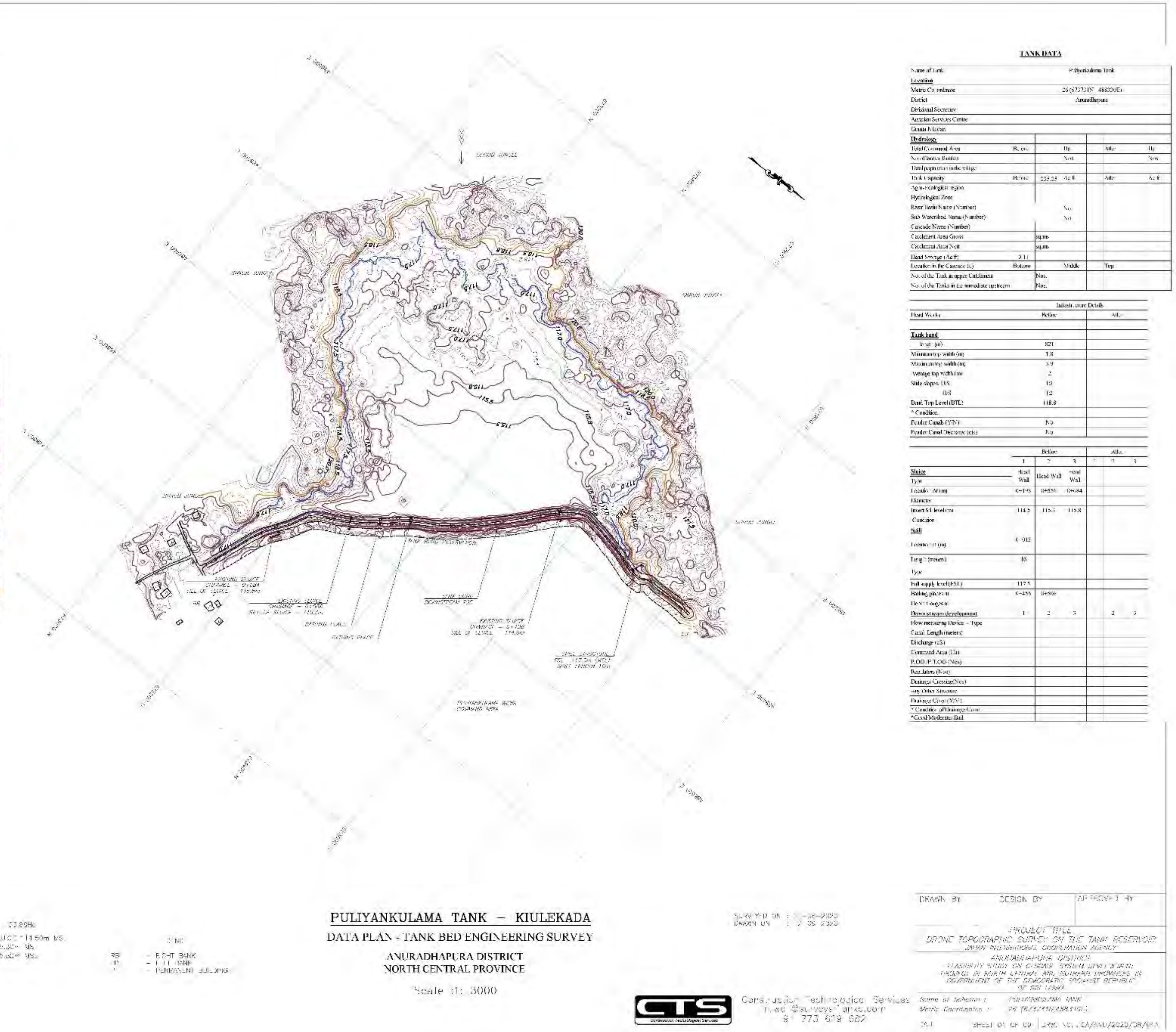
(2) Puliyankulama tank in Kiulekada cascade

AREA CAPACITY DIAGRAM (EXISTING)



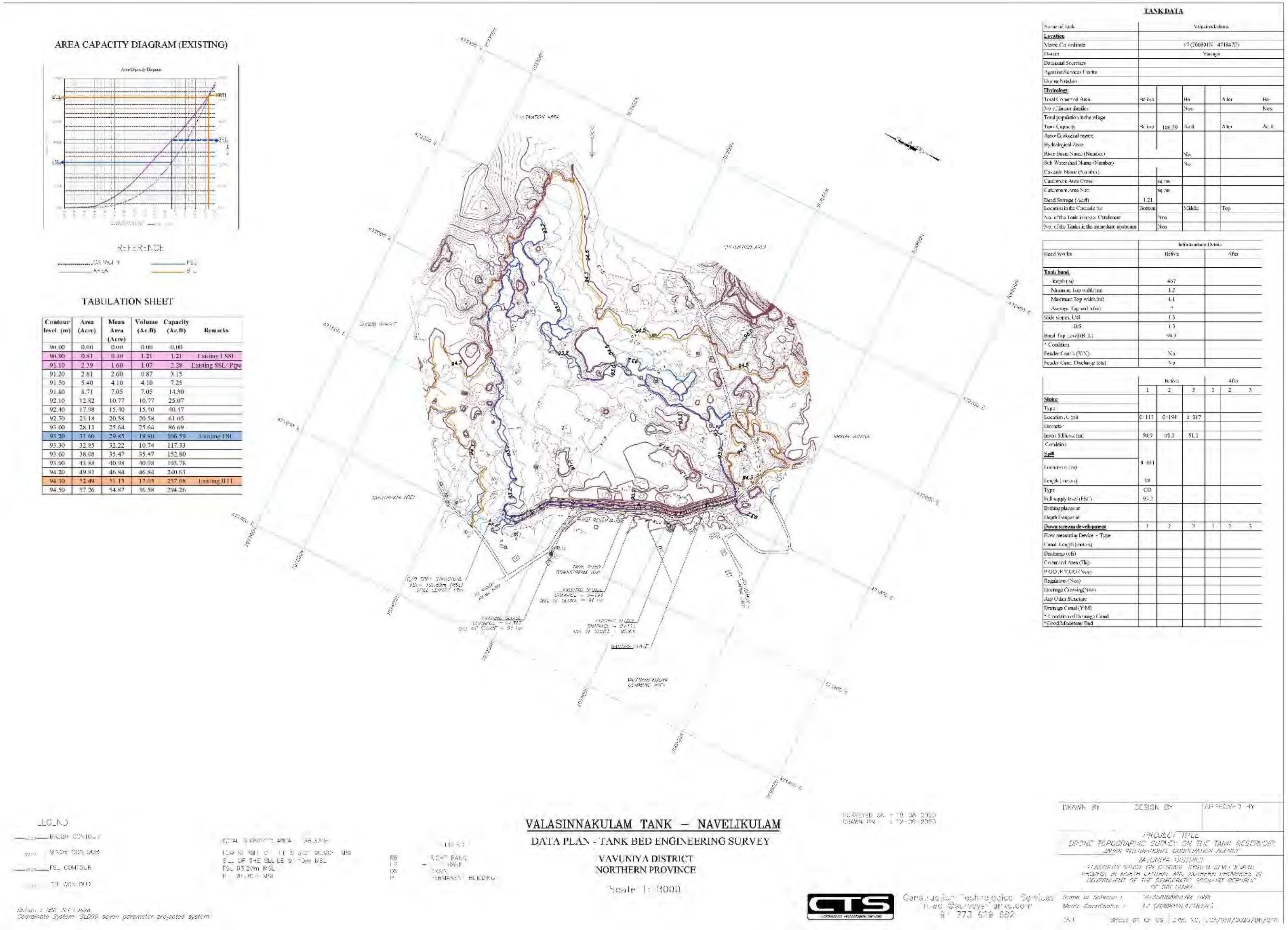
TABULATION SHEET

Contour level (m)	Area (Acre)	Mean Area (Acre)	Volume (Ac.ft)	Capacity (Ac.ft)	Remarks
114.30	0.00	0.00	0.00	0.00	
114.50	0.34	0.17	0.11	0.11	Existing LSSL
114.60	0.36	0.35	0.12	0.23	
114.90	0.44	0.40	0.40	0.63	
115.20	0.90	0.67	0.67	1.30	
115.30	13.68	7.29	2.43	3.73	Existing SSL
115.50	18.31	15.99	10.66	14.39	
115.80	22.85	20.58	20.58	34.97	Existing SSL
116.10	27.88	25.36	25.36	60.33	
116.40	31.84	29.86	29.86	90.19	
116.70	35.74	33.79	33.79	123.99	
117.00	39.90	37.82	37.82	161.81	
117.30	45.00	42.45	42.45	204.26	
117.50	47.97	46.48	30.99	235.25	Existing FSL
117.60	49.33	48.65	16.22	251.46	
117.90	52.97	51.15	51.15	302.61	
118.20	55.72	54.35	54.35	356.95	
118.50	58.78	57.25	57.25	414.21	
118.80	61.53	60.15	60.15	474.36	Existing BTL
119.10	63.69	62.61	62.61	536.97	



Source: Study Team

(3) Valasinnakulam tank in Naveli Kulam cascade

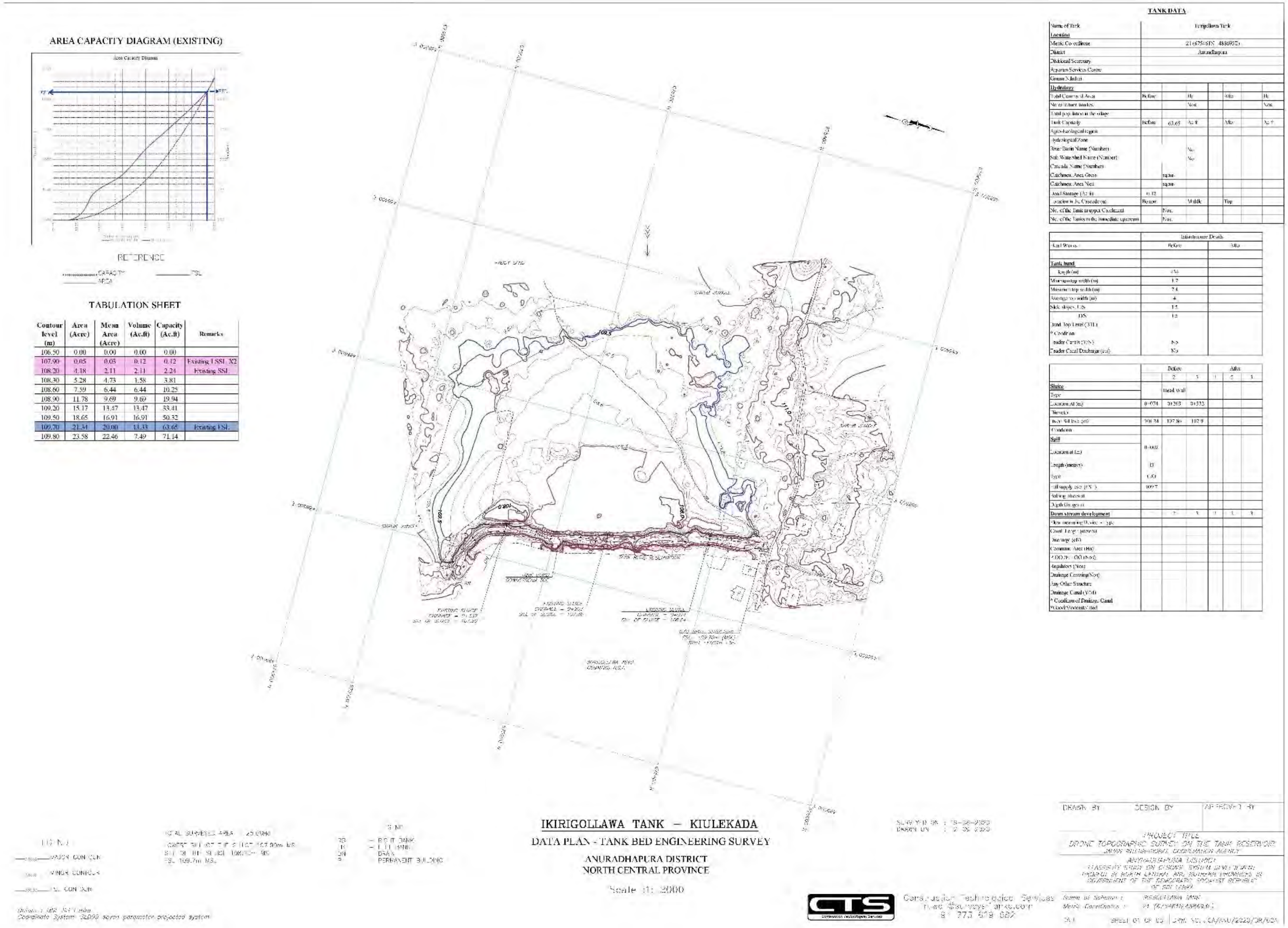


TABULATION SHEET

Contour level (m)	Area (Acre)	Mean Area (Acre)	Volume (Ac.ft)	Capacity (Ac.ft)	Remarks
90.00	0.00	0.00	0.00	0.00	
90.90	0.81	0.40	1.21	1.21	Existing LSSL
91.10	2.39	1.60	1.07	2.28	Existing SSL/ Pipe
91.20	2.81	2.60	0.87	3.15	
91.50	5.40	4.10	4.10	7.25	
91.80	8.71	7.05	7.05	14.30	
92.10	12.82	10.77	10.77	25.07	
92.40	17.98	15.40	15.40	40.47	
92.70	23.18	20.58	20.58	61.05	
93.00	28.11	25.64	25.64	86.69	
93.20	31.60	29.85	19.90	106.59	Existing FSL
93.30	32.85	32.22	10.74	117.33	
93.60	38.08	35.47	35.47	152.80	
93.90	43.88	40.98	40.98	193.78	
94.20	49.81	46.84	46.84	240.63	
94.30	52.49	51.15	17.05	257.68	Existing BTL
94.50	57.26	54.87	36.58	294.26	

Source: Study Team

(4) Ikirigollawa tank in Kiulekada cascade

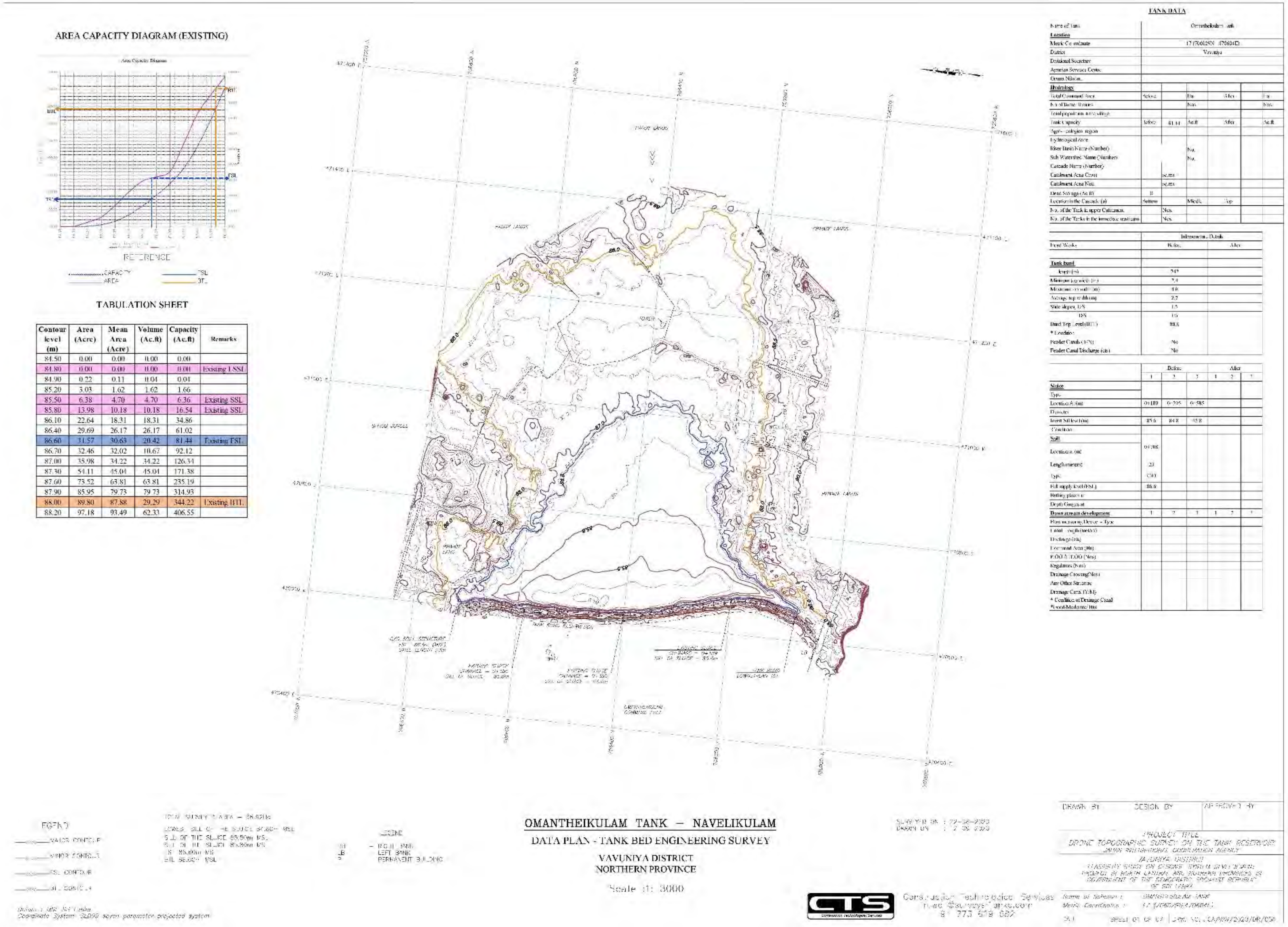


TABULATION SHEET

Contour level (m)	Area (Acre)	Mean Area (Acre)	Volume (Ac.ft)	Capacity (Ac.ft)	Remarks
106.50	0.00	0.00	0.00	0.00	
107.90	0.05	0.05	0.12	0.12	Existing LSSL X2
108.20	4.18	2.11	2.11	2.24	Existing SSL
108.30	5.28	4.73	1.58	3.81	
108.60	7.59	6.44	6.44	10.25	
108.90	11.78	9.69	9.69	19.94	
109.20	15.17	13.47	13.47	33.41	
109.50	18.65	16.91	16.91	50.32	
109.70	21.34	20.00	13.33	63.65	Existing FSL
109.80	23.58	22.46	7.49	71.14	

Source: Study Team

(5) Omantheikulam tank in Naveli Kulam cascade



TABULATION SHEET

Contour level (m)	Area (Acre)	Mean Area (Acre)	Volume (Ac.ft)	Capacity (Ac.ft)	Remarks
84.50	0.00	0.00	0.00	0.00	
84.80	0.00	0.00	0.00	0.00	Existing LSSL
84.90	0.22	0.11	0.04	0.04	
85.20	3.03	1.62	1.62	1.66	
85.50	6.38	4.70	4.70	6.36	Existing SSL
85.80	13.98	10.18	10.18	16.54	Existing SSL
86.10	22.64	18.31	18.31	34.86	
86.40	29.69	26.17	26.17	61.02	
86.60	31.57	30.63	20.42	81.44	Existing FSL
86.70	32.46	32.02	10.67	92.12	
87.00	35.98	34.22	34.22	126.34	
87.30	54.11	45.04	45.04	171.38	
87.60	73.52	63.81	63.81	235.19	
87.90	85.95	79.73	79.73	314.93	
88.00	89.80	87.88	29.29	344.22	Existing BTL
88.20	97.18	93.49	62.33	406.55	

Source: Study Team

Attachment 3.5-1: Summary of Cascade Tank Flood Discharge

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
1-5	Siwalakulama Wewa	1.83	11	2.76	53.6	41.1
1-11		0.93		0.93	26.5	20.0
2-1	Puliyankulama Maha Wewa	1.39	3 4 5	2.33	52.9	41.6
2-2	Bora Wewa	0.27		0.27	11.7	8.8
2-3		0.45		0.45	15.7	11.7
2-4	Weli Wewa	0.17		0.17	8.6	6.7
2-5	Pulikitiyawa Wewa	0.33		0.33	11.8	8.9
3-1	Pyirimaduwa Wewa	1.68	4 6	3.23	54.4	42.0
3-3	Amanakkattuwa Wewa	0.26		0.26	8.9	6.6
3-4		0.20		0.20	7.5	5.6
3-5	Tonigala Wewa	0.04		0.04	1.8	1.3
3-6	Sandanankuttiyagma Wewa	1.35		1.35	31.9	23.1
4-1	Galwaduwagama Pahala Wewa	0.32	2	1.13		
4-2	Galwaduwagama Ihala Wewa	0.81		0.81		
5-1		2.64		2.64	40.4	29.0
5-2	Maha Himbutugolla Wewa	2.04	3 7 8 12	16.86	149.5	126.1
5-3		0.38		0.38	12.2	9.0
5-4		0.38	11	0.98	19.6	16.1
5-5	Ambagahawewa	3.48	1 2 6	23.56	168.9	144.8
5-6	Elapat Wewa	0.58		0.58	22.3	16.9
5-7		1.12		1.12	25.6	19.0
5-8		4.88	4 10 15 17 22	12.80	138.0	111.3
5-10		2.54		2.54	38.9	27.5
5-11		0.60		0.60	16.4	12.1
5-12		0.52		0.52	18.4	13.9
5-15		0.86		0.86	23.8	17.6
5-17		1.96		1.96	34.3	25.1
5-22		1.58		1.58	34.4	25.5
6-1	Periys Kulama	1.84	2	5.23	69.3	60.9
6-2		1.21	6 3 4	3.39	67.7	52.5
6-3		0.39		0.39	12.1	9.4
6-4		0.46		0.46	13.8	10.4
6-6	Ihala Galapita Wewa	1.33		1.33	39.2	29.0
7-1	Kon Wewa	1.86	2	2.92	48.0	38.4
7-2	Mawatha Wewa	0.92	3	1.06	30.5	22.0
7-3		0.14		0.14	7.4	5.5
8-1		0.19		0.19	4.8	3.6
8-2	Pahala Halmillewa Wewa	2.53	3	3.86	59.6	46.7
8-3		1.34		1.34	30.4	22.5
9-1		0.34		0.34	13.0	9.8
9-2		6.16	1	6.50	80.9	63.3
10-1	Kuda Rambe Wewa	0.30		0.30	9.1	6.7

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
11-2	Thirappana Wewa	3.51	3 6	11.80	130.1	111.2
11-3		2.07	5 9	4.42	71.8	59.8
11-4		1.39		1.39	32.5	24.0
11-5		1.01	8	1.30	27.2	20.1
11-6		1.91	4 7	3.87	64.6	50.6
11-7		0.57		0.57	16.4	12.1
11-8		0.29		0.29	8.7	6.4
11-9		1.04		1.04	31.6	23.3
12-1		0.43		0.43	8.4	6.2
12-2		0.83		0.83	20.5	15.0
12-3		3.07	2 4 5 10	11.28	100.1	85.8
12-4	Pahala Kayinattama Wewa	3.04	6 7 9	6.70	85.0	67.0
12-5		0.08		0.08	4.7	3.6
12-6		1.10		1.10	27.7	20.7
12-7	Thenkutiyawa Wewa	0.96		0.96	22.3	18.0
12-8		0.19		0.19	8.5	6.5
12-9		1.42	8	1.60	44.2	33.9
12-10		0.60		0.60	11.0	8.4
13-1		1.40	3 4	6.61	71.5	61.5
13-2		0.88		0.88	21.6	16.0
13-3		0.57		0.57	19.6	14.5
13-4		1.40	5 6 7 9	4.65	69.6	55.4
13-5		0.30		0.30	13.7	10.5
13-6		0.28		0.28	11.1	8.4
13-7		0.16		0.16	5.3	4.0
13-8		0.90		0.90	29.1	21.8
13-9		1.98	10	2.50	46.4	34.3
13-10		0.53		0.53	16.4	12.1
14-1		0.12		0.12	5.7	4.3
14-2		1.22		1.22	31.1	23.9
14-3		0.94	4	1.96	37.9	31.6
14-4		1.02		1.02	27.2	20.1
15-1		0.57		0.57	17.1	12.7
15-2		0.52	3	1.58	31.3	27.0
15-3		1.06		1.06	29.4	21.8
15-4		0.45	2	2.03	32.8	27.5
16-1		0.89		0.89	25.7	19.0
16-2		1.49	4 5	1.94	39.4	31.1
16-3		0.86		0.86	35.5	27.3
16-4		0.28		0.28	9.7	7.2
16-5		0.17		0.17	8.9	6.6
17-1		0.39		0.39	12.0	9.1
17-2		0.25		0.25	5.1	4.1
17-3		0.38		0.38	12.1	8.9

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
17-4		1.01		1.01	22.1	16.4
17-5		0.75		0.75	23.5	17.4
17-6		0.41		0.41	14.3	10.7
17-7		0.29		0.29	9.8	7.5
17-8		0.35		0.35	12.4	9.6
17-9		0.55		0.55	17.9	13.4
17-10		0.42		0.42	14.4	10.9
17-11		0.92	13 14	3.11	52.3	42.4
17-12		0.98		0.98	21.6	16.6
17-13		1.23		1.23	29.8	22.0
17-14		0.25	7 10	0.97	23.5	19.0
17-16		0.39		0.39	10.0	7.4
17-17		1.46	16	1.85	34.8	25.8
17-20		6.28	17	8.13	115.4	89.2
18-2	Mekichchawa Wewa	4.70	3 4 7 21	30.33	176.2	155.2
18-3	Ranuwara Wewa	0.85	5	1.39	29.3	21.1
18-4		0.16		0.16	7.5	5.7
18-5	Galenbenda Wewa	0.40	6	0.54	14.7	10.9
18-6		0.13		0.13	6.6	4.8
18-7	Palu Wewa	3.12	8 11 12	8.67	103.0	84.8
18-8		0.19		0.19	8.4	6.4
18-9		0.31		0.31	13.7	10.5
18-10		1.30	23 25	3.61	55.7	47.1
18-11		0.69	14 22	1.13	25.7	18.3
18-12		2.17	13 17 18	4.24	82.3	63.7
18-13		0.74		0.74	25.3	18.9
18-14		0.15		0.15	5.9	4.5
18-15		0.30	19	0.51	17.8	12.9
18-16		0.19		0.19	7.0	5.3
18-17		0.61		0.61	22.1	16.5
18-18		0.71		0.71	18.9	14.0
18-19		0.21		0.21	9.2	7.0
18-20		2.84	24 27 29	7.44	88.8	75.4
18-21		3.67	10 15 16 20	15.41	130.0	108.4
18-22		0.29		0.29	10.6	7.9
18-23		1.13	26	1.26	29.0	21.0
18-24		1.12	30 31 32	3.67	57.2	46.4
18-25		1.04		1.04	23.0	16.8
18-26		0.13		0.13	6.0	4.3
18-27		0.63		0.63	23.0	17.2
18-29		0.31		0.31	11.5	8.7
18-30		0.52		0.52	13.2	9.8
18-31		1.09		1.09	28.0	20.7
18-32		0.56	33	0.93	23.7	17.6
18-33		0.37		0.37	13.2	9.9

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
19-1	Ambagahawala Wewa	1.10	2	1.46	25.8	19.3
19-2		0.36		0.36	10.2	7.6
19-3	Meda Wewa	2.72	4 5 6 7	8.39	115.2	92.9
19-4	Tammennewa Wewa	2.08		2.08	38.0	30.0
19-5		0.57		0.57	14.7	10.9
19-6		0.47		0.47	16.9	12.8
19-7		2.55		2.55	50.2	38.1
20-1		1.09	2	1.51	36.6	27.2
20-2		0.42		0.42	17.0	12.6
21-1		0.37		0.37	11.5	8.5
21-2	Vihara Wewa	0.32	5	0.51	16.4	12.8
21-3		0.53		0.53	14.0	10.3
21-4	Elle Wewa	6.51	6 8 10 11 12 13	22.46	227.0	192.6
21-5		0.20		0.20	9.3	7.1
21-6		0.53		0.53	16.9	12.5
21-7		0.32		0.32	11.3	8.4
21-8		0.83	9	1.19	26.9	20.1
21-9		0.36		0.36	12.6	9.3
21-10		1.52	14	1.91	35.9	27.2
21-11		3.39	15	8.13	101.3	80.7
21-12		2.19	16	2.84	54.2	39.7
21-13		1.03	7	1.36	32.7	24.8
21-14		0.39		0.39	13.1	9.8
21-15		3.04	17	4.74	73.0	60.8
21-16		0.65		0.65	15.5	11.9
21-17		1.70		1.70	37.9	29.1
22-1		0.87		0.87	24.9	18.4
22-2	Rampathwila Wewa	5.03	3 15 4 5 1	31.87	273.7	248.1
22-3		0.32	7	0.46	10.7	8.5
22-4		4.30	9 10 12 17 19 16 6	19.22	223.9	187.9
22-5	Lulnewa Wewa	2.08	13 14 22	4.79	76.0	60.2
22-6		0.21	11	0.35	12.7	9.5
22-7		0.14		0.14	6.8	5.3
22-8		0.66		0.66	21.4	16.0
22-9		0.35		0.35	13.8	10.5
22-10		0.43		0.43	13.7	10.4
22-11		0.14		0.14	7.6	5.7
22-12		1.90		1.90	39.9	31.7
22-13		0.51		0.51	16.9	16.9
22-14		0.43		0.43	12.8	9.5
22-15		0.84	8	1.50	29.9	23.0
22-16	Maha Messalawa Wewa	1.82	18 25	3.21	50.4	40.3
22-17		3.00	21 23	5.09	83.0	62.0
22-18		0.19		0.19	3.4	2.5
22-19		1.64	20 29	3.60	66.1	53.8

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
22-20		0.15		0.15	7.6	5.9
22-21		0.88	26 27	1.75	31.2	24.0
22-22	Paluketu Wewa	1.76		1.76	34.3	26.6
22-23		0.34		0.34	11.0	8.3
22-24		0.84		0.84	17.4	12.6
22-25		1.20		1.20	32.6	24.1
22-26		0.26		0.26	7.1	5.3
22-27		0.38	30	0.62	17.1	12.4
22-29	Kahatagasdigiliya Wewa	1.81		1.81	45.7	33.8
22-30		0.24		0.24	3.6	2.6
23-1	Kukulewa Wewa	1.03	2 3	1.99	43.2	36.6
23-2		0.34	4 5	0.53	20.0	15.9
23-3		0.43		0.43	13.5	10.2
23-4		0.14		0.14	8.6	6.4
23-5		0.06		0.06	3.2	2.5
24-2		2.05	3 4 7 8	5.03	78.0	65.5
24-3	Dunwattegama Wewa	0.78	6	0.97	24.8	19.0
24-4	Walas Wewa	0.38	5	0.71	17.3	13.8
24-5		0.33		0.33	13.0	9.8
24-6	Gallellagama Wewa	0.19		0.19	7.8	6.1
24-7		0.30		0.30	11.8	9.1
24-8		0.99		0.99	25.7	19.0
25-1	Bandara Ikirigollewa Wewa	1.37	3 4	2.36	47.5	39.0
25-2	Kudagama Wewa	1.09		1.09	28.8	21.3
25-3	Yakadadutu Wewa	0.43		0.43	13.5	10.2
25-4	Walas Wewa	0.56		0.56	20.0	15.0
26-1	Aluth Wewa	0.28		0.28	10.1	7.7
26-2	Wandurugas Wewa	0.58	5	1.31	26.9	21.9
26-3	Timbiri Wewa	0.28		0.28	10.1	7.5
26-4	Walahenguna Wewa	2.30	8	2.80	51.7	38.8
26-5	Siyambalagas Wewa	0.60	6	0.73	22.1	16.5
26-6		0.13		0.13	7.4	5.8
26-7		0.14		0.14	6.0	4.6
26-8		0.36	7	0.49	17.4	12.8
27-1	Kudanika Wewa	1.23	2	3.43	22.5	19.2
27-2	Nika Wewa	0.96	3	2.19	19.2	15.9
27-3	Weli Wewa	1.23		1.23	16.0	12.2
		1.44	2	2.07	39.1	31.0
28-2	Hammilla Wewa	0.63		0.63	22.6	16.9
29-1		0.72	3	1.63	14.9	12.9
29-2	Kuda Wewa	1.98	1	3.60	27.0	21.4
29-3		0.91		0.91	11.0	8.6
30-1		0.28	2 4	4.57	25.9	22.3
30-2		1.78	3	2.01	19.0	14.3

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
30-3		0.23		0.23	4.3	3.3
30-4	Ikirigollewa Wewa	2.27		2.27	18.7	13.7
31-1		0.32	2	1.09	9.2	7.7
31-2		0.77		0.77	8.9	6.9
32-1		0.17		0.17	4.9	3.7
32-2	Timbiri Wewa	2.02	5	15.04	92.4	92.4
32-3		0.15		0.15	8.0	6.1
32-4		1.21		1.21	30.1	22.2
32-5	Bandara Rathmale Wewa	3.53	7 8 9 10 11	13.02	109.4	88.9
32-6	Miwamalewa Wewa	1.73	12	2.43	47.9	34.2
32-7	Andara wewa	0.29		0.29	12.1	9.1
32-8		0.47		0.47	14.4	10.6
32-9		1.73	14 15 16 17	7.62	89.8	73.9
32-10		0.91		0.91	21.0	15.4
32-11		0.20		0.20	4.1	3.0
32-12		0.70		0.70	17.5	13.0
32-14		0.63		0.63	20.5	15.1
32-15		0.30		0.30	11.1	8.4
32-16		2.74	18 19 21	4.77	77.5	60.5
32-17		0.20		0.20	9.2	7.0
32-18		1.02	23	1.36	21.4	16.4
32-19		0.25		0.25	10.6	8.0
32-21		0.42		0.42	17.6	13.4
32-23		0.34		0.34	11.1	8.2
33-1	Gonewe Ihala Wewa	1.56	2 3	2.19	40.2	32.6
33-2		0.37		0.37	14.1	10.7
33-3		0.26		0.26	10.0	7.6
34-1	Gonewa Wewa	0.54		0.54	17.1	12.6
34-2		0.84	3 4	2.10	47.1	41.0
34-3		0.51		0.51	20.5	15.7
34-4		0.41	5	0.75	22.0	17.7
34-5		0.34		0.34	11.7	8.8
35-2		0.33		0.33	13.6	10.2
35-3	Penikewa Wewa	1.44		1.44	29.7	22.0
35-4	Kapirigama Wewa	3.58	5 6 7	18.66	167.7	136.0
35-5	Messalewa Wewa	1.66	8 10	4.00	59.0	50.9
35-6		2.30	9 12 14 18	10.94	126.8	107.5
35-7		0.14		0.14	7.2	5.7
35-8		0.38		0.38	13.7	10.4
35-9		0.63	13	0.81	22.3	17.3
35-10		1.64	15	1.96	44.7	33.9
35-11		0.36		0.36	11.6	8.6
35-12		2.06	17 19 22	3.98	70.8	56.0
35-13		0.18		0.18	10.5	8.4
35-14		1.13	11 16	2.83	44.6	35.9

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
35-15		0.32		0.32	12.9	9.8
35-16		0.92	21	1.34	32.7	24.0
35-17		0.34		0.34	11.4	8.5
35-18		1.02		1.02	26.3	19.4
35-19		0.68	20	1.03	25.3	20.0
35-20		0.35		0.35	14.7	11.2
35-21		0.41		0.41	14.4	10.8
35-22		0.55		0.55	18.8	14.1
36-1		0.42		0.42	13.7	10.1
36-2	Siyambalagas Wewa	3.26	3 4 5 6 8 10	10.37	138.2	115.1
36-3		0.42		0.42	14.6	10.8
36-4		0.95		0.95	23.3	17.3
36-5		0.39		0.39	14.5	10.7
36-6	Ehetuwagama Wewa	0.64		0.64	22.0	16.2
36-7	Kuda Wewa	0.47		0.47	17.1	12.7
36-8		3.24	9	3.72	66.0	48.3
36-9		0.48		0.48	14.3	10.6
36-10		0.99		0.99	29.0	21.4
37-1	Kuda Wewa	2.69	2 3 6	6.84	109.8	87.9
37-2		0.64	4 5	1.79	38.1	31.3
37-3		0.99		0.99	32.5	24.0
37-4		0.45		0.45	16.6	12.4
37-5		0.69		0.69	19.5	14.4
37-6		1.36		1.36	31.9	24.1
38-2	Walketu Wewa	1.74	3 4	2.88	50.3	40.8
38-3	Pahala Katukeliyawa Wewa	0.48		0.48	17.3	13.1
38-4	Ihala Katukeliyawa Wewa	0.65		0.65	18.4	13.6
39-1	Duminnegama Wewa	0.96	2	1.74	36.6	28.3
39-2	Badugama Wewa	0.77		0.77	20.2	14.9
40-1	Linda Wewa	1.19	3	1.64	37.8	28.1
40-2		0.19		0.19	9.2	7.1
40-3		0.26	2	0.45	15.5	12.6
40-4		0.36		0.36	11.1	8.3
41-1	Phihimibiyagollewa Tank	8.69	4 5 6 7 8 9 2	24.86	279.7	249.1
41-2		0.04		0.04	1.9	1.5
41-3	Galwiragllewa Wewa	2.77	10	4.46	60.4	46.2
41-4		0.12		0.12	5.3	4.1
41-5		2.56	14 18 20	3.74	73.0	57.9
41-6		0.68		0.68	20.9	15.8
41-7		3.07	15 16 11 21	8.53	125.8	106.2
41-8		2.40	17	2.69	52.2	41.0
41-9		0.38		0.38	15.2	11.5
41-10		1.11	24	1.68	32.7	26.3
41-11		1.56	22 23	2.63	53.0	41.5
41-12		1.10	13 19	3.35	41.4	34.0

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
41-13		1.81		1.81	24.4	17.8
41-14		0.51		0.51	14.8	10.9
41-15		0.76		0.76	24.7	18.5
41-16		1.54		1.54	39.9	29.5
41-17		0.29		0.29	11.8	9.2
41-18		0.52		0.52	17.5	13.1
41-19		0.44		0.44	13.3	9.9
41-20		0.14		0.14	7.3	5.6
41-21		0.53		0.53	14.8	10.9
41-22		0.68		0.68	20.4	15.1
41-23		0.39		0.39	14.4	10.9
41-24		0.57		0.57	17.4	12.9
42-1	Kirimetiyawa Wewa	2.37	2	5.83	67.1	58.0
42-2	Kolibendewa Wewa	0.94	5 6	3.46	53.3	44.1
42-4		0.56		0.56	17.7	13.2
42-5	Taranagollewa Wewa	1.54		1.54	32.2	24.9
42-6		0.42	4	0.97	24.1	19.3
43-1	Heegaha Wewa	0.33		0.33	11.6	8.8
43-2	Heegaha Wewa	0.14		0.14	6.3	4.8
43-3	Relapanawa Wewa	2.51	4 5 6 7 8	5.11	95.4	78.9
43-4		0.06		0.06	2.9	2.1
43-5		0.25		0.25	10.7	7.9
43-6	Kuda Galkandegama Wewa	0.94		0.94	29.3	21.7
43-7	Kulankatu Wewa	1.02		1.02	33.7	24.9
43-8		0.34		0.34	11.0	8.2
44-1	Kuda Wewa	1.05		1.05	13.7	10.2
44-2	Karanban Kulama	1.03	1	2.08	19.2	15.6
45-1		0.34		0.34	4.9	3.5
45-2		0.56	1	0.89	9.4	7.4
46-1		1.14		1.14	21.7	16.1
46-2		7.68	3 4 6 9	12.34	166.9	129.8
46-3		0.84		0.84	24.4	18.0
46-4		2.00		2.00	35.4	26.6
46-5		2.93		2.93	56.8	45.6
46-6		1.03		1.03	28.1	20.8
46-7		2.80	8	3.39	52.8	40.1
46-8		0.59		0.59	17.9	13.2
46-9		0.79		0.79	19.5	14.4
47-1		0.10		0.10	5.4	4.4
47-2	Kirigallewa Wewa	7.29	3 4 5 6 7	34.07	155.6	155.6
47-3	Karuwalagas Wewa	0.26		0.26	10.8	8.2
47-4	Kuda Wewa	0.77		0.77	21.7	16.0
47-5		3.16		3.16	42.3	31.7
47-6	Galellagama Wewa	4.57	8 9 10 13	20.60	151.4	123.2
47-7	Unagas Wewa	1.99		1.99	39.8	31.3

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
47-8		0.82		0.82	24.9	18.4
47-9		1.66	14	3.89	50.9	43.6
47-10		1.02		1.02	21.4	16.0
47-11		1.31		1.31	23.6	18.0
47-12		0.15		0.15	5.0	3.7
47-13		4.21	11 12 15	10.31	117.7	94.1
47-14		2.23		2.23	40.0	30.6
47-15		3.22	16 17	4.64	83.9	65.8
47-16		1.15		1.15	27.5	20.4
47-17		0.26		0.26	12.9	9.9
48-2		0.43		0.43	6.0	4.3
48-3		0.27	5	0.73	6.7	5.3
48-4	Kudagam Wewa	0.82		0.82	9.1	6.5
48-5	Wewakanda Wewa	0.47		0.47	5.9	4.4
48-6	Mayilagas Wewa	1.11		1.11	10.9	8.0
48-7	Angunachchiya Wewa	5.65	8 9 12 13	23.07	90.1	74.4
48-8		3.12	10 11 14	8.95	50.4	40.6
48-9		1.40		1.40	14.9	11.1
48-10		0.52		0.52	6.6	5.0
48-11		2.19	15	3.19	20.7	17.9
48-12		5.41		5.41	30.8	22.7
48-13		1.67		1.67	13.5	9.9
48-14		2.12		2.12	22.3	16.5
48-15		1.01		1.01	10.6	7.7
49-1		0.89		0.89	6.7	4.9
49-2	Helabagas Wewa	1.75	3	2.45	18.5	15.6
49-3		0.20	4	0.70	7.2	6.7
49-4		0.50		0.50	6.5	5.1
50-1		1.21	10	2.76	17.1	13.8
50-2	Medawachchiya Wewa	4.70	5 7 6 8 11	33.49	119.9	107.9
50-3		0.73		0.73	7.9	5.7
50-4		2.97		2.97	22.7	16.6
50-5		1.58		1.58	12.3	8.8
50-6	Ulpatgama Wewa	0.77		0.77	7.2	5.3
50-7		0.85		0.85	7.9	5.7
50-8		3.12	9 13 14 15 16	22.73	96.5	85.5
50-9		0.95	17	3.75	19.5	15.9
50-10		1.56		1.56	12.8	9.7
50-11		0.85	21 22	2.86	18.3	14.9
50-12		1.77		1.77	12.6	9.6
50-13		0.11	14	0.41	2.9	2.9
50-14		0.30		0.30	3.2	2.3
50-15		5.05	18 20 24 26 27 28	13.09	75.0	63.2
50-16		1.26	25	2.06	20.5	16.2

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
50-17		2.23	23	2.80	21.2	16.4
50-18		0.94		0.94	8.3	6.2
50-19		0.51	21 22	2.53	16.4	13.8
50-20		0.62		0.62	6.1	4.4
50-21		0.23		0.23	3.9	2.8
50-22		1.79		1.79	15.8	11.3
50-23		0.37	30	0.57	7.8	5.9
50-24		1.17		1.17	11.1	7.9
50-25		0.80		0.80	13.2	9.7
50-26		3.50	31 32	4.40	40.1	30.7
50-27		0.70		0.70	8.7	6.5
50-28		0.20		0.20	3.2	2.4
50-30		0.20		0.20	4.7	3.5
50-31		0.50		0.50	7.7	5.8
50-32		0.40		0.40	6.1	4.8
51-1		5.33	2 3 4 7	37.87	85.6	85.6
51-2		1.96	5 6 8	7.23	26.9	22.2
51-3		0.85		0.85	9.6	7.4
51-4		1.94		1.94	18.9	14.0
51-5	Hinguru Wewa	0.39	10	0.95	9.5	7.6
51-6		1.16		1.16	10.6	8.3
51-7		3.31	9 11	22.53	65.6	65.6
51-8		3.15		3.15	28.0	20.7
51-9		3.95	12 13 14 16	18.65	71.0	61.6
51-10		0.56		0.56	7.5	5.6
51-11		0.57		0.57	7.3	5.4
51-12		0.32	15	0.46	6.1	4.4
51-13		1.11		1.11	11.0	11.0
51-14		1.04		1.04	11.1	8.1
51-15		0.15		0.15	2.5	1.8
51-16		6.58	17 18 19 21	12.08	65.6	52.0
51-17		2.30		2.30	17.6	13.1
51-18		0.33		0.33	5.9	4.2
51-19		0.56		0.56	6.8	5.2
51-20		0.86		0.86	9.5	7.1
51-21		1.46	20	2.32	17.9	14.0
52-1		5.33	3 5 7 10 11 13	30.10	107.4	107.4
52-2		0.73	6	1.14	11.4	9.0
52-3		0.62	8	1.00	11.0	8.7
52-4		0.52		0.52	5.9	4.6
52-5	Rock Wewa	0.54		0.54	5.8	4.5
52-6		0.41		0.41	5.3	3.9
52-7		2.51	9 19	11.31	47.1	45.7

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
52-8		0.38		0.38	5.7	4.2
52-9		1.26	14 18	4.21	21.5	17.9
52-10		3.22	15 16	9.34	47.0	37.1
52-11		1.38		1.38	14.3	11.1
52-12		0.40		0.40	5.6	4.2
52-13		1.21		1.21	11.6	8.6
52-14		0.34		0.34	4.8	3.8
52-15		1.16		1.16	9.3	7.1
52-16		3.75	20	4.96	36.1	28.0
52-17		0.76		0.76	9.2	6.8
52-18		2.62		2.62	19.0	14.5
52-19		3.83	17	4.58	31.0	24.2
52-20		1.21		1.21	13.5	9.7
53-1		1.50		1.50	16.3	12.7
53-2	Timbiri Wewa	1.35	1	2.85	23.7	18.9
54-1		3.98		3.98	25.5	19.6
55-1		1.09	4	3.90	20.6	17.6
55-2		0.48	3	0.85	8.2	6.7
55-3		0.37		0.37	5.2	3.8
55-4		1.81	5	2.81	19.6	15.8
55-5		0.99		0.99	10.6	7.7
56-1		0.20		0.20	2.6	1.9
56-2	Nachchi Kulam	3.77	4 5	12.12	63.6	63.6
56-4		1.27		1.27	12.2	8.7
56-5	Kalnaddina Kulam	4.41	6 7 8 10	7.08	64.4	52.8
56-6		0.61		0.61	9.0	6.9
56-7		0.19		0.19	3.2	2.4
56-8		0.36	9	1.42	10.2	9.1
56-9		1.07		1.07	10.6	7.6
56-10		0.45		0.45	5.9	4.4
56-11		1.93	12 13	6.76	39.2	33.2
56-12		2.05	14 16	3.91	28.1	22.9
56-13		0.92		0.92	9.8	7.2
56-14		0.48		0.48	7.5	5.7
56-16		1.38		1.38	13.5	10.3
56-17		1.54		1.54	15.2	11.9
57-1		4.69	2 3	40.79	104.0	94.9
57-2		1.49	7	9.59	32.4	29.2
57-3		8.22	6 8	26.51	86.7	74.9
57-4		0.78		0.78	7.9	5.8
57-5	Kuda Wewa	0.66		0.66	7.8	6.0
57-6		10.73		10.73	56.6	44.2
57-7		3.57	11	8.10	37.0	30.4
57-8		2.52	12 13	7.56	35.9	30.1

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
57-11		4.53		4.53	30.3	23.3
57-12		2.39		2.39	16.8	12.8
57-13		2.65		2.65	19.2	13.9
58-1		0.93		0.93	9.2	6.6
58-2	Koyil Kulam	0.56		0.56	6.2	4.3
58-3	Vedar Kulam	0.13	4	0.53	5.7	4.5
58-4	Itti Kulam	0.40		0.40	5.3	3.9
58-5	Iratperiya Kulam	7.59	1 2 3 6 7 8	32.72	95.7	95.7
58-6	Koyilputhu Kulam	0.16		0.16	3.0	2.3
58-7	Samalan Kulam	4.28	9 13 14 17 15 22	21.23	71.2	62.7
58-8		1.27	12	1.73	15.7	12.2
58-9		0.34		0.34	4.4	3.4
58-11		1.29		1.29	12.7	9.1
58-12		0.46		0.46	6.6	4.8
58-13		0.14		0.14	2.5	1.9
58-14		0.31		0.31	4.3	3.0
58-15		5.38	18 20 21	13.41	67.7	54.9
58-17		1.89		1.89	18.0	13.3
58-18		1.15		1.15	13.0	9.7
58-20		3.07		3.07	26.3	19.5
58-21		3.81		3.81	28.1	21.5
58-22		0.86		0.86	10.9	7.8
59-1		0.42		0.42	5.4	4.2
59-2		0.25		0.25	3.6	2.6
59-3	Kurundan Kulam	1.07	4	3.46	19.3	16.5
59-4		2.40		2.40	18.8	14.4
60-2		0.23		0.23	3.2	2.4
60-3		1.71	2 4 6 8	4.82	29.8	25.5
60-4	Iyankan Kulam	0.56	5	0.89	8.3	6.7
60-5	Tavasi Kulam	0.33		0.33	4.7	3.5
60-6		0.78		0.78	7.8	6.0
60-8		1.22		1.22	11.3	8.8
61-2		0.20		0.20	3.4	2.6
61-3	Koolkachina Kulam	0.19		0.19	2.8	2.1
61-4		0.21		0.21	3.2	2.4
61-5		0.12		0.12	2.5	1.9
61-6	Nagarillupai Kulam	0.68		0.68	8.1	6.3
61-7		0.36		0.36	5.7	4.5
61-8		0.19		0.19	3.4	2.7
61-9		2.64	2 4 5 8 6 7 10	10.78	50.7	41.4
61-10		6.38		6.38	42.0	30.9
62-2	Putur Kulam	1.37	6 1.62	2.99	20.1	16.7
62-6	Suduventapulavu Kulam	1.62		1.62	15.9	12.2

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
63-1	Thala Galkulama Wewa	2.57	2 3 6	5.55	84.7	69.2
63-2		0.55		0.55	16.5	12.2
63-3		1.24		1.24	26.3	20.2
63-6		1.18		1.18	43.0	32.6
64-1		2.47	5 2	6.11	75.2	63.5
64-2		0.13		0.13	7.4	5.9
64-3		0.41		0.41	11.9	8.8
64-4		0.12		0.12	5.1	3.9
64-5		1.66	3 4 6 7 9	3.50	66.3	52.1
64-6		0.81		0.81	25.2	18.9
64-7		0.12		0.12	4.8	3.7
64-9		0.39		0.39	11.1	8.2
65-1		0.54	4	0.81	19.1	15.2
65-2		0.71	1 3	1.92	38.5	31.6
65-3		0.40		0.40	13.3	10.1
65-4	Meegaha Wewa	0.27		0.27	10.2	7.7
66-1		3.26		3.26	51.5	40.8
66-2		0.53		0.53	17.7	13.1
66-3		1.42	4	3.00	47.1	38.0
66-4		0.38	7 6	1.57	32.6	26.5
66-6		0.91		0.91	22.2	17.0
66-7		0.28		0.28	9.7	7.4
67-4		0.40	5	1.62	30.0	25.0
67-5		1.22		1.22	26.5	20.8
67-6		1.38		1.38	31.6	24.2
68-1		2.41	2 3	7.95	90.9	74.4
68-2		2.19	7 6 5	3.89	63.6	51.5
68-3		0.85	8	1.64	30.4	23.7
68-4		0.68		0.68	17.8	13.2
68-5		0.43	4	1.11	24.6	19.4
68-6		0.36		0.36	11.0	8.1
68-7		0.25		0.25	9.6	7.3
68-8		0.79		0.79	20.1	14.9
69-1		1.97	2 3	3.53	63.0	49.8
69-2		0.29		0.29	10.2	7.6
69-3		1.27		1.27	37.8	27.9
70-1		0.28	2	3.94	52.5	45.5
70-2		1.89	3 4	3.65	67.0	54.3
70-3		0.63		0.63	21.9	16.4
70-4		1.13		1.13	30.9	22.9
71-1		0.62	2	1.38	27.5	22.6
71-2		0.76		0.76	19.1	14.1
74-1		3.66	3 2	5.16	73.2	57.2

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
74-2		0.22		0.22	9.0	6.9
74-3	Kohombagaskada Wewa	1.28		1.28	30.9	22.9
75-1	Italwetunu Wewa	3.41	3 4	12.75	93.4	93.4
75-3	Talattewa Wewa	2.00	6 10	5.35	61.8	48.0
75-4	Pattilapu Wewa	1.24	7	3.99	44.3	38.6
75-6	Tonigala Wewa	0.58		0.58	17.9	13.2
75-7		0.83	12	2.75	44.5	37.4
75-8		0.83	11	1.20	30.4	23.0
75-10		0.85	13	2.77	38.9	32.0
75-11		0.36		0.36	16.6	12.7
75-12		1.92		1.92	46.4	34.3
75-13		1.92		1.92	40.2	30.4
76-1	Welene Wewa	0.62		0.62	17.4	12.9
76-2	Maha Hammillewa Wewa	3.54	4 10 15	25.33	95.7	95.7
76-3	Diyamayilogas Wewa	3.01	5 6 12	4.61	70.5	61.7
76-4	Pahala Wewa	0.41		0.41	15.7	11.9
76-5		0.16		0.16	8.2	6.4
76-6	Kudahettiyawa Wewa	0.76		0.76	17.1	12.6
76-7	Ihala Hammillewa Wewa	2.20	18 24	5.45	62.3	53.2
76-8		0.23		0.23	7.7	5.9
76-10		1.81	14 17 22	13.31	112.5	90.5
76-11		0.28		0.28	10.4	7.9
76-12		0.45	8	0.68	18.4	13.0
76-13		0.56	16	2.08	32.3	28.0
76-14		1.52	13 19 21 23	10.37	111.5	95.5
76-15		2.33	7 11	8.07	73.3	73.3
76-16		0.79	26	1.52	31.6	25.6
76-17		0.85		0.85	19.3	14.3
76-18		0.28	20	0.46	13.7	10.1
76-19		1.84	31	4.88	59.5	49.0
76-20		0.18		0.18	5.8	4.4
76-21		0.51		0.51	13.3	9.9
76-22		0.28		0.28	10.1	7.6
76-23		1.38		1.38	31.2	22.6
76-24		2.20	27 29	2.79	53.4	40.0
76-26		0.73		0.73	21.4	15.8
76-27		0.23		0.23	9.8	7.4
76-28		0.43		0.43	13.8	10.3
76-29		0.36		0.36	11.6	8.5
76-30		0.75		0.75	18.4	13.6
76-31		1.62	28 32	3.04	51.1	40.8
76-32		0.99		0.99	26.4	19.5
77-1		4.40	4 7	26.47	185.5	164.9

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
77-2	Moragahadigiliya Wewa	0.60		0.60	17.8	13.5
77-3		0.37		0.37	13.4	10.1
77-4	Mekichchawa Wewa	3.50	6 8 10 11	19.12	169.9	146.0
77-5		0.44		0.44	13.1	9.8
77-6		1.24		1.24	28.1	21.9
77-7	Pahala Kudapattiya Wewa	1.60	9 12	2.95	57.1	44.3
77-8		0.58		0.58	15.0	11.1
77-9		0.48		0.48	17.1	13.1
77-10		0.08		0.08	3.8	3.0
77-11		13.19	13	13.73	183.3	145.2
77-12		0.87		0.87	22.3	16.5
77-13		0.54		0.54	18.9	14.3
78-1	Aliyawetunu Wewa	0.46	5	0.54	16.5	12.4
78-2		1.51		1.51	26.0	18.8
78-3		4.01	7	18.28	102.8	102.8
78-5		0.08		0.08	4.8	3.4
78-6		4.94	8 9 12 13 14	12.24	150.0	119.1
78-7	Kalpe Wewa	6.87	16 20 22 21 19 10	14.27	130.3	102.9
78-8		0.55		0.55	17.4	12.9
78-9		0.72		0.72	18.8	13.9
78-10		0.15		0.15	5.8	4.4
78-12		2.24		2.24	48.0	36.6
78-13		1.37	15 17	3.49	61.0	50.8
78-14		0.30		0.30	12.8	9.8
78-15		0.33		0.33	13.4	10.3
78-16		1.17		1.17	27.0	20.4
78-17		1.18	18	1.79	35.5	27.6
78-18		0.61		0.61	18.4	13.8
78-19		1.83	23 24	3.98	49.6	40.2
78-20		0.85		0.85	23.6	17.4
78-21		0.74		0.74	20.6	15.3
78-22		0.52		0.52	13.9	10.3
78-23		1.95	25	1.95	50.6	37.4
78-24		0.21		0.21	9.7	7.1
79-1	Patanaya Wewa	1.62	2 3	3.93	64.6	52.1
79-2		0.36		0.36	13.4	10.2
79-3	Wila Wewa	0.99	4	1.95	42.9	33.3
79-4		0.96		0.96	25.6	19.0
80-2	Nika wewa	0.44		0.44	14.4	10.8
80-3	Kuda wewa	0.24		0.24	8.4	6.4
80-4		1.65	20	3.52	49.6	40.5
80-5		7.99	6 7 15 18 10 4 3	43.52	325.3	282.5
80-6	Dambagaha wewa	0.79		0.79	21.2	15.7

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
80-7		0.23		0.23	9.7	7.6
80-8		0.13	14	0.78	18.3	15.1
80-9		0.20		0.20	8.5	6.7
80-10	Palu kewlakada wewa	5.76	9 19 23 24 32	29.26	308.8	272.7
80-11		0.05		0.05	3.1	2.4
80-12	Etawira wewa	2.00	27	6.66	63.7	54.5
80-13		0.03		0.03	2.7	2.7
80-14		0.65		0.65	20.6	15.2
80-15		1.21		1.21	30.3	22.4
80-16		0.72		0.72	17.5	13.0
80-18		0.28		0.28	11.6	8.9
80-19		4.57	16 28 18 21 37	7.92	139.3	116.8
80-20		0.85	22	1.86	39.4	31.0
80-21	Kuda Wewa	0.37		0.37	11.7	8.6
80-22		1.01		1.01	25.5	18.9
80-23	Siyambala wewa	0.16	26	0.36	12.4	10.3
80-24		7.43	34 36 31 39 43 38 44	13.90	180.6	144.6
80-26	Indi wewa	0.20		0.20	8.7	6.6
80-27		4.66		4.66	66.8	48.8
80-28		1.05	47	1.84	33.9	27.1
80-29		1.01	33	3.83	57.9	49.0
80-30	SIKKANDA WEWA	0.41		0.41	12.9	9.6
80-31		0.26		0.26	5.3	3.9
80-32		0.72	30	1.13	27.0	21.1
80-33		2.82		2.82	55.6	42.6
80-34		0.44		0.44	15.0	11.1
80-35		0.44		0.44	14.8	11.1
80-36	Paragaha Ulpotha Wewa	2.44	41	2.95	39.3	29.7
80-37		0.13		0.13	6.0	4.7
80-38		0.78		0.78	16.9	12.8
80-39		0.24		0.24	7.9	5.9
80-41		0.51		0.51	15.6	11.5
80-43		0.81		0.81	22.2	16.4
80-44		0.99		0.99	23.9	18.3
80-45		0.42		0.42	15.6	12.0
80-47	Kudagama Wewa	0.37	45	0.79	21.7	17.2
82-5	Ralapanawa Wewa	5.36	7 9 11 12 13 14 16	19.47	187.1	153.4
82-7		0.09		0.09	5.6	4.2
82-9		1.43		1.43	32.9	24.6
82-11		1.25		1.25	28.9	21.1
82-12		0.36		0.36	14.5	11.0
82-13		0.30		0.30	9.4	7.0
82-14		1.04	17	2.48	38.8	29.7

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
82-15		0.69		0.69	16.8	12.9
82-16		3.29	15 19 21 22 23	8.20	110.0	86.9
82-17		0.81	20	1.43	29.2	23.7
82-19		0.60		0.60	18.4	13.6
82-20		0.62		0.62	21.1	15.6
82-21		0.07		0.07	4.9	3.5
82-22		1.50		1.50	37.7	27.9
82-23		2.05		2.05	38.5	28.0
83-1		0.30		0.30	12.0	9.0
83-2		0.24		0.24	5.8	4.3
83-3		0.31		0.31	12.3	9.2
83-4	Patle Wewa	1.50	7	2.31	47.3	33.3
83-6		0.47		0.47	16.1	12.0
83-7		0.80		0.80	17.9	13.1
83-8		0.90		0.90	23.4	17.3
83-9		0.66		0.66	20.2	14.9
83-10		0.59		0.59	18.7	13.9
83-11		0.11		0.11	6.5	4.8
83-14		2.93		2.93	51.5	36.4
83-15		0.13		0.13	6.2	4.8
83-16		0.22		0.22	8.9	6.7
83-17		0.08		0.08	4.3	3.3
83-21		2.02		2.02	50.6	37.4
83-22		7.56	21	9.58	137.4	98.1
84-1		7.53	3 4 2	17.46	181.6	148.6
84-2		0.39		0.39	14.0	10.6
84-3		2.33		2.33	44.2	34.2
84-4		7.21		7.21	111.7	85.5
85-5		7.20	9	22.76	144.9	140.4
85-6		0.32		0.32	6.5	5.2
85-9		6.07	15 14 13 10 11	15.56	138.0	109.8
85-10		0.13		0.13	5.8	4.4
85-11		0.59		0.59	15.0	11.1
85-13		4.07		4.07	63.7	47.1
85-14		0.28		0.28	8.2	6.1
85-15		4.42		4.42	62.2	46.1
86-1		0.55		0.55	18.4	14.0
86-2		4.16	1 3	5.37	82.2	60.4
86-3		0.66		0.66	14.3	10.6
87-1		0.06		0.06	2.2	1.7
87-3		1.25		1.25	29.6	21.9
87-3		1.25		1.25	29.6	21.9
87-6	Kirigollewa Wewa	1.36		1.36	24.8	17.9

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces
in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
87-7	Petiyannekada Wewa	3.52	8 12 18 19 13 9 24	19.11	175.9	151.9
87-8		1.82		1.82	31.1	22.3
87-9		0.15		0.15	4.4	3.2
87-10		0.94		0.94	26.4	19.5
87-11		1.83	17 20 26	3.66	64.1	53.4
87-12		0.82	21	5.16	67.4	59.2
87-13		0.96		0.96	23.8	17.6
87-14		0.35		0.35	12.3	9.0
87-15		0.73	14	1.08	28.6	21.7
87-16		1.93	7 11 15	25.78	204.5	184.4
87-17		0.80		0.80	22.9	17.0
87-18		0.35		0.35	6.5	4.8
87-19		0.43		0.43	11.1	8.2
87-20		0.44		0.44	14.9	11.1
87-21		1.46	22 25 27 29 31	4.34	73.7	60.5
87-22		0.24		0.24	8.9	6.7
87-23		0.65		0.65	14.4	10.3
87-24		2.13	23 28	6.72	87.7	74.1
87-25		0.27		0.27	10.6	8.1
87-26		0.59		0.59	15.2	11.3
87-27		0.48		0.48	13.9	10.3
87-28		1.83	30 32	3.94	68.4	58.3
87-29		0.28		0.28	10.5	8.0
87-30		1.21	33	1.58	36.8	27.3
87-31		1.60		1.60	33.1	24.5
87-32		0.53		0.53	23.8	18.0
87-33		0.37		0.37	9.9	7.3
88-1		0.15		0.15	6.9	5.3
88-2		3.76	3 4 5 6	5.59	98.1	77.8
88-3		0.54		0.54	17.8	13.3
88-4		0.58		0.58	16.8	12.5
88-5		0.34		0.34	12.7	9.6
88-6		0.38		0.38	14.6	11.1
89-1	Ulpatgame Wewa	0.46	2	3.37	45.4	40.5
89-2	Rasnaka Wewa	2.54	4	2.91	57.5	42.2
89-4		0.38		0.38	14.4	10.9
89-7		3.54		3.54	53.6	41.9
90-1		2.47		2.47	42.5	33.7
91-1		28.58	2	29.38	238.3	183.2
91-2		0.80		0.80	20.2	14.9
92-1		3.36	2	20.28	130.3	130.3
92-2		3.16	4 6 7	16.92	118.9	118.9
92-3		0.07		0.07	6.1	4.6

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
92-4		0.39		0.39	11.7	8.7
92-5		0.80	3	0.87	23.1	15.9
92-6		2.50	8	13.00	123.1	113.4
92-7		0.37		0.37	11.6	8.6
92-8		4.45	10 11	10.51	132.2	110.2
92-10		4.20		4.20	84.7	66.5
92-11		1.86		1.86	42.7	31.2
93-2		3.59	3 6	8.14	93.7	81.1
93-3		0.64	4 5	2.20	39.5	34.6
93-4		0.52	8	0.60	14.5	10.6
93-5		0.80	7	0.96	25.3	19.2
93-6		2.35		2.35	42.1	32.6
93-7		0.16		0.16	6.8	5.2
93-8		0.08		0.08	3.5	2.7
94-1		2.39	2 3	7.33	69.7	59.1
94-2		0.80		0.80	22.4	16.5
94-3	Gallewa Wewa	0.55	4	4.14	46.1	38.0
94-4	Dambagahaulpota Wewa	0.82	7	3.59	49.8	42.7
94-7		2.77		2.77	53.9	41.7
95-1		0.51	2 3	1.34	32.0	27.0
95-2		0.60		0.60	17.5	12.9
95-3		0.22		0.22	10.0	7.7
95-4		2.61	7 8 9 10 12 6	7.93	103.5	82.5
95-5	Watte Kuda Wewa	2.10	11	2.78	50.5	40.1
95-6		0.70		0.70	17.9	13.2
95-7		0.63		0.63	13.4	10.0
95-8		0.47		0.47	13.4	9.9
95-9		0.42		0.42	9.1	6.7
95-10		1.97	13	2.27	34.9	24.9
95-11		0.67		0.67	22.3	16.5
95-12		0.83		0.83	23.0	17.0
95-13		0.29		0.29	9.1	6.7
96-1		0.80		0.80	21.6	16.0
96-2	Kiwulkada	4.16	3 5 6	11.21	98.5	81.7
96-3		0.33		0.33	13.1	10.2
96-4		0.23	1	1.03	21.5	17.3
96-5	Gonuhaddana Wewa	2.16	7 8	5.54	78.5	61.9
96-6		0.91	9	1.19	29.1	22.1
96-7	Halmilawatiya	0.72	10 12	2.53	47.8	38.7
96-8		0.85		0.85	25.9	19.4
96-9		0.28		0.28	9.5	7.1
96-10		1.25		1.25	29.4	22.5
96-12		0.56		0.56	22.7	17.2
97-1		2.31		2.31	40.8	30.6

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
97-2		0.97		0.97	19.7	14.4
97-3		0.19		0.19	8.3	6.6
97-5	Ratmalwatiya Wewa	0.27		0.27	10.3	7.8
97-6		0.28		0.28	11.8	8.9
97-7		3.07	10 13 17	9.94	115.8	104.1
97-8		4.54	6 7 12 14	21.48	204.6	204.6
97-9		3.85	16 18	11.82	100.5	80.0
97-10		1.81	19 20	4.10	71.5	58.8
97-11		0.66		0.66	16.0	11.8
97-12		2.04	11 15	3.71	57.4	45.5
97-13		0.54		0.54	14.3	10.6
97-14		3.01		3.01	55.7	41.9
97-15		1.00		1.00	21.5	16.4
97-16		1.34	21 22	7.48	79.3	65.5
97-17		2.23		2.23	38.3	29.3
97-18		0.48		0.48	13.3	9.8
97-19		1.61		1.61	40.9	30.3
97-20		0.69		0.69	22.5	16.7
97-21		1.26		1.26	22.2	17.1
97-22		4.50	23	4.88	73.0	54.7
97-23		0.39		0.39	12.2	9.0
98-2		0.36		0.36	12.5	9.3
98-3		2.08	4 6 7	4.64	72.2	57.1
98-4		0.21		0.21	9.0	6.9
98-5		0.13		0.13	6.1	4.8
98-6		0.80	8	0.99	23.7	18.4
98-7		1.37		1.37	29.0	22.2
98-8		0.19		0.19	6.7	5.0
99-1		0.84	4	0.93	26.8	19.4
99-2		1.39	3 6 8	2.80	47.6	38.1
99-3		0.14		0.14	5.5	4.2
99-4		0.09		0.09	5.1	4.0
99-5		1.74	7 9 10	4.77	67.8	54.3
99-6		1.02		1.02	23.1	17.7
99-7	Olugollewa Wewa	0.16		0.16	7.7	6.0
99-8		0.25		0.25	8.2	6.1
99-9		0.87	11	1.58	35.7	28.3
99-10		1.30		1.30	30.2	21.5
99-11		0.71		0.71	26.2	20.1
100-1	Tittagonewa	3.67	2 3 4	5.62	83.8	69.4
100-2		0.32		0.32	11.4	8.5
100-3		0.55		0.55	13.6	10.1
100-4		1.08		1.08	25.9	19.1

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
101-1	Thawalu Wewa	2.15	5 11	5.35	59.7	47.5
101-2		2.74	1 4 6 3	14.65	137.5	117.9
101-3		0.44		0.44	16.2	12.3
101-4	Elapat Wewa	1.95		1.95	27.5	22.3
101-5		0.33		0.33	11.3	8.4
101-6		1.58	8	4.18	75.5	58.4
101-7		0.59		0.59	16.3	12.1
101-8		1.14	10	2.60	39.8	33.6
101-10		1.45		1.45	33.4	25.6
101-11		2.87		2.87	53.4	41.3
102-1		2.09		2.09	38.6	29.6
103-1		0.53	2	2.52	46.5	39.3
103-2		1.98		1.98	48.7	36.0
104-1		1.84		1.84	34.8	27.0
105-1		5.06	3 4	7.77	100.1	80.1
105-2		3.23		3.23	51.0	37.8
105-3		0.86		0.86	27.8	20.5
105-4		1.86		1.86	41.1	29.7
106-1		0.52	3	0.69	17.1	13.3
106-2		4.67	7 5	12.41	101.7	78.7
106-3		0.17		0.17	6.2	4.6
106-4		1.03		1.03	23.6	16.9
106-5		0.85		0.85	21.8	16.7
106-6		2.94		2.94	47.1	34.1
106-7		2.93	4 6	6.90	75.7	58.4
107-1	Maharalapanawa	6.45	2 3 4 6	17.11	136.1	109.5
107-2		0.13		0.13	7.5	5.6
107-3		3.73	5	8.98	103.7	84.2
107-4	Kudaolugaskada Wewa	0.89		0.89	26.5	19.8
107-5		5.25		5.25	87.2	66.7
107-6		0.66		0.66	24.7	18.7
108-1	Migokada Wewa	10.40		10.40	133.9	96.2
108-2	Mahaolugaskada Wewa	10.54		10.54	125.2	88.1
109-2	Kandagaha Wewa	1.36		1.36	32.5	23.8
109-3		4.17		4.17	61.5	44.5
110-1	Nikawewa	7.71	2 1.85	9.56	109.2	81.1
110-2	Nelligollakada Wewa	1.85		1.85	43.5	32.2
111-1	Katiramarsinna Kulam	0.31		0.31	4.2	3.0
111-2	Thandik kulam	5.04	3 7	28.47	80.4	68.2
111-3		0.32		0.32	4.6	3.4
111-4	Pattiniyarmakilan Kulam	2.78	5 6 8 10 12	8.81	41.9	34.9
111-5	Tirukkovil Navat Kulam	0.86		0.86	9.0	6.7
111-6	Paddakaddu Kulam	0.89		0.89	11.2	8.3

Preparatory Survey on Cascade System Development Project in North Central and Northern Provinces in Democratic Socialist Republic of Sri Lanka

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
111-7	Vavuniya Tank	9.82	11 13 14 18 21	23.11	102.0	77.7
111-8		0.84	16 17	2.68	19.5	16.4
111-9		3.74	1 2 4	41.34	72.6	72.6
111-10		0.87		0.87	10.6	7.7
111-11		0.38		0.38	5.4	4.0
111-12		0.74		0.74	9.8	7.2
111-13		1.70		1.70	18.9	13.4
111-14		0.45		0.45	6.1	4.4
111-16		0.45		0.45	6.4	4.6
111-17		1.38		1.38	14.0	10.0
111-18		1.14		1.14	13.3	10.1
111-21		9.62		9.62	57.5	43.9
112-1	Puthu Kulam	2.62	2 4 6	6.56	42.0	35.0
112-2		0.44	3 5	1.04	11.0	9.2
112-3	Veppan Kulam	0.33		0.33	6.2	4.5
112-4	Paddakaddu Kulam	0.43		0.43	5.5	4.2
112-5		0.27		0.27	4.1	3.0
112-6	Marukkarampalai Kulam	2.47		2.47	19.8	15.5
113-1	Periya Kulam	2.51	2	5.36	26.5	20.6
113-2	Suppandaiyapuliyan Kulam	2.02	3	2.85	20.6	15.2
113-3	Arasan Kulam	0.84		0.84	8.1	6.1
114-1	Taranik Kulam	0.82		0.82	8.3	6.0
114-2	Puliyan Kulam	0.32		0.32	4.5	3.4
114-3	Puvarasan Kulam	1.11		1.11	9.7	7.2
114-6	Manipuram Kulam	0.75		0.75	10.5	7.6
114-7	Podunkanpila Kulam	2.04	6	2.79	19.2	15.0
114-8		0.66	7	3.44	17.3	17.3
115-1		0.83	2 3	2.80	17.5	14.2
115-2	Chinna Kulam	0.19		0.19	2.9	2.0
115-3	Ammivaittan Kulam	1.78		1.78	15.0	11.7
115-4	Tavasiya Kulam	2.20	5 6	5.03	28.0	22.8
115-5	Kurisudda Kulam	1.96		1.96	14.0	10.8
115-6	Ichchan Kulam	0.86		0.86	9.1	6.9
116-1	Kuda Wewa	0.29		0.29	4.0	2.9
116-2	Karapinchakulam	0.85		0.85	7.8	6.0
116-3	Karumpanichchai kulam	0.54		0.54	6.2	4.6
116-4	Peyadikulan kulam	3.05		3.05	18.3	13.8
116-5	Dickwewa	0.44		0.44	5.6	4.1
116-6	Putdubulankulama	2.21	5 11 19	13.60	54.1	48.4
116-7		0.19		0.19	3.5	2.8
116-8		1.21	10 12 13	2.62	21.5	17.7
116-9		4.12	6 7 8	20.53	72.0	72.0
116-10		0.43		0.43	5.6	4.0

Tank No	Name of Tank	Catchment Area (km²)	Upper linked tank	Total catchment area (km²)	Peak Inflow (m³/s)	Peak Outflow (m³/s)
116-11		1.12	17 21	6.12	28.2	23.4
116-12		0.29		0.29	3.7	2.7
116-13		0.69		0.69	8.0	5.8
116-14		1.05		1.05	10.0	7.4
116-15		0.76		0.76	8.3	6.2
116-16		0.87	23	2.20	12.9	10.2
116-17		0.88	16 20	4.07	22.2	17.4
116-18		0.76	24	1.60	13.4	10.8
116-19		1.43	14 15 18	4.83	31.9	26.4
116-20		1.00		1.00	10.9	8.1
116-21		0.44	22	0.93	10.5	9.0
116-22		0.49		0.49	7.8	5.9
116-23		0.28	25	1.32	8.9	7.7
116-24		0.83		0.83	10.5	7.7
116-25		1.04		1.04	9.5	7.3
117-1		1.65		1.65	15.7	11.9
117-2		3.41	5	5.04	41.9	33.5
117-4		0.77	6	2.26	14.4	12.8
117-5		1.63		1.63	27.3	18.9
117-6	Valli Kulam	1.49		1.49	13.9	10.6
117-7	Kattadi Kulam	0.29		0.29	4.0	2.9
117-9		0.73		0.73	7.0	5.0
117-10		1.58		1.58	14.6	10.8
117-11		1.66		1.66	14.3	10.8
117-13		7.65	4 10 14	30.54	100.1	100.1
117-14		8.59	7 9 11 16 17	19.05	86.2	70.8
117-15		0.46		0.46	5.9	4.2
117-16		1.41		1.41	15.8	11.6
117-17		3.07	15 18	6.38	35.4	28.0
117-18		2.84		2.84	23.0	16.9
118-2	Maravan Kulam	0.59		0.59	7.4	5.6
118-3	Kidachchuri Kulam	1.77		1.77	19.3	14.3
119-1	Mullai Kulam	1.42	2 0.47	1.89	17.9	13.9
119-2	Rampai Kulam	0.47		0.47	5.9	4.4
120-2	Karunkalik Kulam	2.03		2.03	17.4	13.4
120-3	Karunkalisinna Kulam	1.87	8	2.73	18.5	14.7
120-4	Tapasavelliya Wewa	1.49		1.49	11.7	8.8
120-5		0.26		0.26	4.1	2.9
120-6	Puliyan Kulam	2.24		2.24	21.7	16.1
120-7	Mahilan Kulam	0.66		0.66	7.5	5.7
120-8		0.86		0.86	10.1	7.3
120-9		10.25	13 15	17.60	77.3	68.9
120-11		14.10	12	23.92	103.7	81.2
120-12		9.82		9.82	49.2	38.6
120-13		5.07		5.07	32.9	25.7
120-15		2.27		2.27	19.8	14.8
121-2	Vannaththikal Kulam	1.43		1.43	14.4	10.8
121-3	Pandiyankallu Kulam	3.15	4 6 8	17.30	65.9	57.2
121-4	Kayan Kulam	0.54		0.54	7.0	5.2
121-6	Nampan Kulam	3.60	10 11	8.27	47.3	39.0
121-7	Mundumurippu Kulam	2.45	9 14	4.63	32.8	26.3
121-8		0.70	7	5.33	26.6	22.9
121-9		0.66		0.66	10.0	7.3
121-10		1.17	12 13	2.51	21.2	16.2
121-11		2.16		2.16	16.0	12.2
121-12		1.20		1.20	12.0	9.4
121-13		0.14		0.14	3.1	2.3
121-14		1.52		1.52	14.4	11.5
122-1		0.49		0.49	6.7	5.2
122-2	Vala Sinna Kulam	0.32	7	1.18	9.5	8.5
122-3		0.24		0.24	4.0	3.1
122-4	Omantai Kulam	1.17	2 5 9	3.72	27.3	22.5
122-5		0.61		0.61	7.5	5.9
122-6	Neveli Kulam	2.82	8	8.66	40.0	40.0
122-7	Panichankulam	0.33	15	0.85	8.3	6.9
122-8		1.48	10 11 12 13	5.83	35.6	29.9
122-9		0.76		0.76	8.2	6.2
122-10		1.94		1.94	16.9	12.7
122-11		0.43		0.43	5.2	3.9
122-12		1.66		1.66	13.3	10.1
122-13		0.33		0.33	5.0	3.8
122-15		0.52		0.52	6.3	4.8
123-1		1.14	2	3.26	15.2	14.3
123-2	Kanthakkaran Kulam	2.12		2.12	15.4	11.6
124-1	Puvarasan Kulam	4.83		4.83	31.6	23.9
124-2	Tavasiyur Kulam	0.82	3	1.94	13.1	10.7
124-3		1.12		1.12	10.7	7.7
125-1	Kilavi Kulam	0.79		0.79	7.5	5.4
125-2		3.24	3 4	6.03	30.5	24.7
125-3	Podun Kulam	0.40		0.40	4.6	3.3
125-4		2.39		2.39	16.4	12.2
126-1		3.61		3.61	21.8	17.6
127-1	Samalan Kulam	2.65		2.65	26.1	19.6
127-2	Atachchi Kulam	1.52		1.52	15.5	11.1
127-3		1.37		1.37	15.1	11.1
127-4	Chemamadu Kulam	8.85	5 6 7 8	27.13	104.1	88.5

Tank No	Name of Tank	Catchment Area (km^2)	Upper linked tank	Total catchment area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
127-5	Vedan Kulam	0.97		0.97	10.3	7.6
127-6	Ilamaruthan Kulam	3.31	9	4.92	35.9	27.5
127-7	Nalavankaireeran Kulam	1.37		1.37	12.1	9.1
127-8		9.11	10	11.01	54.5	42.5
127-9		1.61		1.61	15.5	11.4
127-10		1.90		1.90	15.7	11.5
128-1	Punkan Kulam	4.98	2 3 4 8	11.88	52.4	43.7
128-2	Periyapuliyan Kulam	2.49		2.49	14.9	11.5
128-3	Maraiyaditta Kulam	2.80		2.80	17.0	12.7
128-4	Singariathimaddai Kulam	0.90		0.90	7.7	5.5
128-5		0.38		0.38	5.2	3.8
128-6	Malikaikulam	4.58	10	6.38	36.8	29.1
128-7	Naruvili Kulam	0.65		0.65	7.4	5.3
128-8		0.71		0.71	8.5	6.4
128-9		1.88	7	2.54	18.6	14.2
128-10		1.80		1.80	19.6	14.4

Source: Study Team

Attachment 3.6-1: Cropped Area and Cropping Intensity in Six Model Cascades

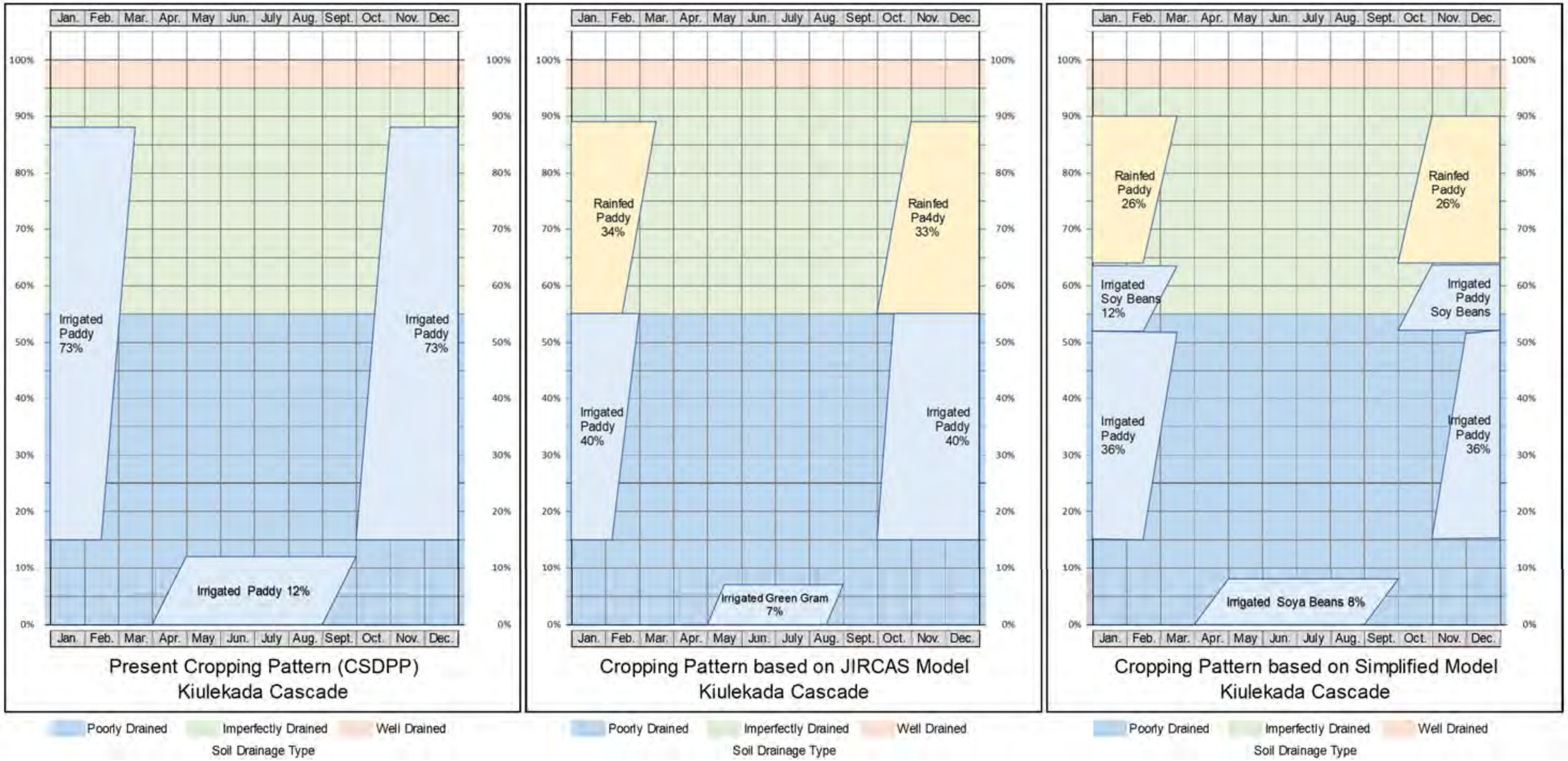
Model Cascade		Command Area	Maha Crop		Yala Crop		Total	
			Main Tank		Main Tank		Main Tank	
Kiulekada								
Present (CSPDD)								
	Irrigated paddy	313 ha	230 ha	73%	38 ha	12%	268 ha	86%
JIRCUS Model								
	Irrigated paddy	313 ha	125 ha	40%	-	-	125 ha	40%
	Rainfed paddy	313 ha	105 ha	34%	-	-	105 ha	34%
	Irrigated green gram	313 ha	-	-	22 ha	7%	22 ha	7%
	Total	313 ha	230 ha	73%	22 ha	7%	252 ha	80%
Simplified model								
	Irrigated paddy	313 ha	111 ha	36%	-	-	111 ha	36%
	Rainfed paddy	313 ha	81 ha	26%	-	-	81 ha	38%
	Irrigated soya beans	313 ha	38 ha	12%	25 ha	8%	63 ha	20%
	Total	313 ha	230 ha	85%	25 ha	8%	255 ha	81%
Alagalla								
Present (CSPDD)								
	Irrigated paddy	65 ha	65 ha	100%	53 ha	82%	118 ha	182%
JIRCUS Model								
	Irrigated paddy	65 ha	49 ha	75%	-	-	49 ha	75%
	Rainfed paddy	65 ha	16 ha	25%	-	-	16 ha	25%
	Irrigated green gram	65 ha	-	-	3 ha	4%	3 ha	4%
	Total	65 ha	65 ha	100%	3 ha	4%	68 ha	104%
Simplified model								
	Irrigated paddy	65 ha	45 ha	70%	-	-	45 ha	70%
	Rainfed paddy	65 ha	12 ha	18%	-	-	12 ha	18%
	Irrigated soya beans	65 ha	8 ha	12%	8 ha	12%	16 ha	24%
	Total	65 ha	65 ha	100%	8 ha	12%	73 ha	112%
Naveli kulam								
Present (CSPDD)								
	Irrigated paddy	247 ha	195 ha	79%	48 ha	20%	244 ha	99%
JIRCUS Model								
	Irrigated paddy	247 ha	109 ha	44%	-	-	109 ha	44%
	Rainfed paddy	247 ha	86 ha	35%	-	-	86 ha	35%
	Irrigated green gram	247 ha	-	-	30 ha	12%	30 ha	12%
	Total	247 ha	195 ha	79%	30 ha	12%	225 ha	91%
Simplified model								
	Irrigated paddy	247 ha	107 ha	43%	-	-	107 ha	43%
	Rainfed paddy	247 ha	59 ha	24%	-	-	59 ha	24%
	Irrigated soya beans	247 ha	30 ha	12%	24 ha	10%	54 ha	22%
	Total	247 ha	195 ha	79%	24 ha	10%	220 ha	89%

Model Cascade	Irrigable Area	Maha Crop		Yala Crop		Total	
		Main Tank		Main Tank		Main Tank	
Ichchankulama							
Present (CSPDD)							
Irrigated paddy	355 ha	150 ha	42%	0 ha	0%	150 ha	42%
JIRCUS Model							
Irrigated paddy	355 ha	156 ha	44%	-	-	156 ha	44%
Rainfed paddy	355 ha	0 ha	0%	-	-	0 ha	0%
Irrigated green gram	355 ha	-	-	14 ha	4%	14 ha	4%
Total	355 ha	156 ha	44%	14 ha	4%	170 ha	48%
Simplified model							
Irrigated paddy	355 ha	97 ha	27%	-	-	97 ha	27%
Rainfed paddy	355 ha	11 ha	3%	-	-	11 ha	3%
Irrigated soya beans	355 ha	43 ha	12%	24 ha	7%	67 ha	19%
Total	355 ha	150 ha	42%	24 ha	7%	174 ha	49%
Rathmalawewa							
Present (CSPDD)							
Irrigated paddy	469 ha	241 ha	51%	28 ha	6%	269 ha	57%
JIRCUS Model							
Irrigated paddy	469 ha	197 ha	42%	-	-	197 ha	42%
Rainfed paddy	469 ha	44 ha	9%	-	-	44 ha	9%
Irrigated green gram	469 ha	-	-	5 ha	1%	5 ha	1%
Total	469 ha	241 ha	51%	5 ha	1%	246 ha	52%
Simplified model							
Irrigated paddy	469 ha	155 ha	33%	-	-	155 ha	33%
Rainfed paddy	469 ha	30 ha	6%	-	-	30 ha	6%
Irrigated soya beans	469 ha	56 ha	12%	35 ha	7%	91 ha	19%
Total	469 ha	241 ha	51%	35 ha	7%	275 ha	59%
Siyambalagaswewa							
Present (CSPDD)							
Irrigated paddy	245 ha	105 ha	43%	86 ha	35%	191 ha	78%
JIRCUS Model							
Irrigated paddy	245 ha	54 ha	22%	-	-	54 ha	22%
Rainfed paddy	245 ha	51 ha	21%	-	-	51 ha	21%
Irrigated green gram	245 ha	-	-	5 ha	2%	5 ha	2%
Total	245 ha	105 ha	43%	5 ha	2%	110 ha	45%
Simplified model							
Irrigated paddy	245 ha	96 ha	39%	-	-	96 ha	39%
Rainfed paddy	245 ha	0 ha		-	-	0 ha	0%
Irrigated soya beans	245 ha	29 ha	12%	20 ha	8%	49 ha	20%
Total	245 ha	125 ha	51%	20 ha	8%	145 ha	59%

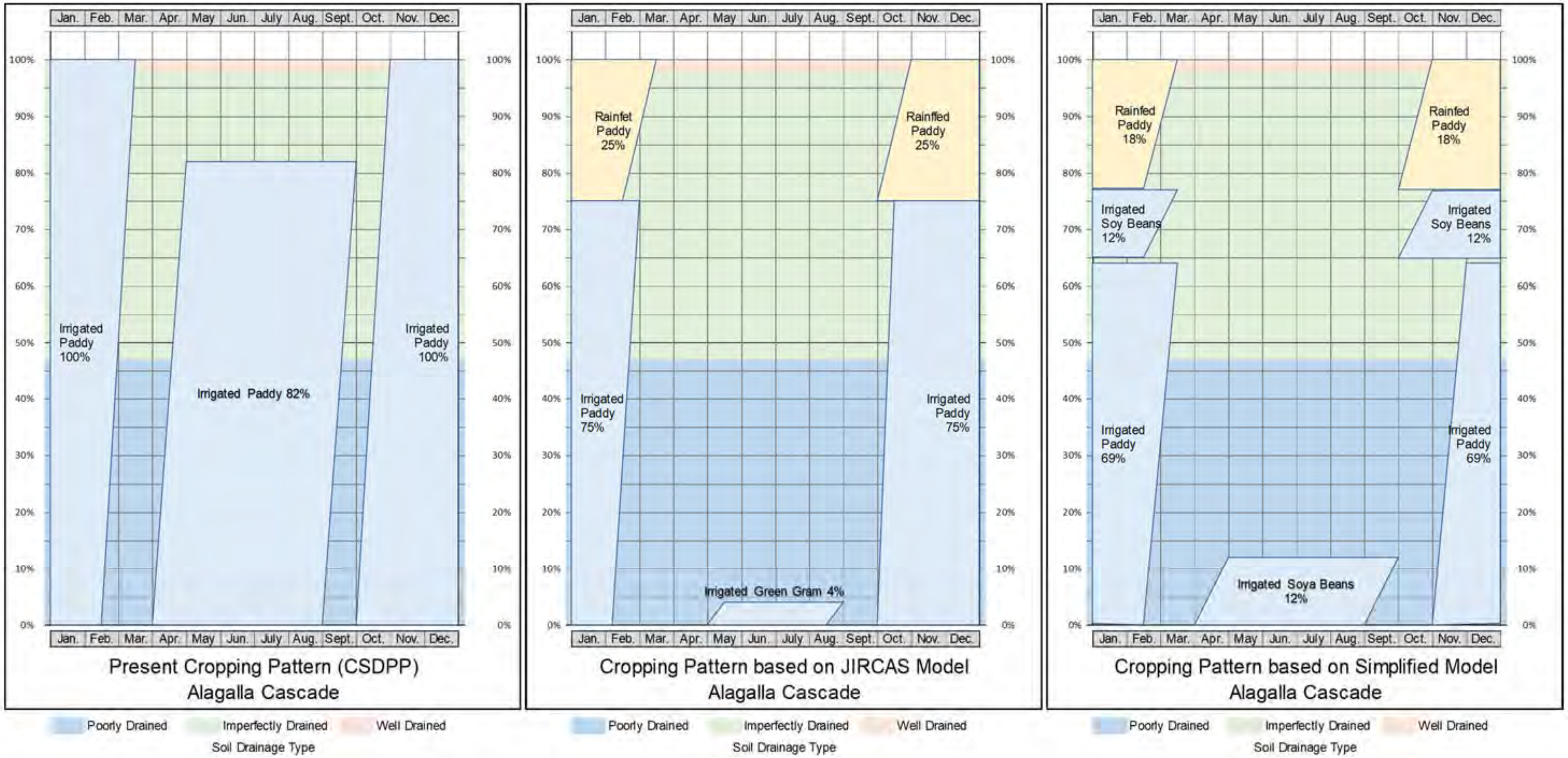
Model Cascade	Irrigable Area	Maha Crop		Yala Crop		Total	
		Main Tank		Main Tank		Main Tank	
Total of 6 Cascade							
Present (CSPDD)							
Irrigated paddy	1,694 ha	986 ha	58%	254 ha	15%	1,240 ha	73%
JIRCUS Model							
Irrigated paddy	1,694 ha	690 ha	41%	-	-	690 ha	41%
Rainfed paddy	1,694 ha	296 ha	17%	-	-	296 ha	17%
Irrigated green gram	1,694 ha	-	-	79 ha	5%	79 ha	5%
Total	1,694 ha	986 ha	58%	79 ha	5%	1,064 ha	63%
Simplified model							
Irrigated paddy	1,694 ha	610 ha	36%	-	-	610 ha	36%
Rainfed paddy	1,694 ha	172 ha	10%	-	-	172 ha	11%
Irrigated soya beans	1,694 ha	204 ha	12%	136 ha	8%	340 ha	20%
Total	1,694 ha	986 ha	58%	136 ha	8%	1,122 ha	66%

Source: Study Team

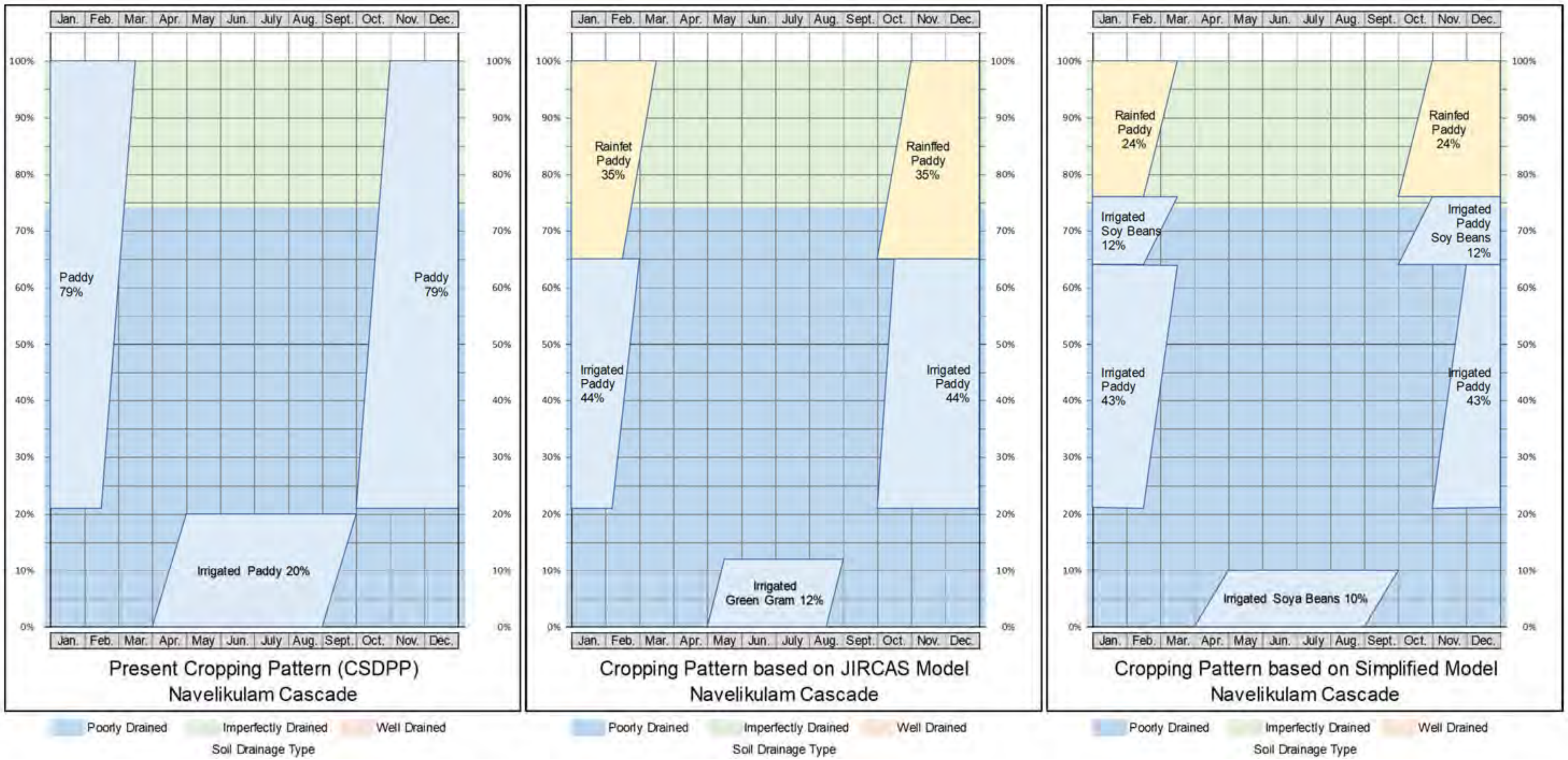
Attachment 3.6-2: Cropping Pattern under Three Models for Six Model Cascades



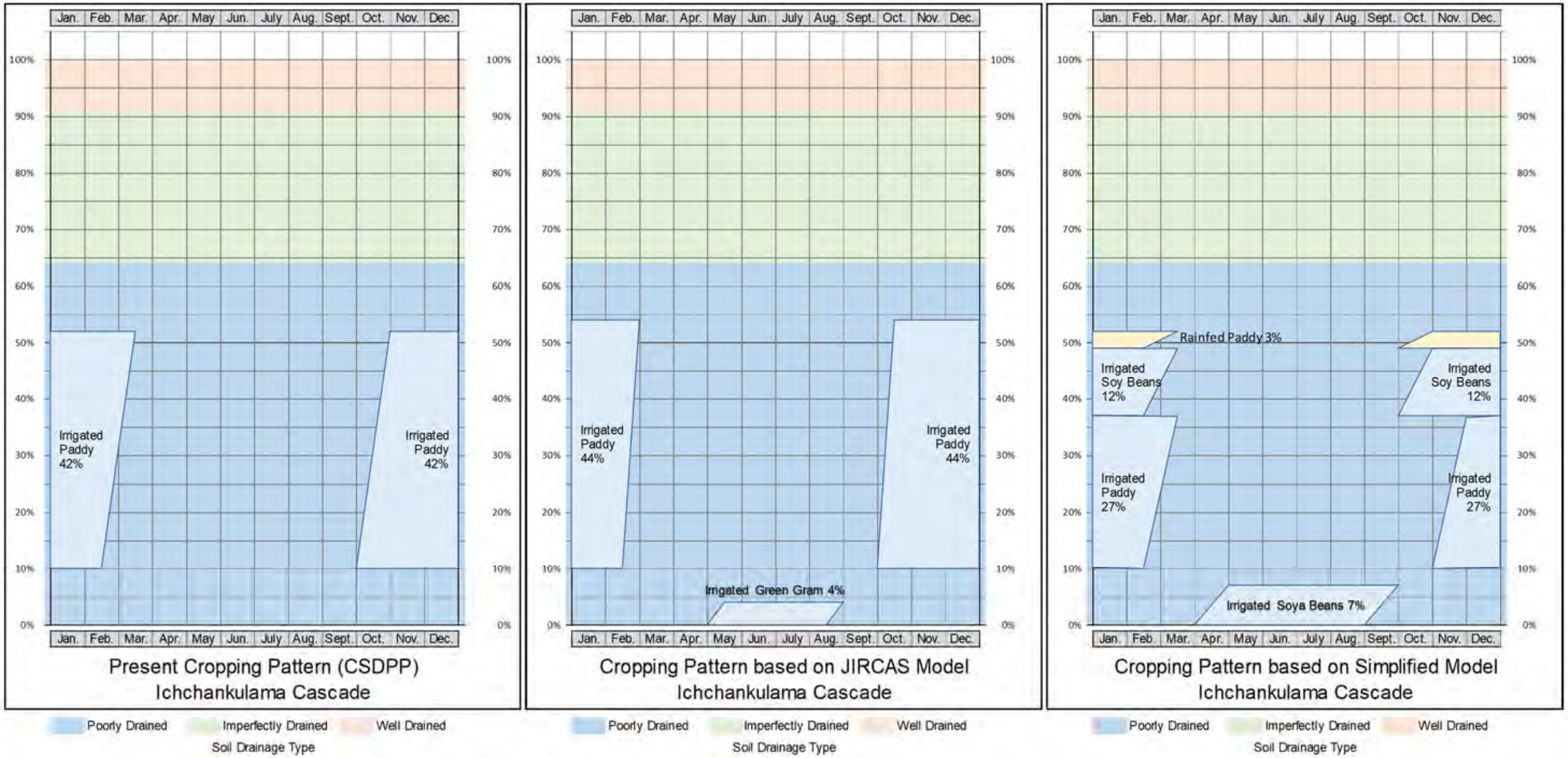
Source: Study Team



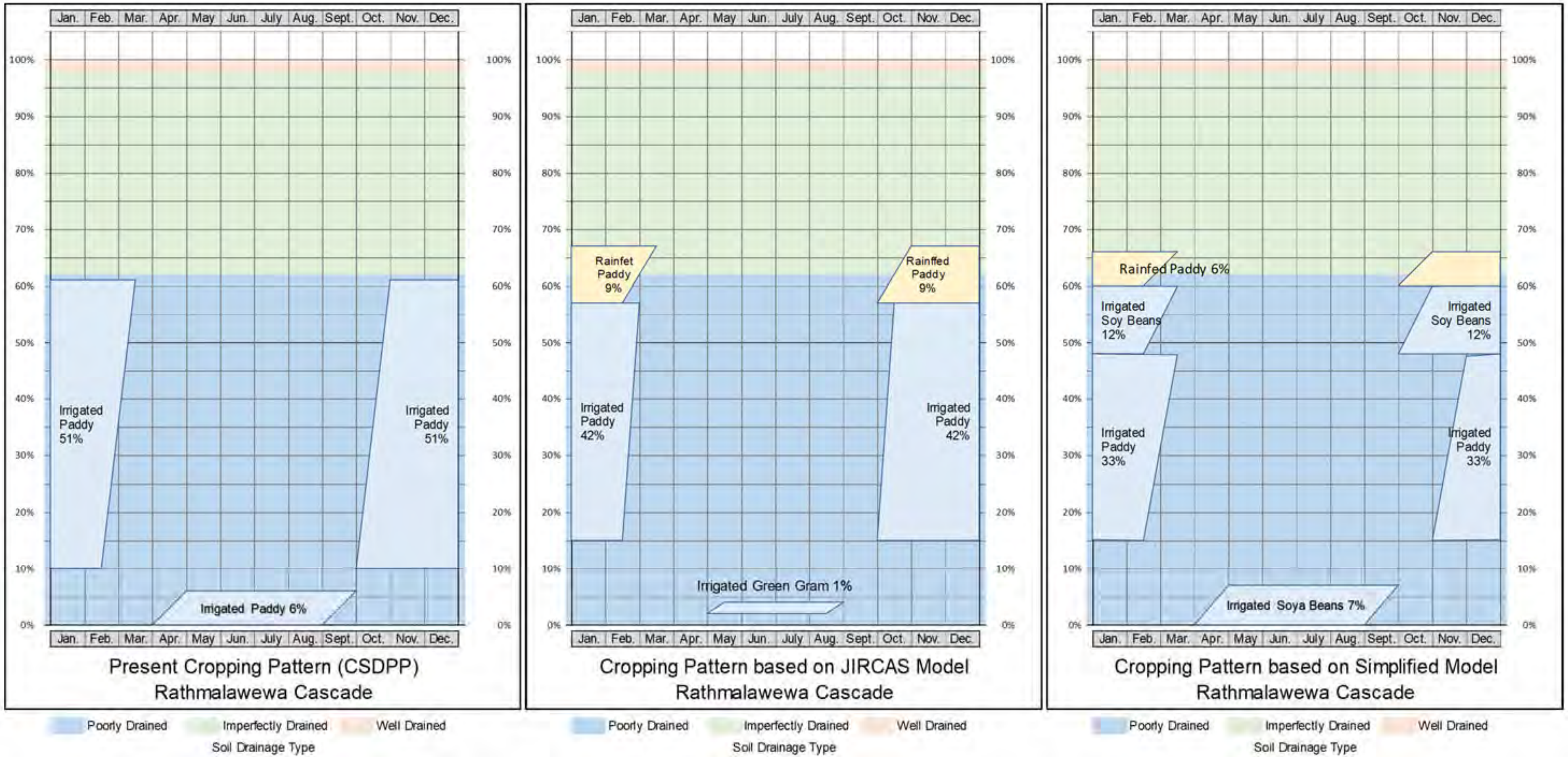
Source: Study Team



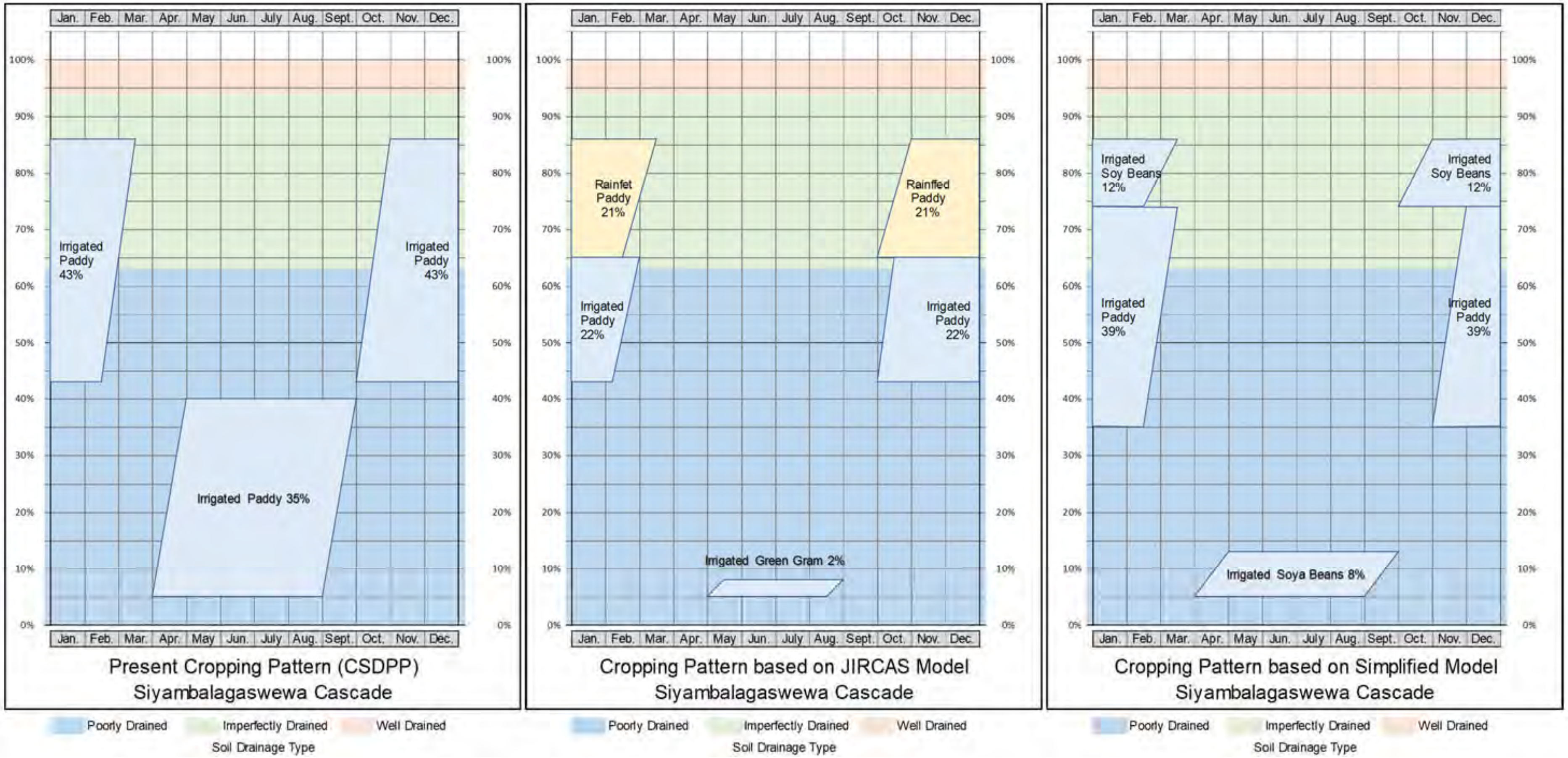
Source: Study Team



Source: Study Team



Source: Study Team



Source: Study Team

Attachment 3.6-3: Parameters of Water Balance Study on Cascade System

(1) RUNOF

$$RUNOF = rcf \cdot \left(\frac{RAIN}{1000}\right) \cdot \frac{CAREA}{API},$$

where rcf is runoff coefficient, $RAIN$ is daily precipitation (mm), $CAREA$ is catchment area (m^2), API is antecedent precipitation index.

When *n* is the number of successive non-precipitation days before precipitation starts:

$n = 0$ then $API = 1$

$$1 \leq n \leq 11, \text{then } API = 1 + {}^{1}/_{2} + {}^{1}/_{3} + \cdots + {}^{1}/_{(n+1)},$$

$$n \geq 12, \text{then } API = 1 + {}^{1}/_{2} + {}^{1}/_{3} + \cdots + {}^{1}/_{(11+1)}.$$

To calculate a delay in runoff generation that follows an extended dry spell, after “50 days or more of non-precipitation and tanks are dry,” *RUNOF* was set to 0 until cumulative precipitation reached a certain level. This cumulative precipitation was named *delay*.

(2) RAINTK

$$RAINTK = \text{TKAREA} \cdot \text{RAIN} / 1000,$$

where *TKAREA* is tank submerged area (m^2).

(3) RETFLW

$$RETFLW = \sum_{k=m}^{n} fret \cdot \left(\text{WTQ}_k + \text{SPLOSS}_k\right),$$

where *fret* is return flow coefficient related to water issue and tank seepage, k is number of upstream tanks, m is tank number of the first upstream tank, n is tank number of the last upstream tank.

$RETFLW$ is generated only in the wet cropping period when water management is extensive.

(4) SPLIN

$$SPLIN = \sum_{k=m}^{n} fretspil \cdot \text{SPLOUT}_k,$$

where $fretspill$ is return flow coefficient related to spillway discharge, k is number of upstream tanks, m is tank number of the first upstream tank, n is tank number of the last upstream tank.

(5) TLNIN

Link canal discharge: the discharge for NCPC for upper most tank was decided based on irrigation block based allocated water by per Preparatory Survey. The average for 40 years was proportionally divided based on the command area within the irrigation block. The other tank discharge will be equal to $LNOUT$.

(6) EVLOSS

$$EVLOSS = TKAREA \cdot EVAPO \cdot fevap,$$

where $fevap$ *is* coefficient for pan evaporation (0.8 was employed), $EVAPO$ is pan evaporation (3.47 mm/day was employed).

(7) WTQ

The volume of irrigation water issue was calculated based on the cropping calendar decided each tank according to the "Technical Guideline of Irrigation Works, A.J.O.Prnrajha, 1988". The effective rainfall was calculated with 2002 year at Kebithigollewa.

(8) SPLOUT

$$SPLOUT = 86400 \cdot 1.7 \cdot WCEL \cdot (TKH - SPLV)^{1.5},$$

where $WCRL$ is spillway overflow width, $SPLV$ is full capacity water level, TKH is tank water level.

(9) SPLOSS

$$SPLOSS = [a\, ln(h)\ +\ b]\ \times TKVOL \diagup 100,$$

where A, b: coefficients for individual tanks determined based on water balance during the non-precipitation time. $TKVOL$: tank water volume

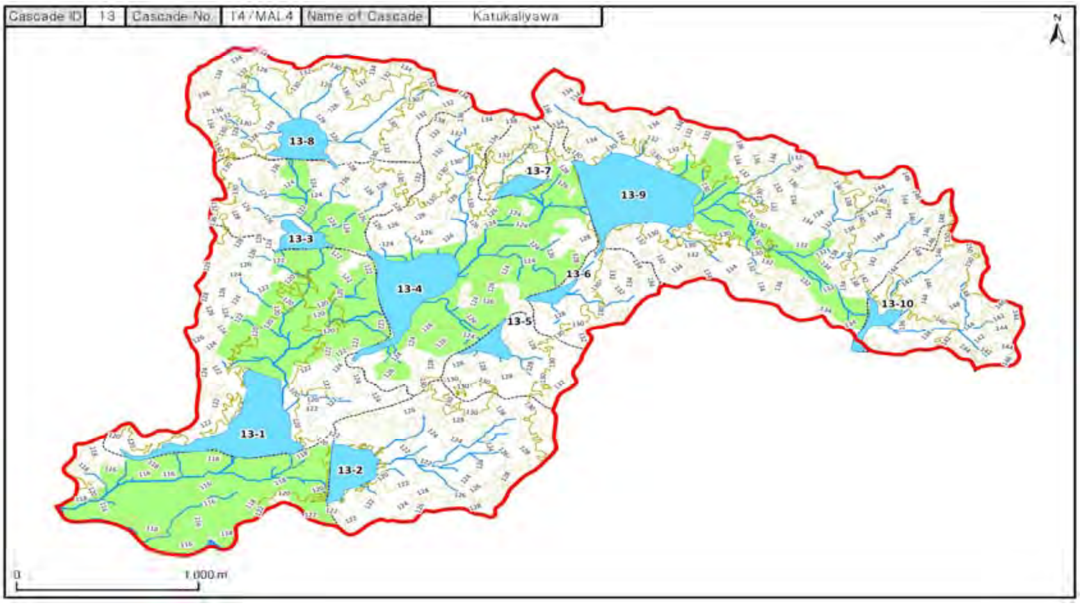
(10) LNOUT

Link canal discharge going out to the lower tank was decided considering the optimum usage of NCPC water. 5% of conveyance loss was considered. $LONOUT$ equal zero (0) in the conditions without NCPC water.

Attachment 3.6-4: Example Result of Simplified Water Balance Calculation Model

Basic Data

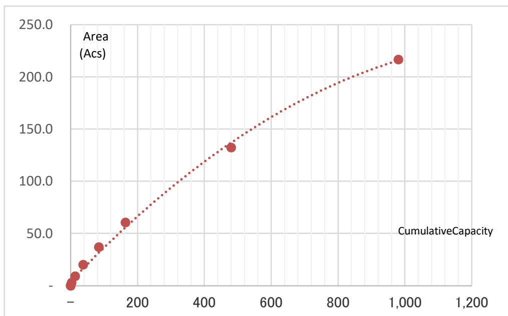
Cas_ID13



Cascade information	Tank No	Name	WSA (ha)	Catchment (ha)	Irrigable Area (ha)	Irrigable Area (acs)
	13-1		18.9	139.5	8.1	20.02
	13-2		7.2	88.3	3.6	8.99
	13-3		3.4	56.8	8.1	20.02
	13-4		16.8	140.0	47.4	117.05
	13-5		2.7	30.1	8.9	22.02
	13-6		1.6	27.7	6.5	16.01
	13-7		2.2	16.3	4.1	10.01
	13-8		6.6	89.5	12.2	30.02
	13-9		25.5	197.7	16.2	40.01
	13-1		2.7	52.8	3.6	8.99
		Total	87.6	838.8	118.6	293.1

Assumed unified tank WSA= 87.6 ha Depth= 4.79 m ※H-A Equation; H(m)=5.034×A(km2) ^0.368

Depth of tank (m)	Area (m2)	Area (Acs)	Capacity (m3)	Cumulative Capacity (m3)	Cumulative Capacity (Ac.ft)
0.00	0	0.0			-
0.50	1,887	0.5	471	471	0
1.00	12,379	3.1	3,563	4,035	3
1.50	37,197	9.2	12,373	16,408	13
2.00	81,404	20.1	29,698	46,106	37
2.50	149,253	36.9	57,648	103,754	84
3.00	244,974	60.5	98,566	202,320	164
4.00	535,364	132.3	390,187	592,508	481
4.79	876,176	216.5	1,006,269	1,208,589	980



Name of Cascade	Cas_ID13		
Catchment area	3.24 Sq.miles	8.39	km^2
Paddy Variety	**Low Land Paddy (135)**	1	
Paddy Variety	**Low Land Paddy (105)**	2	
OFC (Typical OFC crops)	**Soya Beans**	6	
Paddy135			
Irrigable area for **Maha**	Acs	-	m^2
Paddy105			
Irrigable area for **Maha**	196 Acs	793,185	m^2
OFC			
Irrigable area for **Maha**	35.2 Acs	142,353	m^2
Irrigable area for **Yala**	39 Acs	157,828	m^2

Ecological Zone	**DL1**	19
Evaporation Station	**Nachchcaduwa**	7

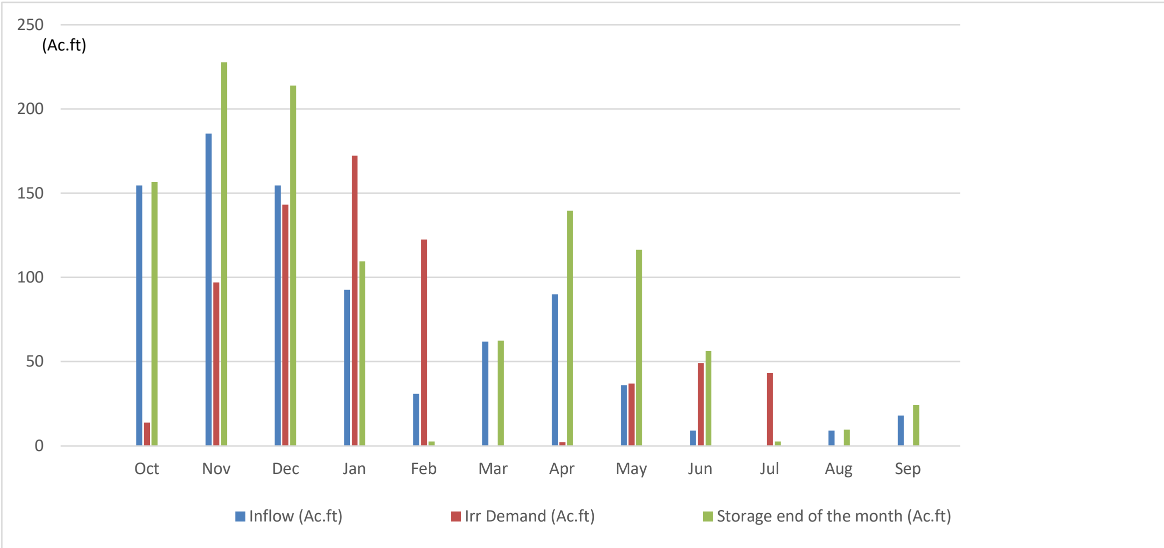
	75% probab. Total R/F (ft)	Specific yeild (Ac.ft/Sq.mls)	Specific yeild (Ac.ft)
Maha	1.833	210.0	680.1
Yala	0.750	50.0	161.9
	(m)	(m^3*km^2)	(m^3)
Maha	0.56	99,973	838,567
Yala	0.23	23,803	199,659

			SI
Capacity at MOL	19.6	Ac.ft	24,172 m^3
FSL capacity	980.2	Ac.ft	1,208,589 m^3

SI UNIT		
1ft=	**0.3048**	m
1Acs=	**4046.86**	m^2
1acft=	**1233.0**	m^3
1sqml=	**2.58999**	km^2
=	**259.0**	ha

	Maha						Yala					
Month	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Kc Value(paddy 105)		**1.00 1.15**	**1.15 1.20**	**1.20 0.90**	**0.90**							
Crop Days (paddy 105)		**20 10**	**20 11**	**19 6**	**19**							
Kc Value(ofc)	**0.65**	**0.85 1.05**	**1.05 1.05**	**1.05 0.75**			**0.65**	**0.85 1.05**	**1.05 1.05**	**1.05 0.75**		
Crop Days (ofc)	**15**	**20 10**	**15 16**	**9 20**			**15**	**20 10**	**15 15**	**10 20**		
Evaporation (ft)	**0.352**	**0.294**	**0.313**	**0.323**	**0.360**	**0.488**	**0.407**	**0.420**	**0.444**	**0.446**	**0.488**	**0.480**
Evaporation (m)	0.107	0.09	0.095	0.098	0.11	0.149	0.124	0.128	0.135	0.136	0.149	0.146
Paddy Land preparation (ft)												
Land preparation (m)												
75 % probab. R/F (ft)	**0.417**	**0.500**	**0.417**	**0.250**	**0.083**	**0.167**	**0.417**	**0.167**	**0.042**		**0.042**	**0.083**
75 % probab. R/F (m)	0.127	0.152	0.127	0.076	0.025	0.051	0.127	0.051	0.013		0.013	0.025
ET ref (ft) - Tec/guide	**0.517**	**0.358**	**0.375**	**0.392**	**0.417**	**0.517**	**0.492**	**0.533**	**0.575**	**0.625**	**0.633**	**0.625**
ET ref (m) - Tec/guide	0.157	0.109	0.114	0.119	0.127	0.157	0.15	0.163	0.175	0.191	0.193	0.191
ET crop (ft) - Kc*ET.ref (paddy 105)		**0.376**	**0.438**	**0.442**	**0.254**							
ET crop (m) - Kc*ET.ref (paddy 105)		0.115	0.133	0.135	0.078							
ET crop (ft) - Kc*ET.ref (ofc)	**0.163**	**0.328**	**0.394**	**0.330**			**0.160**	**0.489**	**0.604**	**0.531**		
ET crop (m) - Kc*ET.ref (ofc)	0.05	0.1	0.12	0.101			0.049	0.149	0.184	0.162		
ET crop (ft) - Average	**0.163**	**0.369**	**0.431**	**0.425**	**0.254**		**0.160**	**0.489**	**0.604**	**0.531**		
ET crop (m) - Average	0.05	0.112	0.131	0.129	0.078		0.049	0.149	0.184	0.162		
FIR (ft) Ea (%) 60	**0.271**	**0.615**	**0.719**	**0.708**	**0.424**		**0.266**	**0.815**	**1.006**	**0.885**		
FIR (m) Ea (%)	0.083	0.187	0.219	0.216	0.129		0.081	0.248	0.307	0.27		
Eff. R/F (ft)	**0.223**	**0.279**	**0.223**	**0.112**		**0.056**	**0.223**	**0.056**				
Eff. R/F (m)	0.068	0.085	0.068	0.034		0.017	0.068	0.017				
Irr. Req (ft) Ec (%) 80	**0.059**	**0.420**	**0.619**	**0.745**	**0.530**		**0.054**	**0.949**	**1.258**	**1.107**		
Irr. Req (m) Ec (%)	0.018	0.128	0.189	0.227	0.162		0.016	0.289	0.383	0.337		
Storage start of the month (Ac.ft)	**19.60**	**156.71**	**227.81**	**213.94**	**109.60**	**2.52**	**62.35**	**139.53**	**116.41**	**56.41**	**2.52**	**9.52**

Storage start of the month (m3)	24,189	193,363	281,091	263,975	135,233	3,108	76,930	172,165	143,631	69,607	3,114	11,748
Inflow (Ac.ft)	**154.57**	**185.48**	**154.57**	**92.74**	**30.91**	**61.83**	**89.96**	**35.98**	**9.00**		**9.00**	**17.99**
Inflow (m3)	190,716	228,859	190,716	114,430	38,143	76,286	110,999	44,400	11,100	-	11,100	22,200
Area at start of the month (Acs)	**10.33**	**56.33**	**77.23**	**73.31**	**41.37**	**4.07**	**25.48**	**50.98**	**43.59**	**23.42**	**4.07**	**6.65**
Area at start of the month (m2)	41,793	227,970	312,533	296,677	167,430	16,462	103,100	206,309	176,398	94,764	16,469	26,901
Evaporation (Ac.ft)	**3.635**	**16.562**	**24.173**	**23.679**	**14.894**	**1.985**	**10.369**	**21.412**	**19.353**	**10.444**	**1.986**	**3.191**
Evaporation (m3)	4,485	20,435	29,826	29,217	18,377	2,449	12,794	26,419	23,879	12,886	2,450	3,937
Seapage (Ac.ft)	**0.098**	**0.784**	**1.139**	**1.070**	**0.548**	**0.013**	**0.312**	**0.698**	**0.582**	**0.282**	**0.013**	**0.048**
Seapage (m3)	121	967	1,405	1,320	676	16	385	861	718	348	16	59
Irr Demand (Ac.ft)	**13.726**	**97.036**	**143.129**	**172.333**	**122.554**		**2.096**	**37.000**	**49.055**	**43.164**		
Demand (m3)	16,936	119,729	176,601	212,634	151,215	-	2,586	45,653	60,527	53,258	-	-
Spillage (Ac.ft)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Spillage (m3)												
Storage end of the month (Ac.ft)	**156.71**	**227.81**	**213.94**	**109.60**	**2.52**	**62.35**	**139.53**	**116.41**	**56.41**	**2.52**	**9.52**	**24.28**
Storage end of the month (m3)	193,363	281,091	263,975	135,233	3,108	76,930	172,165	143,631	69,607	3,114	11,748	29,952

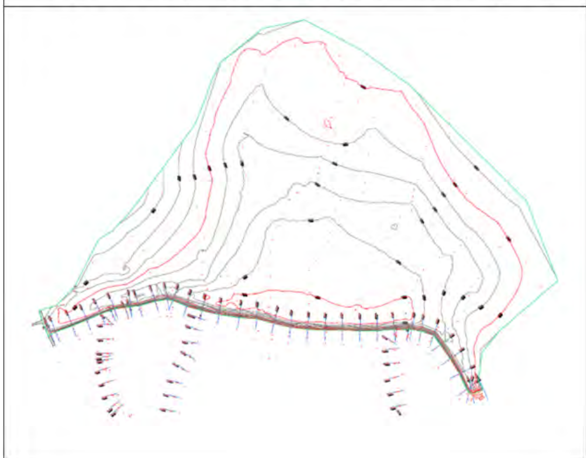
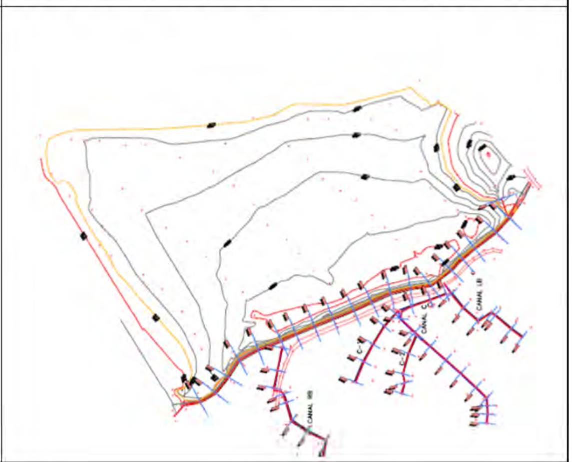


Attachment 3.6-5: Tank Capacity Survey Result by CSDPP

Tank Reservoir Capacity

1. Topographic Survey (2017, CSDPP)
2. H-A Curve (H-A Equation)
3. Estimate of Tank Capacity

1. Topographic Survey (2017, CSDPP)

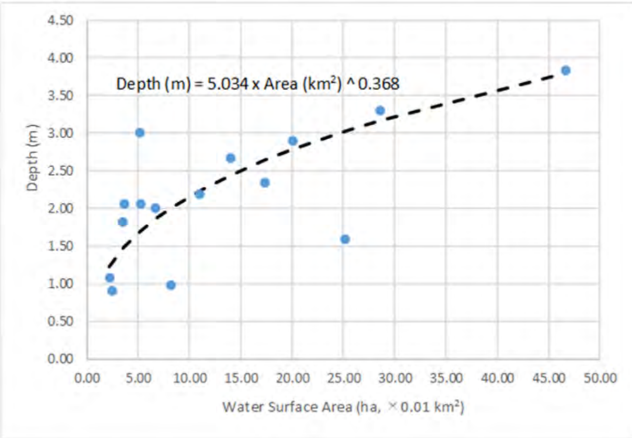
Puliyankulam (Kiulekada Cascade, Anuradhapura)	Vala sinna kulam (Navelikulam Cascade, Vavuniya)
	

2. H-A Curve (H-A Equation)

H = 5.034 X A ^ 0.368

H: Water Depth (m)

A: Water Surface Area (km2)



3. Estimate of Tank Capacity

Trial Calculation

H (depth)= 3.0 m

V (tank capacity)

= 202,000 m3

Depth (m)	Area (km^2)	Volume (1,000 m^3)
0.0	0.000	–
0.5	0.002	0
1.0	0.012	4
1.5	0.037	12
2.0	0.081	30
2.5	0.149	58
3.0	0.245	99
Total		202

Attachment 3.8-1: Crop Budget after the Project and after NCPC Coming

	Irrigation type	Crop	Crop Intensity	(A) Gross Income 1) Unit Price (LKR/kg)	2) Unit Yield (kg/ha)	Total Gross Income (LKR/ha)	(B) Production Cost 1) Labour (LKR/ha)	2) Material (LKR/ha)	3) Machinery (LKR/ha)	Total Cost (LKR/ha)	(A)-(B) Net Income (LKR/ha)	Annual Net Income of 1 ha Farm (LKR)
After the Project												
Maha	Irrigated	Paddy	45%	54	5,600	302,400	60,000	49,250	49,500	158,750	143,650	64,643
		Black gram	4%	300	1,750	525,000	127,500	36,200	28,400	192,100	332,900	13,316
		Chilli	4%	140	10,000	1,400,000	520,500	85,500	22,500	628,500	771,500	30,860
		Eggplant	4%	52	22,000	1,144,000	474,000	94,500	22,500	591,000	553,000	22,120
	Rainfed	Paddy	43%	54	3,200	172,800	49,500	19,360	49,500	118,360	54,440	23,409
Yala	Irrigated	Green gram	4%	237	1,750	414,750	118,500	21,200	27,500	167,200	247,550	9,902
		Chilli	2%	140	11,500	1,610,000	540,000	85,500	22,500	648,000	962,000	19,240
		Big onion	2%	100	20,000	2,000,000	625,500	108,600	22,500	756,600	1,243,400	24,868
		Egg plant	3%	52	23,000	1,196,000	504,000	94,500	22,500	621,000	575,000	17,250
	Inadequately irrigated	Paddy	14%	54	2,880	155,520	58,500	25,090	49,500	133,090	22,430	3,140
		Total	**125%**								**Total**	**228,748**
After NCPC												
Maha	Irrigated	Paddy	64%	54	5,600	302,400	60,000	49,250	49,500	158,750	143,650	91,936
		Black gram 1)	1%	300	1,750	525,000	127,500	36,200	28,400	192,100	332,900	3,329
		Soybean	17%	125	2,500	312,500	139,500	28,000	22,500	190,000	122,500	20,825
		Chilli	4%	140	10,000	1,400,000	520,500	85,500	22,500	628,500	771,500	30,860
		Eggplant 2)	8%	52	22,000	1,144,000	474,000	94,500	22,500	591,000	553,000	44,240
Yala	Irrigated	Paddy 3)	18%	54	5,100	275,400	60,000	49,250	49,500	158,750	116,650	20,997
		Soybean 4)	34%	125	2,500	312,500	139,500	28,000	22,500	190,000	122,500	41,650
		Green gram 5)	4%	237	1,750	414,750	118,500	21,200	27,500	167,200	247,550	9,902
		Big onion	6%	100	20,000	2,000,000	625,500	108,600	22,500	756,600	1,243,400	74,604
		Chilli	11%	140	11,500	1,610,000	540,000	85,500	22,500	648,000	962,000	105,820
		Eggplant	11%	52	23,000	1,196,000	504,000	94,500	22,500	621,000	575,000	63,250
		Total	**178%**								**Total**	**507,413**

Source: Study Team, compiling from CSDPP report Note:

1) Instead of green gram planned by CSDPP, black gram could be selected due to cultivation condition and profitability.

2) Eggplant could be selected as a representative crop of vegetables.

3) Unit yield of paddy-irrigated in Yala after NCPC is 10% discount from Mahaweli achievement yield as well as paddy-irrigated in Maha with project condition.

4) Instead of maize in Yala planned by CSDPP, soybean could be selected due to profitability.

5) Instead of black gram in Yala planned by CSDPP, green gram could be selected due to cultivation condition and profitability.

Attachment 3.12-1: Top 50 Tank List by Elevation Gap for Pipeline Canal

No.	Tank ID	Tank No	Cas_ID	Tank Name	Ave. Height of WSA	Ave. Height of Irrigable Area	Elevation Gap
1	10111	101-11	101	Lewapanikkawewa	94.3	76.8	17.49
2	9211	92-11	92	Dunukaiiya Ulpatha	118.0	101.3	16.70
3	8515	85-15	85	Ihala diulwewa	80.2	66.8	13.42
4	10605	106-5	106	Thibiripataha	94.5	82.0	12.47
5	8222	82-22	82	Kuda Puliyankulama.	89.0	77.2	11.81
6	9709	97-9	97	Kebetigollewa Wewa	116.0	104.5	11.48
7	12004	120-4	120	Tapasavelliya Wewa	101.6	90.2	11.45
8	12809	128-9	128	Kayankulam	103.3	92.1	11.19
9	10706	107-6	107	Kuda halmillawatiya	116.2	105.1	11.12
10	8322	83-22	83	Taualam Hammillewa Wewa	82.1	71.4	10.72
11	10701	107-1	107	Perukkan kulam	101.2	91.1	10.07
12	8216	82-16	82	Morawewa	75.7	65.7	10.03
13	8603	86-3	86	Kudagame Wewa	60.9	51.1	9.79
14	8221	82-21	82	Samurdi Wewa	86.4	76.7	9.67
15	8314	83-14	83	Anaolendri Wewa	73.8	64.2	9.66
16	10607	106-7	106	Maha Kongollawa	93.3	83.7	9.63
17	9703	97-3	97	Amunuwetiya	105.0	95.4	9.63
18	9911	99-11	99	Punchi muuna malgas wewa	110.3	101.0	9.27
19	6706	67-6	67	Thelabugaswewa	131.7	122.5	9.24
20	9308	93-8	93	Maha Amunugale Wewa	104.3	95.3	8.93
21	10802	108-2	108	Kale Piliyankulama	110.8	101.9	8.90
22	2215	22-15	22	Kunuurugama	121.9	113.2	8.74
23	12804	128-4	128	Sangariathimoddai Kulam	96.2	87.6	8.61
24	4708	47-8	47	Semewa Wewa	119.0	110.4	8.60
25	2604	26-4	26	Walahenguna Wewa	101.4	92.8	8.60
26	11504	115-4	115	Tavasiya Kulam	77.0	68.6	8.47
27	11710	117-10	117	Vykalikoolan Kulam	92.6	84.2	8.37
28	8044	80-44	80	Ibbagala	109.4	101.2	8.23
29	8027	80-27	80	Nelugollawa	93.4	85.1	8.22
30	3507	35-7	35	Galkadawala Kayan Wewa	123.1	114.9	8.18
31	5002	50-2	50	Medawachchiya Wewa	88.1	79.9	8.17
32	12011	120-11	120	Erupotana Wewa	106.2	98.0	8.16
33	8005	80-5	80	Horowpothana wewa	73.7	65.6	8.12
34	10504	105-4	105	Kolibanda wewa	113.7	105.9	7.81
35	8212	82-12	82	Asanawewa	73.0	65.2	7.72
36	8509	85-9	85	Kapugollawa	60.9	53.3	7.63
37	12708	127-8	127	Periyamarailuppai Kulam	103.1	95.6	7.53
38	8404	84-4	84	Ambagas Wewa	62.3	54.8	7.44
39	7711	77-11	77	Maha Divul Wewa	101.1	93.7	7.43
40	11408	114-8	114	Theva Kulam	82.9	75.5	7.37
41	9504	95-4	95	Wattewewa Mahawewa	109.0	101.6	7.35
42	901	9-1	9	Tharanagollewa	122.0	114.8	7.25
43	8513	85-13	85	Dunuwatttegama wewa	72.5	65.3	7.24
44	7622	76-22	76	Kuda Rambe Wewa	109.8	102.6	7.21
45	8205	82-5	82	Ralapanawa Wewa	63.8	56.7	7.15
46	9723	97-23	97	Horouwenbidunu Wewa	133.6	126.5	7.10
47	3504	35-4	35	Kapirigama Wewa	113.2	106.1	7.05
48	7617	76-17	76	Rambewa Wewa	110.7	103.7	7.04
49	12005	120-5	120	Kunchululam	101.1	94.2	6.98
50	9705	97-5	97	Ratmalwatiya Wewa	106.1	99.2	6.94

Source: Study Team

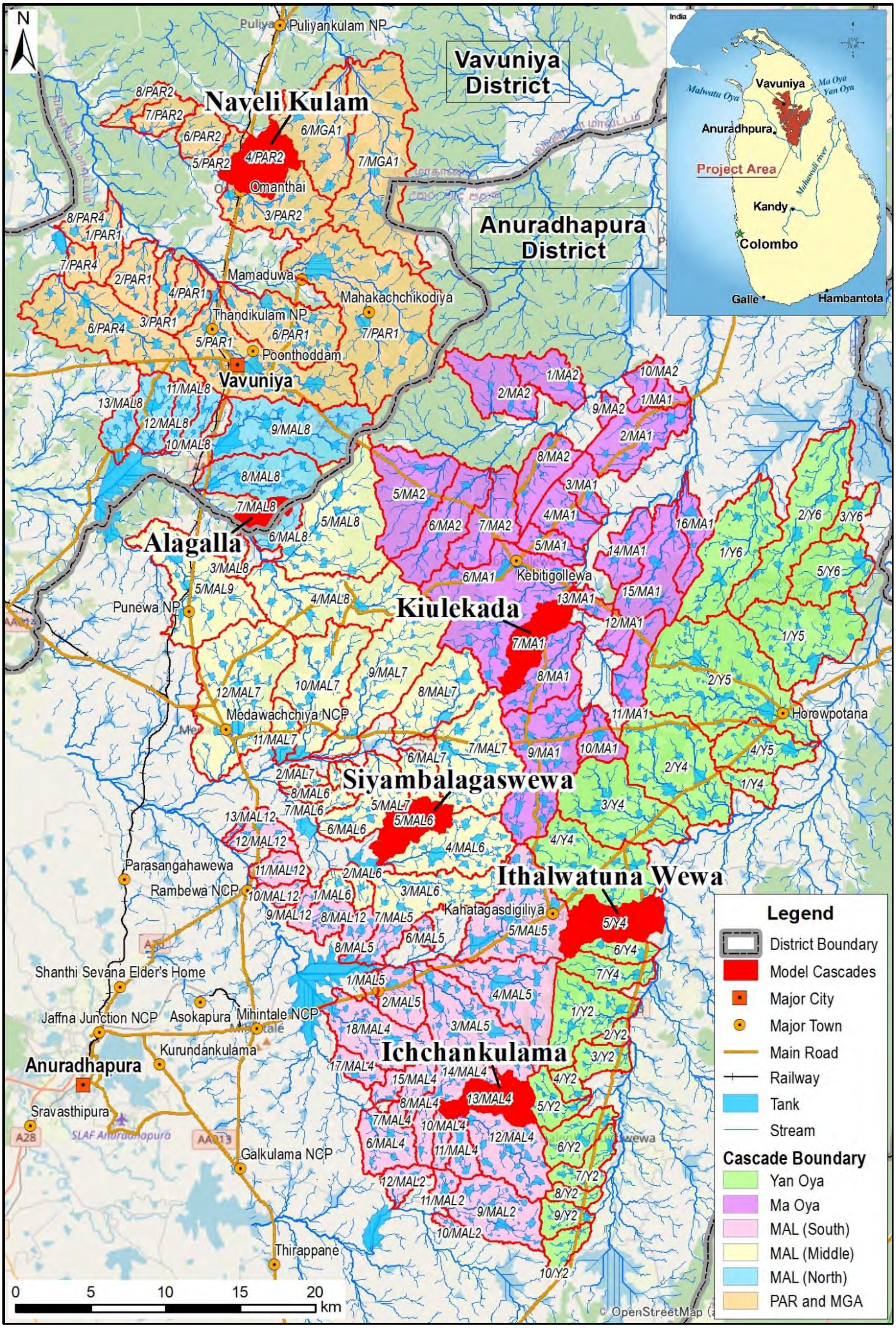
Attachment 3.13-1: List of Target Tanks for Partial Desilting Works

Zoning by River Basin	District	Name of Cascade	No. of Tank	Name of Tank	Total Score
South MAL	Anuradhapura	Bora Wewa	2-2	Bora Wewa	10
South MAL	Anuradhapura	Kon Wewa	7-2	Mawatha Wewa	10
South MAL	Anuradhapura	Ichchan Kulam	12-2	Karakolawewa	10
South MAL	Anuradhapura	Palugas Wewa	17-17	Kirimetiyawa	10
South MAL	Anuradhapura	Mekechchawa	18-22	Ihala Pattilewa	10
South MAL	Anuradhapura	Mekechchawa	18-32	Elapathawewa	10
South MAL	Anuradhapura	Ranpathwila Wewa	22-27	surukkursyagama	10
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-9	Peenagama kudawewa	10
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-16	Mahakudiyawa	10
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-22	Mailagammana	10
Middle MAL	Anuradhapura	Gagurane Pathaha	46-4	Moonamalgahawewa	10
Middle MAL	Anuradhapura	Gagurane Pathaha	46-9	Weerasole	10
Middle MAL	Anuradhapura	Kudagama Wewa	48-9	Lenadiulwewa	10
Yan Oya	Anuradhapura	Ithalwatuna Wewa	75-8	Wirudugollewa	10
Yan Oya	Anuradhapura	Ithalwatuna Wewa	75-12	Mahawewa	10
Yan Oya	Anuradhapura	Maha Hammillewa	76-12	Hettiyawa	10
Yan Oya	Anuradhapura	Maha Hammillewa	76-19	Pahalakanhidiyagama	10
Yan Oya	Anuradhapura	Patanaya	79-3	Wilawewa mahawewa	10
PAR and MGA	Vavuniya	Periyakada	117-5	Vilaththik kulam	10
South MAL	Anuradhapura	Mahagal kulam	11-5	Dembatawewa	8
South MAL	Anuradhapura	Mekechchawa	18-11	Pahala Pattilewa	8
South MAL	Anuradhapura	Mekechchawa	18-18	Demata Wewa	8
South MAL	Anuradhapura	Mekechchawa	18-31	Koonwewa	8
South MAL	Anuradhapura	Ranpathwila Wewa	22-14	Elapaththe Wewa	8
South MAL	Anuradhapura	Konketupothana	24-4	Walas Wewa	8
South MAL	Anuradhapura	Konketupothana	24-7	Siyambalagaswewa	8
Middle MAL	Anuradhapura	Tibiri Wewa	32-9	Nabadawewa	8
Middle MAL	Anuradhapura	Tibiri Wewa	32-14	Hettikattya	8
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-3	Penikewa Wewa	8
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-6	Aluthgama	8
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-21	Puliyankulama	8
Middle MAL	Anuradhapura	Siyabalagaswewa	36-6	Ehetuwagama	8
Middle MAL	Anuradhapura	Thalgaha	37-5	Medagamawewa	8
Middle MAL	Anuradhapura	Pihibiyagollawa	41-14	Ihalagama Kilawewa	8
Middle MAL	Anuradhapura	Gagurane Pathaha	46-8	Katukeliyawa tank	8
Yan Oya	Anuradhapura	Maha Hammillewa	76-7	Ihala Halmillewa	8
Yan Oya	Anuradhapura	Maha Hammillewa	76-16	Ambagahawewa	8
Yan Oya	Anuradhapura	Maha Hammillewa	76-18	Konwewa	8
Yan Oya	Anuradhapura	Maha Hammillewa	76-30	Nayakapuwewa	8
South MAL	Anuradhapura	Palugas Wewa	17-12	Pansal Wewa	6
South MAL	Anuradhapura	Mekechchawa	18-13	Tammannagoda Wewa	6
South MAL	Anuradhapura	Mekechchawa	18-30	Ulpathwewa	6
South MAL	Anuradhapura	Mekechchawa	18-33	Morawewa	6
South MAL	Anuradhapura	Abagahawela	19-6	Alapaththawa	6
South MAL	Anuradhapura	Ella Wewa	21-2	Vihara Wewa	6
South MAL	Anuradhapura	Ranpathwila Wewa	22-6	Puhudiwla	6
South MAL	Anuradhapura	Gekarawa Wewa	25-3	Karuwalagaswewa	6
South MAL	Anuradhapura	Kongollawewa	26-2	Wadurugaswewa	6

Zoning by River Basin	District	Name of Cascade	No. of Tank	Name of Tank	Total Score
South MAL	Anuradhapura	Kongollawewa	26-8	Kongollewa Mahawewa	6
South MAL	Anuradhapura	Nika Wewa	27-2	Kudanikawewa	6
Middle MAL	Anuradhapura	Tibiri Wewa	32-21	Nahakogewa	6
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-15	Kohombagaswewa	6
Middle MAL	Anuradhapura	Siyabalagaswewa	36-9	Weddewa	6
Middle MAL	Anuradhapura	Thalgaha	37-2	Weliwewa	6
Middle MAL	Anuradhapura	Lidawewa	40-3	Randenigama	6
Middle MAL	Anuradhapura	Pihibiyagollawa	41-6	Welpothuwewa	6
Yan Oya	Anuradhapura	Ithalwatuna Wewa	75-6	Thonigala	6
Yan Oya	Anuradhapura	Maha Hammillewa	76-4	Pahalawewa	6
Yan Oya	Anuradhapura	Maha Hammillewa	76-23	Madayakade	6
Yan Oya	Anuradhapura	Maha Hammillewa	76-24	Galkandegama Mahawewa	6
Yan Oya	Anuradhapura	Patanaya	79-4	Elavissakoda wewa	6
Ma Oya	Anuradhapura	Elapattewa	93-5	Garinda Ulpatha	6
South MAL	Anuradhapura	Ichchan Kulam	12-6	MawathaWewa	4
South MAL	Anuradhapura	Palugas Wewa	17-4	Kurundankulama	4
South MAL	Anuradhapura	Mekechchawa	18-15	Walpalugamawewa	4
South MAL	Anuradhapura	Kukulawa Wewa	23-3	Palugaswewa	4
South MAL	Anuradhapura	Kongollawewa	26-5	Siyambalagaswewa	4
South MAL	Anuradhapura	Nika Wewa	27-3	Weliwewa	4
Middle MAL	Anuradhapura	Gonawa Wewa	34-4	Gonewa Ihalawewa	4
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-8	Karuwalagaswewa	4
Middle MAL	Anuradhapura	Siyabalagaswewa	36-4	Diwulgahawewa	4
Middle MAL	Anuradhapura	Siyabalagaswewa	36-5	Kudawewa	4
Middle MAL	Anuradhapura	Siyabalagaswewa	36-7	Thimbiriwewa	4
Middle MAL	Anuradhapura	Thalgaha	37-3	Puliyamkulama	4
Middle MAL	Anuradhapura	Thalgaha	37-4	Kudugama	4
Middle MAL	Anuradhapura	Walketu Wewa	38-3	Pahalakatukeliyawa	4
Middle MAL	Anuradhapura	Pihibiyagollawa	41-9	Bala Hodawewa Kudawewa	4
Middle MAL	Anuradhapura	Gagurane Pathaha	46-3	Habawewa tank	4
PAR and MGA	Vavuniya	Parandikallu	116-8	Pichchuvilathikulam	4
South MAL	Anuradhapura	Ichchan Kulam	12-10	Palugaswewa	2
South MAL	Anuradhapura	Galmaduwa	16-3	Katukaliyawa Wewa	2
South MAL	Anuradhapura	Palugas Wewa	17-6	Karambankulama	2
South MAL	Anuradhapura	Palugas Wewa	17-9	Koonwegama	2
South MAL	Anuradhapura	Mekechchawa	18-9	Thanahenewewa	2
South MAL	Anuradhapura	Abagahawela	19-2	Bokalawewa	2
South MAL	Anuradhapura	Mekicha Wewa	28-2	Halmillewa	2
Middle MAL	Anuradhapura	Tibiri Wewa	32-8	Lindawewa	2
Middle MAL	Anuradhapura	Kapirilgama Wewa	35-2	Andarawewa	2
PAR and MGA	Vavuniya	Parandikallu	116-21	Ekarpuliyankulam	2

Source: Study Team

Attachment 4.3-1: Location Map of Model Cascades



Source: Study Team

Attachment 4.5-1 Draft Terms of Reference for Consulting Services

Chapter 1. Background

The Government of Sri Lanka has received a loan from a lender to finance the Cascade System Development Project (CSDP), hereinafter referred to as "the Project") in the North Central and Northern Provinces. The Government of Sri Lanka intends to use part of the proceeds of the loan for eligible payments for consulting services for which this ToR is issued.

(1) Objectives

Objectives of the Project is to develop the cascade systems (hereinafter referred to as the sub-projects) in Anuradhapura and Vavuniya districts, in order to attain efficient use of water available for irrigation, flood prevention of farm lands and facilities, efficient transportation of agriculture inputs and outputs, etc. and thereby promote agriculture development adaptable to climate change and improve agriculture productivity and profitability.

From the implementation of the Project, the following benefits and social economic impact could be expected.

Table 1 Expected Benefits and Impact of the Project

Benefits	Social Economic Impacts
- Improvement of overall irrigation efficiency, - Flood damage can be reduced, - Traditional paddy varieties will be introduced, - Diversity to high value crops will be demonstrated, - Management of livestock and fisheries will be demonstrated, - Reduction in transportation cost of farm inputs and outputs, - Increment of net farm income, etc.	- Activation of rural communities and economy - Increased on-farm and off-farm employment - Enhanced food security - Promotion of agriculture, livestock, and fishery development - Improvement of living standards - Gender empowerment, etc.

Source: Study Team

(2) Project Components

The Project, that is a sector loan type, comprises of the following four components. The Project will be financed by a lender, with terms and conditions set forth in the Loan Agreement and the rest shall be totally funded by the Government of Sri Lanka.

Table 2 Project Components

Number of Component	Name of Component
Component 1	Cascade System Development
Component 2	Soft Component
Component 3	Project Management and Monitoring
Component 4	Consulting Services

Source: Study Team

(3) Scope of the Project

The scope of the Project will be as stated below:

Table 3 Scope of the Project

No.	Component	Scope of Works
1	Cascade System Development	Subcomponent 1.1: Infrastructure and Facility Development (1) Civil Works for Infrastructure Development (2) Facilities for Proper O&M (3) Facilities for Agriculture Production and Post-harvesting

No.	Component	Scope of Works
		(4) Facilities for Farm Income Diversification Subcomponent 1.2: Procurement of Machinery and Equipment
2	Soft Component	Subcomponent 2-1: Institution and Capacity Development 1) Capacity improvement of FOs and the relevant government officers for water management 2) Promotion of awareness campaign of tank day Subcomponent 2-2: Agriculture Development 1) Cultivation skills development with provision of quality inputs 2) Enhancement of agriculture extension system platform Subcomponent 2-3: Post-harvest and Marketing Development 1) Establishment of the community supported agriculture model Subcomponent 2-4: Livestock Development 1) Stable feed production and delivery through entrepreneur development 2) Development of models for dairy cattle and backyard poultry under value chain system Subcomponent 2-5: Fishery Development 1) Promotion of inland fisheries development in selective tanks
3	Project Management and Monitoring	1) Establishment of PMU and PIUs 2) Strengthening of PMU and PIUs for proper project management and monitoring 3) Monitoring and evaluation 4) Thematic study and action research

Source: Study Team

(4) Implementation Schedule

[redacted]

Table 4 Overall Implementation Schedule

Non-disclosure information

Source: Study Team

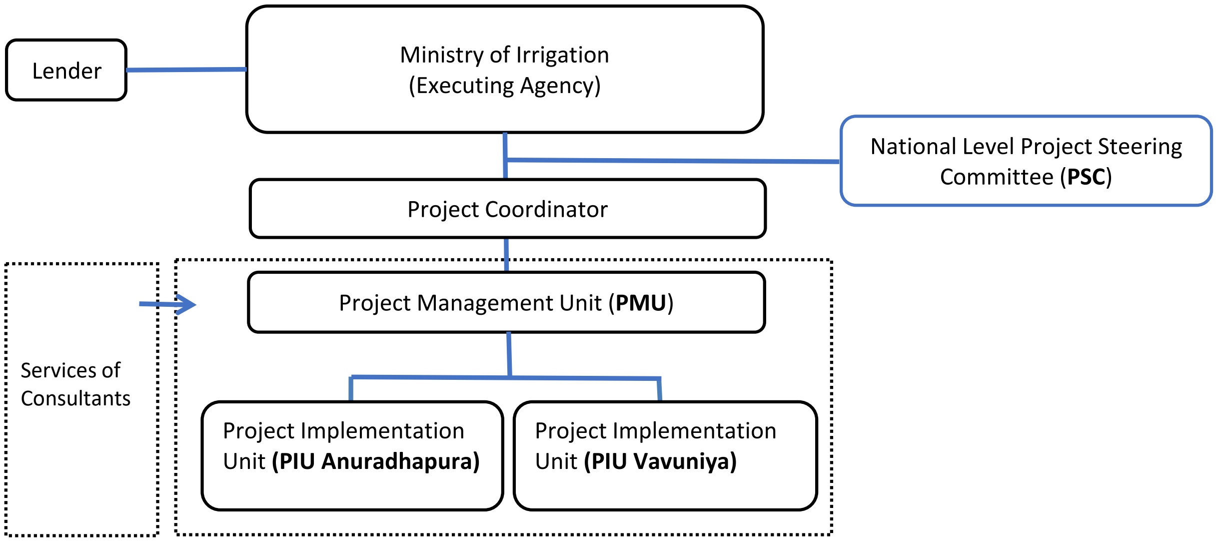
(5) Location of the Project

The Project will cover Anuradhapura District in North Central Province and Vavuniya District in Northern Province as shown in the Project Location Map.

(6) Executing Agency

The executing agency of the Project will be the Ministry of Irrigation (MOI), GOSL, who has overall responsibility for the project implementation.

MOI will set up the Project Steering Committee (PSC) at national level, Project Management Unit (PMU) at project level, and Project Implementation Unit (PIU) at district level. In principle, the Irrigation Department (ID), Department of Agrarian Development (DAD), Department of Agriculture (DOA), Department of Animal Production and Health (DAH), National Aquatic Resources and Research and Development Agency (NAQDA) at national and provincial levels in addition to local governments will be the members of these committees and units.



Source: Study Team

Figure 1 Overall Project Organisation Structure

(7) Technical Information

Civil works for infrastructure and facility development; materials, machinery, equipment and goods shall be compliant with the Sri Lankan Standards; Construction Industry Development Authority (CIDA) and/or internationally authorized standards.

Chapter 2. Objectives of Consulting Services

The consulting services shall be provided by an international consulting firm (hereinafter referred to as the Consultant) in association with national consultants in compliance with the guideline of lender. The objective of the consulting services is to achieve the efficient and proper preparation and implementation of the Project through the following works:

- Overall project management (Task and Assistance);
- Review of detailed design for infrastructure and facility development (Task);
- Procurement (Assistance);
- Construction supervision (Assistance);
- Soft component (Task); and
- Project management and monitoring (Assistance).

Chapter 3. Scope of Consulting Services

In this Project, the position of the Consultant in principle is on advisory services to PMU and PIUs. In case of "Assist", the Consultant will support PMU and PIUs in the project activities.

(1) Overall Project Management

The Consultant shall:

1-1 Undertake the overall project management, monitoring of the progress of the Project and coordinate among MOI, a lender and other agencies concerned for project implementation;

1-2 Prepare the inception report containing the outline of the project plan, implementation method, schedule, etc.;

1-3 Prepare the monthly, quarterly and annual reports containing the present status of the Project such as physical and financial progress, loan use, performance and problems within the reporting period, work schedule for coming reporting period and other necessary information;

1-4 Attend the regular and ad hoc meeting and workshops;

1-5 Prepare the operational guidelines and guide PMU/PIUs how to use the guidelines;

1-6 Prepare the services completion report containing necessary information such as the project performance and consultant activities with supporting data;

1-7 Assist PMU/PIUs in monitoring the performance, progress, issue and problem of on-going works and program from time to time for taking the necessary action;

1-8 Assist PMU/PIUs in selection of priority sub-projects based on the approved criteria;

1-9 Assist PMU/PIUs in preparation of annual work plan and budget plan;

1-10 Assist PMU/PIU in preparation of Statement of Performance (SOP) and Statement of Expenditure (SOE) to be submitted to a lender;

1-11 Assist PMU/PIUs in monitoring and evaluation such as benchmark survey and environmental monitoring survey;

1-12 Assist PMU/PIUs in preparation of technical reports related to the Project, if request;

1-13 Organise overseas trainings to third country;

1-14 Assist PMU/PIUs in formulation of the future project, if required.

1-15 Assist PMU/PIUs in safety in the project activities including preventive measures for COVID-19; and

1-16 In case of accidents during the construction, assist the Employer to report to a lender the details of such accidents in manner reasonably requested by a lender.

(2) Detailed Design

The Consultant shall:

2-1 Review and verify available primary and secondary data collected during the Preparatory Survey for the Project;

2-2 Review available design criteria and design manuals for tank irrigation and farm roads:

2-3 Review the detailed design to be carried out by local consultant/s during the implementation of the Project, whether or not the detailed design be in sufficient detail to ensure clarity and understanding by the PMU, PIUs, contractors and other relevant stakeholders;

2-4 Modify the detailed design in assisting PIUs whenever necessary; and

2-5 Monitor the monthly progress of detailed design works and design review.

(3) Procurement

The Consultant shall:

3-1 Review the bidding documents currently used by PID and DAD and modify it if necessary;

3-2 Assist PIUs in issuing bid invitation, conducting pre-bid conference, issuing addendum/corrigendum, and clarifications to bidders' queries;

3-3 Assist PIUs in evaluating bids in accordance with the criteria set forth in the bidding documents;

3-4 Assist PIUs in preparation of a bid evaluation report for approval of the bid evaluation committee;

3-5 Assist PIUs in contract negotiation by preparing agenda and facilitating negotiations including preparation of minutes of negotiation meeting; and

3-6 Assist PIUs in preparation of a draft and final contract agreement.

3-7 Monitor the monthly progress of procurement works.

(4) Construction Supervision

The Consultant shall:

4-1 Prepare the construction check list for Civil Works;

4-2 Assist the Engineer (PIUs) absolutely in construction supervision for civil works (infrastructure and facility development) including time control, quality control, cost control, finishing the contract, safety management and settlement of disputes;

4-3 Monitor the monthly physical and financial progress, problems and solutions of each contract packages;

4-4 Assist PIUs in fund management including checking of invoices to be submitted by contractors and suppliers, etc.;

4-5 Assist the Engineer in issuing variations during the construction;

4-6 Assist the Engineer in settlement of claims issued by the contractors; and

(5) Soft Component Programs

The Consultant shall:

5-1 General

1) Prepare the basic training plan and guidelines for soft component activities in collaboration with the departments concerned for PMU's approval;
2) Prepare the annual work plan for soft component activities in consultation with the relevant departments for PMU's approval;
3) Implement the soft component activities in collaboration with the relevant departments; and
4) Monitor and evaluate the physical and financial progress of soft component activities.

5-2 Institution and Capacity Development

5-2-1 Capacity improvement of FOs and relevant government officers for water management

1) Select pilot FOs in the model cascades in consultation with PID/DAD;
2) Improve the water management under tank irrigation in cooperation with PID/DAD;
3) Conduct the training to FOs on irrigation and crop planning in cooperation with PID/DAD;
4) Carry out training needs assessment for FO's capacity building;
5) Conduct the water management trainings to APRAs; and
6) Host trainees from non-model cascades.

5-2-2 Promotion of awareness campaign of tank day

1) Conduct awareness trainings to FOs in cooperation with PID/DAD and local government; and
2) Implement the tank day in cooperation with PID/DAD, FOs, local governments and communities.

5-3 Agriculture Development

5-3-1 Cultivation skills development with provision of quality inputs

1) Conduct promotional seminars on crop diversification in cooperation with PDOA;
2) Prepare action plan for crop diversification in cooperation with PDOA;
3) Promote good agriculture practice (GAP) in cooperation with PDOA;
5) Provide quality inputs in cooperation with PDOA; and
6) Host trainees for non-model cascades in cooperation with PDOA.

5-3-2 Enhancement of agriculture extension system

1) Promote farmer to farmer extension programme in cooperation with PDOA;
2) Establish a collaborative extension mechanism in cooperation with PDOA; and
3) Enhance agriculture extension system in cooperation with PDOA.

5-4 Post Harvest and Marketing Development

5-4-1 Establishment of the community supported agriculture model

1) Select pilot FOs in the model cascades in cooperation with PDOA;
2) Formulate the partnership in cooperation with PDOA;
3) Provide trainings on skills development for post-harvesting with the agreed requirement in cooperation with PDOA; and
4) Establish the community supported agriculture model in cooperation with PDOA.

5-5 Livestock Development

5-5-1 Stable feed production and delivery through entrepreneur development

1) Select pilot FOs in the model cascades in cooperation with PDAH;
2) Provide trainings on skills development of production of silage in cooperation with PDAH; and
3) Enhance entrepreneur development in cooperation with PDAH.

5-5-2 Development of models for dairy cattle and backyard poultry under value chain system

1) Select pilot FOs in the model cascades in cooperation with PDAH;
2) Provide trainings on skills development of livestock in cooperation with PDAH;
3) Enhance collaboration with private sectors under value chain system in cooperation with PDAH; and
4) Establish livestock models in cooperation with PDAH.

5-6 Fishery Development:

5-6-1 Promotion of inland fishery development in selective tanks

1) Select pilot FOs in the model cascades in cooperation with NAQDA;
2) Provide trainings on skills development of inland fishery in cooperation with NAQDA; and
3) Establish inland fishery model in cooperation with NAQDA.

(6) Project Management and Monitoring

The Consultant shall:

6-1 Strengthen PMU and PIUs for proper project management and monitoring;

6-2 Assist PMU in implementing monitoring and evaluation including benchmark survey, management information system (MIS) and environmental monitoring; and

6-3 Advise PMU in selecting subjects for thematic and action research and give technical advices to PMU.

Chapter 4. Expected Time Schedule

The total duration of Consulting Services will be 69 months; starting in January 2023 and ending in September 2028.

Chapter 5. Staffing (Expertise Required)

[redacted]

(1) Qualification of Key Experts

The qualification of key experts is shown in Table 5.

Table 5 Qualification of Key Experts

Designation	Qualification
International Expert	
Team Leader/ Project Management	Education: • BS in irrigation or civil engineering. Experience: • 15 years' work experience in irrigation-related projects; • Two comprehensive irrigation projects in which he/she served as team leader or co-team leader; • Two irrigation-related projects in South Asian countries, preferably Sri Lanka; and • 10 years' work experience in external ODA loan projects.
Construction Management Expert-A	Education: • BS in irrigation and civil engineering. Experience: • 10 years' work experience in design and construction supervision of irrigation-related projects or similar; • Two irrigation projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in external ODA loan projects.
Agricultural Expert-A	Education: • BS in agriculture. Experience: • 10 years' work experience in agriculture development, preferably rice, vegetable and fruits; • Two agriculture projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in external ODA loan projects.
Local Expert	
Co-team Leader/ Project Management	Education: • BS in irrigation or civil engineering. Experience: • 15 years' work experience in irrigation-related projects; • Two comprehensive irrigation-related projects in which he/she served as team leader or co-team leader; and • Three years' work experience in foreign funded projects, especially in the field of irrigation rehabilitation
Construction Management Expert-B	Education: • BS in irrigation or civil engineering. Experience: • 10 years' work experience in national funded projects; and • Five years' work experience in bidding, bid evaluation, planning, design and construction supervision of irrigation-related projects or similar.

Designation	Qualification
Agriculture Expert-B	Education: • BS in agriculture. Experience: • 10 years' work experience in national funded projects; and • Five years' work experience in irrigated agriculture development, preferably rice, vegetable and fruits.

Note: Expert-A is International Expert and Expert-B is Local Expert.
Source: Study Team

(2) Qualification of International Non-Key Experts

The qualification of International Non-Key Experts is shown in Table 6. The qualification of International Non-Key Experts is not evaluated in the evaluation of technical proposals.

Table 6 Qualification of International Non-Key Experts

Designation	Qualification
Irrigation Design Engineer-A	Education: • BS in irrigation or civil engineering. Experience: • 10 years' work experience in irrigation development, preferably irrigation design; • Two irrigation projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in externalODA loan projects.
Water Management Expert-A	Education: • BS in irrigation and civil engineering. Experience: • 10 years' work experience in irrigation development, preferably irrigation water management; • Two irrigation projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in external ODA loan projects.
Post Harvest and Market Expert-A	Education: • BS in agriculture or commerce. Experience: • 10 years' work experience in agriculture development, preferably post harvesting and marketing; • Two agriculture projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in external ODA loan projects.
Environmental and Social Expert-A	Education: • BS in environment and sociology or any relevant filed for this task. Experience: • 10 years' work experience in environmental and social considerations; • Two agriculture and rural development projects in South Asian countries, preferably Sri Lanka; and • Five years' work experience in external ODA loan projects.

(3) Scope of Works for the Respective Experts

Detailed information on the major tasks and duties each member of the consultant team shall perform is provided as follows:

Table 7 Major Tasks and Duties of Key Experts of the PMC

No	Position	Major Tasks and Duties
A1 B1	Team Leader/ Project Management (Key) Co-team Leader/ Project Management (Key)	<u>Overall Project Management</u> - To represent the Consultant Team and assume overall responsibility for the consulting services based on the contract for the services; - To execute the overall project management, monitoring of the progress of the Project and coordinate among MOI, PMU, PIUs, a lender and other agencies concerned for project implementation; - To prepare overall work schedule of the consulting services and implementation of the Project, and provide suggestions/ recommendation to MOI and PMU/PIUs; - To organize and control the Consultant Team and coordinate all activities of the Team including the mobilization of the members at the request time according to task requirement; - To guide and supervise the Consultant Team in providing suitable and effective consulting services necessary to ensure good quality and acceptable progress rates for all the works; - To assist and support all the Consultant's engineers/experts in all the works; - To prepare the inception report containing the outline of the project plan, implementation method, schedule; - To prepare the project operation guideline and guide PMU/PIUs how to use the guideline; - To prepare the monthly, quarterly, annual reports containing the present status of the project such as physical and financial progress and loan use, performance and problem within the reporting period, work schedule for coming reporting period and other necessary information; - To attend the regular and ad hoc meetings and workshops; - To plan and implement soft component programs in cooperation with the relevant experts; - To assist PMU/PIUs in monitoring the performance, progress, issue and problem of on-going works and program and to report to the Employer/ the Engineer from time to time for taking the necessary quick action; - To assist PMU/PIUs in selection of priority sub-projects based on the approved criteria; - To assist PMU/PIUs in preparation of Statement of Performance (SOP) and Statement of Expenditure (SOE) to be submitted to a lender; - To assist PMU/PIUs in monitoring and evaluation such as benchmark survey and environmental impact assessment; - To prepare the services completion report containing necessary information such as the project performance and consultant activities with supporting data; - To assist PMU/PIUs in safety in the project activities including preventive measures for COVID-19; - To organize overseas training to third country; - To carry out the project formulation study for future project, if required; - In case of accidents during the construction, assist the Employer to report to a lender the details of such accidents in manner reasonably requested by a lender; and - To prepare and submit reports to MOI, which are detailed in Chapter 6 in relation to the implementation of the Project.
A2 B2	Irrigation Design Engineer-A (Non-Key) Irrigation Design Engineer-B (Non-Key)	<u>Review of Detailed Design</u> - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To review available design criteria and design manuals for tank irrigation and farm roads; - To prepare detail work plan, schedule and work demarcation of design review of the infrastructure development; - To prepare check list of important points in design review; - To review the detailed design to be carried out by local consultant/s during the implementation of the Project in collaboration with PIUs, whether or not the detailed design be in sufficient detail to ensure clarity and understanding by the MOI, contractors and other relevant stakeholders; - To modify the detailed design in collaboration with PIUs, whenever necessary; - To monitor the monthly progress of detailed design works and design review; and - To prepare the services completion report for the respective parts including keeping proper records.
A3 B3	Construction Management Expert-A (Key) Construction Management Expert-B (Key)	<u>Procurement Support</u> - To review the bidding documents currently used by PMU/PIUs and modify it if necessary; - To assist PIUs in issuing bid invitation, conducting pre-bid conference, issuing addendum/corrigendum, and clarifications to bidders' queries; - To assist PIUs in evaluating bids in accordance with the criteria set forth in the bidding documents; - To assist PIUs in preparation of a bid evaluation report for approval of the bid evaluation

No	Position	Major Tasks and Duties
		committee; - To assist PIUs in contract negotiation by preparing agenda and facilitating negotiations including preparation of minutes of negotiation meeting; - To assist PIUs in preparation of a draft and final contract agreement; - To monitor the monthly progress of procurement works; and - To prepare the services completion report for the respective parts including keeping proper records. Support for Construction Supervision - To review the available reports, design documents and design drawings of tank irrigation facilities and farm roads to be rehabilitated; - To prepare detail work plan, schedule and work demarcation of the site supervisor teams; - To prepare the construction check list for infrastructure development; - To assist the Engineer (PIUs) in construction supervision for civil works (infrastructure development) including time control, quality control, cost control, finishing the contract, safety management and settlement of disputes; - To monitor the monthly physical and financial progress of each contract packages; - To assist PIUs in fund management including checking of invoices to be submitted by contractors and suppliers, etc.; - To assist the Engineer in issuing variations during the construction; - To assist the Engineer in settlement of claims issued by the contractors; and - To prepare the services completion report for the respective parts including keeping proper records.
A4 B4	Water Management Expert-A (Non-Key) Water Management Expert-B (Non-Key)	Institution and Capacity Development (Water Management) - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available reports and information useful for water management in Sri Lanka; - To collect and review the available training manuals and modules useful for water management and modify those if necessary; - To prepare implementation plan and schedule for water management activities in cooperation with PID/DAD; - To develop training materials and modules for the water management activities in cooperation with PID/DAD; - To select pilot sites for water management program in cooperation with PID/DAD; - To implement various trainings for the capacity improvement of FOs and relevant government officers for water management in cooperation with PID/DAD; - To implement various trainings for the promotion of awareness campaign of Tank Day in cooperation with PID/DAD and local governments; - To prepare training reports; - To organize follow-up trainings if required; and - To keep the training reports and records for preparation of services completion report.
A5 B5	Agricultural Expert-A (Key) Agricultural Expert-B (Key)	Agriculture Development - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available reports and information useful for agriculture development in Sri Lanka; - To collect and review the available training manuals and modules useful for agriculture development and modify those if necessary; - To prepare implementation plan and schedule for agriculture development program in cooperation with PDOA; - To develop training materials and modules for the program in cooperation with PDOA; - To select pilot sites for agriculture development program in cooperation with PDOA; - To implement various trainings for the cultivation skills development with provision of quality inputs in cooperation with PDOA; - To implement various training activities for the enhancement of agriculture extension system platform in cooperation with PDOA; - To prepare training reports; - To organize follow-up trainings if required ; and - To keep the training reports and records for preparation of services completion report.
A6 B6	Post Harvest and Market Expert-A (Non-Key) Post Harvest and	Post Harvest and Marketing Development - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available reports and information useful for agriculture and

No	Position	Major Tasks and Duties
	Market Expert-B (Non-Key)	post-harvest and marketing development in Sri Lanka; - To collect and review the available training materials and modules useful for agriculture post-harvest and marketing development and modify those if necessary; - To prepare implementation plan and schedule for agriculture post-harvest and marketing development program in cooperation with PDOA; - To develop training materials and modules for the program in cooperation with PDOA; - To select pilot sites for agriculture post-harvest and marketing development program in cooperation with PDOA; - To implement various trainings for the establishment of the community supported agriculture model in cooperation with PDOA; - To prepare training reports; - To organize follow-up trainings if required; and - To keep all the training reports and records for preparation of services completion report.
A7 B7	Environmental and Social Expert-A (Non-Key) Environmental and Social Expert-B (Non-Key)	<u>Overall Project Management (Environmental and Social Consideration)</u> - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available environmental guidelines in Sri Lanka; - To assist PMU/PIUs in preparation of the monitoring plan; - To assist PMU/PIUs in implementation of the monitoring based on agreed plan; - To assist PMU/PIUs in conducting the environmental impact assessment; and - To keep the monitoring reports and data for preparation of services completion report.
B8	Livestock Expert-B (Non-Key)	<u>Livestock Development</u> - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available reports and information useful for livestock development in Sri Lanka; - To collect and review the available training materials and modules useful for livestock development and modify those if necessary; - To prepare implementation plan and schedule for livestock development program in cooperation with PDAH; - To prepare training materials and modules for the program in cooperation with PDAH; - To select pilot sites for livestock development program in cooperation with PDAH; - To implement various trainings for the stable feed production and delivery through entrepreneur development in cooperation with PDAH; - To implement various trainings for the development of models for dairy cattle and backyard poultry under value chain system in cooperation with PDAH; - To prepare training reports; - To organize follow-up trainings if required; and - To keep the training reports and records for preparation of services completion report.
B9	Fishery Expert-B (Non-Key)	<u>Fishery Development</u> - To review and verify available primary and secondary data collected during the Preparatory Survey for the Project; - To collect and review the available reports and information useful for inland fishery development in Sri Lanka; - To collect and review the available training materials and modules useful for inland fishery development and modify those if necessary; - To prepare implementation plan and schedule for inland fishery development program in cooperation with NAQDA; - To prepare training materials and modules for the program in cooperation with NAQDA; - To select pilot sites for inland fishery development program in cooperation with NAQDA; - To implement various trainings for the promotion of inland fishery development in selective tanks in cooperation with NAQDA; - To prepare training reports; - To organize follow-up trainings if required; and - To keep the training reports and records for preparation of services completion report.

Note: Team Leader is International Key Expert and Co-Team Leader is Local Key Expert.
Source: Study Team

The above table is reference and the Consultant may modify it or propose additional experts to better accomplish the tasks indicated in the TOR. Other than above, supporting staff such as office manager, secretary, accountant, site supervisors, CAD operators and surveyors are to be assigned.

Chapter 6. Reporting

Within the scope of consulting services, the Consultant shall prepare and submit reports and documents to PMU as shown in Table 8. the Consultant shall provide electronic copy of each of these reports.

Table 8 Summary of Reports to be submitted by the Consultant

Category	Type of Report	Timing	No. of Copies
Consultancy Services	Inception Report	Within 3 months after commencement of the Services	10
	Monthly Progress Report	Monthly, by the 7th of each following month	10
	Quarterly Progress Report	Quarterly, by the 15th of the following month	10
	Annual Progress Report	Annually, by the end of the following month	10
	Services Completion Report	At the end of Services	10
Operational Guideline	Implementation arrangement and procedure for the Project with sample forms and documents	Within 6 months after commencement of the Services	10
Trainings for Soft Component	Annual Training Programme	Annually, by the 15th of the following month	10
	Training Materials	2 weeks before each training	10
	Evaluation Report of Training Programme	Annually, by the 15th of the following month	10
Environmental and Social Safeguard	Environmental Monitoring Report	Annually, by the 15th of the following month	10
Project Evaluation	Baseline Survey Report	Within 6 months after commencement of the Services	10
Project Evaluation Other Report	Project-end Evaluation Survey Report	Before the completion of services	10
	Technical Report	As required or upon request	As required

Source: Study Team

Contents to be included in each report are as follows:

(1) Inception Report (10 sets)

Inception report, to be submitted within 3 months after the commencement of the services, shall contain overall work schedule, work plan, administrative arrangement, results of review of available data and information, relevant to the Project during the inception period, and so on.

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

Monthly progress report and quarterly progress report, to be prepared monthly by the 7th of the following month and quarterly by the 15th of the following month, shall contain detailed information of physical and financial progress of the project components, issues and problems, consultant's input and activities, and schedule of works for the next period.

(3) Annual Progress Report (10 sets)

Annual work plan, to be prepared annually by the end of the following month, shall contain detailed information of packaging plan, activities, schedule and budget estimate for the next physical year in addition to the performance of this year.

(4) Services Completion Report (10 sets)

Based on the monitoring and evaluation records of the project activities, the consultant shall prepare and submit the services completion report which covers the results of all the project components at the end of the services.

(5) Operational Guidelines for the Project (10 sets)

Guidelines for project implementation with sample forms and documents, which include project description, scope, implementation arrangement and procedure for fund management, etc.

(6) Sample Bid Documents of Infrastructure and Facility Development (10 sets)

Sample bid documents, to be prepared after the completion of design review/modification of tanks and irrigation facilities, and if required PQ documents as well.

(7) Construction Check list for Infrastructure and Facility Development (10 sets)

Construction check list, to be prepared in compliance with the government guideline within 3 months after the commencement of the services, shall contain progress control, quality control, safety control, etc.

(8) Annual Training Programme for Soft Component (10 sets)

Annual training Programme report, to be prepared annually by the 15^{th} of the following month, shall contain training details such as overall training plan, respective training subject, schedule, trainees, number of trainers and cost.

(9) Training Materials for Soft Component (10 sets)

Training materials shall be prepared at least 2 weeks before each training according to the annual training programme.

(10) Evaluation Report of Training Programme for Soft Component (10 sets)

Evaluation report for trainings, to be prepared annually the 15^{th} of the following month, shall contain list of training program, cost, number of participants, level of intelligibility, degree of satisfaction, etc.

(11) Environmental Monitoring Report (10 sets)

Environmental monitoring plan, to be prepared by the PMU annually by the 15^{th} of the following month, shall contain water quality, soil condition, fertilizer application, usage of forest products, etc.

(12) Baseline Survey Report (10 sets)

Baseline survey report, to be prepared within 6 months after the commencement of the services, shall contain basic information, cropping pattern and production, marketing and post-harvesting activities, social environmental background, water source and soil condition, to be used as benchmark for terminal impact assessment at the end of the project.

(13) Project-end Evaluation Survey Report (10 sets)

Terminal impact assessment report, to be prepared 3 months before the completion of the services, shall contain various aspects; basic information, cropping pattern and production, incomes, marketing and post-harvesting activities, social environmental background, water source and soil condition to be used as benchmark for impact assessment at the end of the project.

(14) Other Technical Reports (as required)

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

Chapter 7. Obligation of the Executing Agency

A certain range of arrangements and services will be provided by the Executing Agency to the Consultant for smooth implementation of the Consulting Services. In this context, the ID/MOI shall:

(1) Reports and data

Make available to the Consultant available reports and data related to the Project.

(2) Cooperation and counterpart staff

Appoint counterpart officials, agent and representative as may be necessary for effective implementation of the Consulting Services;

(3) Office space in Anuradhapura

Provide office space sufficient for the Consulting Services, with necessary equipment, furniture and utilities free of any charge, otherwise it should be stated that ID would be unable to provide such facilities in the RFP.

(4) Vehicles and Motorbikes

Make available to the Consultant four 4WD vehicles and 12 motorbikes. If the consultant requires more vehicles or motorbikes, the required costs should be included in the proposal.

(5) Assistance and Exemption

Use its best efforts to ensure that the assistance and exemption, as described in the Standard Request for Proposal issued by a lender, shall be provided to the Consultant, in relation to

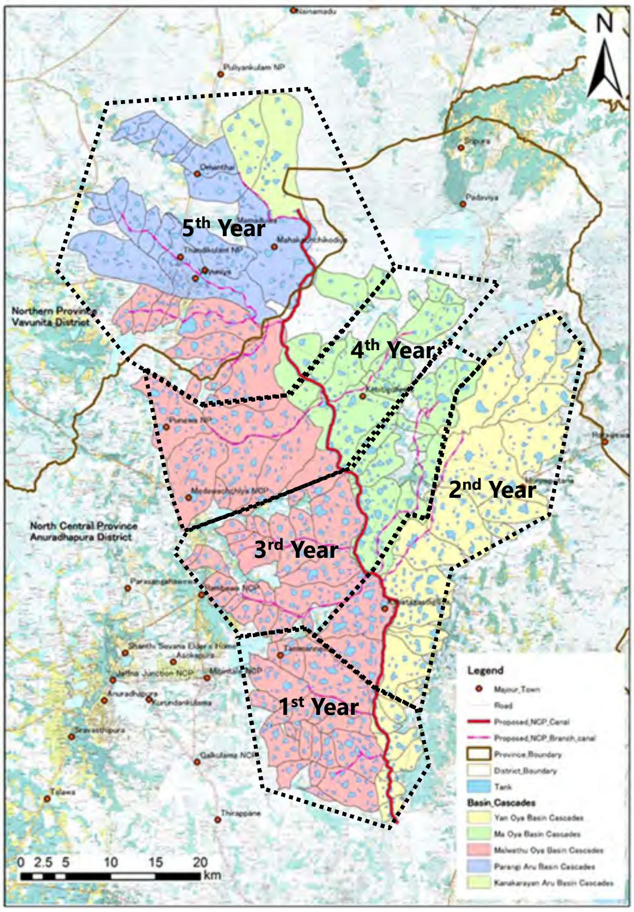
- work permit and such other documents;
- entry and exit visas, residence permits, exchange permits and such other documents
- clearance through customs;
- instructions and information to officials, agent and representatives of the Client's Government;
- exemption from any requirement for registration to practice their profession; and
- privilege pursuant to the applicable law in the Client's Country.

Attachment 6.4-1 Review of CSDPP Implementation Schedule for Cascade Infrastructure Development

Considering the present implementing capacity of PDI/NCP and DAD/NP, stage-wise implementation plan is proposed for the Project. The following three plans were examined considering the sequence of construction, the distribution balance of regional, economic and social benefits in the target area.

Plan (A): NCPC Irrigation Block (CSDPP)

Plan (A) is a standard implementation plan starting the construction from the upstream to downstream command areas along branch canals. This plan is commonly used where main canal system has been completed or going to be completed. Under Plan (A), 124 sub-projects are divided into five groups based on the diversion points of branch canals as shown in Figure 1 and Table 1.



Source: Study Team

Figure 1 Plan (A) Grouping of Sub-projects by NCPC Irrigation Block

Table 1 Implementation Period of Rehabilitation Works by NCPC Irrigation Block (Plan (A))

NCPC Irrigation Block	No. of sub-project	Grouping
Upstream Left	27	1st Stage Group
Upstream Right	19	2nd Stage Group
Upstream Middle	31	3rd Stage Group
Downstream Middle	20	4th Stage Group
Downstream End	31	5th Stage Group

Source: Study Team

Plan (B): River Basin

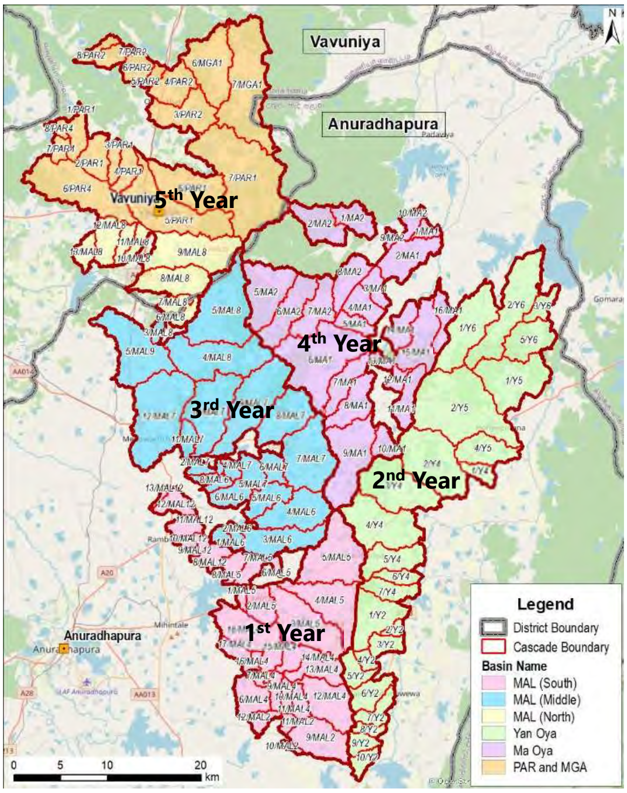
Plan (B) is almost similar to Plan (A). The difference is only that Plan (B) divide 124 sub-projects into five river basins in consideration of district boundary. To make use of the detailed survey results of the model cascade systems as reference, it is better to group the sub-projects by river basin and district boundary as shown in Table 2 and Figure 2.

Table 2 Grouping of Sub-projects for Rehabilitation Works by River Basin (Plan (B))

District (Province)	River Basin	Model Cascade System	No. of Sub-projects	Grouping
Anuradhapura (NCP)	Yan Oya	Ithalawatuna wewa	22	2nd Stage Group
	Ma Oya	Kiulekada Wewa	24	4th Stage Group
	Maluwathu Oya	Ichchan Kulama	30	1st Stage Group
		Siyabalagaswewa	22	3rd Stage Group
Vavuniya (NP)		Alangalla	8	5th Stage Group
	Parangi Aru	Noveli Kulam	18	
	Kanakarayan Aru	-		

Source: Study Team

Because of the large number of sub-projects in Maluwathu Oya, which will be levelled dividing into three groups; south, middle and north. While, as the number of sub-projects in Parangi Aru and Kanakarayan Aru are relatively small, it is proposed to combine along with the north Maluwathu Oya.



Source: Study Team

Figure 2 Plan (B) Grouping of Sub-projects by River Basin

Plan (C): Development Priority

Plan (C) is that 124 sub-projects will be prioritized simply based on economic viability evaluated by cost benefit (B/C) ratio of each sub-projects regardless of branch canal alignment, river basin, district boundary and reginal balance.

Comparison of Plans

Taking into consideration of the above, the following grouping plans of sub-projects for the rehabilitation works are examined from merits and demerits.

Table 3 Comparison of Grouping of Rehabilitation Works

Plan	Merit	Demerit
(A) NCPC Irrigation Block (5 blocks in total)	• Construction supervision is relatively efficient because the construction sites are concentrated in specific area. • Regional balance can be maintained in combination with Plan (C). (Quick effect of the Project can be expected with NCPC condition)	• Some irrigation block is located across the districts. • Effect of the Project will not be quick as Plan (C).
(B) River Basin and District (5 zones in total)	• Construction supervision is relatively efficient because the construction sites are concentrated in specific area. • Administrative boundaries can be considered. • Regional balance can be maintained in combination with Plan (C). (Quick effect of the Project can be expected with NCPC condition)	• Effect of the Project will not be quick as Plan (C).
(C) Development Priority (No block and zone)	• Quick effect of the Project can be expected without NCPC condition.	• Construction supervision is relatively inefficient comparing Plans (A) and (B) because the construction sites are scattered. • Reginal balance may not be maintained during the construction period.

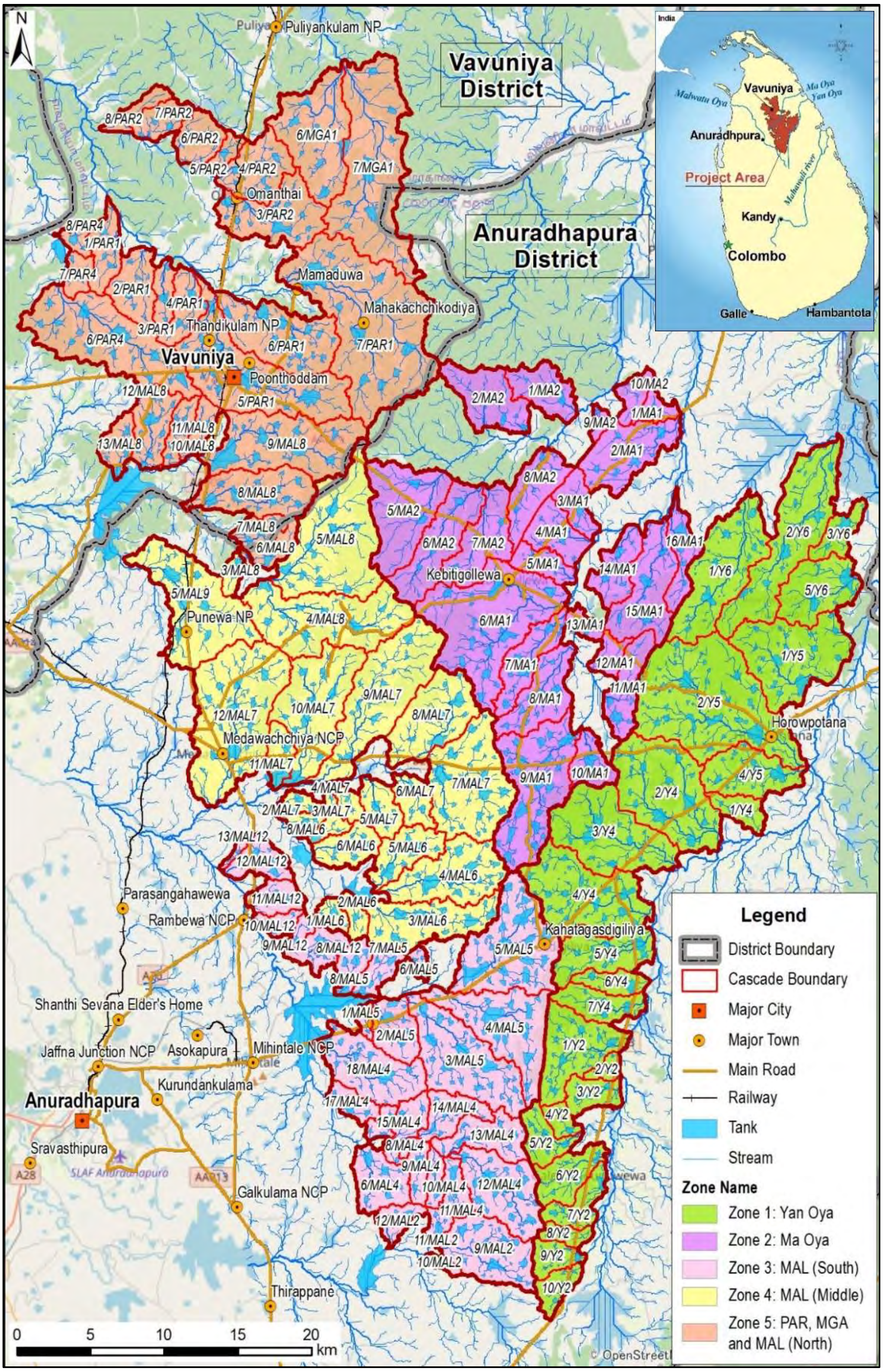
Source: Study Team

Plan (A) and Plan (B) are usually applied for irrigation development projects, which develop the command areas in order from upstream to downstream command areas. In consideration of that the Project be designed without NCPC condition, it is not always necessary to apply Plan (A) or Plan (B).

Meanwhile, Plan (C) has advantage to realize a quick benefit of the Project without NCPC condition. In case that the reginal development balance is considered as an important factor, Plan (C) would not fulfil such requirement.

<u>Therefore, it is recommendable for the Project to apply the combination of Plan (B) and Plan (C). In other words, the sub-projects for the rehabilitation works will be grouped with priority within each river basin.</u>

JICA Project Team proposes to divide the Project area into five zones based on the river basins for the rehabilitation works as shown in the following figure.



Source: Study Team

Figure 3 Combination of Plan (B) and Plan (C)
Grouping of Sub-projects by Zone
by River Basin

Attachment 6.5-1: Plan for Contract Packaging by Sub-project

The number of contract packages is estimated based on the following conditions:

i) Calculation of the number of contract package within each cascade
ii) 1 to 3 tanks per contract for medium scheme
iii) 1 to 5 tanks per contract for minor scheme
iv) Adjustment of the number of tanks per contract with adjacent cascades if possible

The following table shows the summary of contract packages by zone

Table 1 Summary of Contract Packages by Zone

Non-disclosure information

Note: Six out of twenty-six cascades in Zone 5 are located across the districts
Source: Study Team

The following table shows the detail breakdown of the number of contract package by sub-project.

Table 2: Detail Breakdown of Contract Package

Non-disclosure information

Non-disclosure information

Non-disclosure information

Non-disclosure information

Source: Study Team

Attachment 7.1-1: Detail Test Result of Water Quality Test of the Five Project Target Tanks

Report No: NBRO/WQ/20/031-a

TEST REPORT

1.0 Sample Particulars

Customer: Project Management Associate International (Pvt) Ltd No. 51/1 Rajagiriya road Rajagiriya	**Test Item:** Surface water **Service requested:** Parameter as per the customer's request dated 02/03/2020
Number of samples: 05	**Quantity of sample:** Each approximately, 1 L in a plastic bottle for chemical parameter analysis 300 mL in a sterilized glass bottles for microbiological analysis 500 mL in a glass bottle for Oil & Grease analysis.
Samples collected by: NBRO – ESSD Laboratory Mr. Prabath Liyanaarachchi - Scientist Mr. Chamath Vithana - Technical Assistant	**Witnessed by:** JICA Mr. Nalinda Pieris – Environmental Specialist Project Management Associate International (Pvt) Ltd Mr. Karunandarajah – Tec. Coordinator Mr. Adiakai - Tec. Coordinator
Date of sampling: 01/07/2020	**Time of sampling:** 9.39 – 16:10 hrs.
Date receipt to the laboratory: 02/07/2020	**Date of analysis:** 01/07/2020 to 23/08/2020

2.0 Sample Identification

Location reference	Sample description	Laboratory reference
Vavniya tank (111-7) Cascade ID - 111 8.75842 N 80.50228 E	Water sample was taken close to the spill of the Vavniya tank located near to Vavniya town. Depth of the water column was about 1 m. Appearance of water was slightly turbid and yellowish in color. *Eichhornia crassipes* (Japan Jabara) and aquatic weeds were floating on the water surface. Paddy fields were observed in the vicinity. Water is used for agricultural and washing purposes.	**W1**
Gonu Hathdenawa Maha Wewa (96-5) Cascade ID - 96 8.58934 N 80.68464 E	Water sample was taken close from Gonu Hathdenawa Maha Wewa near to Kebithigollawa area. Depth of the water column was about 1 m. Appearance of water was slightly turbid and yellowish in color. Floating plants (*Eichhornia crassipes* (Japan Jabara), *Salvinia sp.*) and submerged plants (Hydrilla) were observed in the water column. Water is used for agriculture, bathing and washing purposes.	**W2**
Mora Wewa (82-16) Cascade ID - 82 8.59305 N 80.83830 E	Water sample was taken from Mora Wewa near to Horowpathana area. Depth of the water column was about 2 m. Appearance of water was clear. Aquatic weeds and submerged plants (Hydrilla) were observed in the water column. Water is used for agriculture, bathing and washing purposes.	**W3**

Location reference	Sample description	Laboratory reference
Lulnewa Wewa (22-5) Cascade ID - 22 8.41505 N 80.66487 E	Water sample was taken from Lulnewa Wewa near to Bethkewewa area. Depth of the water column was about 2 m. Appearance of water was slightly turbid and yellowish in color. Aquatic weeds and submerged plants (Hydrilla) were observed in the water column. Water is used for agriculture, bathing and washing purposes.	**W4**
Mada Wewa (19-3) Cascade ID - 19 8.38768 N 80.59292 E	Water sample was taken from Mada Wewa near to Seeppukulama area. Depth of the water column was about 1 m. Appearance of water was slightly turbid and yellowish in color. Aquatic weeds, Lotus, *Salvinia sp.* and submerged plants (Hydrilla) were observed in the water column. Water is used for agriculture, bathing and washing purposes.	**W5**

Weather – Hot sunny weather condition prevailed during the sampling period
Reference: Annexure I: Google image for sampling locations

3.0 Test Results

	Method	Results					LOD	*E U (K=2)*
		W1	W2	W3	W4	W5		
*pH	APHA-4500-H^+ B	7.8	8.0	8.0	7.7	7.2		-
Temperature, °C	APHA-2550 B	29.7	29.8	29.9	30.4	30.2		-
*Electrical Conductivity mS/cm	APHA-2510 B	0.777	0.357	0.394	1.256	0.661		-
Color , mg Pt/L	Photometric method	ND	ND	ND	ND	ND	15	-
*Dissolved Oxygen, mg /L	APHA-4500 O C	3.2	3.5	3.8	2.8	1.8		-
Biochemical Oxygen Demand at 20°C (BOD5) mg / L	APHA-5210 B	10	12	10	14	4	1	*4%*
*Turbidity, NTU	APHA- 2130 B	6	8	10	3	4		-
Total Suspended Solids, mg/L	APHA -2540 D	25	4	3	12	5		*14%*
Total Iron (as Fe), mg/L	APHA 3111	0.3	0.2	0.2	0.1	0.1		-
Fluoride (as F^-), mg/L	APHA 4500 F^- D	ND	ND	ND	2.6	ND	2.0	-
Chloride (as Cl^-), mg/L	APHA 4500 Cl^- B	78	25	24	199	97		-
Nitrate (as N), mg/L	APHA 4500 NO_3^- B	8.8	4.8	0.1	4.0	4.0		-
Ammonia (as N), mg/L	Photometric Method	0.1	0.1	0.1	0.2	0.1		
Total Hardness (as $CaCO_3$), mg/L	APHA-2340 C	172	70	90	302	150		*1%*
Total Phosphate (as P),mg/L	APHA-4500 D	ND	ND	ND	ND	ND	0.1	-
Oil & Grease, mg/L	APHA-5520 B	ND	4.0	1.8	ND	ND	1.4	-
Sulfate (as SO_4^{2-}) , mg/L	APHA-4500 E	35	23	18	26	21		-
Chemical Oxygen Demand, O_2 mg /L	APHA -5220 B	108	130	140	166	138		*12%*
E Coli / 100mL	SLS 1461 Part I	100	700	100	700	1800		-

	Method	Results					LOD	*E U* *(K=2)*
		W1	W2	W3	W4	W5		
Total Coliform / 100mL	SLS 1461 Part I	400	2600	290	700	2500		-
Cadmium (as Cd), mg/L	APHA 3111	ND	ND	ND	ND	ND	0.001	-
Chromium (as Cr), mg/L		ND	ND	ND	ND	ND	0.01	-
Cupper (as Cu), mg/L		ND	ND	ND	ND	ND	0.01	-
Lead (as Pb), mg/L		ND	ND	ND	ND	ND	0.01	-
Manganese (as Mn), mg/L		0.12	0.04	0.05	0.14	0.12		-
Mercury (as Hg), mg/L		ND	ND	ND	ND	ND	0.001	-
Nickel (as Ni), mg/L		ND	ND	ND	ND	ND	0.01	-
Selenium (as Se), mg/L		ND	ND	ND	ND	ND	0.001	-
Zinc (as Zn), mg/L		0.05	0.03	ND	0.18	ND	0.02	-
Barium (as Ba), mg/L		0.11	0.03	0.03	0.22	0.11		-
Arsenic (as As), mg/L		0.002	ND	ND	ND	ND	0.001	-
Aluminum (as Al), mg/L		ND	ND	ND	ND	ND	0.05	-
Anionic Surfactants , mg/L	APHA-5540 C	1.10	0.10	0.09	0.14	0.14		-
Phenolic Compound, mg/L	APHA 5530 B & D	ND	ND	ND	0.6	ND	0.5	
Pesticides								
Fenoxy prop p ethyl, mg/L	Solvent Extraction followed by Liquid Chromatography Tandem Mass Spectrometer	ND	ND	ND	ND	ND	0.01	-
Metribuzin, mg/L		ND	ND	ND	ND	ND	0.01	-
Hexaconazole, mg/L		ND	ND	ND	ND	ND	0.001	-
Tebuconazole, mg/L		ND	ND	ND	ND	ND	0.001	-
BPMC, mg/L		ND	ND	ND	ND	ND	0.001	-
Diazinon, mg/L		ND	ND	ND	ND	ND	0.01	-
Pirimiphos methyl, mg/L		ND	ND	ND	ND	ND	0.001	-
Thiamethoxam , mg/L		ND	ND	ND	ND	ND	0.01	-
Bisphyribac sodium, mg/L		ND	ND	ND	ND	ND	0.01	-
Carbofuran, mg/L		ND	ND	ND	ND	ND	0.001	-
Chlophyrifos, mg/L		ND	ND	ND	ND	ND	0.001	-
Fipronil, mg/L		ND	ND	ND	ND	ND	0.01	-
Imidachloprid, mg/L		ND	ND	ND	ND	ND	0.01	-
Phenthoate, mg/L		ND	ND	ND	ND	ND	0.001	-
Profenofos, mg/L		ND	ND	ND	ND	ND	0.001	-
Quinalphos, mg/L		ND	ND	ND	ND	ND	0.001	-
Dimethoate, mg/L		ND	ND	ND	ND	ND	0.01	-
Diuron, mg/L		ND	ND	ND	ND	ND	0.01	-
Fenithrothion, mg/L		ND	ND	ND	ND	ND	0.001	-
Captan, mg/L		ND	ND	ND	ND	ND	0.001	-
Methomyl, mg/L		ND	ND	ND	ND	ND	0.001	-
Tricyclozole, mg/L		ND	ND	ND	ND	ND	0.001	-
Isoprothiolane, mg/L		ND	ND	ND	ND	ND	0.01	-

	Method	Results					LOD	
		W1	W2	W3	W4	W5		
Fenthion, mg/L	Solvent Extraction followed by Liquid Chromatography Tandem Mass Spectrometer	ND	ND	ND	ND	ND	0.01	-
Fenamiphos, mg/L		ND	ND	ND	ND	ND	0.001	-
Flutolanil, mg/L		ND	ND	ND	ND	ND	0.001	-
Triazophos, mg/L		ND	ND	ND	ND	ND	0.001	-
Novaluron, mg/L		ND	ND	ND	ND	ND	0.01	-
Deltamethrin, mg/L		ND	ND	ND	ND	ND	0.001	-

*Measured on site

APHA - Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF 2017, 23rd Edition.

SLS - SLS 1461, Microbiological test method for water, Part I Detection and enumeration of *Escherichia coli* and Coliform bacteria, Section 3 Reference Method.

ND – Not detected

Pesticides – Analysis was carried out in laboratory of Industrial Technology Institute

Analysis was carried out by: M P Arunasiri - Technical Assistant
H G Abeywardana - Technical Assistant

Checked by: ....

S A M S Dissanayake
Coordinator / Senior Scientist / Technical Manager
Water Quality Lab
Environmental Studies & Services Division
National Building Research Organisation

Certified by: ....
S V Dias
Director/ Environmental Studies and Services Division

Attachment 7.1-2: Detail Test Result of Soil Test of the Five Project Target Tanks

Continuation Sheet....

Report No: NBRO/WQ/20/031-b

TEST REPORT

1.0 Sample Particulars

Customer: Project Management Associate International (Pvt) Ltd No. 51/1 Rajagiriya road Rajagiriya	**Test Item:** Soil **Service requested:** Parameter as per the customer's request dated 02/03/2020
Number of samples: 05	**Quantity of sample:** Each approximately 5 kg in sample
Samples collected by: NBRO – ESSD Laboratory Mr. Prabath Liyanaarachchi - Scientist Mr. Chamath Vithana - Technical Assistant	**Witnessed by:** **JICA** Mr. Nalinda Pieris – Environmental Specialist **Project Management Associate International (Pvt) Ltd** Mr. Karunandarajah – Tec. Coordinator Mr. Adiakai - Tec. Coordinator
Date of sampling: 01/07/2020	**Time of sampling:** 9.39 – 16:10 hrs.
Date receipt to the laboratory: 02/07/2020	**Date of analysis:** 01/07/2020 to 24/08/2020

2.0 Sample Identification

Location reference	Sample description	Laboratory reference
Vavniya tank (111-7) Cascade ID - 111 8.759746 N 80.503004 E	Soil sample was collected from a paddy field close to Vavniya tank located near to Vavniya town. Sample is wet and dark brown in color.	S1
Gonu Hathdenawa Maha Wewa (96-5) Cascade ID - 96 8.590950 N 80.680486 E	Soil sample was collected from a paddy field close to the Gonu Hathdenawa Maha Wewa near to Kebithigollawa area. Sample is wet and dark brown in color.	S2
Mora Wewa (82-16) Cascade ID - 82 8.595921 N 80.839911 E	Soil sample was collected from an abandoned paddy field close to Mora Wewa near to Horowpathana area. Sample is wet and dark brown in color.	S3
Lulnewa Wewa (22-5) Cascade ID - 22 8.414810 N 80.66321 E	Soil sample was collected from a paddy field close to the Lulnewa Wewa near to Bethkewewa area. Sample is wet and dark brown in color.	S4

Continuation Sheet....

Report No: NBRO/WQ/20/031-b

Location reference	Sample description	Laboratory reference
Mada Wewa (19-3) Cascade ID - 19 8.384633 N 80.59001 E	Soil sample was collected from a paddy field close to the Mada Wewa near to Seeppukulama area. Sample is wet and dark brown in color.	S5

Weather – Hot sunny weather condition prevailed during the sampling period
Reference: Annexure I: Google image for sampling locations

3.0 Test Results

Parameter/Unit	Method	Results					LOD
		S1	S2	S3	S4	S5	
Cadmium (as Cd), mg/kg	APHA 3111	ND	ND	ND	ND	ND	2.0
Chromium (as Cr), mg/kg		12.0	23.6	12.5	15.6	8.5	-
Lead (as Pb), mg/kg		4.1	2.3	2.5	4.0	3.4	-
Mercury (as Hg), mg/kg		ND	ND	ND	ND	ND	0.4
Arsenic (as As), mg/kg		ND	ND	ND	ND	ND	0.4
Phenolic Compound, mg/kg	APHA 5530 B & D	ND	ND	ND	ND	ND	-
Oil & Grease, mg/kg	APHA-5520 B	26.5	54.5	53.3	74.4	30.5	-
Poly Aromatic Hydrocarbon							
Naphthalene, mg/kg	CPSD-AN-00576	0.12	ND	ND	ND	ND	0.1
Acenaphthylene, mg/kg		ND	ND	ND	ND	ND	0.1
Acenaphthene, mg/kg		ND	ND	ND	ND	ND	0.1
Fluorene, mg/kg		ND	ND	ND	ND	ND	0.1
Phenanthrene, mg/kg		ND	ND	ND	ND	ND	0.1
Anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Fluoranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Pyrene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[a]anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Chrysene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[a]pyrene, mg/kg		ND	ND	ND	1.10	ND	0.1
Benzo[e]pyrene, mg/kg		ND	ND	ND	1.31	ND	0.1
Indeno[1,2,3-cd]pyrene, mg/kg		ND	ND	ND	3.34	ND	0.1
Dibenzo[a,h]anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[g,h,i]perylene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[b]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[j]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[k]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1

Pesticides							
Fenoxy prop p ethyl, mg/kg	Solvent Extraction followed by Liquid Chromatography Tandem Mass Spectrometer	ND	ND	ND	ND	ND	0.01
Metribuzin, mg/kg		0.1	ND	ND	ND	0.2	0.01
Hexaconazole, mg/kg		ND	ND	ND	ND	ND	0.001
Tebuconazole, mg/kg		ND	ND	ND	ND	ND	0.001
BPMC, mg/kg		ND	ND	ND	ND	ND	0.001
Diazinon, mg/kg		0.1	ND	ND	0.9	ND	0.01
Pirimiphos methyl, mg/kg		ND	ND	ND	ND	ND	0.001
Thiamethoxam , mg/kg		ND	ND	ND	ND	ND	0.01
Bisphyribac sodium, mg/kg		ND	ND	ND	ND	ND	0.01
Carbofuran, mg/kg		0.4	ND	ND	0.5	0.7	0.001
Chlophyrifos, mg/kg		ND	ND	ND	ND	ND	0.001
Fipronil, mg/kg		ND	ND	ND	ND	ND	0.01
Imidachloprid, mg/kg		ND	ND	ND	ND	ND	0.01
Phenthoate, mg/kg		ND	ND	ND	ND	ND	0.001
Profenofos, mg/kg		ND	ND	ND	ND	ND	0.001
Quinalphos, mg/kg		ND	ND	ND	ND	ND	0.001
Dimethoate, mg/kg		ND	ND	ND	ND	ND	0.01
Diuron, mg/kg		0.07	ND	ND	ND	0.1	0.01
Fenithrothion, mg/kg		0.09	ND	ND	0.1	0.8	0.001
Captan, mg/kg		ND	ND	ND	ND	ND	0.001
Methomyl, mg/kg		ND	ND	ND	ND	ND	0.001
Tricyclozole, mg/kg		ND	ND	ND	ND	ND	0.001
Isoprothiolane, mg/kg		ND	ND	ND	ND	ND	0.01
Fenthion, mg/kg		ND	ND	ND	ND	ND	0.01
Fenamiphos, mg/kg		ND	ND	ND	ND	ND	0.001
Flutolanil, mg/kg		ND	ND	ND	ND	ND	0.001
Triazophos, mg/kg		ND	ND	ND	ND	ND	0.001
Novaluron, mg/kg		ND	ND	ND	ND	ND	0.01
Deltamethrin, mg/kg		ND	ND	ND	ND	ND	0.001

PCB							
PCB 28, mg/kg	AOAC official method of analysis, 1990 15th Edition	ND	ND	ND	ND	ND	0.001
PCB 52, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 101, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 118, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 138, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 153, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 180, mg/kg		ND	ND	ND	ND	ND	0.001

*Measured on site
APHA - Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF 2017, 23rd Edition.

ND – Not detected

Pesticides – Analysis was carried out in laboratory of Industrial Technology Institute
Poly Aromatic Hydrocarbon - Analysis was carried out in laboratory of BUREAU VERITAS LANKA (PVT) LTD

Analysis was carried out by: M P Arunasiri - Technical Assistant

Checked by: ....

S A M S Dissanayake

Certified by: ....
S V Dias
Director/ Environmental Studies and Services Division

Attachment 7.1-3: Detail Test Result of Bottom Sediments Test of the Five Project Target Tanks

Continuation Sheet….

Report No: NBRO/WQ/20/031-c

TEST REPORT

1.0 Sample Particulars

Customer:	**Test Item:** Bottom sediments
Project Management Associate International (Pvt) Ltd No. 51/1 Rajagiriya road Rajagiriya	**Service requested:** Parameter as per the customer's request dated 02/03/2020
Number of samples: 05	**Quantity of sample:** Each approximately 5 kg of sediments
Samples collected by: NBRO – ESSD Laboratory Mr. Prabath Liyanaarachchi - Scientist Mr. Chamath Vithana - Technical Assistant	**Witnessed by:** **JICA** Mr. Nalinda Pieris – Environmental Specialist **Project Management Associate International (Pvt) Ltd** Mr. Karunandarajah – Tec. Coordinator Mr. Adiakai - Tec. Coordinator
Date of sampling: 01/07/2020	**Time of sampling:** 9.39 – 16:10 hrs.
Date receipt to the laboratory: 02/07/2020	**Date of analysis:** 01/07/2020 to 24/08/2020

2.0 Sample Identification

Location reference	Sample description	Laboratory reference
Vavniya tank (111-7) Cascade ID - 111 8.75842 N 80.50228 E	Bottom sediment sample was collected from Vavniya tank close to spill (near to Vavniya town). Sample is wet and dark brown in color.	**BS1**
Gonu Hathdenawa Maha Wewa (96-5) Cascade ID - 96 8.58934 N 80.68464 E	Bottom sediment sample was collected from Gonu Hathdenawa Maha Wewa near to Kebithigollawa area. Sample is wet and dark brown in color.	**BS2**
Mora Wewa (82-16) Cascade ID - 82 8.593922 N 80.838267 E	Bottom sediment sample was collected from Mora Wewa near to Horowpathana area. Sample is wet and dark brown in color.	**BS3**
Lulnewa Wewa (22-5) Cascade ID - 22 8.41603 N 80.66549 E	Bottom sediment sample was collected from Lulnewa Wewa near to Bethkewewa area. Sample is wet and dark brown in color.	**BS4**

Location reference	Sample description	Laboratory reference
Mada Wewa (19-3) Cascade ID - 19 8.38768 N 80.59292 E	Bottom sediment sample was collected from Mada Wewa near to Seeppukulama area. Sample is wet and dark brown in color.	BS5

Weather – Hot sunny weather condition prevailed during the sampling period
Reference: Annexure I: Google image for sampling locations

3.0 Test Results

Parameter/Unit	Method	Results					LOD
		BS1	BS2	BS3	BS4	BS5	
Cadmium (as Cd), mg/kg	APHA 3111	ND	ND	ND	ND	ND	2.0
Chromium (as Cr), mg/kg		ND	ND	ND	ND	ND	-
Lead (as Pb), mg/kg		ND	ND	ND	ND	ND	-
Mercury (as Hg), mg/kg		ND	ND	ND	ND	ND	0.4
Arsenic (as As), mg/kg		ND	ND	ND	ND	ND	0.4
Phenolic Compound, mg/kg	APHA 5530 B & D	ND	ND	ND	ND	ND	-
Oil & Grease, mg/kg	APHA-5520 B	111.9	57.1	51.5	72.9	28.0	-
Poly Aromatic Hydrocarbon							
Naphthalene, mg/kg	CPSD-AN-00576	ND	ND	1.52	ND	ND	0.1
Acenaphthylene, mg/kg		ND	ND	ND	ND	ND	0.1
Acenaphthene, mg/kg		ND	ND	ND	ND	ND	0.1
Fluorene, mg/kg		ND	ND	ND	ND	ND	0.1
Phenanthrene, mg/kg		ND	ND	ND	ND	ND	0.1
Anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Fluoranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Pyrene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[a]anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Chrysene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[a]pyrene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[e]pyrene, mg/kg		ND	ND	ND	ND	ND	0.1
Indeno[1,2,3-cd]pyrene, mg/kg		ND	ND	ND	ND	ND	0.1
Dibenzo[a,h]anthracene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[g,h,i]perylene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[b]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[j]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1
Benzo[k]flouranthene, mg/kg		ND	ND	ND	ND	ND	0.1

Pesticides							
Fenoxy prop p ethyl, mg/kg	Solvent Extraction followed by Liquid Chromatography Tandem Mass Spectrometer	ND	ND	ND	ND	ND	0.01
Metribuzin, mg/kg		ND	ND	ND	ND	ND	0.01
Hexaconazole, mg/kg		ND	ND	ND	ND	ND	0.001
Tebuconazole, mg/kg		ND	ND	ND	ND	ND	0.001
BPMC, mg/kg		ND	ND	ND	ND	ND	0.001
Diazinon, mg/kg		ND	ND	ND	ND	ND	0.01
Pirimiphos methyl, mg/kg		ND	ND	ND	ND	ND	0.001
Thiamethoxam , mg/kg		ND	ND	ND	ND	ND	0.01
Bisphyribac sodium, mg/kg		ND	ND	ND	ND	ND	0.01
Carbofuran, mg/kg		ND	ND	ND	ND	ND	0.001
Chlophyrifos, mg/kg		ND	ND	ND	ND	ND	0.001
Fipronil, mg/kg		ND	ND	ND	ND	ND	0.01
Imidachloprid, mg/kg		ND	ND	ND	ND	ND	0.01
Phenthoate, mg/kg		ND	ND	ND	ND	ND	0.001
Profenofos, mg/kg		ND	ND	ND	ND	ND	0.001
Quinalphos, mg/kg		ND	ND	ND	ND	ND	0.001
Dimethoate, mg/kg		ND	ND	ND	ND	ND	0.01
Diuron, mg/kg		ND	ND	ND	ND	ND	0.01
Fenithrothion, mg/kg		ND	ND	ND	ND	ND	0.001
Captan, mg/kg		ND	ND	ND	ND	ND	0.001
Methomyl, mg/kg		ND	ND	ND	ND	ND	0.001
Tricyclozole, mg/kg		ND	ND	ND	ND	ND	0.001
Isoprothiolane, mg/kg		ND	ND	ND	ND	ND	0.01
Fenthion, mg/kg		ND	ND	ND	ND	ND	0.01
Fenamiphos, mg/kg		ND	ND	ND	ND	ND	0.001
Flutolanil, mg/kg		ND	ND	ND	ND	ND	0.001
Triazophos, mg/kg		ND	ND	ND	ND	ND	0.001
Novaluron, mg/kg		ND	ND	ND	ND	ND	0.01
Deltamethrin, mg/kg		ND	ND	ND	ND	ND	0.001

PCB							
PCB 28, mg/kg	AOAC official method of analysis, 1990 15th Edition	ND	ND	ND	ND	ND	0.001
PCB 52, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 101, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 118, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 138, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 153, mg/kg		ND	ND	ND	ND	ND	0.001
PCB 180, mg/kg		ND	ND	ND	ND	ND	0.001

*Measured on site
APHA - Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF 2017, 23rd Edition.

ND – Not detected

Pesticides – Analysis was carried out in laboratory of Industrial Technology Institute
Poly Aromatic Hydrocarbon - Analysis was carried out in laboratory of BUREAU VERITAS LANKA (PVT) LTD
CPSD-AN-00576 – Internally validated Method of BUREAU VERITAS LANKA (PVT) LTD

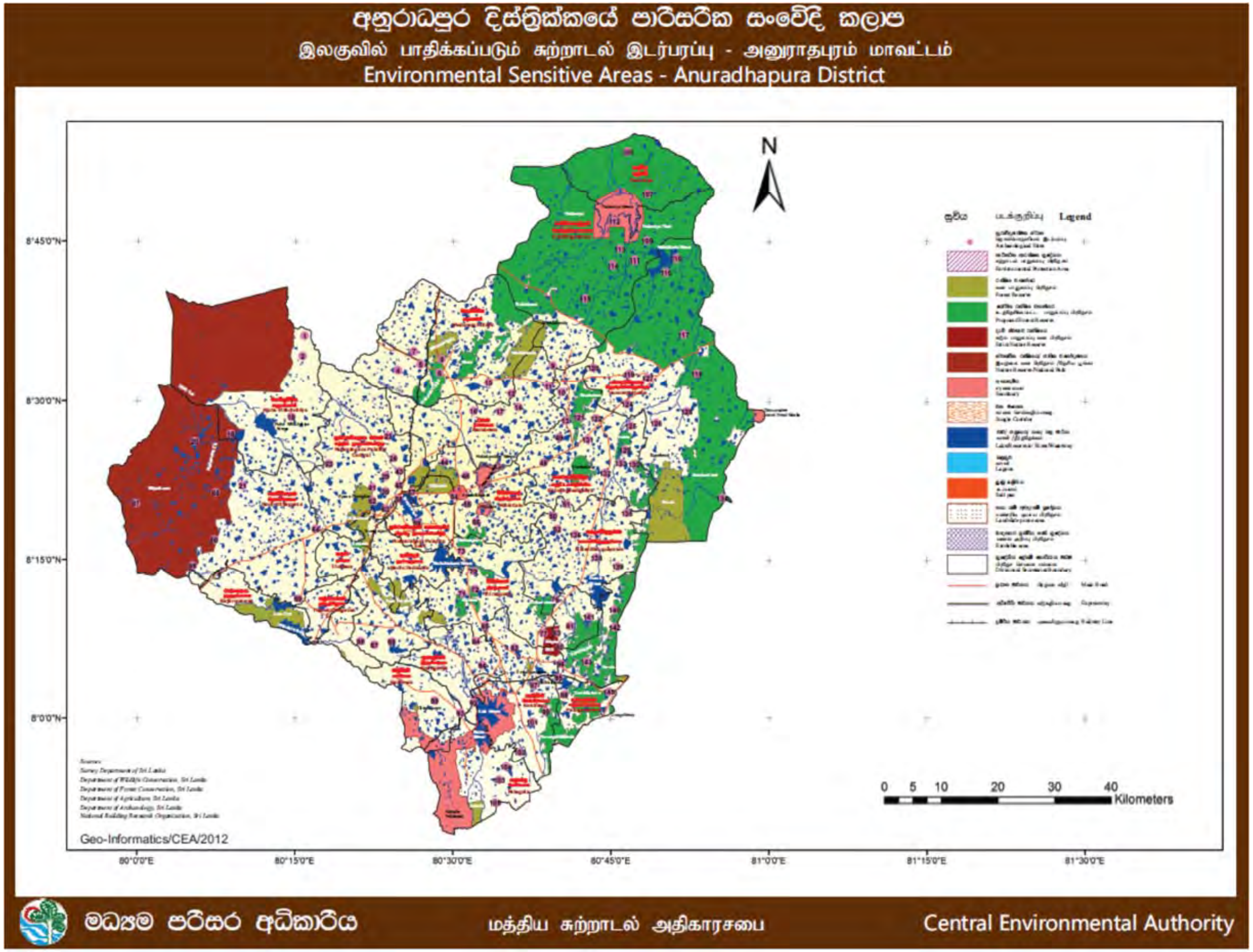
Analysis was carried out by: M P Arunasiri - Technical Assistant

Checked by: ....

S A M S Dissanayake

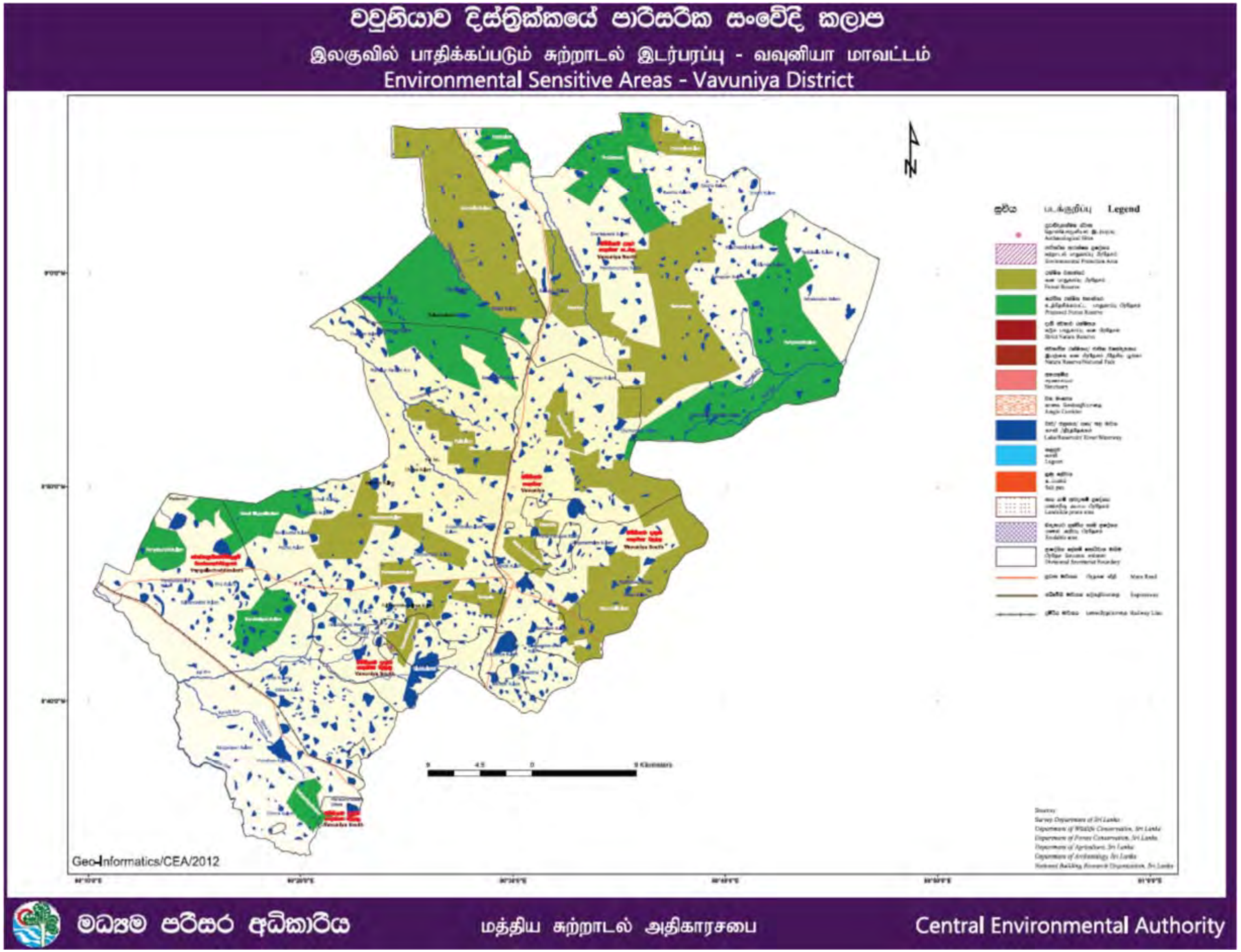
Certified by: ....
S V Dias
Director/ Environmental Studies and Services Division

Attachment 7.1-4: Environmental Sensitive Areas in Anuradhapura District



Source: Environmental Resource Profile, CEA

Attachment 7.1-5: Environmental Sensitive Areas in Vavuniya District



Source: Environmental Resource Profile, CEA

Attachment 7.1-6: Biological Environment of the Study Areas and Existing Vegetation and Flora and Fauna

1. Existing Vegetation and Flora and Fauna

Biogeographically, the proposed project target areas lie within the low country Dry Zone. Floristically it is under the Dry and Arid Lowlands Floristic Zone. Tropical Dry Mixed Evergreen Forests {*Manilkara* Community, Mixed community (*Chloroxylon-Vitex-Berrya-Schleichera* series)}, Tropical Thorn Forests (*Manilkara-Chloroxylon-Salvadora-Randia* series), Damana and Villu Grasslands, Flood-plain Wetlands, Riverine and Gallery Forests are typical natural vegetation formations in the Dry and Arid Lowlands Floristic Zone. Tropical Dry Mixed Evergreen Forests or dry zone forests and Tropical Thorn Forests can be observed in protected areas in the proposed project target areas and as well as catchment areas of tanks and some highlands in the command areas of the tanks. Riverine and Gallery Forests can be observed beside rivers and streams as a thin belt along the rivers or streams. However, most of the Riverine and Gallery Forests that in command areas of tanks are disturbed due to human activities. Sometimes, Gallery Forests can be observed in the riparian periphery of the small tanks and commonly called as Thavalla or Thavulla forests in Sinhala. Sometimes, Gallery Forests can also be observed in the immediate downstream of the tank bund due to seepage water. Flood-plain Wetlands can be observed in the food plains of large rivers and riparian periphery of the small tanks. Damana and Villu Grasslands are rare in the proposed project target areas. Addition to above, forest plantations, abandoned lands, rocky outcrops can be observed in the area.

According to "*The National Red List 2012 of Sri Lanka: Conservation Status of the Fauna and Flora*", distribution of the endemic and threatened species of the main fauna groups and flora in the Anuradhapura and Vavuniya Districts listed in Table 1.

Table 1: Distribution of the Endemic and Threatened Species of the Main Fauna Groups and Flora in the Anuradhapura and Vavuniya Districts

	Freshwater Fish			**Amphibians**			**Reptiles**		
	CR*	**EN****	**VU*****	**CR**	**EN**	**VU**	**CR**	**EN**	**VU**
Anuradhapura	1 (1)****	3 (2)	4 (3)	0	0	3 (2)	2 (2)	5 (3)	8 (3)
Vavuniya	1 (1)	1 (0)	0	0	0	0	0	0	1 (0)

	Birds			**Mammals**			**Total**
	CR	**EN**	**VU**	**CR**	**EN**	**VU**	
Anuradhapura	0	1 (0)	6 (0)	0	12 (1)	12 (1)	57 (18)
Vavuniya	0	3 (1)	5 (2)	0	0	0	11 (3)

	Flora			
	Total Species	**Threatened Species**	**Endemic Species**	**Threatened Endemic Species**
Anuradhapura	956	236	100	47
Vavuniya	218	41	9	5

*Note: * CR: Critically Endangered, **EN: Endangered, ***VU: Vulnerable, ****the numbers inside the parentheses indicate endemic species.*
Source: The National Red List 2012 of Sri Lanka: Conservation Status of the Fauna and Flora, GOSL

During 2012 red listing process, species distribution maps were prepared by extracting past records and due to prevailing war in the northern province not much past records were found to the Vavuniya district and hence total species number that in the Vavuniya district came to low value. Theoretically, both Anuradhapura and Vavuniya district need to have represent similar numbers as Vavuniya district also share common biological factors as Anuradhapura district except some isolated hills that in the Anuradhapura district (Ritigala). In that isolated hills like Ritigala, some wet zone characters are there, and some wet zone species can be observed. And some restricted fauna and flora species to such locations can also be observed in that isolated hills. Therefore, except wet zone species and restricted fauna and flora species that can be observed in the isolated hills of Anuradhapura district, most of the fauna and flora species that can be observed in the Anuradhapura district can also be observed in the Vavuniya district as well.

Of the 956 total recorded flora species in the Anuradhapura district, 236 species are threatened, 100 species are endemics and the threatened endemic are 47 species. Anyhow, some of the threatened or endemic or threatened endemic species can be found only in some isolated hills that in the Anuradhapura district (Ritigala). Therefore, such numbers are less in the proposed project target areas as such isolated hills not in the proposed project target areas. Similarly, endemic and threatened fauna species also less in the proposed project target areas as such isolated hills not in the proposed project target areas.

Some endemic and threatened flora species that can be observed in the proposed project target area listed in Table 2.

Table 2: Some Endemic and Threatened Flora Species that can be Observed in the Proposed Project Target Areas

Species Name	Sinhala Name	Tamil Name	HA	SS	NCS	AN	VN
Alseodaphne semecarpifolia	Wewarana	Ranai	T	N	VU	+	+
Aponogeton natans	Kekatiya	Koddi	H	N	VU	+	+
Argyreia populifolia	Giritilla	-	C	E		+	+
Calophyllum calaba	Guru Keena	Chirupunnai	T	E		+	+
Cassine glauca	Neralu	Piyari	T	E		+	+
Centrostachys aquatica	-	-	H	N	CR(PE)	+	+
Chloroxylon swietenia	Buruta	Moodudad Marum	T	N	VU	+	+
Cleistanthus pallidus	-	Visa	T	E		+	+
Crinum latifolium	Goda Manel	-	H	N	VU	+	+
Cryptocoryne beckettii	Ati Udayan	-	H	E	VU	+	+
Cryptocoryne wendtii	Ati Udayan	-	H	E	VU	+	
Cycas nathorstii	Madu	-	T	N	VU	+	+
Cynometra zeylanica	-	-	T	E	NT	+	+
Derris parviflora	Kala Wel	-	C	E		+	+
Dimocarpus gardneri	-	Nurai	T	E	VU		+
Dioscorea spicata	Gonala	-	C	N	VU	+	+
Diospyros ebenum	Kaluwara	Karunkali	T	N	EN	+	+
Diospyros nummulariifolia	-	-	T	E		+	+
Diplodiscus verrucosus	Dik Wenna	Vid Pani	T	E		+	+
Drypetes gardneri	Gal Wira	-	T	E	NT	+	+

Species Name	Sinhala Name	Tamil Name	HA	SS	NCS	AN	VN
Erythroxylum zeylanicum	-	-	S	E		+	+
Eugenia willdenowii	-	-	T	E		+	+
Glenniea unijuga	Wal Mora	Kuma	T	E		+	+
Glossocarya scandens	-	-	C	E	NT	+	+
Hydnocarpus venenata	Makulu	Makul	T	E		+	+
Mangifera zeylanica	Etamba	Kaddu Ma	T	E		+	+
Manilkara hexandra	Palu	Palai	T	N	VU	+	+
Margaritaria indicus	Karawu	-	T	N	VU	+	+
Memecylon capitellatum	Dedi Kaha	Katti Kaya	T	E		+	+
Munronia pinnata	Bin Kohomba	-	H	N	EN	+	+
Nymphaea nouchali	Manel	-	H	N	VU	+	+
Osbeckia zeylanica	-	-	H	N	VU		+
Pachygone ovata	-	Kaddukkodi	C	N	VU	+	+
Premna alstoni	-	-	S	E		+	+
Pterygota thwaitesii	Galnawa	-	T	E	VU	+	+
Rinorea virgata	-	-	S	N	VU	+	+
Salacia reticulata	Kotala Himbutu	-	C	N	EN	+	+
Sauropus rigidus	Ginihiriya	-	H	E	NT	+	+
Semecarpus nigro-viridis	Badulla	-	T	E		+	+
Spondias pinnata	Wal Ambarella	-	T	N	VU	+	+
Strychnos nux-vomica	Goda Kaduru	Eddi	T	N	VU	+	+
Strychnos potatorum	Ingini	Tetta	T	N	VU	+	+
Tinospora cordifolia	Rasakinda	Chintil	C	N	VU	+	+
Tinospora crispa	Tittakinda	-	C	N	VU	+	+
Trichopus zeylanicus	Bim Pol	-	H	N	VU	+	+
Uvaria sphenocarpa	-	-	C	E		+	+
Vanda tessellata	-	-	Ep	N	VU	+	+
Vernonia zeylanica	Pupula	Kappilay	C	E		+	+
Xylopia nigricans	Heen Kenda	See Vindai	T	E	NT	+	+

Note: HA – Habit, T – Tree, S – Shrub, H – Herbaceous, C – Climber or Creeper, Ep – Epiphytes, S – Species Status, N – Native, E – Endemic, NCS – National Conservation Status, EN – Endangered, VU – Vulnerable, CR (PE) – Critically Endangered Possibly Extinct, AN – Anuradhapura, VN – Vavuniya
Source: Study Team

Of the above species, *Centrostachys aquatica* is a rare species and listed as Critically Endangered Possibly Extinct in 2012 national red list. *Centrostachys aquatica* is 0.5m – 1.5m height, prostrate to straggling or erect, perennial aquatic or subaquatic species. It has wide distributional range in tropical Africa from Nigeria to Sudan and Ethiopia, south to Zaire, Tanzania, and the Flora Zambesiaca area; in tropical Asia from India and Sri Lanka to Indonesia; Including Burma and Thailand to Java and Norfolk Island.

Centrostachys aquatica known from Sri Lanka by a single collection deposited at the National Herbarium in the Peradeniya Botanic garden by unknown collector on 4th July 1887 from tank at Kitulhitiyawa, between Dambulla and Kekirawa in the Anuradhapura district. Since then no records were found from the country, Sri Lanka.

Because of its rarity within the country, Sri Lanka, and since it does not recollect or rerecord more than 100 years (133 years), it was categorized as “Critically Endangered Possibly Extinct” {CR (PE)} flora species in 2012 national red data book. It is also a protected flora species under the schedule VIII of the fauna and flora protection (Amendment) Act, No. 22 of 2009 (FFPO, 2009).

Centrostachys aquatica was rediscovered from a small tank, Mora Wewa (Cascade ID 82, Tank ID 16), near Horowpothana in Anuradhapura district on 1st July 2020 after 133 years. Several patches of *Centrostachys aquatica* were found in the riparian periphery of the tank on the exposed tank bed due to dry weather. It was also found on the upstream slope of the tank bund.

2. Invasive Alien Species (IAS) – Flora

Salvinia molesta (Salvinia) and *Eichhornia crassipes* (Water Hyacinth) are the most common aquatic invasive flora species that can be observed in the proposed project target areas of both districts. Aquatic invasive flora species, *Hydrilla verticillata* (Water Thyme) can also be observed in the proposed project target areas of both districts. *Typha angustifolia* (Cattail, Bulrush) is common semi aquatic invasive flora species and *Leucaena leucocephala* (Ipil Ipil), *Panicum maximum* (Guinea Grass), *Lantana camara* (Lantana), *Pennisetum polystachion* (Mission Grass), *Mimosa invisa* are common terrestrial invasive flora species that can be observed in the proposed project target areas of both districts. Terrestrial invasive flora species, *Parthenium hysterophorus* (Parthenium) can be commonly observed in the proposed project target areas of the Vavuniya district. Of the above IASs, *Salvinia molesta*, *Eichhornia crassipes*, *Typha angustifolia*, *Leucaena leucocephala*, *Panicum maximum*, *Lantana camara* are listed as prioritized invasive alien flora species in the national invasive flora species list prepared by biodiversity secretariat. *Acacia auriculiformis* (Earleaf Acacia) and *Muntingia calabura* (Jamfruit Tree) are potential invasive alien flora species that can be observed in the proposed project target areas of both districts.

3. Invasive Alien Species (IAS) – Fauna

Two invasive fish species, *Pterygoplichthys disjunctivus* (Vermiculated sailfin catfish or Scavenger), *Pterygoplichthys pardalis* (Amazon sailfin catfish or Scavenger) and one invasive land snail species, *Lissachatina fulica* (Giant African land snail) can be observed in the proposed project target areas of both districts.

4. Migratory Birds

Since there are many favorable habitats (Forests, Scrublands, Wetlands, etc.) for migratory forest birds and migratory water birds, many migratory birds can be observed during bird migratory season. Migratory birds such as, *Hirundo rustica* (Barn Swallow), *Lanius cristatus* (Brown Shrike), *Chlidonias hybrida* (Whiskered Tern), *Merops philippinus* (Blue-tailed Bee-eater), *Terpsiphone paradisi* (Asian Paradise- flycathcher), *Muscicapa daurica* (Asian Brown Flycatcher), *Pitta brachyura* (Indian Pitta), *Actitis hypoleucos* (Common Sandpiper), *Tringa ochropus* (Green Sandpiper), *Phylloscopus magnirostris* (Large-billed Leaf Warbler), *Phylloscopus trochiloides* (Greenish Warbler), *Sterna hirundo* (Common Tern) can be observed commonly in the area.

Attachment 7.1-7: Environmental Standard

1. Air Quality

Table 1 shows the National Environmental (Ambient Air Quality) Regulations published in the Gazette Notification No.1562/22 of 15.08.2008.

Table 1 Sri Lankan National Ambient Air Quality Standards

Pollutant	Average Time*	Maximum Permissible Level		Method of Measurement
		µg/m³	ppm	
PM_{10}	Annual	50		Hi-volume sampling or Beta Attenuation
	24 hrs.	100		
$PM_{2.5}$	Annual	25		Hi-volume sampling or Beta Attenuation
	24 hrs.	50		
NO_2	24 hrs.	100	0.05	Colorimetric using Saltzman Method or Gas phase chemiluminescence
	8 hrs.	150	0.08	
	1 hr.	250	0.13	
SO_2	24 hrs.	80	0.03	Pararosaniliene Method or Pulse Fluorescent
	8 hrs.	120	0.05	
	1 hr.	200	0.08	
Ozon (O_3)	1 hr.	200	0.10	Chemiluminescence Method or equivalent Ultraviolet photometric
CO	8 hrs.	10,000	9.00	Non-Dispersive Infrared Spectroscopy”
	1 hr.	30,000	26.00	
	Anytime	58,000	50.00	

Note: * *Minimum number of observations required to determine the average over the specified period; 03-hour average = 03 consecutive hourly average; 08 hour average = 08 hourly average; 24 hour average = 18 hourly average; Yearly average = 09 monthly average with at least 02 monthly average each quarter.*
+ By using Chemicals or Automatic Analyses.

Source: The National Environmental (Ambient Air Quality) Regulations published in the Gazette Notification No.1562/22 of 15.08.2008.

2. Emission Standard

Emission Standard National Environmental (Air, Fuel and Vehicle Importation Standards) Regulations No. 1, 2003

Table 2 Emission Standards

Petrol Vehicles		
	Emission Standard (idling and 2,500 R.P.M./no load)	
	CO (Carbon monoxide) (% vol)	HC (Hydrocarbon) (ppm vol)
Type of vehicles other than motor cycles and motor tricycles	3.0	1,000
Petrol motor cycles	4.0	6,000
Petrol motor tricycles	4.0	6,000
Diesel Vehicles		
	Smoke Opacity on Snap Acceleration (K factor m^{-1})	
All diesel vehicles	4.0	

Source : National Environmental (Air, Fuel and Vehicle Importation Standards) Regulations No. 1, 2003

3. Water Quality

Table 3 to 5 indicates Tolerance Limit for the Discharge of Industrial Water indicated in National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water)

Table 3 Tolerance Limits for the Discharge of Industrial Waste in to Inland Surface Water

No.	Parameter	Unit Type of limit	Tolerance Limit values
1	Total dissolved solids	mg/l, max.	50
2	Particle size of the total suspended solids	µm, less than	850
3	pH at ambient temperature	-	6.0 – 8.5
4	Biochemical oxygen demand (BOD5 in five days at 20℃ or BOD3 in three days at 27℃)	mg/l	30
5	Temperature of discharge	℃, max.	Shall no exceed 40℃ in any section of the stream within 15 m downstream from the effluent outlet.
6	Oils and greases	mg/l, max.	10
7	Phenolic compounds (as C_6H_5OH)	mg/l, max.	1
8	Chemical Oxygen Demand (COD)	mg/l, max.	250
9	Colour	Wavelength rage	
		436 nm (Yellow range)	7 m^{-1}
		525 nm (Red range)	5 m^{-1}
		620 nm (Blue range)	3 m^{-1}
10	Dissolved phosphates (as P)	mg/l, max.	5
11	Total Kjeldahl nitrogen (as N)	mg/l, max.	150
12	Ammoniacal nitrogen (as N)	mg/l, max.	50
13	Cyanide (as CN)	mg/l, max.	0.2
14	Total residual chlorine	mg/l, max.	1.0
15	Fluorides (as F)	mg/l, max.	2.0
16	Sulphide (as S)	mg/l, max.	2.0
17	Arsenic (as As)	mg/l, max.	0.2

No.	Parameter	Unit Type of limit	Tolerance Limit values
18	Cadmium (as Cd)	mg/l, max.	0.1
19	Chromium, total (as Cr)	mg/l, max.	0.5
20	Chromium, Hexavalent (as Cr^{6+})	mg/l, max.	0.1
21	Copper (as Cu)	mg/l, max.	3.0
22	Iron (as Fe)	mg/l, max.	3.0
23	Lead (as Pb)	mg/l, max.	0.1
24	Mercury (as Hg)	mg/l, max.	0.0005
25	Nickel (as Ni)	mg/l, max.	3.0
26	Selenium (as Se)	mg/l, max.	0.05
27	Zinc (as Zn)	mg/l, max.	2.0
28	Pesticides	mg/l, max.	0.005
29	Detergents/surfactants	mg/l, max.	5
30	Faecal Coliform	MPN/100ml, max	40
31	Radio Active Material: (a) Alpha emitters (b) Beta emitters	 micro curie/m1, max. micro curie/m1, max.	 10^{-8} 10^{-7}

Note: 1) All efforts should be made to remove unpleasant odour as far as possible. 2) These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution. 3) The above mentioned general standards shall cease to apply with regard to a particular industry when industry specific standards are notified for that industry. 4) Pesticides as per World Health Organization (WHO) and Food and Agriculture Organization (FAO) requirements.

Source: National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water)

Table 4 Tolerance Limits for Industrial Waste Discharged on Land for Irrigation Purpose

No.	Parameter	Unit Type of limit	Tolerance Limit values
1	Total dissolved solids	mg/l, max.	2100
2	pH at ambient temperature	–	5.5 – 9.0
3	Biochemical oxygen demand (BOD_5 in five days at 20°C or BOD_3 in three days at 27°C)	mg/l, max.	250 30
4	Oils and greases	mg/l, max.	10
5	Chemical Oxygen Demand (COD)	mg/l, max.	400
6	Chlorides (as C1)	mg/l, max.	600
7	Sulphates (as SO_4)	mg/l, max.	1000
8	Boron (as B)	mg/l, max.	2.0
9	Arsenic (as As)	mg/l, max.	0.2
10	Cadmium (as Cd)	mg/l, max.	2.0
11	Chromium , total (as Cr)	mg/l, max.	1.0
12	Lead (as Pb)	mg/l, max.	1.0
13	Mercury (as Hg)	mg/l, max.	0.01
14	Sodium adsorption ratio (SAR)	–	10 -15
15	Residual sodium carbonate (RSC)	mol/l, max.	2.5
16	Electrical conductivity	µS/cm, max	2250
17	Faecal coliform	MPN/100ml, max	40
18	Copper (as Cu)	mg/l, max.	1.0
19	Cyanide (as CN)	mg/l, max.	0.2
20	Radio Active Material: (a) Alpha emitters (b) Beta emitters	 micro curie/m1, max. micro curie/m1, max.	 10^{-9} 10^{-8}

Source: National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water)

Table 5 Hydraulic Loading Applicable for Different Soils

No.	Soil Texture Class	Recommended dosage of settled Industrial Effluents (m^3 /hectare, day)
1	Sandy	225-280
2	Sandy loam	170-225
3	Loam	110-170
4	Clay loam	55-110
5	Clay	35-55

Source: National Environmental (Protection and Quality) Regulations, No. 1 of 2008. (Water)

4. Noise

Maximum Permissible Noise Levels (as LAcq T[1]) indicated in National Environmental (Noise Control) Regulations No.1 1996 is shown in the Table 6.

Table 6 Maximum permissible Noise Levels for prescribed activities

Area	LAcq T	
	Day Time (6:00 to 18:00)	Night Time (18:00 to 6:00)
Low Noise (Pradeshiya Sabha area)	55 dB(A)	45 dB(A)
Medium Noise (Municipal Council/Urban Council area)	63[2] dB(A)	50 dB(A)
High Noise (EPZZ of BOI & Industrial Estates approved under part IVC of the NEA)	70 dB(A)	60 dB(A)
Silent Zone (100 m from the boundary of a courthouse, hospital, public library, school, zoo, sacred areas and areas set apart for recreation or environmental purposes)	50 dB(A)	45 dB(A)

Note: 1) LAeq T means the equivalent continuous, A-weighted sound pressure determined over a time interval T (in dB). 2) Provided that the noise level should not exceed 60 dB (A) inside existing houses, during day time.
Source: National Environmental (Noise Control) Regulations No.1 1996 Maximum Permissible Noise Levels

For construction activities, different standard applies. It is shown in Table 7.

Table 7 Noise Regulations for Construction Activities

Area	LAcq T	
	Day Time (6:00 to 21:00)	Night time (21:00 to 6:00)
Industrial / Commercial	75 dB (A)	60 dB (A)
Urban / Rural / Mixed Residential	65 dB (A)	56 dB (A)

Source: National Environmental (Noise Control) Regulations No.1 1996 Maximum Permissible Noise Levels

Attachment 7.1-8: List of Tanks Seemingly Overlap with Reserved Forest

Sr. # (Cascade)	Sr. # (Tank)	Cascade ID	Symbol	Tank ID			
				Reserved Forest		**National Park or Sanctuary**	
				Catchment Area	Around the Tank System Area	Catchment Area	Tank System Area
1	1	80	2/Y5			80－20	
	2					80－22	
	3					80－27	
	4					80－30	
	5					80－32	
	6					80－35	
	7					80－38	
	8					80－43	
2	9	83	1/Y6	83－3			
	10			83－6			
	11			83－8			
	12			83－10			
	13			83－11			
	14				83－14		
	15					83－22	
3	16	82	1/Y5			82－15	
	17					82－19	
	18					82－22	
4	19	85	2/Y6	85－10			
	20				85－11		
	21				85－13		
	22					85－14	
	23					85－15	
5	24	46	8 MAL7		46－1		
	25				46－5		
	26				46－9		
6	27	50	12MAL7	50－14			
	28			50－17			
	29			50－21			
	30			50－22			
	31			50－23			
	32				50－3		
	33				50－4		
	34				50－23		
7	35	48	10MAL7	48-14			

Sr. # (Cascade)	Sr. # (Tank)	Cascade ID	Symbol	Tank ID			
				Reserved Forest		National Park or Sanctuary	
				Catchment Area	Around the Tank System Area	Catchment Area	Tank System Area
8	36	47	9MAL7		47－3		
	37				47－5		
	38				47－7		
	39				47－9		
	40				47－10		
	41				47－11		
	42				47－12		
	43				47－14		
	44				47－15		
	45				47－16		
	46				47－17		
9	47	52	5MAL9	52-17			
	48			52-18			
10	49	101	2 MA1	101－10			
	50			101－11			
11	51	100	3MA1	100-1			
12	52	92	15MA1		92－11		
13	53	109	2MA2	109-3			
14	54	108	5MA2	108－1			
	55			108－2			
15	56	107	6MA2		107－2		
	57				107－3		
	58				107－4		
	59				107－6		
16	60	105	7MA2		105－1		
	61				105－4		
17	62	104	9MA2	104－1			
18	63	102	10MA2		102－1		
19	64	111	5PAR1	111－21			
20	65	116	6PAR1	116－9			
	66				116－7		
21	67	120	7PAR1	120－5			
	68			120－6			
	69			120－9			
22	70	121	3PAR2	121－14			
	71			121－11			
	72			121－12			
23	73	122	4PAR2	122－10			

Sr. # (Cascade)	Sr. # (Tank)	Cascade ID	Symbol	Tank ID			
				Reserved Forest		**National Park or Sanctuary**	
				Catchment Area	Around the Tank System Area	Catchment Area	Tank System Area
24	74	117	6PAR4		117－1		
	75			117－5			
	76			117－10			
	77			117－13			
	78			117－14			
	79			117－15			
	80			117－17			
25	81	128	6MGA1	128－3			
	82			128－8			
	83			128－10			
26	84	127	7MGA1		127－4		
	85				127－3		
	86			127－8			
	87			127－9			
27	88	58	9MAL8	58-15			
	89			58－17			
	90			58－20			
	91				58-18		

Source: Study Team

Attachment 7.1-9: Monitoring Form

I. Construction Phase

The latest result of the monitoring items shall be submitted to the part of Quarterly Progress Report throughout the construction phase.

1. Response / Action to comments and instruction from authorities and the public

Comments or Instructions		Response/ Action which was taken by contractor
Authority (Government)		
Public (Residents)		

2. Concurrence from the Forest Department

Tank Name	Current Status	Latest Communication Date and Details	Contact Person at FD

3. Air Pollution

Tank Name:

Parameter	Unit	Measured Value	Sri Lankan Standard Value	Baseline	Location (Measured point)	Note
PM10	μg/m^3		100 (24hr)	45		
SO_2	μg/m^3		100 (24hr)	3.5		
NO_2	μg/m^3		80 (24hr)	8		
CO	mg/m^3		3 (1hr)	3		

Please add more tables as necessary.

4. Waste

(1) Solid Waste (surplus soil)

Item	Volume (m^3)	Period		Explanation of status*	Treatment Plan
Excavated Soil Volume		From	To		
Used Soil Volume					
Surplus Soil Volume					

*Example: X m^3 surplus soil has carried to the contractor's stock yard, Y m^3 excavated soil is temporarily stocked in the site, etc.

Please add more tables es as necessary.

(2) Debris and Green Waste

Tank Name:

Item	Volume (m^3)	Period		Explanation of status*	Treatment Plan
Concrete Debris		From	To		
Green waist					
Other					

*Example: X m^3 concrete debris has been carried to the contractor's stock yard, Y m^3 green waste was generated, temporarily stocked in the site, etc.

Please add more tables as necessary.

(3) Waste from Labor Camp
Camp Location:

Item	Photo of the site	Observations	Treatment Plan

Please add more tables as necessary.

5. Fair Employment

(1) Employment has been fairly done? YES NO
In case NO is checked, please give reasons:

____

(2) Have compensations to labors have been properly made? YES NO
In case NO is checked, please give reasons:

____

(3) Complaints from Labors

	Construction site	Labors' Name	Details of Complains	Measures to be taken or have been taken
1				
2				

6. Working Environment and Sanitation

Item	Monitoring Result	Actions to be taken, by when, and Actions have been taken, by whom
Safety conditions of the labor camp		
Sanitary conditions of the labor camp		
Provision of the safety gear to labors		

7. Accidents

Item	Accident date and time	Detail of accident	Causes of accident	Measures to prevent recurrence
1				
2				

II Operational Phase

1. Water Quality

Items	Location 1 (Specify)	Location 2 (Specify)	Location 3 (Specify)	National Tolerance Standard
pH				6.0 – 8.0
Turbidity (NTU)				N/A
Suspended Solid (mg/L)				50
BOD (mg/L)				30
COD (mg/L)				250
Electric Conductivity				N/A
Oils and Greases (mg/L)				10
Phenolic Compounds				1
Heavy Metals (Cadmium, Lead, Mercury, etc.) (mg/L)				Cd: 0.1 Pb: 0.1 Hg: 0.0005
Pesticides (29 chemical substances) (mg/L)				0.005
E-coli (/100ml)				N/A

Tested by: ____, Date: ____________________________

2. Soil Contamination

Items	Location 1 (Specify)	Location 2 (Specify)	Location 3 (Specify)
Cadmium (as Cd) (mg/kg)			
Chromium (as Cr)			
Lead (mg/kg)			
Mercury (mg/kg)			
Arsenic (mg/kg)			
Phenolic Compounds (mg/kg)			
Oils and Greases (mg/kg)			
Pesticides (29 chemical substances) (mg/kg)			
PCB (mg/kg)			

Tested by: ____, Date: ___________________________

3. Biodiversity

Tank Name:

Item	Date (Season)	Weather, Temperature	Observer	Locations (Surveyed areas)	Observation Result	Note (Actions)
Sentinel Surveillance of Ecosystem						

4. Animal Damage

Item	Date (Season)	Location	Detail of Damage	Actions to be taken
Sentinel Surveillance				

5. Conflict and Complaints among CMO / FO members

	Name of CMO or FO	Contents of Conflict or Complain	Measures to be taken or have been taken by whom	Note (Frequency etc.)
1				
2				

6. Gender

Item	Monitoring Result	Actions to be taken and have been taken, by whom
Participation of female members to the CMO meetings and other activities		
Female participants to the training opportunities (Fill below table as well)		

Name of Training	Date & Time	Venue	The number of Participants	
			Female	Male

Attachment 7.1-10: Result of the Stakeholder Meetings

1. Result of the Stakeholder Meeting: Alagalla Cascade

<table>
<tr><td>Date & Time</td><td colspan="3">October 8, 2020 09.30 to 11:30 AM</td></tr>
<tr><td>Venue</td><td>District: Vavuniya</td><td>ASC: Madukanda</td><td>Village: Alagalla</td></tr>
<tr><td rowspan="2">Participants (restricted to max. 15 due to Covid-19)</td><td>Number of Participants</td><td colspan="2">Summary of Participants</td></tr>
<tr><td>19</td><td colspan="2">03 Female Farmers, 12 Male Farmers
01 Officer from DAD, 03 from Study Team</td></tr>
<tr><td>Participants from DAD/PID</td><td colspan="3">Mr. A.Kumarathunga, Agriculture Research & Production Assistant (ARPA)</td></tr>
<tr><td>Agenda</td><td colspan="3">• Welcome
• Briefing about the project
• Environmental Status
• Anticipated Environmental and Social Impact(both positive and negative)
• Suggested mitigation methods & monitoring
• Discussion
• Concluding remarks</td></tr>
<tr><td rowspan="6">Q&As,
and Discussions</td><td>Questions/ Discussion point</td><td colspan="2">Answers/Discussion</td></tr>
<tr><td>Time frame of the project</td><td colspan="2">• Participants were happy with the project proposal and appreciated. However, they are worried about the timing of project implementation. They have urgent need of tank rehabilitation.
• This was explained by the project staff, why it needs long period of time.</td></tr>
<tr><td>Crop Damage by Peacocks and Monkeys</td><td colspan="2">• Participants mentioned that the current environmental issue and needs immediate solution for them is the crop damage by Peacocks and Monkeys. The damage by Elephant can be controlled but it is impossible to control the damage by Peacock and Monkeys. In this regard, the participants requested to include some solution in FS-CSDP. If not, cultivation of other field crops may fail.</td></tr>
<tr><td>Use of heavy machineries</td><td colspan="2">• Participants mentioned that special attention should be given for safety measures when operating in the village. If machines are operating in the tank area will not be a problem for villager's safety.</td></tr>
<tr><td>Community Support</td><td colspan="2">• Farmer President and the President of Temple Society mentioned that they are ready to provide any support for the team to minimize the possible negative environmental impacts.</td></tr>
<tr><td>Concluding the session</td><td colspan="2">• Member of the project team conveyed gratitude of the study team for the assistance given by the villagers.
• Farmer President expressed their ideas about the project and appreciated our friendly participation with villagers.</td></tr>
</table>

Source: Study Team

Non-disclosure information due to portrait protection	**Non-disclosure information due to portrait protection**	**Non-disclosure information due to portrait protection**
Source: Study Team	*Source: Study Team*	*Source: Study Team*

2. Result of the Stakeholder Meeting: Navelikulam cascade

<table>
<tr><td>Date & Time</td><td colspan="3">October 9, 2020 09.30 to 10:30 AM</td></tr>
<tr><td>Venue</td><td>District: Vavuniya</td><td>ASC: Omanthai</td><td>Village: Omanthai</td></tr>
<tr><td rowspan="2">Participants (restricted to max. 15 due to Covid-19)</td><td>Number of Participants</td><td colspan="2">Summary of Participants</td></tr>
<tr><td>17</td><td colspan="2">14 Male Farmers,
01 Officer from DAD, 02 from Study Team</td></tr>
<tr><td>Participants from DAD/PID</td><td colspan="3">Mr.V. Kaleichelvam, Divisional Officer/Omanthai, DAD Vavuniya</td></tr>
<tr><td>Agenda</td><td colspan="3">• Welcome
• Briefing about the project
• Environmental Status
• Anticipated Environmental and Social Impact(both positive and negative)
• Suggested mitigation methods & monitoring
• Discussion
• Concluding remarks</td></tr>
<tr><td rowspan="6">Q&As,
and Discussions</td><td>Questions/ Discussion point</td><td colspan="2">Answers/Discussion</td></tr>
<tr><td>New settlements?</td><td colspan="2">• The main question raised by the farmers was weather the project is going to settle new people in that area after the rehabilitation with NCPC water as it is a burning issue in the area. Project team carefully explained that under the FS-CSDP, there are no new settlement programs. It has only rehabilitation of existing tank system and related programs such as agriculture, fishery, etc.
• However, the study team realized that some participants are in fear that people from south will be settled after rehabilitation.</td></tr>
<tr><td>Environmental Issues
(Site cleaning after constructions)</td><td colspan="2">• A farmer pointed out that one of the main negative impacts is cleaning the sites by contractors. It is generally not done according to their experience in the past. Because of that, FO had to spend some money for site cleaning. FO requested to look after that matter by the project.</td></tr>
<tr><td>Elephant Damage</td><td colspan="2">• Farmers said that the elephant damage is severe. Farmers requested to include Elephant Fences under the project. They are ready to share the cost in kind or cash.</td></tr>
<tr><td>Project Implementation</td><td colspan="2">• Farmers requested to implement an awareness program covering environmental issues also, before project implementation.
• Farmers questioned whether we can assure time period of project implementation. It was explained that the project is still under preparation and it cannot be assured at this time.</td></tr>
<tr><td>Concluding the session</td><td colspan="2">• Member of the project team conveyed gratitude of the study team for the assistance given by the villagers.
• Farmer and DO/DAD expressed their ideas about the project in a positive way and also asked to convey their kind gratitude to Lender.</td></tr>
<tr><td rowspan="2">Pictures</td><td>Non-disclosure information due to portrait protection</td><td colspan="2">Non-disclosure information due to portrait protection</td></tr>
<tr><td>Discussion</td><td colspan="2">JST’s Presentation in two languages</td></tr>
</table>

Source: Study Team

3. Result of the Stakeholder Meeting: Kiulekada cascade

<table>
<tr><td>Date & Time</td><td colspan="3">October 10, 2020, 02.30 to 04:10 PM</td></tr>
<tr><td>Venue</td><td>District: Anuradhapura</td><td>ASC: Kabithigollawa</td><td>Village: Puliyankulama</td></tr>
<tr><td rowspan="2">Participants (restricted to max. 15 due to Covid-19)</td><td>Number of Participants</td><td colspan="2">Summary of Participants</td></tr>
<tr><td>17</td><td colspan="2">07 Female Farmers, 07 Male Farmers
01 Officer from DAD, 02 from Study Team</td></tr>
<tr><td>Participants from DAD/PID</td><td colspan="3">Mr.G.A.Harischandra, ARPA, DAD, Kabithigollawa</td></tr>
<tr><td>Agenda</td><td colspan="3">・ Welcome
・ Briefing about the project
・ Environmental Status
・ Anticipated Environmental and Social Impact(both positive and negative)
・ Suggested mitigation methods & monitoring
・ Discussion
・ Concluding remarks</td></tr>
<tr><td rowspan="7">Q&As, and Discussions</td><td>Questions/Discussion point</td><td colspan="2">Answers/Discussion</td></tr>
<tr><td>Appreciation by farmers for consideration of environment under the project</td><td colspan="2">• After providing the information related to environment under the project, farmers appreciated it and mentioned that this the first time they heard such information; such as dust, vehicle noise, site cleaning, etc. are considered as environmental issues.</td></tr>
<tr><td>Environmental Issues (Dust and vehicle movement)</td><td colspan="2">• Almost all the farmers are concerned how much traffic and dust would be caused during project implementation by the vehicle movement. They reminded the experience when the village roads were constructed; drivers did not care villagers’ movement specially movement of school children. Children’s school uniforms were with full of dust or mud.
• People strongly requested to mitigate such situations at least morning and afternoon school opening and closing time.</td></tr>
<tr><td>Environmental Issues (Soil pit, gravel pit etc.)</td><td colspan="2">• Farmers mentioned that there are soil pits and gravel pits used by contractors 2-3 years back in their village. Those pits have not been levelled and still they are there as it was. During the rainy season it collects water and provide good opportunity for mosquito breeding.
• Farmers suggest to monitor such situation under the project as those things are beyond their control (They said that they can’t fight with big contractors).</td></tr>
<tr><td>Environmental Issues (Elephant Damage)</td><td colspan="2">• Farmers said that protect the crop from elephants is beyond their capacity now. Farmers requested to include Elephant Fences under the project. They are ready to share the cost in kind or cash or concessionary credit.</td></tr>
<tr><td>Farmers willingness to cooperate for environmental issues</td><td colspan="2">• Farmers proposed to form a committee for environmental protection in the FO area during the construction period.</td></tr>
<tr><td>Concluding the session</td><td colspan="2">• Member of the project team conveyed gratitude of the study team for the assistance given by the villagers.
• Farmer President thanked all the participants and concluded the session.</td></tr>
</table>

Source: Study Team

Non-disclosure information due to portrait protection	**Non-disclosure information due to portrait protection**
Source: Study Team	*Source: Study Team*

4. Result of the Stakeholder Meeting: Siyambalagaswewa Cascade

<table>
<tr><td>Date & Time</td><td colspan="4">October 14, 2020, 09.30 to 11:30 AM</td></tr>
<tr><td>Venue</td><td colspan="2">District: Anuradhapura</td><td>ASC: Kallanchiya</td><td>Village: Siyambalagaswewa</td></tr>
<tr><td rowspan="2">Participants (restricted to max. 15 due to Covid-19)</td><td colspan="2">Number of Participants</td><td colspan="2">Summary of Participants</td></tr>
<tr><td colspan="2">15</td><td colspan="2">11 Male Farmers
01 Female Farmers
03 from Study Team</td></tr>
<tr><td>Participants from DAD/PID</td><td colspan="4">ARPA, Kallanchiya ASC, DAD (only at Welcome section)</td></tr>
<tr><td>Agenda</td><td colspan="4">・ Welcome
・ Briefing about the project
・ Environmental Status
・ Anticipated Environmental and Social Impact (both positive and negative)
・ Suggested mitigation methods & monitoring
・ Discussion
・ Concluding remarks</td></tr>
<tr><td rowspan="5">Q& A,
and Discussions</td><td>Questions/ Discussion point</td><td colspan="3">Answers/Discussion</td></tr>
<tr><td>Environmental Issues (Dust and vehicle movement)</td><td colspan="3">• Farmers mentioned that they are ready to bare all the consequences if the tank is rehabilitated. Dust and other noise pollution could be tolerated on behalf of the tank rehabilitation as irrigation water is the main source of their income.
• People strongly requested to attend tank rehabilitation including desilting as soon as possible as the tank capacity is not enough to manage the season now.</td></tr>
<tr><td>Environmental Issues (Soil pit, gravel pit etc)</td><td colspan="3">• Farmers mentioned that the soil pits and gravel pits used by contractors in the past have created several issues in the village. Contractors do not listen to villagers and therefore they expect to intervene by the project to close the used soil and gravel pits.</td></tr>
<tr><td>Coordinating Mechanism for monitoring with Farmers</td><td colspan="3">• Farmers suggested introducing a coordination mechanism in the village to discuss the issues facing during construction period. This will cover all the aspects like construction, environment, social, etc. FO leaders can attend such monitoring meetings. Further, Farmers mentioned such kind of meetings help them to understand current situation of the rehabilitation program. Accordingly FO can plan their agriculture programs.</td></tr>
<tr><td>Environmental Issues (Elephant Damage, Monkey damage, Peacock damage)</td><td colspan="3">• Farmers said that they will not be able to get real benefit of rehabilitation if the crop is not protected from Elephant, Monkey and Peacock.
• Currently farmers are struggling to protect the crop from Monkeys and Peacock which comparatively damage is higher than Elephants.</td></tr>
</table>

	Heavy use of agro-chemicals and environmental pollution.	• Farmers said that the use of agro-chemicals for agriculture activities is comparatively higher than earlier. This has resulted to pollute ground water and thereby pollute well water as well. • Farmers added, with the development of the area under CSDP, it is expected to increase agriculture production and therefore it will need more agro-chemicals. • More use means more pollution…Farmers said. • In this regard, farmers proposed to have a program in CSDP to minimize use of agro-chemicals and its safety use.
	Concluding the session	• Member of the project team conveyed gratitude of the study team for the assistance given by the villagers. • Farmer President thanked all the participants and concluded the session

Source: Study Team

Non-disclosure information due to portrait protection

Non-disclosure information due to portrait protection

Non-disclosure information due to portrait protection

Non-disclosure information due to portrait protection

Source: Study Team

5. Result of the Stakeholder Meeting: Ichchankulama Cascade

<table>
<tr><td>Date & Time</td><td colspan="3">October 17, 2020, 10.30 to 12:00 AM</td></tr>
<tr><td>Venue</td><td>District: Anuradhapura</td><td>ASC: Galenbindunuwewa</td><td>Village: Ichchankulama</td></tr>
<tr><td rowspan="2">Participants (restricted to max. 15 due to COVID-19)</td><td>Number of Participants</td><td colspan="2">Summary of Participants</td></tr>
<tr><td>15</td><td colspan="2">01 Female Farmers, 10 Male Farmers
01 Female Officer DAD, 03 from JST</td></tr>
<tr><td>Participants from DAD/PID</td><td colspan="3">Ms. H.M. Sirani Premakumarie, ARPA, DAD, Galenbindunuwewa</td></tr>
<tr><td>Agenda</td><td colspan="3">・ Welcome
・ Briefing about the project
・ Environmental Status
・ Anticipated Environmental and Social Impact(both positive and negative)
・ Suggested mitigation methods & monitoring
・ Discussion
・ Concluding remarks</td></tr>
<tr><td rowspan="6">Q&As,
and Discussions</td><td>Questions/ Discussion point</td><td colspan="2">Answers/Discussion</td></tr>
<tr><td>No food for cattle after rehabilitation</td><td colspan="2">• Farmers mentioned that after rehabilitation and with NCPC water, both seasons will be cultivated. As a consequence of that, there will be no pasture lands for cattle. Currently, at least for one season tank bed could be used as a pasture land.
• When the tank gets water from NCPC, there will be no tank bed pasture. This will become an environmental issue in the area and, cattle may damage the crop to find food like Monkeys, Peacock and Elephants.
• Therefore, framers suggest that some solutions for rearing cattle in the village, under the Project.
• Farmers reiterated not to create a situation that the crop is damaged by cattle due to no food for them. One of their main incomes is from milk during dry periods.</td></tr>
<tr><td>Environmental Issues
(Dust, Soil pit, gravel pit, etc.)</td><td colspan="2">• According to farmers, issues related to Dust, Soil Pits, Heavy Vehicle movements, etc. are not very much important to them as they are used to such situations in the past. However, big contractors do not care villagers and they act as they want. Therefore, the contractors must be educated before they start the work in the village. This responsibility must be with the project. farmers mentioned.</td></tr>
<tr><td>FO strengthening and enhance farmer’s knowledge</td><td colspan="2">• One and only female farmer opened her voice. “People are lacking with knowledge on important of protecting our environment. Therefore, the villagers should be educated to understand how we can do tank rehabilitation with minimum disturbance to the living environment”. She further mentioned that not only for FO members, other non-FO members like house wives should also be educated.</td></tr>
<tr><td>Environmental Issues
(Elephant Damage, Monkey damage, Peacock damage)</td><td colspan="2">• Like in other areas farmers mentioned Elephant damage, Monkeys damage and Peacock damage. They said “there is no point of talking about this damage. We have been talking this for a long time. No solution. We have to bear this loss”. Farmers desperately mentioned.</td></tr>
<tr><td>Concluding the session</td><td colspan="2">• Member of the project team conveyed gratitude of the study team for the assistance given by the villagers.
• Farmer President thanked all the participants and concluded the session</td></tr>
</table>

Source: Study Team

Non-disclosure information due to portrait protection

Source: Study Team

Non-disclosure information due to portrait protection

Source: Study Team

Non-disclosure information due to portrait protection

Source: Study Team

Non-disclosure information due to portrait protection

Source: Study Team

Attachment 7.1-11: Environmental Checklist

Environmental checklist (Agriculture, Irrigation and Livestock Industry)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been officially completed? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b)N/A* (c) N/A (d) N	(a) The minor tank rehabilitation work does not require EIA under Sri Lankan law. (b) N/A (c) N/A (d) Part of 33 target tank areas are seemingly overlap with the reserved forests identified by the Forest Department, but it is not certain due to non-availability of detail GIS information. It was discussed and confirmed with the Forest Department that the concurrence from the Forest Department by conducting the field survey is required before the commencement of the construction work.
	(2) Explanation to the Local Stakeholders	(a) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? (b) Are proper responses made to comments from the public and regulatory authorities?	(a) Y (b) Y	(a) The stake holder meetings were held at the 5 model cascades of the Project to provide the information and to collect the opinion /comment from stakeholders. Local stakeholders (farmers) understood the environmental impacts, and long for the implementation of the Project. (b) Opinions and concerns of the stakeholders were addressed by the authorities as well as the Study Team.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Both the environmental and the social aspects have been included in making a decision, comparing the alternative plans.
2 Pollution Control	(1) Water Quality	(a) Are considerations given to water pollution of the surrounding waterbodies, such as rivers and groundwater by effluents or leachates from agricultural lands? Are adequate use/disposal standards for fertilizers, agrochemicals, and livestock wastes established? Is a framework established to increase awareness of the standards among farmers? (b) Is a monitoring framework established for water pollution of rivers and ground water?	(a) Y (b) Y	**(a)** Soil from excavation work may cause water turbidity, and concrete residue from construction work may contaminate in the water during construction period; however, they will remain within the tank system area and impact of these will be negligible. For the agricultural promotion component, usage of high-quality input will be promoted, but training and extension services for the proper application of inputs will be included, and it will reduce a risk of water and soil pollution. (b) Monitoring of water quality in operational phase is incorporated in the monitoring plan.
	(2) Wastes	(a) Are wastes properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) The contract document of the construction shall include the obligation for proper waste treatment as a condition.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Soil Contamination	(a) Is there a possibility that impacts in irrigated lands, such as salinization of soils will result? (b) Are adequate measures taken to prevent soil contamination of irrigated lands by agrochemicals, heavy metals and other hazardous substances? (c) Are any agrochemicals management plans prepared? Are any usages or any implementation structures organized for proper use of the plans	(a) N (b) Y (c) Y	(a) Only rehabilitation of the existing tanks systems will be conducted and not salinization of soil from the rehabilitation is expected. (b) For the agricultural promotion component, training and extension services for the proper application of inputs will be included, and it will reduce a risk of water and soil pollution. (c) Same as above.
	(4) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N/A	(a) Large amount of groundwater extraction will not occur.
	(5) Odor	(a) Are there any odor sources? Are adequate odor control measures taken?	(a) N	(a) Exhaust gases from construction vehicles may cause some undesirable odder. However, impacts will be quite limited because the construction site is outside the residential area odder will not reach. SOs and NOs from the construction vehicles will be monitored.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) Y	(a) Part of 33 target tank areas are seemingly identified as inside the reserved forests by the Forest Department, but it is not certain due to non-availability of detail GIS information. It was discussed and confirmed with the Forest Department that the concurrence from the Forest Department by conducting the field survey is required before the commencement of the construction work.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will result in the loss of breeding and feeding grounds for valuable wildlife? If they are lost, are there substitutes for the grounds near the original locations? (d) Is there a possibility that overgrazing will cause ecological degradation, such as impacts on wildlife habitats and desertification? (e) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(a) N (b) N (c) N (d) N (e) N/A	(a) The project will take place only inside the tank systems which have been preserved and utilized by residents since antient times, although some are surrounded by natural environment. (b) According to the local ecologist, the main habitation of those species are mainly hill area, which is outside the target tank system areas. (c) On the contrary, it provides better breeding and feeding grounds for the wildlife. (d) No such impact is expected. However, ecosystem will be carefully monitored. It is in the monitoring plan. (e) N/A

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement and land acquisition	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A	(a) Resettlement and land acquisition will not occur.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is proper allotment made for rights to agricultural land use? Is there a possibility that the allotment will result in inequitable distribution or usurpation of land and available resources? (c) Are proper allotments, such as water rights allotment in the project area made? Is there a possibility that the allotments will result in in equitable distribution or usurpation of water rights and available resources? (d) Is there a possibility that the amount of water used (surface water, groundwater) by the project will adversely the downstream fisheries and water uses? (e) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? Is adequate consideration given to public health education, if necessary?	(a) Y (b) N (c) N (d) N (e) N	(a) There may be power and interest struggle between communities of different ethnicity, social status, size of FO, etc. The opinion of minority groups may be ignored in the CMO meetings. The countermeasures for this risk are considered and included. (b) No such possibility is expected. (c) Same as above (d) Same as above (e) Same as above
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no risk of damaging archeological, historical, cultural or religious heritage sites.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There will be no adverse effect on the landscape.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) Y (b) Y	(a) Special attention is given to the minorities in the project. There are no indigenous people in the project area. (b) Same as above
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) N/A (b) Y (c) Y (d) Y	(a) Working environmental standards, specialised for construction projects, are not in place in Sri Lanka. However, in order to avoid situations where workers' safety and rights are ignored, items concerning labour conditions and safety measures are considered in the study and shall be included in the construction contract. (b) Same as above (c) Same as above (d) Same as above
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a) Mitigation measures for the items that may cause adverse impact have been prepared. (b) The construction may disturb the wildlife living near the tank systems. Therefore, the construction time will be limited only during the daytime. Also, the impact on ecosystem is included as a monitoring item. (c) Adequate measures for the fair opportunity for employment and renumeration for local labor, fair condition of labor, prevention of accidents and infectious diseases, etc. are considered.

**N/A: Not Applicable.*
Source: Study Team

Attachment 8.2-1: Crop Budget of Paddy

Economic Farm Gate Price Estimation

Paddy

Rice	Unit	Import Parity Price		
		Financial Price	Conversion Factor	Economic Price
1. FOB Price, Rice (Thailand), 5% broken 1/	USD / ton	393.5	-	393.5
2. Adjustment of Quality 4/	USD / ton	20	-	20
2. Freight charge including Insurance 2/	USD / ton	10	-	10.0
3. CIF Price at Colombo in USD	USD / ton	384	-	383.8
4. CIF Price at Colombo in LKR 3/	LKR / ton	71,100	-	71,100
5. Port charge, handling and warehousing	LKR / ton	363	0.94	341
6. Wholesale price at Colombo international port	LKR / ton	71,463	0.94	67,175
7. Transportation cost	LKR / ton	1,500	0.94	1,410
8. Wholesale price at Dambulla	LKR / ton	72,963	0.94	68,585
9. Milling cost and margin	LKR / ton	2,500	0.94	2,350
10. By-products through processing	LKR / ton	10,000	0.94	9,400
11. Millgate paddy price	LKR / ton	55,801	0.94	52,453
12. Transport/handling from farm gate	LKR / ton	1,500	0.94	1,410
13. Farm gate price	LKR / kg	54	0.94	51

1/ World Bank Commodities Price Data (The Pink Sheet), Annual average from Jan. to Dec. 2019 in USD, September, 2020
Rice (Thailand), 100% broken A.1 super

2/ Estimated based on data from the price estimate of countainer shipping lines company in Thailand, SAF, Sep. 2019
From Bangkok to Colmbo, at September 2020, freight charge = 750 USD/40HC
Weight of rice in 40HC = 76 ton

3/ Exchange rate, 1 USD = 185.00 LKR

4/ Ajustment of Quality from low moisture content or parboil paddy

Attachment 8.2-2: Crop Budget of Crops (Economic)

Economic Price of Crop Budget (1/4)

MAHA SEASON		Paddy-inadequately irrigated (Present)				Paddy-irrigated (Future)				Paddy-rainfed (Present, Future)					
A. GROSS RECEIPTS	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	CFs	Note
1. Gross Value of Farm Produce	ton	54	51	4,500	229,500	54	51	5,600	285,600	54	51	3,200	163,200	0.94	1/
4. Total (A)					**229,500**				**285,600**				**163,200**		
B. EXPENSES	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**		
1. Expenditure on Labour															
1.1 Land preparation	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	3	4,320	0.96	2/
1.2 Plastering bunds	MD	1,500	1,440	5	7,200	1,500	1,440	5	7,200	1,500	1,440	12	17,280	0.96	2/
1.3 Levelling and broad casting	MD	1,500	1,440	6	8,640	1,500	1,440	6	8,640	1,500	1,440	6	8,640	0.96	2/
1.4 Ridge & furrow making	MD	0	0	0	0	0	0	0	0	0	0	0	0	0.96	2/
1.5 Seeding and transplanting	MD	0	0	0	0	1,500	1,440	1	1,440	0	0	0	0	0.96	2/
1.6 Fertilizer application	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	2	2,880	0.96	2/
1.7 Weed control	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	3	4,320	0.96	2/
1.8 Pest & disease control	MD	1,500	1,440	2	2,880	1,500	1,440	2	2,880	1,500	1,440	2	2,880	0.96	2/
1.9 Water management	MD	1,500	1,440	12	17,280	1,500	1,440	12	17,280	0	0	0	0	0.96	2/
1.10 Harvesting and processing	MD	1,500	1,440	5	7,200	1,500	1,440	5	7,200	1,500	1,440	5	7,200	0.96	2/
Sub-total					56,160				57,600				47,520		
2. Expenditure on Material															
2.1 Seed	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.2 Levelling and broad casting	kg	70	66	112	7,392	70	66	100	6,580	70	66	100	6,580	0.94	1/
2.3 Fertilizer (Organic)	kg	0	0	0	0	10	9	2,500	23,500	0	0	0	0	0.94	1/
2.4 Fertilizer (Chemical)	kg	30	231	300	69,300	30	231	300	69,231	30	231	220	50,769	7.69	3/
2.5 Weedicides	kg	4,950	4,304	1	4,304	4,950	4,304	1	4,304	3,380	2,939	1	2,939	0.87	4/
2.6 Pesticide	kg	3,300	2,870	1	2,870	3,300	2,870	1	2,870	2,380	2,070	1	2,070	0.87	4/
Sub-total					83,866				106,485				62,358		
4. Machinery															
3.1 Land preparation	LS	22,500	21,150	1	21,150	22,500	21,150	1	21,150	22,500	21,150	1	21,150	0.94	1/
3.2 Harvesting and processing	LS	25,000	23,500	1	23,500	25,000	23,500	1	23,500	25,000	23,500	1	23,500	0.94	1/
3.3 Transport to stores	LS	2,000	1,880	1	1,880	2,000	1,880	1	1,880	2,000	1,880	1	1,880	0.94	1/
Sub-total					46,530				46,530				46,530		
5. Total (B)					**186,556**				**210,615**				**156,408**		
C. NET VALUE OF PRODUCE					**42,944**				**74,985**				**6,792**		

Source: Study Team

Note:

1/	Standard Conversion Factor =	0.94
2/	Shadow Wage Rate =	0.96
3/	CF for chemical fertilizer =	7.69
4/	CF for pesticide and weedicide =	0.87

Economic Price of Crop Budget (2/4)

MAHA SEASON		Black gram				Chilli				Eggplant					
A. GROSS RECEIPTS	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	CFs	Note
1. Gross Value of Farm Produce	ton	300	282	1,750	493,500	140	132	10,000	1,320,000	52	49	22,000	1,078,000	0.94	1/
4. Total (A)					**493,500**				**1,320,000**				**1,078,000**		

B. EXPENSES	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	CFs	Note
1. Expenditure on Labour															
1.1 Land preparation	MD	1,500	1,440	1	1,440	1,500	1,440	25	36,000	1,500	1,440	15	21,600	0.96	2/
1.2 Plastering bunds	MD	0	0	0	0	0	0	0	0	0	0	0	0	0.96	2/
1.3 Levelling and broad casting	MD	0	0	0	0	0	0	0	0	0	0	0	0	0.96	2/
1.4 Ridge & furrow making	MD	1,500	1,440	20	28,800	1,500	1,440	65	93,600	0	0	0	0	0.96	2/
1.5 Seeding and transplanting	MD	1,500	1,440	5	7,200	1,500	1,440	20	28,800	1,500	1,440	63	90,720	0.96	2/
1.6 Fertilizer application	MD	1,500	1,440	10	14,400	1,500	1,440	35	50,400	1,500	1,440	18	25,920	0.96	2/
1.7 Weed control	MD	1,500	1,440	20	28,800	1,500	1,440	50	72,000	1,500	1,440	70	100,800	0.96	2/
1.8 Pest & disease control	MD	1,500	1,440	2	2,880	1,500	1,440	35	50,400	1,500	1,440	30	43,200	0.96	2/
1.9 Water management	MD	1,500	1,440	8	11,520	1,500	1,440	40	57,600	1,500	1,440	20	28,800	0.96	2/
1.10 Harvesting and processing	MD	1,500	1,440	19	27,360	1,500	1,440	77	110,880	1,500	1,440	100	144,000	0.96	2/
Sub-total					122,400				499,680				455,040		
2. Expenditure on Material															
2.1 Seed	kg	900	846	30	25,380	7,500	7,050	1	7,050	18,000	16,920	0	5,076	0.94	1/
2.2 Levelling and broad casting	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.3 Fertilizer (Organic)	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.4 Fertilizer (Chemical)	kg	30	231	240	55,385	30	231	800	184,615	30	231	795	183,462	7.69	3/
2.5 Weedicides	kg	2,000	1,739	1	1,739	0	0	0	0	0	0	0	0	0.87	4/
2.6 Pesticide	kg	0	0	0	0	54,000	46,957	1	46,957	65,250	56,739	1	56,739	0.87	4/
Sub-total					82,504				238,622				245,277		
4. Machinery															
3.1 Land preparation	LS	22,500	21,150	1	21,150	22,500	21,150	1	21,150	22,500	21,150	1	21,150	0.94	1/
3.2 Harvesting and processing	LS	3,900	3,666	1	3,666	0	0	0	0	0	0	0	0	0.94	1/
3.3 Transport to stores	LS	2,000	1,880	1	1,880	0	0	0	0	0	0	0	0	0.94	1/
Sub-total					26,696				21,150				21,150		
5. Total (B)					**231,600**				**759,452**				**721,467**		
C. NET VALUE OF PRODUCE					**261,900**				**560,548**				**356,533**		

Source: Study Team

Note:

1/	**Standard Conversion Factor =**	0.94
2/	**Shadow Wage Rate =**	0.96
3/	**CF for chemical fertilizer =**	7.69
4/	CF for pesticide and weedicide =	0.87

Economic Price of Crop Budget (3/4)

YALA SEASON		Paddy-inadequately irrigated (Present)				Paddy-inadequately irrigated (Future)				Green gram					
A. GROSS RECEIPTS	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	CFs	Note
1. Gross Value of Farm Produce	ton	54	51	2,880	146,880	54	51	2,880	146,880	237	223	1,750	390,250	0.94	1/
4. Total (A)					**146,880**				**146,880**				**390,250**		
B. EXPENSES	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**		
1. Expenditure on Labour															
1.1 Land preparation	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	1	1,440	0.96	2/
1.2 Plastering bunds	MD	1,500	1,440	5	7,200	1,500	1,440	5	7,200	0	0	0	0	0.96	2/
1.3 Levelling and broad casting	MD	1,500	1,440	6	8,640	1,500	1,440	6	8,640	0	0	0	0	0.96	2/
1.4 Ridge & furrow making	MD	0	0	0	0	0	0	0	0	1,500	1,440	20	28,800	0.96	2/
1.5 Seeding and transplanting	MD	0	0	0	0	0	0	0	0	1,500	1,440	5	7,200	0.96	2/
1.6 Fertilizer application	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	10	14,400	0.96	2/
1.7 Weed control	MD	1,500	1,440	3	4,320	1,500	1,440	3	4,320	1,500	1,440	20	28,800	0.96	2/
1.8 Pest & disease control	MD	1,500	1,440	2	2,880	1,500	1,440	2	2,880	1,500	1,440	2	2,880	0.96	2/
1.9 Water management	MD	1,500	1,440	12	17,280	1,500	1,440	12	17,280	1,500	1,440	7	10,080	0.96	2/
1.10 Harvesting and processing	MD	1,500	1,440	5	7,200	1,500	1,440	5	7,200	1,500	1,440	14	20,160	0.96	2/
Sub-total					56,160				56,160				113,760		
2. Expenditure on Material															
2.1 Seed	kg	0	0	0	0	0	0	0	0	320	301	25	7,525	0.94	1/
2.2 Levelling and broad casting	kg	70	66	112	7,392	70	66	112	7,392	0	0	0	0	0.94	1/
2.3 Fertilizer (Organic)	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.4 Fertilizer (Chemical)	kg	30	231	300	69,300	30	231	300	69,300	30	231	240	55,440	7.69	3/
2.5 Weedicides	kg	4,950	4,304	1	4,304	4,950	4,304	1	4,304	0	0	0	0	0.87	4/
2.6 Pesticide	kg	3,300	2,870	1	2,870	3,300	2,870	1	2,870	6,000	5,217	1	5,217	0.87	4/
Sub-total					83,866				83,866				68,182		
4. Machinery															
3.1 Land preparation	LS	22,500	21,150	1	21,150	22,500	21,150	1	21,150	22,500	21,150	1	21,150	0.94	1/
3.2 Harvesting and processing	LS	25,000	23,500	1	23,500	25,000	23,500	1	23,500	5,000	4,700	1	4,700	0.94	1/
3.3 Transport to stores	LS	2,000	1,880	1	1,880	2,000	1,880	1	1,880	0	0	0	0	0.94	1/
Sub-total					46,530				46,530				25,850		
5. Total (B)					**186,556**				**186,556**				**207,792**		
C. NET VALUE OF PRODUCE					**-39,676**				**-39,676**				**182,458**		

Source: Study Team

Note:

1/	Standard Conversion Factor =	0.94
2/	Shadow Wage Rate =	0.96
3/	CF for chemical fertilizer =	7.69
4/	CF for pesticide and weedicide =	0.87

Economic Price of Crop Budget (4/4)

YALA SEASON		Chilli				Big onion				Eggplant					
A. GROSS RECEIPTS	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Yield (Unit/ha)	**Reeipts (LKR/ha)**	CFs	Note
1. Gross Value of Farm Produce	ton	140	132	11,500	1,518,000	100	94	20,000	1,880,000	52	49	23,000	1,127,000	0.94	1/
4. Total (A)					**1,518,000**				**1,880,000**				**1,127,000**		
B. EXPENSES	Unit	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**	Rate (LKR/Unit)	**Economic Price (LKR/Unit)**	Input (Unit/ha)	**Cost (LKR/ha)**		
1. Expenditure on Labour															
1.1 Land preparation	MD	1,500	1,440	25	36,000	1,500	1,440	25	36,000	1,500	1,440	15	21,600	0.96	2/
1.2 Plastering bunds	MD	0	0	0	0	0	0	0	0	0	0	0	0	0.96	2/
1.3 Levelling and broad casting	MD	0	0	0	0	0	0	0	0	0	0	0	0	0.96	2/
1.4 Ridge & furrow making	MD	1,500	1,440	65	93,600	1,500	1,440	51	73,440	0	0	0	0	0.96	2/
1.5 Seeding and transplanting	MD	1,500	1,440	20	28,800	1,500	1,440	85	122,400	1,500	1,440	63	90,720	0.96	2/
1.6 Fertilizer application	MD	1,500	1,440	35	50,400	1,500	1,440	18	25,920	1,500	1,440	18	25,920	0.96	2/
1.7 Weed control	MD	1,500	1,440	50	72,000	1,500	1,440	53	76,320	1,500	1,440	70	100,800	0.96	2/
1.8 Pest & disease control	MD	1,500	1,440	35	50,400	1,500	1,440	20	28,800	1,500	1,440	30	43,200	0.96	2/
1.9 Water management	MD	1,500	1,440	50	72,000	1,500	1,440	45	64,800	1,500	1,440	30	43,200	0.96	2/
1.10 Harvesting and processing	MD	1,500	1,440	80	115,200	1,500	1,440	120	172,800	1,500	1,440	110	158,400	0.96	2/
Sub-total					518,400				600,480				483,840		
2. Expenditure on Material															
2.1 Seed	kg	7,500	7,050	1	7,050	10,000	9,400	5	47,000	18,000	16,920	0	5,076	0.94	1/
2.2 Levelling and broad casting	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.3 Fertilizer (Organic)	kg	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
2.4 Fertilizer (Chemical)	kg	30	231	800	184,800	30	231	370	85,470	30	231	795	183,645	7.69	3/
2.5 Weedicides	kg	0	0	0	0	12,500	10,870	1	10,870	0	0	0	0	0.87	4/
2.6 Pesticide	kg	54,000	46,957	1	46,957	35,000	30,435	1	30,435	65,250	56,739	1	56,739	0.87	4/
Sub-total					238,807				173,775				245,460		
4. Machinery															
3.1 Land preparation	LS	22,500	21,150	1	21,150	22,500	21,150	1	21,150	22,500	21,150	1	21,150	0.94	1/
3.2 Harvesting and processing	LS	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
3.3 Transport to stores	LS	0	0	0	0	0	0	0	0	0	0	0	0	0.94	1/
Sub-total					21,150				21,150				21,150		
5. Total (B)					**778,357**				**795,405**				**750,450**		
C. NET VALUE OF PRODUCE					**739,643**				**1,084,595**				**376,550**		

Source: Study Team

Note:

1/	Standard Conversion Factor =	0.94
2/	Shadow Wage Rate =	0.96
3/	CF for chemical fertilizer =	7.69
4/	CF for pesticide and weedicide =	0.87

Attachment 8.2-3: Economic Benefit of Irrigation

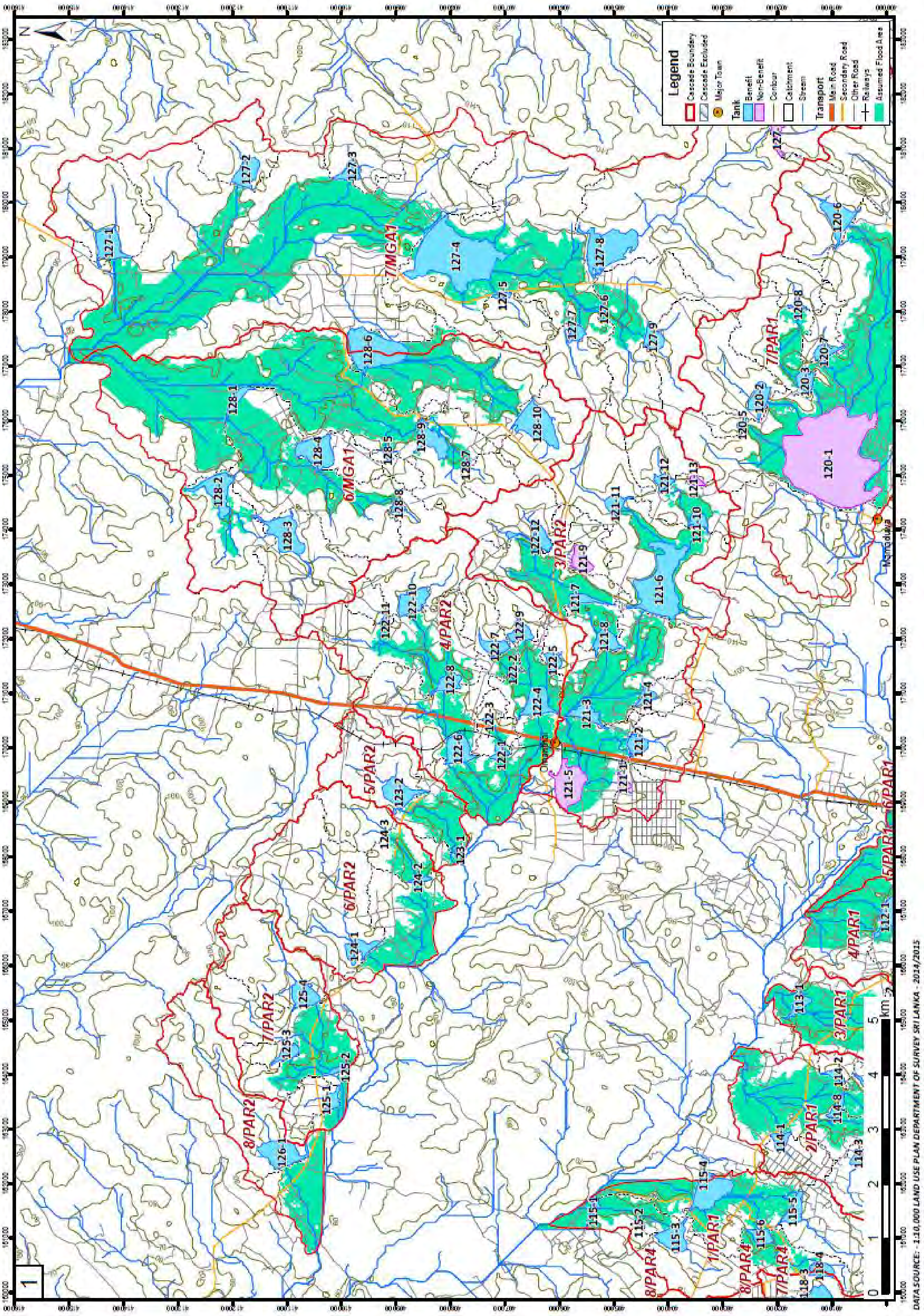
Annual Benefit

			Cropping Pattern		(A) Gross Income			(B) Production Cost				Net Income (LKR/ha)	Net Benefit (LKR Million)
			Area (%)	Area (ha)	1) Unit Price (LKR/kg)	2) Unit Yield (kg/ha)	**A. Total Gross Income (LKR/ha)**	1) Labour (LKR/ha)	2) Material (LKR/ha)	3) Machinery (LKR/ha)	**B. Total Cost (LKR/ha)**		
Without Project Condition													
Maha	Irrigated	Paddy	58%	16,340	51	4,500	**229,500**	56,160	83,866	46,530	**186,556**	**42,944**	**702**
	Rainfed	Paddy	42%	11,832	51	3,200	**163,200**	47,520	62,358	46,530	**156,408**	**6,792**	**80**
Yala	Inadequately irrigated	Paddy	25%	7,043	51	2,880	**146,880**	56,160	83,866	46,530	**186,556**	**-39,676**	**-279**
TOTAL			125%	35,215									**503**
With Project Condition													
Maha	Irrigated	Paddy	45.0%	12,677	51	5,600	**285,600**	57,600	106,485	46,530	**210,615**	**74,985**	**951**
		Black gram	4.0%	1,127	282	1,750	**493,500**	122,400	82,504	26,696	**231,600**	**261,900**	**295**
		Chilli	4.0%	1,127	132	10,000	**1,320,000**	499,680	238,622	21,150	**759,452**	**560,548**	**632**
		Eggplant	4.0%	1,127	49	22,000	**1,078,000**	455,040	245,277	21,150	**721,467**	**356,533**	**402**
	Rainfed	Paddy	43.0%	12,114	51	3,200	**163,200**	47,520	62,358	46,530	**156,408**	**6,792**	**82**
Yala	Irrigated	Green gram	4.0%	1,127	223	1,750	**390,250**	113,760	68,182	25,850	**207,792**	**182,458**	**206**
		Chilli	2.0%	563	132	11,500	**1,518,000**	518,400	238,807	21,150	**778,357**	**739,643**	**417**
		Big onion	2.0%	563	94	20,000	**1,880,000**	600,480	173,775	21,150	**795,405**	**1,084,595**	**611**
		Egg plant	3.0%	845	49	23,000	**1,127,000**	483,840	245,460	21,150	**750,450**	**376,550**	**318**
	Inadequately irrigated	Paddy	14.0%	3,944	51	2,880	**146,880**	56,160	83,866	46,530	**186,556**	**-39,676**	**-156**
TOTAL			125%	35,215									**3,758**
Increment of Net Benefit													**3,255**

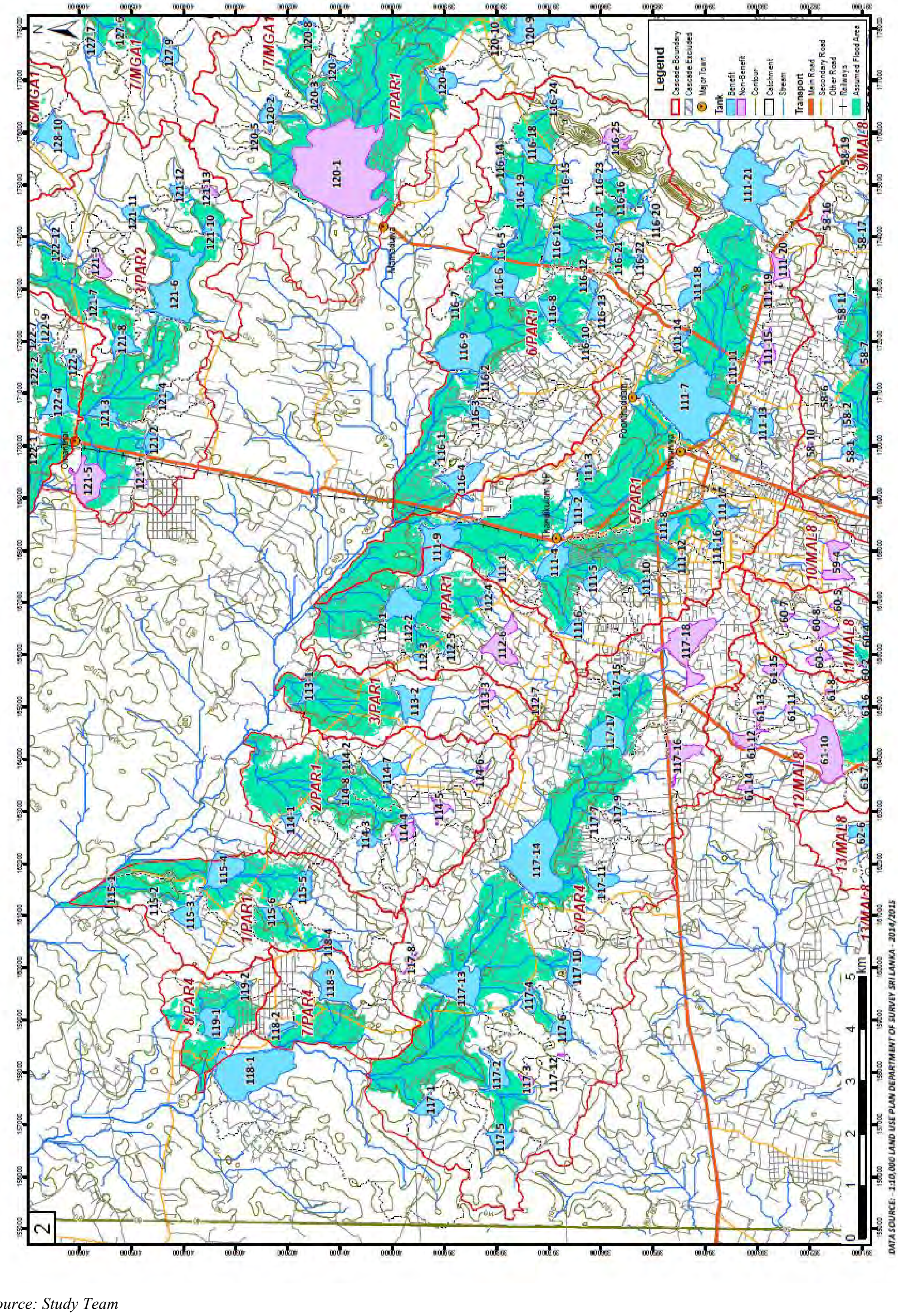
Irrigated Area = 28,172 ha

Source: Study Team

Attachment 8.2-4: Flood Inundation Area Map Analysed by GIS



Source: Study Team



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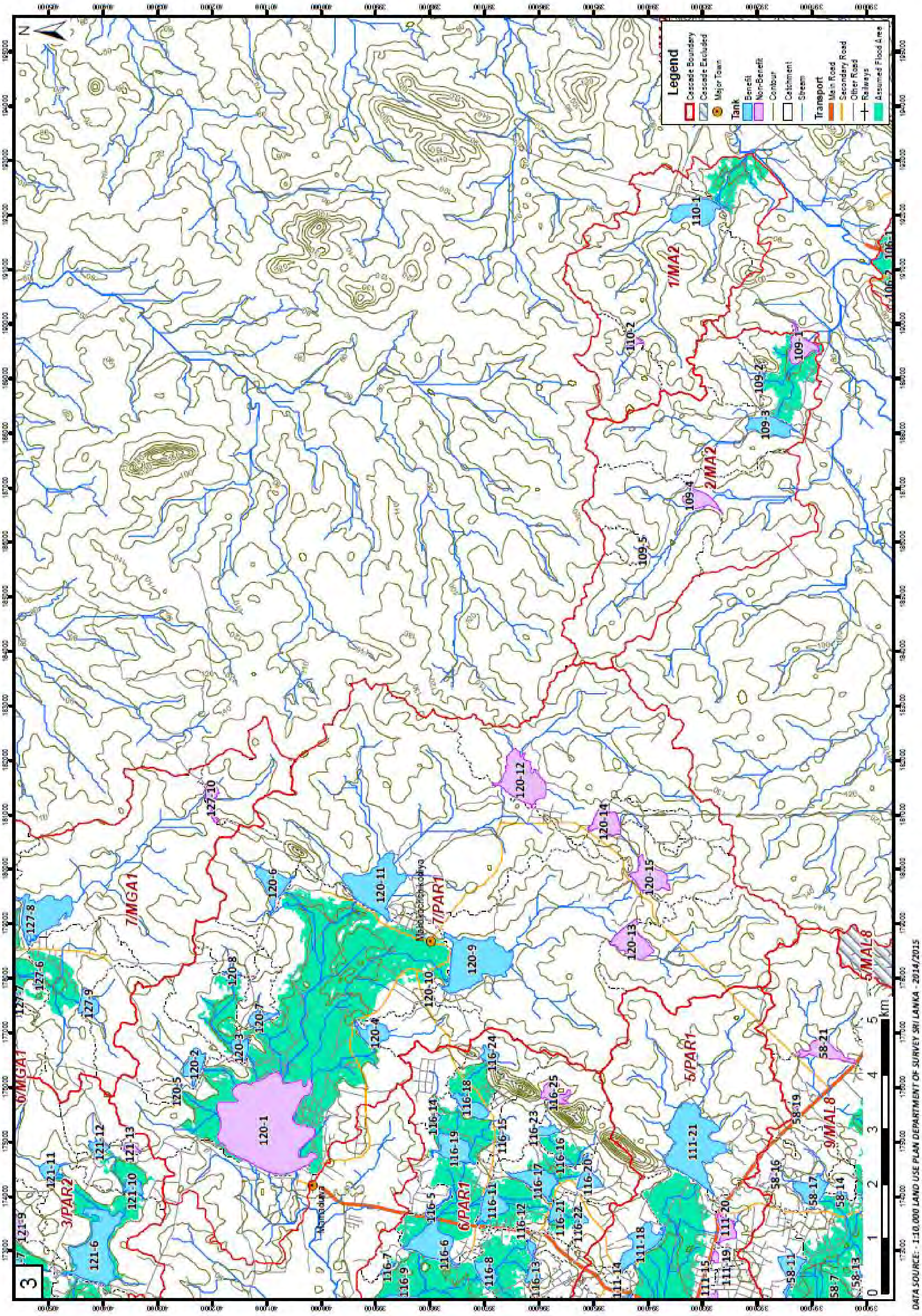
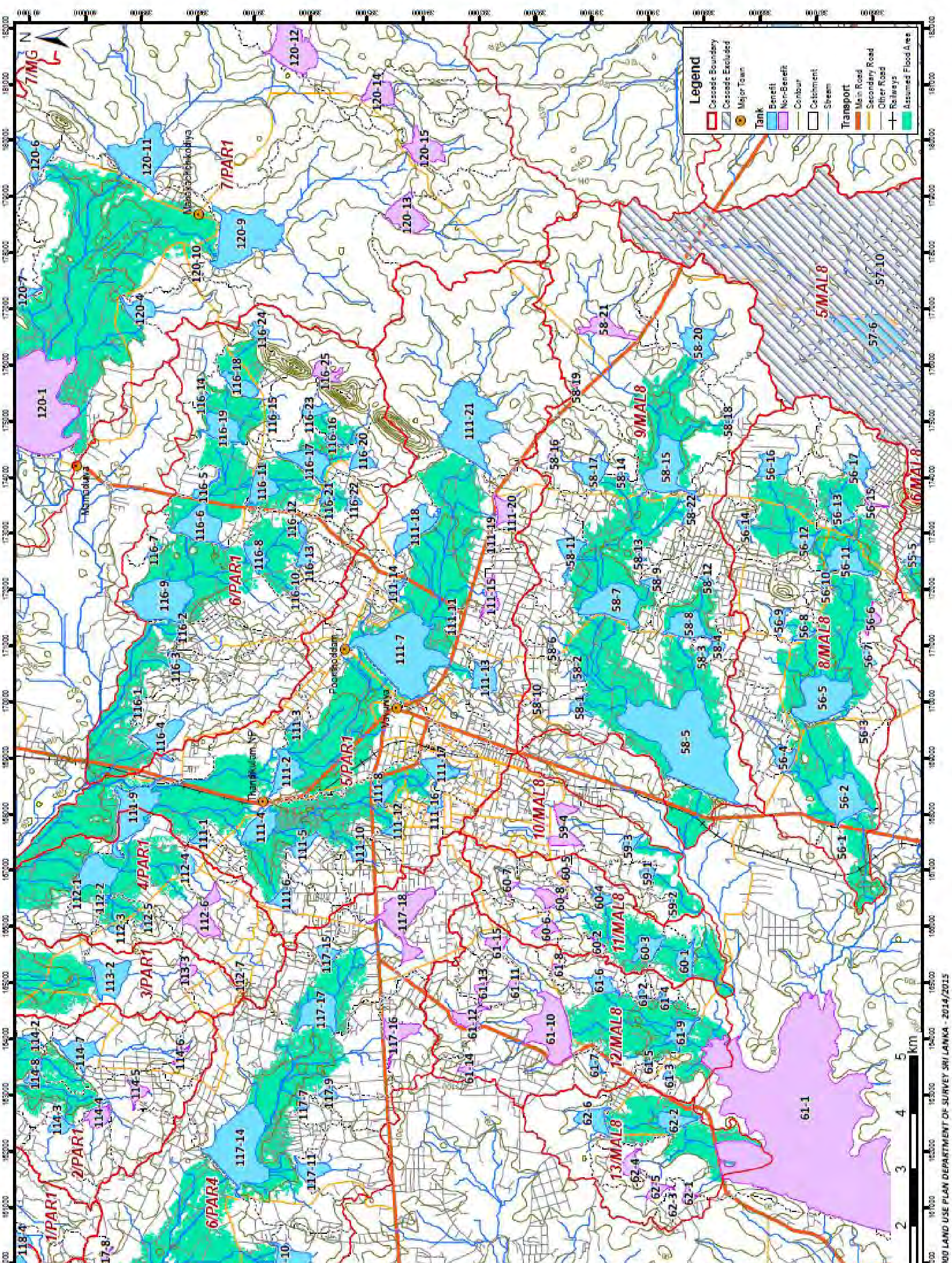


Source: Study Team



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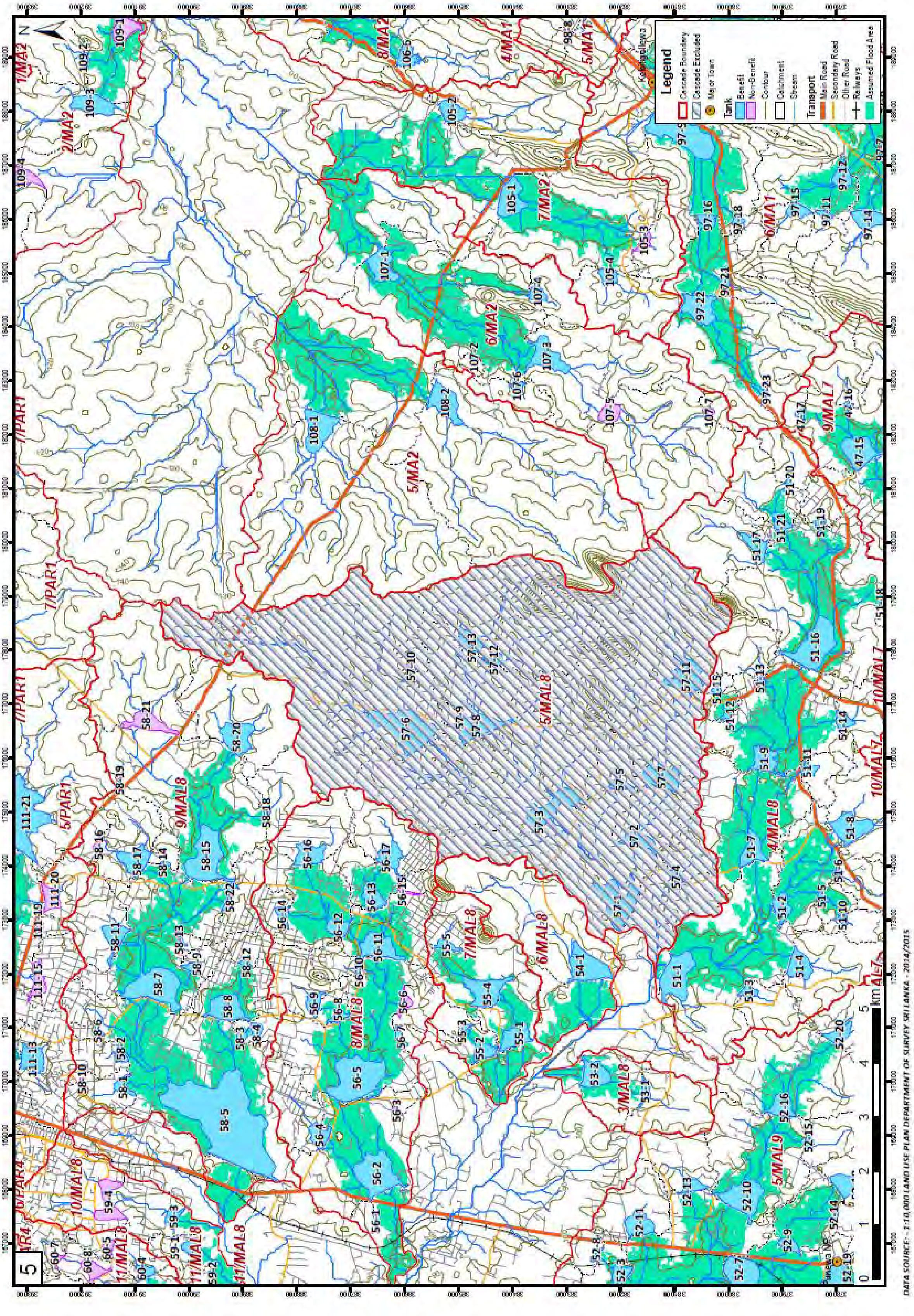

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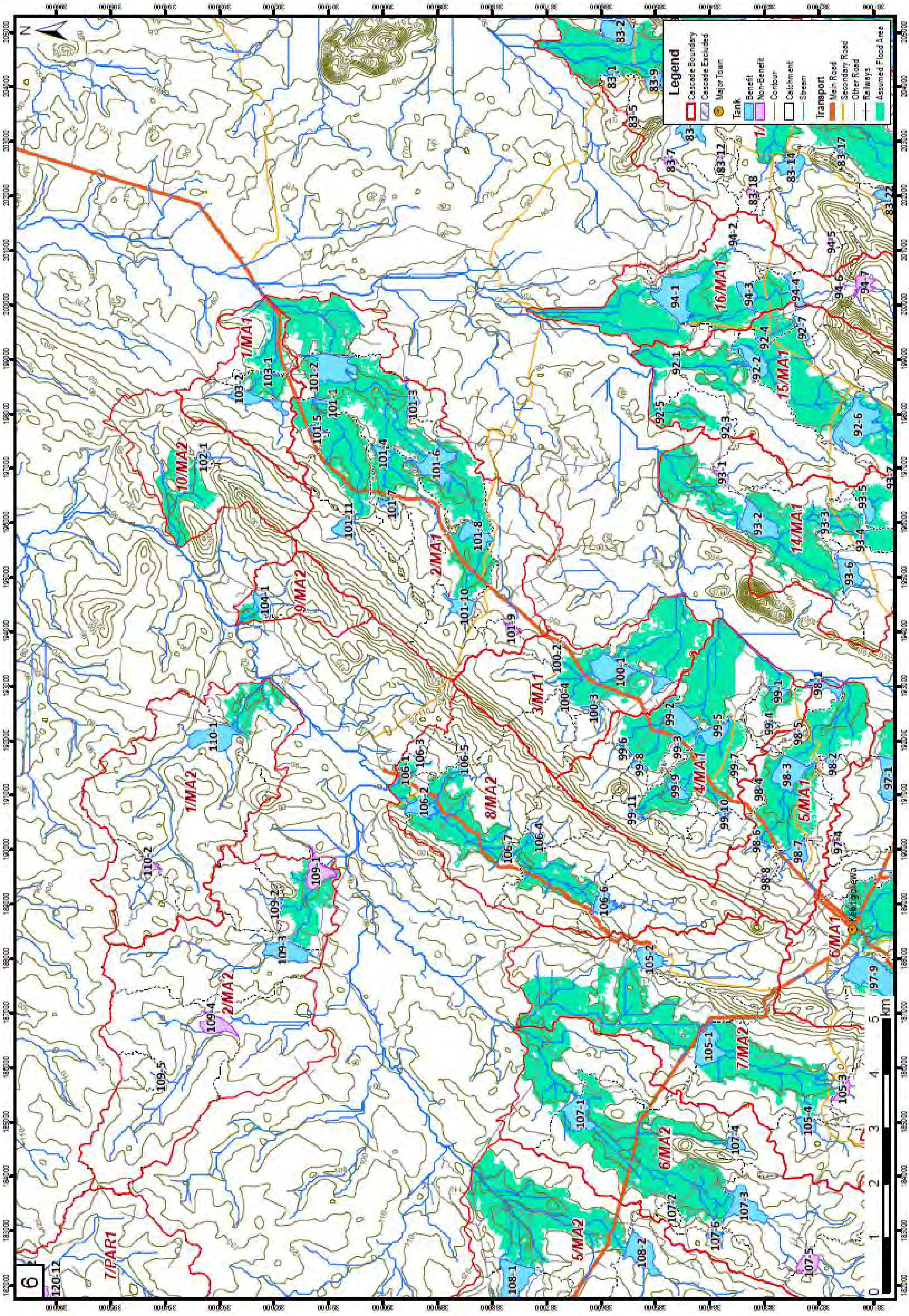

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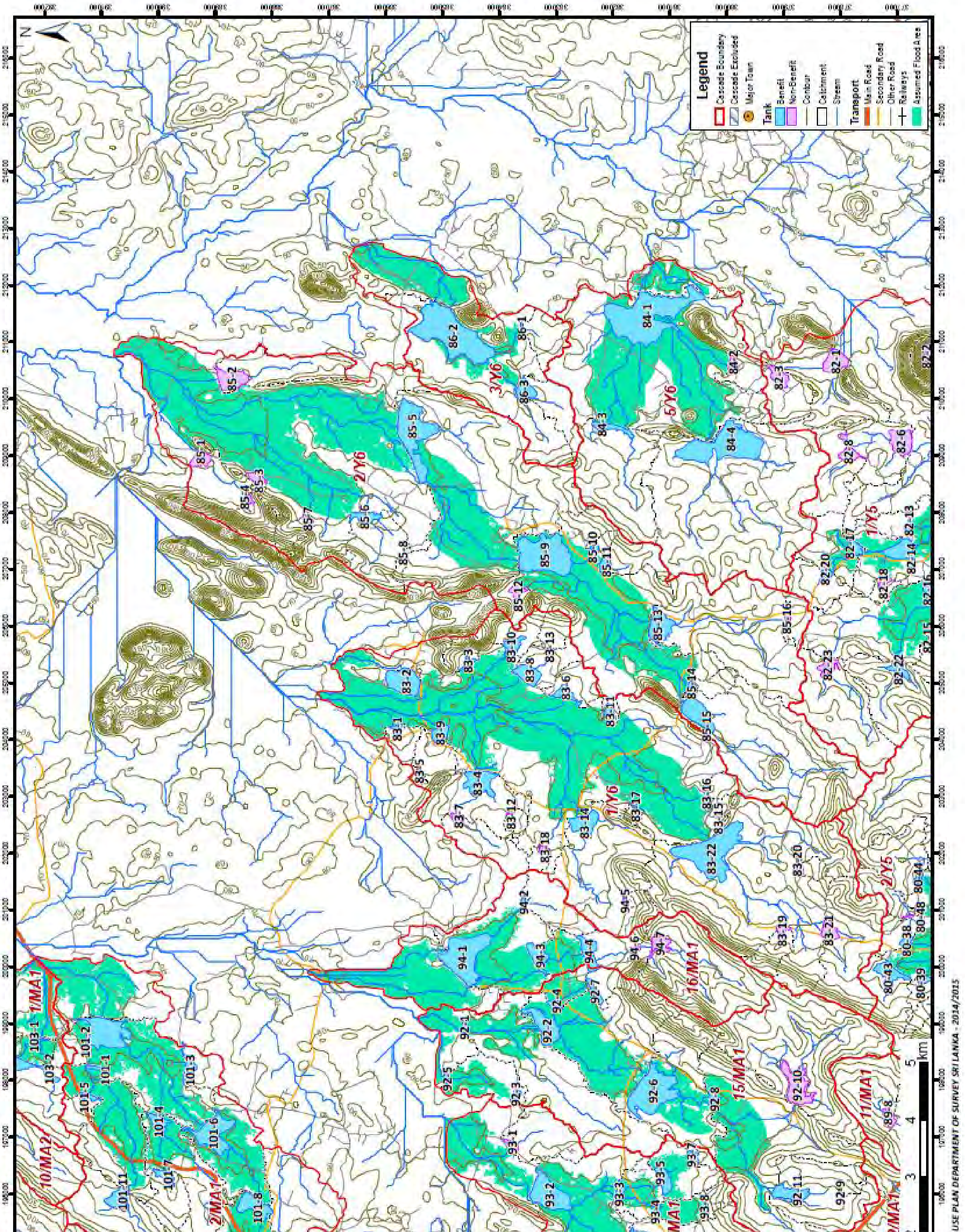

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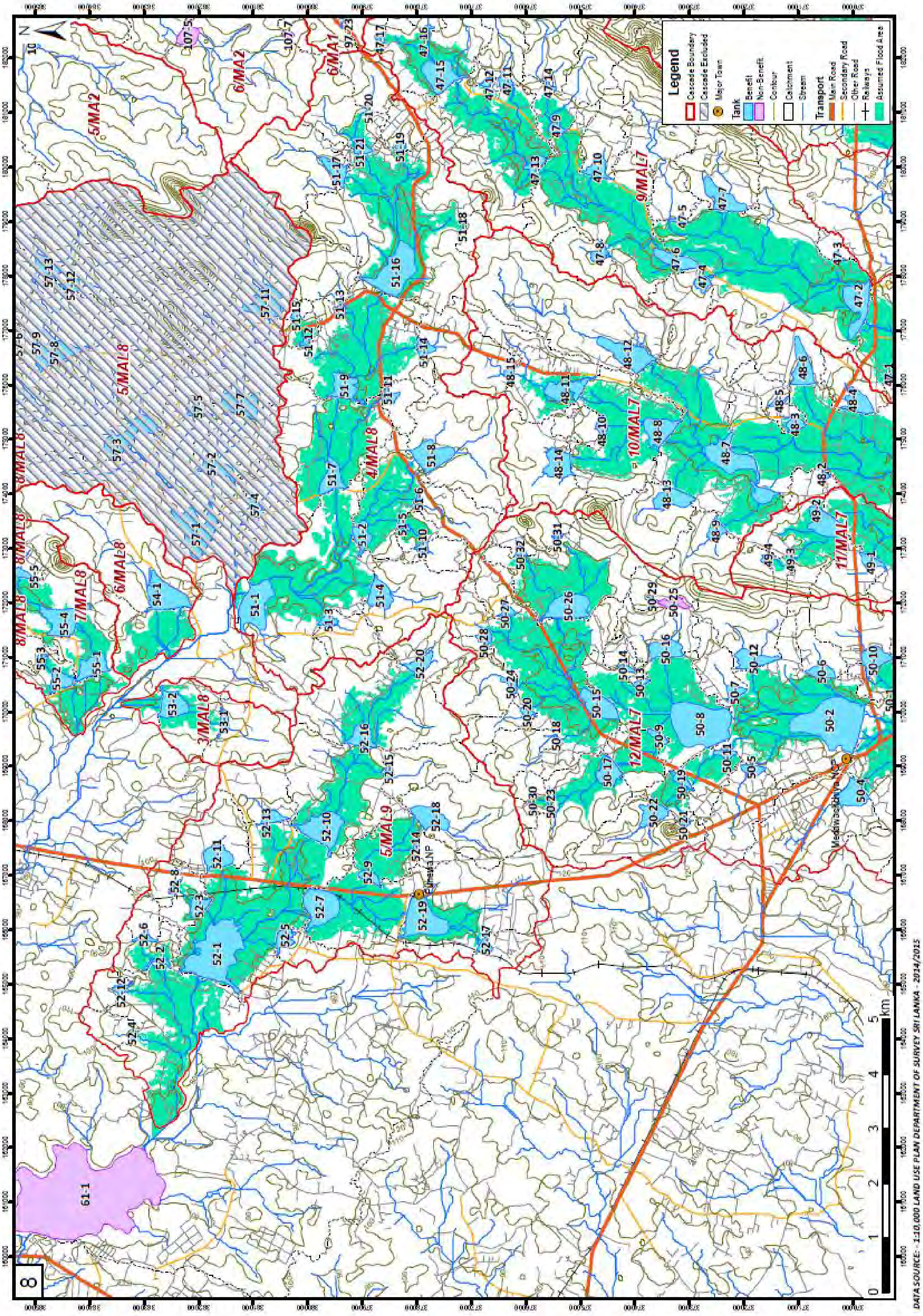

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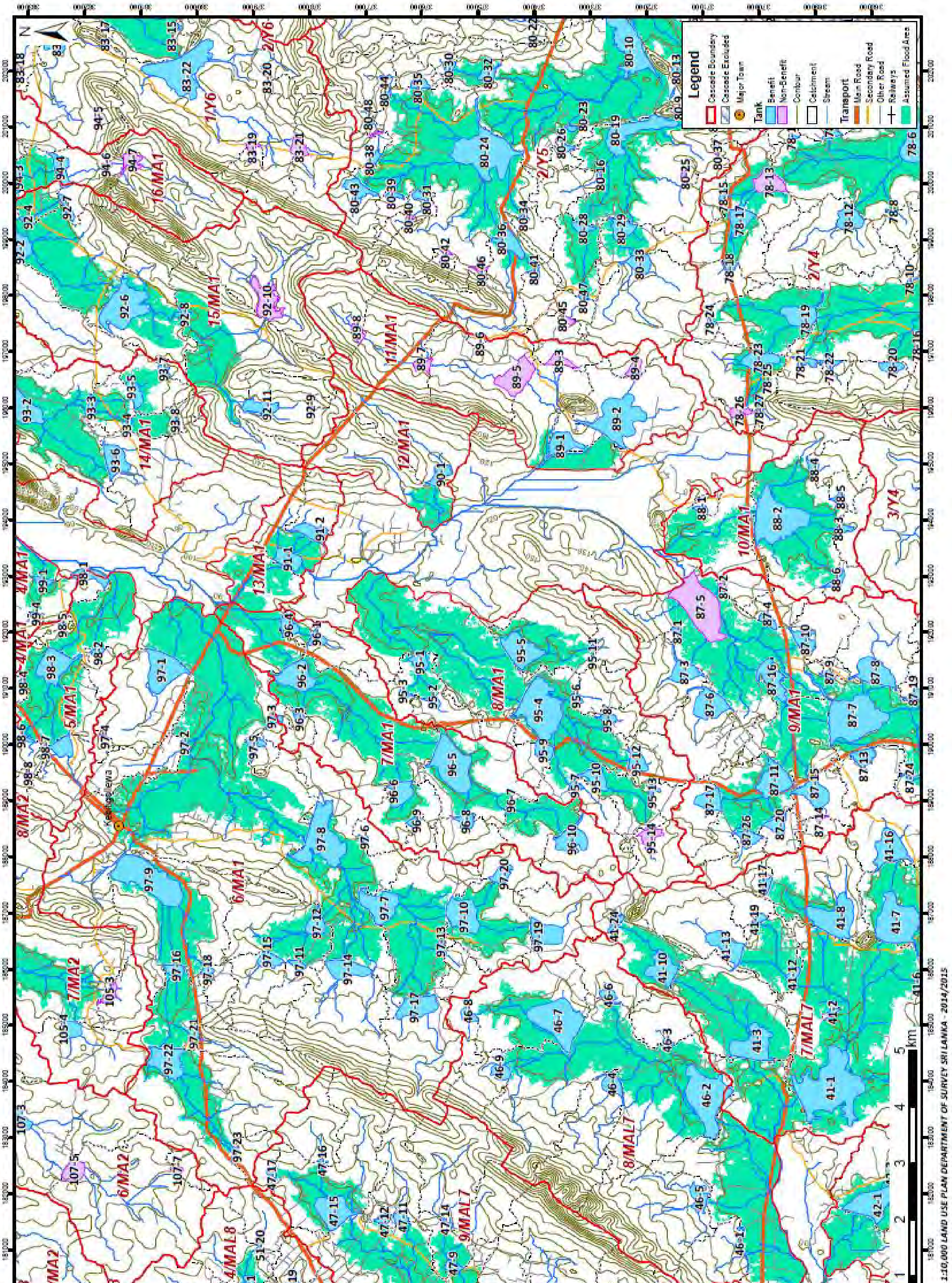

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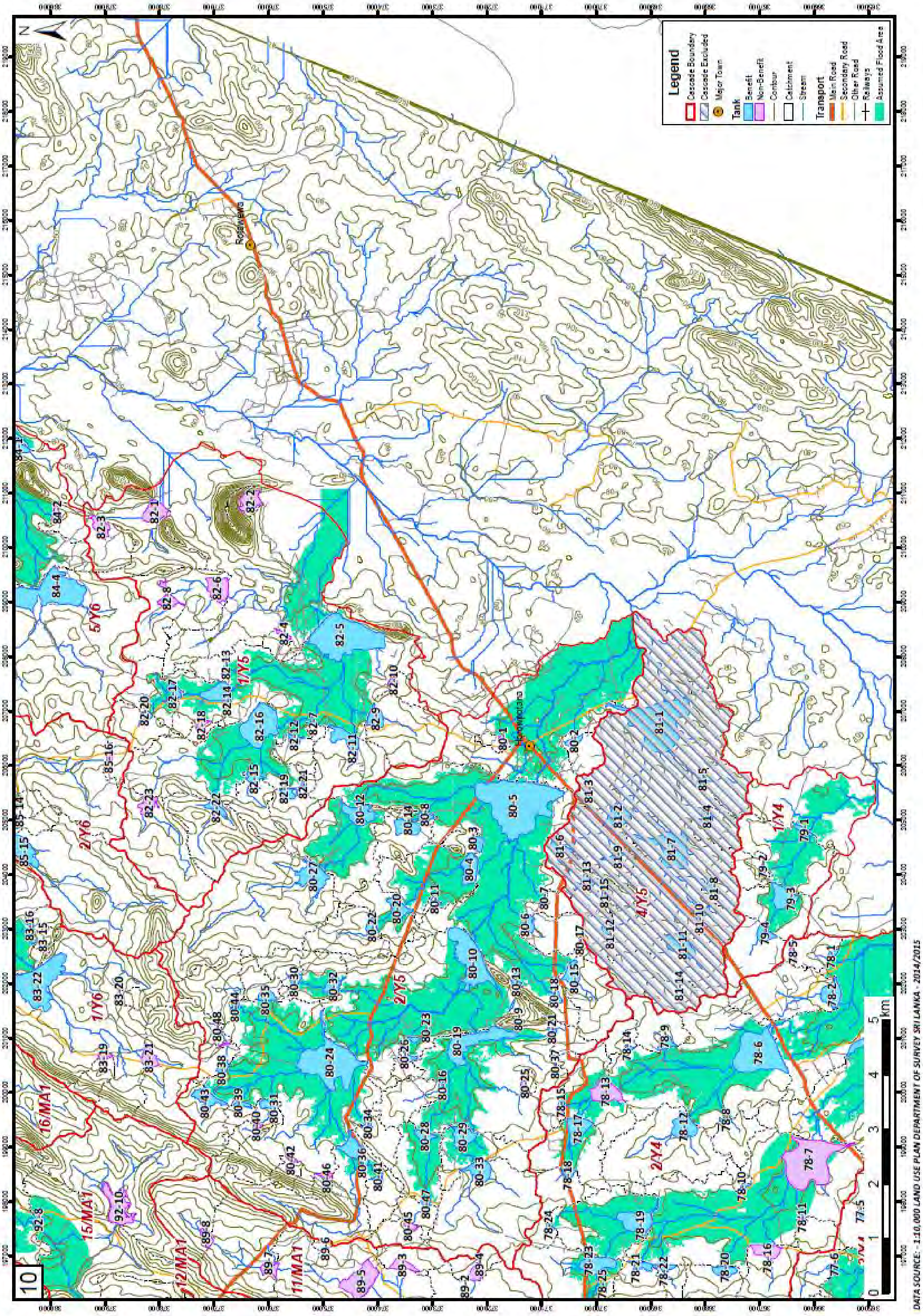

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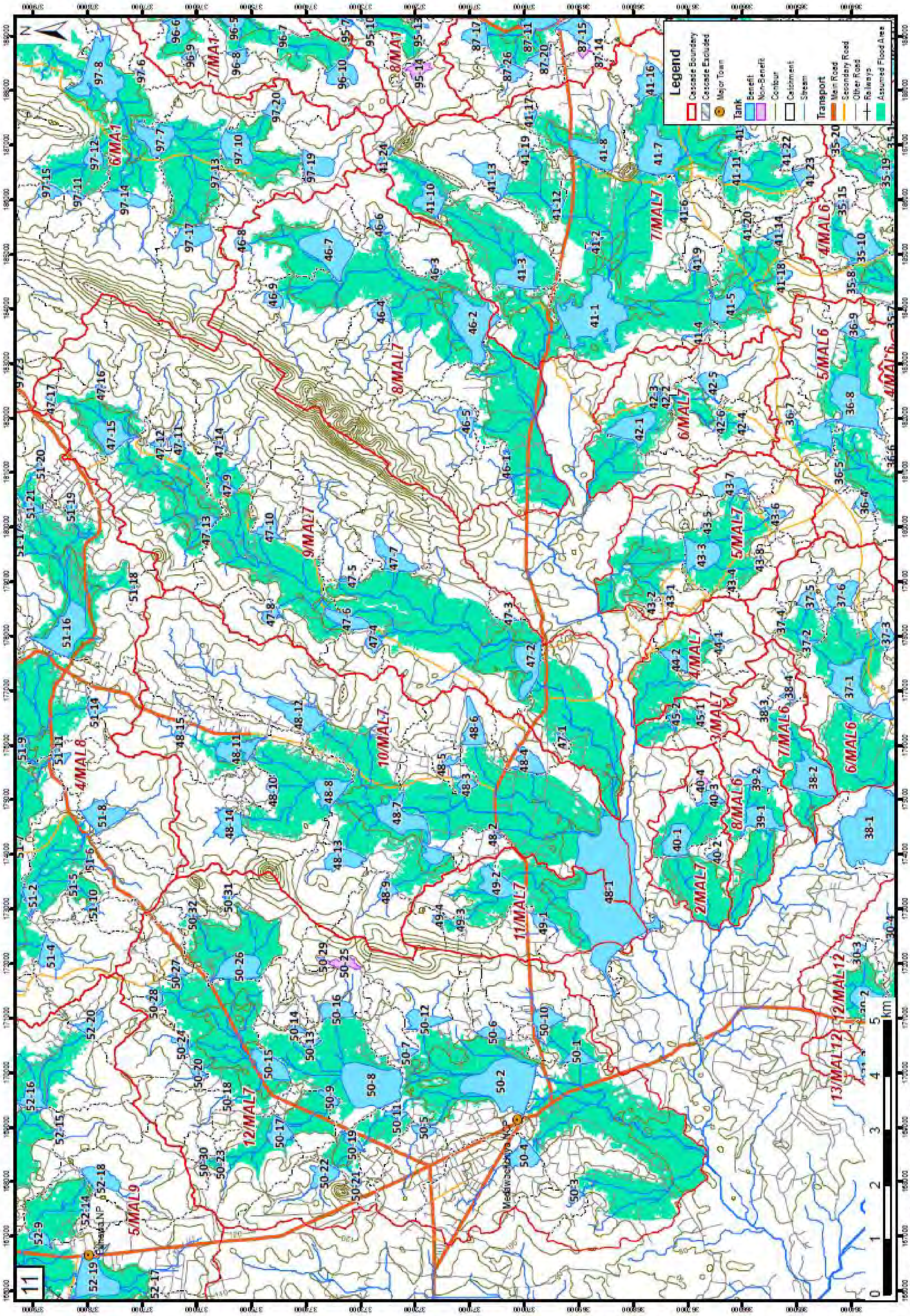

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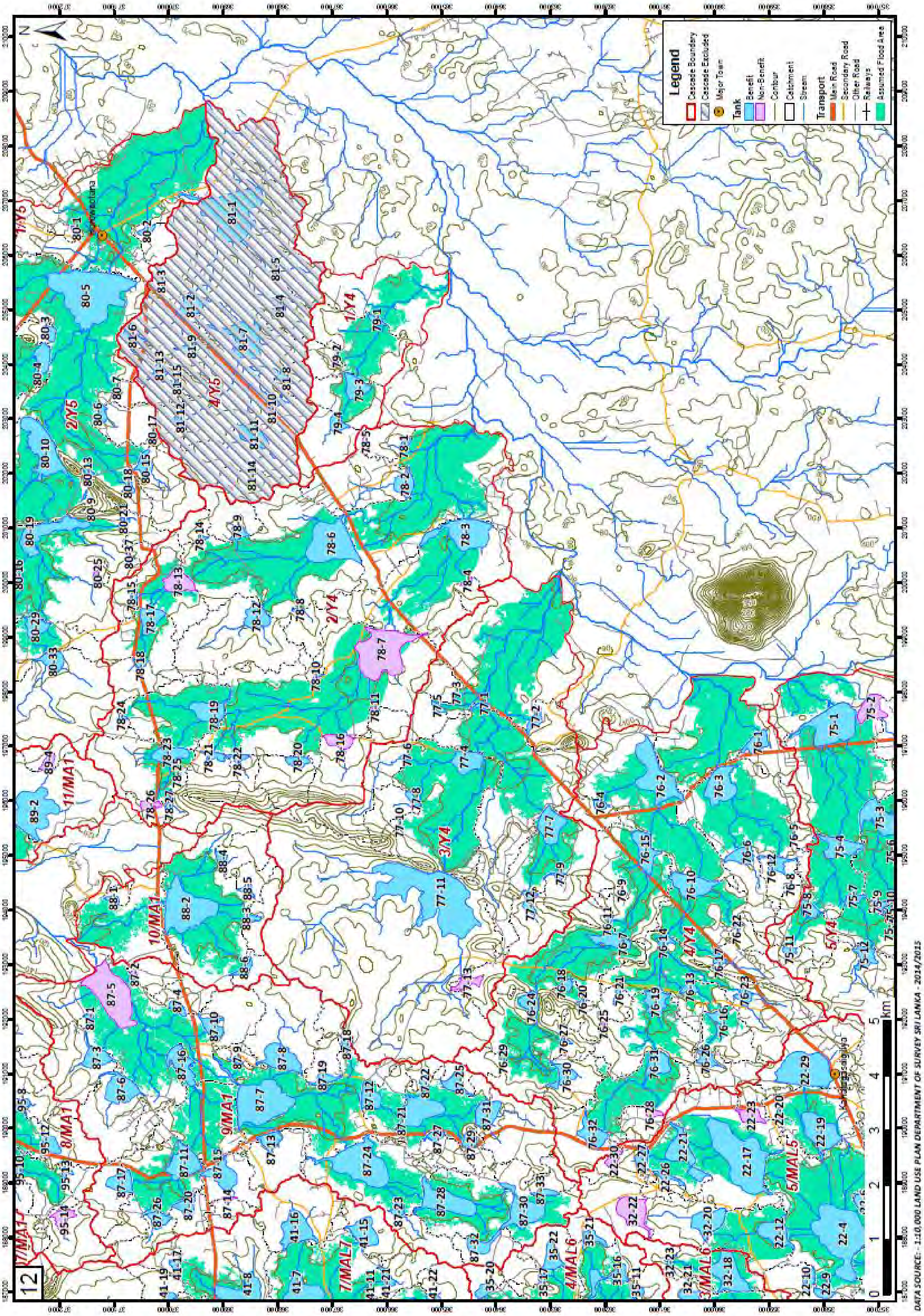

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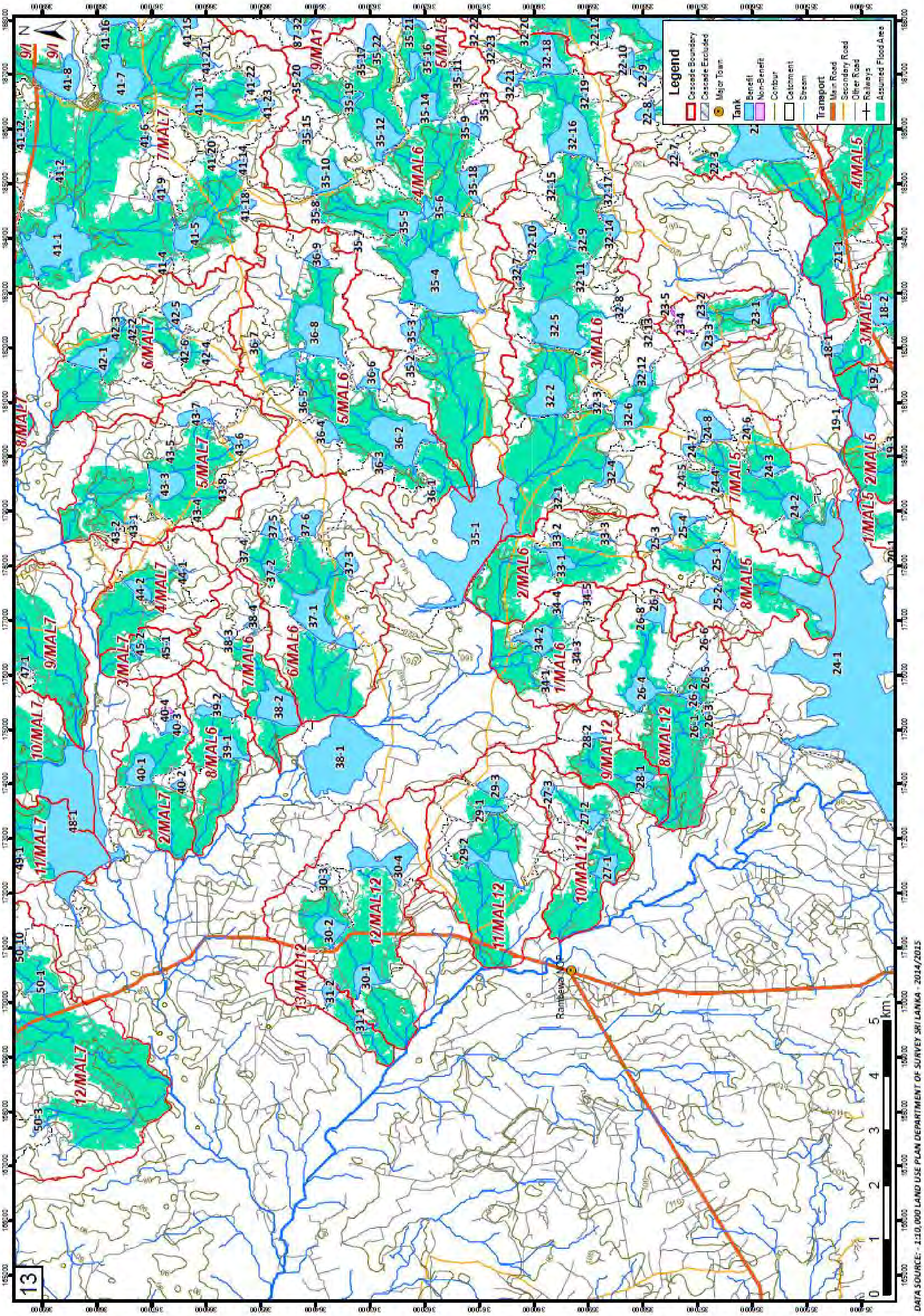

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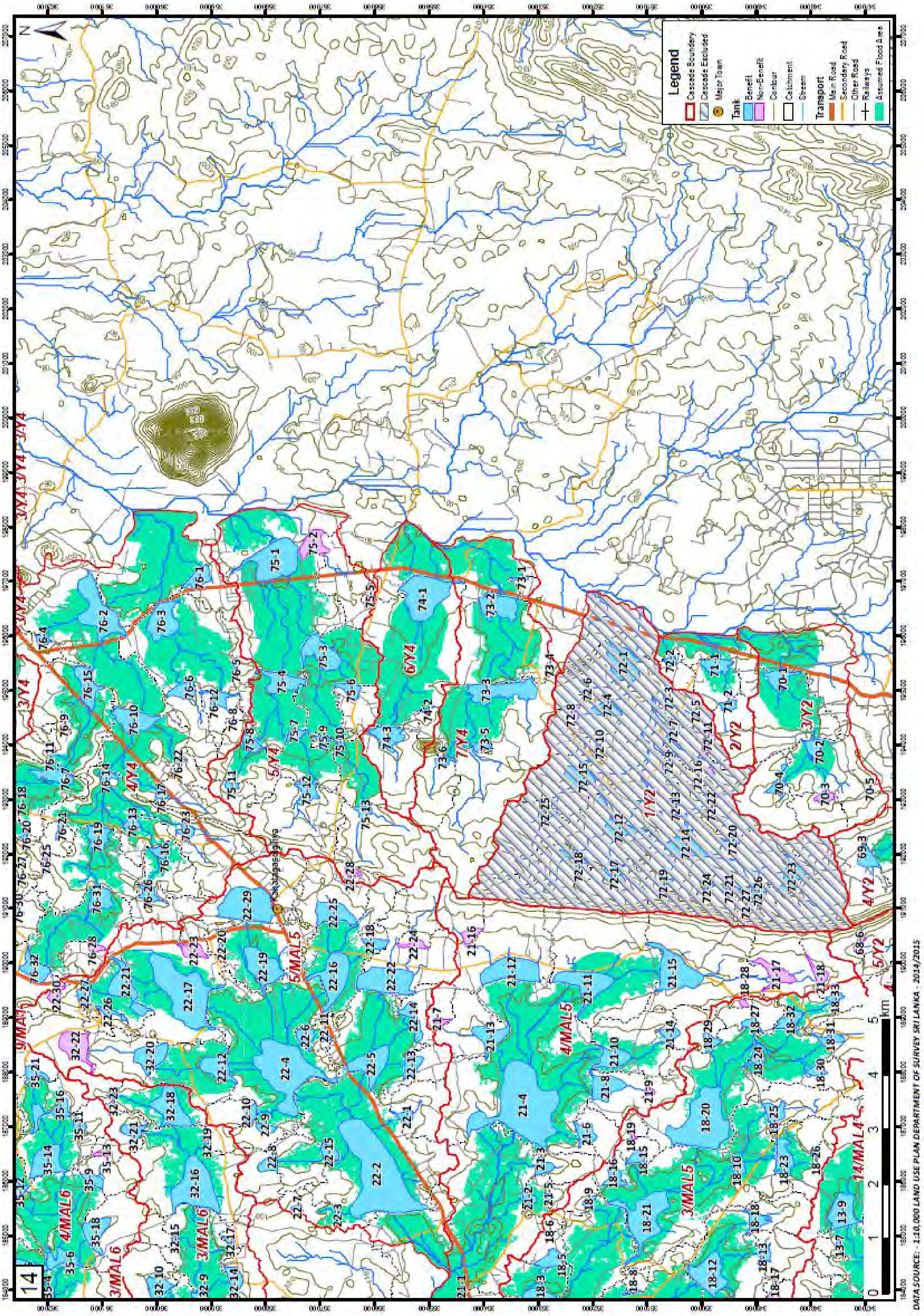

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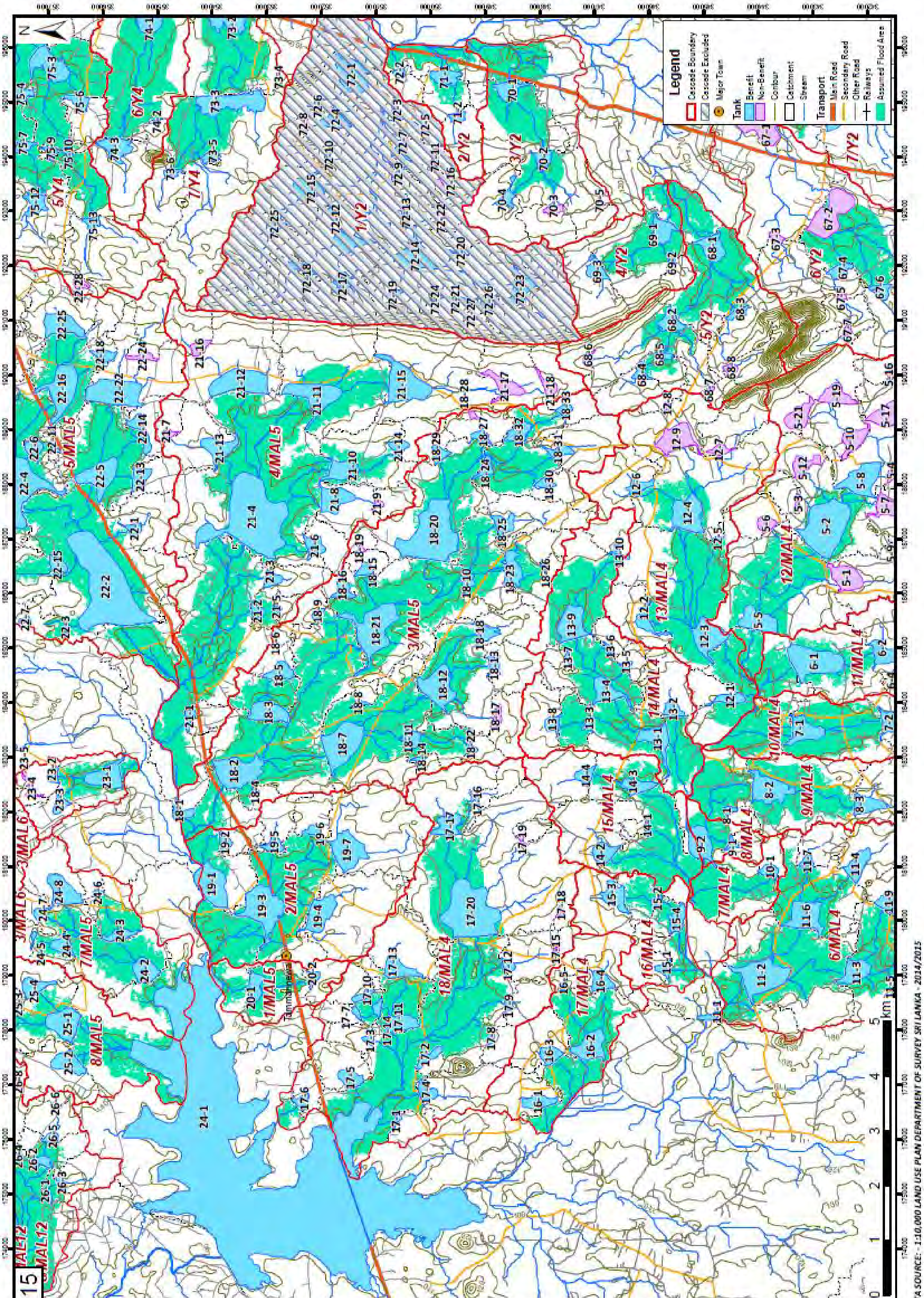

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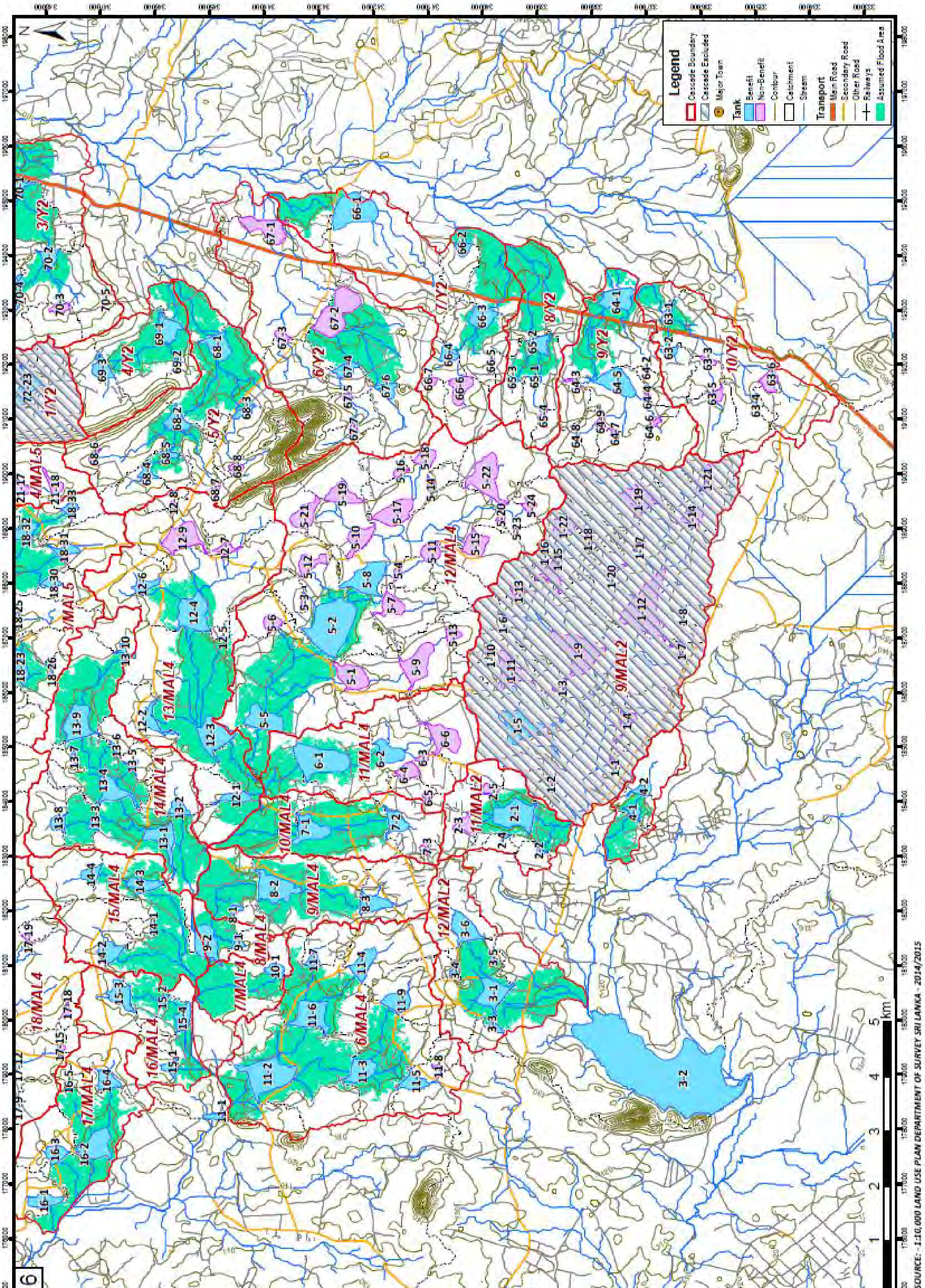

Source: Study Team

Attachment 8.2-5: Summary of Flood Damage Quantity

Cas_ID	Symbol	Cascade Name	Total tanks	Benefit tanks	Head works (nos.)	Irrigation Canal (km)	Farm Road (km)	Loss of Paddy Harvest (nos.)	Flood Area (ha)	Public Facility (nos.)	House (nos.)	Main Road (km)	Secondary Rd. (km)	Other Rd. (km)	Railway (km)	Well (nos.)	Remarkd
1	9/MAL2	Siwala Kulam															Excluded
2	11/MAL2	Bora Wewa	5	3	3	2.70	0.0	3	113.4	0	46	0.0	0.0	3.8	0.0		
3	12/MAL2	Pairimaduwa Wewa	6	6	6	5.60	4.5	6	203.1	4	141	0.0	2.5	4.1	0.0		
4	10/MAL2	Galwaduwagama	2	2	2	2.17	0.0	2	59.2	0	19	0.0	0.0	2.8	0.0		
5	12/MAL4	Abagaha Wewa	24	3	3	0.22	2.8	3	317.9	0	21	0.0	1.1	3.3	0.0		
6	11/MAL4	Periya Kulam	6	2	2	4.10	1.7	2	134.5	0	2	0.0	0.0	1.9	0.0		
7	10/MAL4	Kon Wewa	3	2	2	5.21	1.1	2	231.1	0	106	0.0	3.9	6.3	0.0		
8	9/MAL4	Pahala Halmillewa	3	3	3	0.00	2.3	3	238.4	0	83	0.0	2.4	6.6	0.0		
9	8/MAL4	Tharanogolllawa	2	2	2	0.00	0.0	2	44.2	0	0	0.0	0.0	0.5	0.0		
10	7/MAL4	Siyabalabedigaswewa	1	1	1	0.00	0.0	1	93.7	0	0	0.0	0.0	0.9	0.0		
11	6/MAL4	Mahagal kulam	9	7	7	0.00	6.2	7	492.1	0	86	0.0	4.7	11.7	0.0		
12	13/MAL4	Ichchan Kulam	10	7	7	4.00	2.9	7	393.2	0	3	0.0	0.4	5.2	0.0		
13	14/MAL4	Katukaliyawa	10	10	10	3.70	0.0	10	447.0	0	185	0.0	0.9	11.3	0.0		
14	15/MAL4	Kasamaduwa	4	4	4	3.30	0.8	4	194.0	0	23	0.0	0.4	3.2	0.0		
15	16/MAL4	Ittiktiya	4	4	4	0.00	0.0	4	86.4	0	1	0.0	0.5	2.1	0.0		
16	17/MAL4	Galmaduwa	5	5	5	0.75	0.0	5	184.5	0	63	0.0	2.2	1.7	0.0		
17	18/MAL4	Palugas Wewa	20	17	17	0.02	13.2	17	775.3	0	263	0.2	4.5	11.3	0.0		
18	3/MAL5	Mekechchawa	33	29	29	8.27	18.6	29	1521.1	0	343	0.6	9.3	22.5	0.0		
19	2/MAL5	Abagahawela	7	7	7	2.20	4.0	7	374.1	0	213	1.9	2.9	7.3	0.0		
20	1/MAL5	Ethawetuna Wewa	2	2	2	0.00	1.5	2	85.7	0	21	0.3	0.0	0.9	0.0		
21	4/MAL5	Ella Wewa	18	13	13	2.00	2.3	13	978.1	0	217	1.2	2.2	13.4	0.0		
22	5/MAL5	Ranpathwila Wewa	30	26	26	6.33	11.0	26	1457.6	0	334	3.4	4.8	14.5	0.0		
23	6/MAL5	Kukulawa Wewa	5	3	3	3.00	4.7	3	66.2	0	13	0.0	0.7	0.8	0.0		
24	7/MAL5	Konketupothana	8	7	7	0.00	16.5	7	278.9	0	18	0.0	1.5	2.7	0.0		
25	8/MAL5	Gekarawa Wewa	4	4	4	1.30	4.4	4	241.4	0	7	0.0	0.8	0.8	0.0		
26	8/MAL12	Kongollawewa	8	6	6	0.00	4.3	6	313.5	0	114	0.0	0.0	11.4	0.0		
27	10/MAL12	Nika Wewa	3	3	3	0.00	2.6	3	178.8	0	13	0.0	0.0	2.9	0.0		
28	9/MAL12	Mekicha Wewa	2	2	2	0.00	2.4	2	133.0	0	61	0.0	0.0	4.4	0.0		
29	11/MAL12	Kuda Wewa	3	3	3	0.00	2.2	3	274.9	0	90	0.8	1.8	3.1	0.0		
30	12/MAL12	Rathmalgaha Wewa	4	4	4	0.00	5.7	4	322.7	0	173	1.1	0.0	5.3	0.0		
31	13/MAL12	Kudagama Wewa	2	2	2	0.00	1.0	2	46.0	0	1	0.0	0.0	0.6	0.0		
32	3/MAL6	Tibiri Wewa	23	21	21	4.28	16.6	21	980.8	0	214	0.0	6.5	11.1	0.0		
33	2/MAL6	Gonawa Ihala Wewa	3	3	3	0.00	3.4	3	218.8	0	89	0.0	2.9	1.5	0.0		
34	1/MAL6	Gonawa Wewa	5	3	3	0.42	1.6	3	122.4	0	45	0.0	0.8	1.8	0.0		
35	4/MAL6	Kapirilgama Wewa	22	21	21	4.31	29.4	21	1075.3	0	190	0.0	3.6	11.3	0.0		
36	5/MAL6	Siyabalagaswewa	10	10	10	0.00	5.6	10	434.6	0	34	0.0	0.3	5.8	0.0		
37	6/MAL6	Thalgaha	6	6	6	0.00	3.3	6	338.6	0	30	0.0	1.0	4.4	0.0		
38	7/MAL6	Walketu Wewa	4	4	4	0.00	9.7	4	127.7	0	5	0.0	0.0	1.6	0.0		
39	8/MAL6	Dumminnegama	2	2	2	0.00	3.0	2	150.0	0	10	0.0	0.0	2.6	0.0		
40	2/MAL7	Lidawewa	4	3	3	1.60	5.0	3	199.4	0	67	0.0	0.0	4.1	0.0		
41	7/MAL7	Pihibiyagollawa	24	24	24	10.29	22.2	24	1604.9	0	505	3.1	7.6	25.5	0.0		
42	6/MAL7	Kirimetiyawa	6	6	6	3.27	3.5	6	207.3	0	21	0.0	0.6	4.2	0.0		
43	5/MAL7	Ralapanawa	8	7	7	2.41	2.3	7	304.3	0	41	0.0	2.6	4.0	0.0		
44	4/MAL7	Kardan Kulam	2	2	2	1.80	3.0	2	130.8	0	46	0.0	0.9	2.3	0.0		
45	3/MAL7	Diulgas Wewa	2	2	2	0.00	0.3	2	0.0	0	2	0.0	0.0	0.0	0.0		
46	8/MAL7	Gagurane Pathaha	9	9	9	0.90	7.5	9	753.6	0	121	2.4	0.0	13.1	0.0		
47	9/MAL7	Kirigollewa	17	17	17	17.13	6.4	17	1248.7	0	277	1.2	7.1	30.0	0.0		
48	10/MAL7	Kudagama Wewa	15	15	15	0.00	2.4	15	1070.1	0	310	1.9	2.7	21.5	0.0		
49	11/MAL7	Kuda Wewa	4	4	4	0.00	0.0	4	312.5	0	43	0.6	0.0	4.9	0.0		
50	12/MAL7	Madawachchiya Wewa	32	30	30	12.82	5.3	30	1726.0	0	801	5.8	0.0	36.7	0.0		
51	4/MAL8	Parana Halmillewa	21	21	21	17.96	5.0	21	1151.2	0	255	5.1	2.2	27.4	0.0		
52	5/MAL9	Kidewaran Kulam	20	20	20	14.37	14.3	20	1298.2	0	345	3.0	1.4	28.1	3.6		
53	3/MAL8	Thibiri Wewa	2	2	2	1.80	2.0	2	73.9	0	4	0.0	0.0	1.3	0.0		
54	6/MAL8	Dutuwewa	1	1	1	0.00	2.7	1	84.4	0	12	0.0	0.0	1.3	0.0		
55	7/MAL8	Alagalla	5	5	5	3.08	0.5	5	218.8	0	78	0.0	1.6	6.6	0.0		
56	8/MAL8	Nochchikulam	17	13	13	18.46	6.4	13	823.3	0	414	0.8	6.4	19.3	0.4		
57	5/MAL8	Aluth Halmillewa															Excluded
58	9/MAL8	Irataperiya Kulam	22	18	18	11.78	19.3	18	1117.0	0	254	0.7	3.2	29.9	0.9		
59	10/MAL8	Kurundan Kulam	4	2	2	1.70	0.5	2	42.6	0	0	0.0	0.0	0.2	0.0		
60	11/MAL8	Kandapuran Kulam	8	3	3	2.55	0.7	3	183.0	0	58	0.0	0.4	4.5	0.0		
61	12/MAL8	Karuweppan Kulam	15	6	6	2.55	4.4	6	270.9	0	69	0.1	0.8	8.2	0.0		
62	13/MAL8	Suduventapulavu	6	2	2	4.27	1.1	2	216.6	0	193	1.3	1.4	4.3	0.0		
63	10/Y2	Ihalagal Kulam	6	1	1	0.02	0.3	1	44.4	0	13	0.4	0.0	0.7	0.0		
64	9/Y2	Eluwan Kulama	9	2	2	2.35	0.0	2	116.8	0	83	0.9	0.0	3.1	0.0		
65	8/Y2	Meegaswewa	4	3	3	0.91	0.0	3	171.4	0	81	0.7	0.0	4.5	0.0		
66	7/Y2	Kannimaduwa Wewa	7	4	4	2.10	4.6	4	181.3	0	29	0.5	0.5	3.6	0.0		
67	6/Y2	Pahala Nittawa	7	2	2	1.30	1.5	2	167.0	0	29	0.0	0.0	2.5	0.0		
68	5/Y2	Puliyan Kulam	8	5	5	2.51	2.2	5	269.1	0	36	0.0	0.7	6.1	0.0		
69	4/Y2	Ella Wewa	3	3	3	2.81	1.0	3	120.7	0	17	0.0	0.0	1.5	0.0		
70	3/Y2	Olukolagala Wewa	5	3	3	2.67	3.8	3	230.4	0	70	0.8	0.0	3.7	0.0		
71	2/Y2	Punchihammillawa	2	2	2	2.58	1.0	2	81.1	0	10	1.2	0.3	0.7	0.0		
72	1/Y2	Mahakirimetiyawa															Excluded
73	7/Y4	Hettuwewa	6	4	4	6.87	2.1	4	380.8	0	76	0.4	1.9	5.8	0.0		
74	6/Y4	Kon Wewa	3	3	3	1.73	3.5	3	306.7	0	51	1.1	0.9	4.1	0.0		
75	5/Y4	Ithalwatuna Wewa	13	11	11	0.10	11.7	11	783.8	0	312	1.4	1.8	13.4	0.0		
76	4/Y4	Maha Hammillewa	32	28	28	2.65	14.9	28	1452.6	0	274	3.7	3.0	18.2	0.0		
77	3/Y4	Moragahadigiliya	13	11	11	20.43	15.6	11	823.3	0	118	1.7	0.4	9.6	0.0		
78	2/Y4	Pemorakewa	27	20	20	25.82	14.9	20	1429.8	0	332	3.2	7.6	11.7	0.0		
79	1/Y4	Patanaya	4	4	4	4.43	5.0	4	194.1	0	21	0.0	0.0	2.6	0.0		
80	2/Y5	Nilla Wewa	48	39	39	28.32	13.4	39	2365.3	0	1229	7.7	5.9	39.2	0.0		
81	4/Y5	Rathmala Wewa															Excluded
82	1/Y5	Ralapanawa	23	14	14	17.09	13.4	14	732.7	0	263	0.0	3.3	15.8	0.0		
83	1/Y6	Hammillawa	22	12	12	9.91	11.9	12	817.0	0	232	0.0	3.5	11.2	0.0		

Attachment 8.2-5: Summary of Flood Damage Quantity

Cas_ID	Symbol	Cascade Name	Total tanks	Benefit tanks	Head works (nos.)	Irrigation Canal (km)	Farm Road (km)	Loss of Paddy Harvest (nos.)	Flood Area (ha)	Public Facility (nos.)	House (nos.)	Main Road (km)	Secondary Rd. (km)	Other Rd. (km)	Railway (km)	Well (nos.)	Remarkd
84	5/Y6	Dutu Wewa	4	3	3	6.50	3.8	3	450.4	0	72	0.0	0.0	8.3	0.0		
85	2/Y6	Kapugollewa Ela	16	8	8	14.81	8.9	8	1236.9	0	165	0.0	3.0	18.9	0.0		
86	3/Y6	Wagollakada	3	3	3	1.21	1.6	3	222.9	0	10	0.0	0.0	3.8	0.0		
87	9/MA1	Maha Wewalkadawala	33	30	30	5.29	9.8	30	1222.4	0	107	6.6	3.1	10.1	0.0		
88	10/MA1	Walahawidda Wewa	6	6	6	3.49	3.8	6	319.2	0	19	0.5	0.0	1.4	0.0		
89	11/MA1	Ulpathagama Wewa	8	2	2	8.75	1.7	2	60.7	0	14	0.0	0.1	0.8	0.0		
90	12/MA1	Ulpotha	1	1	1	0.00	0.0	1	39.2	0	16	0.0	0.0	1.5	0.0		
91	13/MA1	Kiriketu Wewa	2	2	2	3.20	2.0	2	123.6	0	18	1.0	1.0	0.4	0.0		
92	15/MA1	Mahatikka Wewa	11	9	9	6.83	7.7	9	601.1	0	165	0.0	4.0	5.4	0.0		
93	14/MA1	Elapattewa	8	7	7	5.20	6.5	7	388.3	0	44	0.0	0.7	6.2	0.0		
94	16/MA1	Gallewa Wewa	7	4	4	17.50	0.0	4	353.7	0	63	0.0	2.4	1.2	0.0		
95	8/MA1	Ihala Thammennawa	14	13	13	4.94	2.1	13	734.8	0	73	1.8	0.0	7.8	0.0		
96	7/MA1	Kiulekada Wewa	12	11	11	4.94	0.0	11	568.2	0	45	2.9	0.0	4.9	0.0		
97	6/MA1	Ayiyatige Wewa	23	22	22	25.27	14.3	22	1682.4	0	698	8.3	5.1	22.9	0.0		
98	5/MA1	Palupuliyam Kulama	8	7	7	6.40	0.0	7	265.9	0	98	0.8	2.4	2.3	0.0		
99	4/MA1	Ithalwiddawa Wewa	11	11	11	10.68	2.6	11	455.3	0	86	2.3	1.4	7.1	0.0		
100	3/MA1	Mahanettiyawa	4	4	4	1.48	2.5	4	252.6	0	66	1.4	0.0	2.8	0.0		
101	2/MA1	Olugaskada	11	10	10	1.54	9.5	10	726.4	0	148	3.0	0.7	9.3	0.0		
102	10/MA2	Sinhaya Ulpotha	1	1	1	0.00	0.0	1	86.5	0	2	0.0	0.0	0.0	0.0		
103	1/MA1	Pahala Herath Mamillewa	2	2	2	2.08	0.0	2	81.6	0	22	1.6	0.0	1.7	0.0		
104	9/MA2	Medagama Wewa	1	1	1	0.15	0.0	1	11.8	0	0	0.0	0.0	0.0	0.0		
105	7/MA2	Kunchuttuwa	4	3	3	6.10	3.5	3	452.1	0	18	0.4	0.2	5.8	0.0		
106	8/MA2	Puliyan Kulama	7	7	7	5.03	1.1	7	284.0	0	60	3.7	0.6	3.4	0.0		
107	6/MA2	Maha Ralapanawa	7	5	5	2.38	4.9	5	459.2	0	79	1.4	0.0	9.9	0.0		
108	5/MA2	Migakada Wewa	2	2	2	1.30	2.5	2	280.1	0	56	0.6	0.0	7.0	0.0		
109	2/MA2	Viharahalmillawa	5	2	2	2.01	0.0	2	92.9	0	0	0.0	0.0	1.7	0.0		
110	1/MA2	Nikawewa	2	1	1	0.00	0.0	1	56.5	0	20	0.0	0.0	1.7	0.0		
111	5/PAR1	Puthuk Kulam	21	17	17	40.48	18.4	17	1369.1	6	2500	5.5	5.0	50.2	2.9		
112	4/PAR1	Putuk Kulam	7	5	5	3.25	3.4	5	312.6	2	93	0.0	1.1	13.4	0.0		
113	3/PAR1	Periya Kulam	3	1	1	5.02	0.0	1	199.2	0	110	0.0	2.2	6.5	0.0		
114	2/PAR1	Kollamutamadu Kulam	8	5	5	10.01	7.2	5	291.5	0	46	0.0	1.5	6.5	0.0		
115	1/PAR1	Chinna Kulam	6	6	6	10.14	8.7	6	336.1	0	105	0.0	4.5	7.7	0.0		
116	6/PAR1	Parandikallu	25	24	24	27.12	15.9	24	969.3	4	392	2.5	2.3	28.9	0.8		
117	6/PAR4	Periyakada	18	13	13	20.38	17.2	13	1119.4	1	446	0.0	3.1	36.0	0.0		
118	7/PAR4	Kidachchuri	4	3	3	4.23	5.9	3	112.1	12	60	0.0	2.4	2.5	0.0		
119	8/PAR4	Mullaik Kulam	2	2	2	1.31	1.4	2	158.6	0	131	0.0	2.0	6.8	0.0		
120	7/PAR1	Karunkalisinna Kulam	15	9	9	15.31	14.3	9	1122.8	0	229	0.0	4.7	27.6	0.0		
121	3/PAR2	Marutan Kulam	14	10	10	0.00	8.2	10	659.9	0	266	0.9	1.4	17.0	0.9		
122	4/PAR2	Naveli Kulam	15	13	13	8.26	7.1	13	465.8	0	115	1.4	0.7	11.3	1.2		
123	5/PAR2	Kasawapulaiyan Kulam	2	2	2	2.01	1.7	2	80.2	0	19	0.0	0.5	1.4	0.0		
124	6/PAR2	Alankulam	3	3	3	3.50	1.8	3	156.9	0	11	0.0	0.4	4.5	0.0		
125	7/PAR2	Podun Kulam	4	4	4	6.81	4.1	4	145.4	0	41	0.0	1.4	2.3	0.0		
126	8/PAR2	Palaimoddalk Kulam	1	1	1	2.50	0.5	1	105.4	0	76	0.0	1.2	3.5	0.0		
127	7/MGA1	Chamalan Kulam	10	8	8	18.16	15.3	8	1196.4	0	50	0.0	3.6	24.1	0.0		
128	6/MGA1	Periyapuliyan Kulam	10	10	10	24.02	13.0	10	1260.2	0	195	0.0	2.3	30.0	0.0		
Total			1,185	955	955	676.81	657.8	955	59,003	29	17,518	105.37	196.09	1,069.28	10.73	0.00	

Source: Study Team

Attachment 8.2-6: Summary of Flood Damage Cost

Cas_ID	Symbol	Cascade Name	Total tanks	Benefit tanks	Head works	Irrigation Canal	Farm Road	Loss of Paddy Harvest	Flood Area	Public Facility	House	Main Road	Secondary Road	Other Rd.	Railway	Well	Flood Damage Cost: Subtotal	Flood Damage Cost: Cost Escalation	Flood Damage Cost: Occurrence Probability	Flood Damage Cost: Total	Remarks
					(LKR Million)												(LKR M.)	(%)	(%)	(LKR M.)	
1	9/MAL2	Siwala Kulam	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.38	5.00	0.00	Excluded
2	11/MAL2	Bora Wewa	5	3	0.96	0.30	0.00	1.23	0.00	0.00	2.00	0.00	0.00	0.38	0.00	0.00	4.87	18.38	5.00	0.29	
3	12/MAL2	Pairimaduwa Wewa	6	6	1.92	0.62	0.45	2.46	0.00	0.00	6.15	0.00	0.25	0.41	0.00	0.00	12.26	18.38	5.00	0.73	
4	10/MAL2	Galwaduwagama	2	2	0.64	0.24	0.00	0.82	0.00	0.00	0.83	0.00	0.00	0.28	0.00	0.00	2.81	18.38	5.00	0.17	
5	12/MAL4	Abagaha Wewa	24	3	0.96	0.02	0.28	1.23	0.00	0.00	0.90	0.00	0.11	0.33	0.00	0.00	3.83	18.38	5.00	0.23	
6	11/MAL4	Periya Kulam	6	2	0.64	0.45	0.17	0.82	0.00	0.00	0.09	0.00	0.00	0.19	0.00	0.00	2.36	18.38	5.00	0.14	
7	10/MAL4	Kon Wewa	3	2	0.64	0.57	0.11	0.82	0.00	0.00	4.62	0.00	0.39	0.63	0.00	0.00	7.78	18.38	5.00	0.46	
8	9/MAL4	Pahala Halmillewa	3	3	0.96	0.00	0.23	1.23	0.00	0.00	3.62	0.00	0.24	0.66	0.00	0.00	6.94	18.38	5.00	0.41	
9	8/MAL4	Tharanogolllawa	2	2	0.64	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	1.51	18.38	5.00	0.09	
10	7/MAL4	Siyabalabedigaswewa	1	1	0.32	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.82	18.38	5.00	0.05	
11	6/MAL4	Mahagal kulam	9	7	2.24	0.00	0.62	2.87	0.00	0.00	3.75	0.00	0.47	1.17	0.00	0.00	11.12	18.38	5.00	0.66	
12	13/MAL4	Ichchan Kulam	10	7	2.24	0.44	0.29	2.87	0.00	0.00	0.13	0.00	0.04	0.52	0.00	0.00	6.53	18.38	5.00	0.39	
13	14/MAL4	Katukaliyawa	10	10	3.20	0.41	0.00	4.10	0.00	0.00	8.06	0.00	0.09	1.13	0.00	0.00	16.99	18.38	5.00	1.01	
14	15/MAL4	Kasamaduwa	4	4	1.28	0.36	0.08	1.64	0.00	0.00	1.00	0.00	0.04	0.32	0.00	0.00	4.72	18.38	5.00	0.28	
15	16/MAL4	Ittiktiya	4	4	1.28	0.00	0.00	1.64	0.00	0.00	0.04	0.00	0.05	0.21	0.00	0.00	3.22	18.38	5.00	0.19	
16	17/MAL4	Galmaduwa	5	5	1.60	0.08	0.00	2.05	0.00	0.00	2.75	0.00	0.22	0.17	0.00	0.00	6.87	18.38	5.00	0.41	
17	18/MAL4	Palugas Wewa	20	17	5.44	0.00	1.32	6.97	0.00	0.00	11.46	0.02	0.45	1.13	0.00	0.00	26.79	18.38	5.00	1.59	
18	3/MAL5	Mekechchawa	33	29	9.28	0.91	1.86	11.89	0.00	0.00	14.95	0.06	0.93	2.25	0.00	0.00	42.13	18.38	5.00	2.49	
19	2/MAL5	Abagahawela	7	7	2.24	0.24	0.40	2.87	0.00	0.00	9.28	0.19	0.29	0.73	0.00	0.00	16.24	18.38	5.00	0.96	
20	1/MAL5	Ethawetuna Wewa	2	2	0.64	0.00	0.15	0.82	0.00	0.00	0.92	0.03	0.00	0.09	0.00	0.00	2.65	18.38	5.00	0.16	
21	4/MAL5	Ella Wewa	18	13	4.16	0.22	0.23	5.33	0.00	0.00	9.46	0.12	0.22	1.34	0.00	0.00	21.08	18.38	5.00	1.25	
22	5/MAL5	Ranpathwila Wewa	30	26	8.32	0.70	1.10	10.66	0.00	0.00	14.56	0.34	0.48	1.45	0.00	0.00	37.61	18.38	5.00	2.23	
23	6/MAL5	Kukulawa Wewa	5	3	0.96	0.33	0.47	1.23	0.00	0.00	0.57	0.00	0.07	0.08	0.00	0.00	3.71	18.38	5.00	0.22	
24	7/MAL5	Konketupothana	8	7	2.24	0.00	1.65	2.87	0.00	0.00	0.78	0.00	0.15	0.27	0.00	0.00	7.96	18.38	5.00	0.47	
25	8/MAL5	Gekarawa Wewa	4	4	1.28	0.14	0.44	1.64	0.00	0.00	0.31	0.00	0.08	0.08	0.00	0.00	3.97	18.38	5.00	0.23	
26	8/MAL12	Kongollawewa	8	6	1.92	0.00	0.43	2.46	0.00	0.00	4.97	0.00	0.00	1.14	0.00	0.00	10.92	18.38	5.00	0.65	
27	10/MAL12	Nika Wewa	3	3	0.96	0.00	0.26	1.23	0.00	0.00	0.57	0.00	0.00	0.29	0.00	0.00	3.31	18.38	5.00	0.20	
28	9/MAL12	Mekicha Wewa	2	2	0.64	0.00	0.24	0.82	0.00	0.00	2.66	0.00	0.00	0.44	0.00	0.00	4.80	18.38	5.00	0.28	
29	11/MAL12	Kuda Wewa	3	3	0.96	0.00	0.22	1.23	0.00	0.00	3.92	0.08	0.18	0.31	0.00	0.00	6.90	18.38	5.00	0.41	
30	12/MAL12	Rathmalgaha Wewa	4	4	1.28	0.00	0.57	1.64	0.00	0.00	7.54	0.11	0.00	0.53	0.00	0.00	11.67	18.38	5.00	0.69	
31	13/MAL12	Kudagama Wewa	2	2	0.64	0.00	0.10	0.82	0.00	0.00	0.04	0.00	0.00	0.06	0.00	0.00	1.66	18.38	5.00	0.10	
32	3/MAL6	Tibiri Wewa	23	21	6.72	0.47	1.66	8.61	0.00	0.00	9.33	0.00	0.65	1.11	0.00	0.00	28.55	18.38	5.00	1.69	
33	2/MAL6	Gonawa Ihala Wewa	3	3	0.96	0.00	0.34	1.23	0.00	0.00	3.88	0.00	0.29	0.15	0.00	0.00	6.85	18.38	5.00	0.41	
34	1/MAL6	Gonawa Wewa	5	3	0.96	0.05	0.16	1.23	0.00	0.00	1.96	0.00	0.08	0.18	0.00	0.00	4.62	18.38	5.00	0.27	
35	4/MAL6	Kapirilgama Wewa	22	21	6.72	0.47	2.94	8.61	0.00	0.00	8.28	0.00	0.36	1.13	0.00	0.00	28.51	18.38	5.00	1.69	
36	5/MAL6	Siyabalagaswewa	10	10	3.20	0.00	0.56	4.10	0.00	0.00	1.48	0.00	0.03	0.58	0.00	0.00	9.95	18.38	5.00	0.59	
37	6/MAL6	Thalgaha	6	6	1.92	0.00	0.33	2.46	0.00	0.00	1.31	0.00	0.10	0.44	0.00	0.00	6.56	18.38	5.00	0.39	
38	7/MAL6	Walketu Wewa	4	4	1.28	0.00	0.97	1.64	0.00	0.00	0.22	0.00	0.00	0.16	0.00	0.00	4.27	18.38	5.00	0.25	
39	8/MAL6	Dumminnegama	2	2	0.64	0.00	0.30	0.82	0.00	0.00	0.44	0.00	0.00	0.26	0.00	0.00	2.46	18.38	5.00	0.15	
40	2/MAL7	Lidawewa	4	3	0.96	0.18	0.50	1.23	0.00	0.00	2.92	0.00	0.00	0.41	0.00	0.00	6.20	18.38	5.00	0.37	
41	7/MAL7	Pihibiyagollawa	24	24	7.68	1.13	2.22	9.84	0.00	0.00	22.01	0.31	0.76	2.55	0.00	0.00	46.50	18.38	5.00	2.75	
42	6/MAL7	Kirimetiyawa	6	6	1.92	0.36	0.35	2.46	0.00	0.00	0.92	0.00	0.06	0.42	0.00	0.00	6.49	18.38	5.00	0.38	
43	5/MAL7	Ralapanawa	8	7	2.24	0.27	0.23	2.87	0.00	0.00	1.79	0.00	0.26	0.40	0.00	0.00	8.06	18.38	5.00	0.48	
44	4/MAL7	Kardan Kulam	2	2	0.64	0.20	0.30	0.82	0.00	0.00	2.00	0.00	0.09	0.23	0.00	0.00	4.28	18.38	5.00	0.25	
45	3/MAL7	Diulgas Wewa	2	2	0.64	0.00	0.03	0.82	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	1.58	18.38	5.00	0.09	
46	8/MAL7	Gagurane Pathaha	9	9	2.88	0.10	0.75	3.69	0.00	0.00	5.27	0.24	0.00	1.31	0.00	0.00	14.24	18.38	5.00	0.84	
47	9/MAL7	Kirigollewa	17	17	5.44	1.88	0.64	6.97	0.00	0.00	12.07	0.12	0.71	3.00	0.00	0.00	30.83	18.38	5.00	1.82	
48	10/MAL7	Kudagama Wewa	15	15	4.80	0.00	0.24	6.15	0.00	0.00	13.51	0.19	0.27	2.15	0.00	0.00	27.31	18.38	5.00	1.62	
49	11/MAL7	Kuda Wewa	4	4	1.28	0.00	0.00	1.64	0.00	0.00	1.87	0.06	0.00	0.49	0.00	0.00	5.34	18.38	5.00	0.32	
50	12/MAL7	Madawachchiya Wewa	32	30	9.60	1.41	0.53	12.30	0.00	0.00	34.91	0.58	0.00	3.67	0.00	0.00	63.00	18.38	5.00	3.73	
51	4/MAL8	Parana Halmillewa	21	21	6.72	1.98	0.50	8.61	0.00	0.00	11.11	0.51	0.22	2.74	0.00	0.00	32.39	18.38	5.00	1.92	
52	5/MAL9	Kidewaran Kulam	20	20	6.40	1.58	1.43	8.20	0.00	0.00	15.04	0.30	0.14	2.81	0.00	0.00	35.90	18.38	5.00	2.12	
53	3/MAL8	Thibiri Wewa	2	2	0.64	0.20	0.20	0.82	0.00	0.00	0.17	0.00	0.00	0.13	0.00	0.00	2.16	18.38	5.00	0.13	
54	6/MAL8	Dutuwewa	1	1	0.32	0.00	0.27	0.41	0.00	0.00	0.52	0.00	0.00	0.13	0.00	0.00	1.65	18.38	5.00	0.10	
55	7/MAL8	Alagalla	5	5	1.60	0.34	0.05	2.05	0.00	0.00	3.40	0.00	0.16	0.66	0.00	0.00	8.26	18.38	5.00	0.49	
56	8/MAL8	Nochchikulam	17	13	4.16	2.03	0.64	5.33	0.00	0.00	18.04	0.08	0.64	1.93	0.00	0.00	32.85	18.38	5.00	1.94	
57	5/MAL8	Aluth Halmillewa	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.38	5.00	0.00	Excluded
58	9/MAL8	Irataperiya Kulam	22	18	5.76	1.30	1.93	7.38	0.00	0.00	11.07	0.07	0.32	2.99	0.00	0.00	30.82	18.38	5.00	1.82	
59	10/MAL8	Kurundan Kulam	4	2	0.64	0.19	0.05	0.82	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	1.72	18.38	5.00	0.10	
60	11/MAL8	Kandapuran Kulam	8	3	0.96	0.28	0.07	1.23	0.00	0.00	2.53	0.00	0.04	0.45	0.00	0.00	5.56	18.38	5.00	0.33	
61	12/MAL8	Karuweppan Kulam	15	6	1.92	0.28	0.44	2.46	0.00	0.00	3.01	0.01	0.08	0.82	0.00	0.00	9.02	18.38	5.00	0.53	
62	13/MAL8	Suduventapulavu	6	2	0.64	0.47	0.11	0.82	0.00	0.00	8.41	0.13	0.14	0.43	0.00	0.00	11.15	18.38	5.00	0.66	
63	10/Y2	Ihalagal Kulam	6	1	0.32	0.00	0.03	0.41	0.00	0.00	0.57	0.04	0.00	0.07	0.00	0.00	1.44	18.38	5.00	0.09	
64	9/Y2	Eluwan Kulama	9	2	0.64	0.26	0.00	0.82	0.00	0.00	3.62	0.09	0.00	0.31	0.00	0.00	5.74	18.38	5.00	0.34	
65	8/Y2	Meegaswewa	4	3	0.96	0.10	0.00	1.23	0.00	0.00	3.53	0.07	0.00	0.45	0.00	0.00	6.34	18.38	5.00	0.38	
66	7/Y2	Kannimaduwa Wewa	7	4	1.28	0.23	0.46	1.64	0.00	0.00	1.26	0.05	0.05	0.36	0.00	0.00	5.33	18.38	5.00	0.32	
67	6/Y2	Pahala Nittawa	7	2	0.64	0.14	0.15	0.82	0.00	0.00	1.26	0.00	0.00	0.25	0.00	0.00	3.26	18.38	5.00	0.19	
68	5/Y2	Puliyan Kulam	8	5	1.60	0.28	0.22	2.05	0.00	0.00	1.57	0.00	0.07	0.61	0.00	0.00	6.40	18.38	5.00	0.38	
69	4/Y2	Ella Wewa	3	3	0.96	0.31	0.10	1.23	0.00	0.00	0.74	0.00	0.00	0.15	0.00	0.00	3.49	18.38	5.00	0.21	
70	3/Y2	Olukolagala Wewa	5	3	0.96	0.29	0.38	1.23	0.00	0.00	3.05	0.08	0.00	0.37	0.00	0.00	6.36	18.38	5.00	0.38	
71	2/Y2	Punchihammillawa	2	2	0.64	0.28	0.10	0.82	0.00	0.00	0.44	0.12	0.03	0.07	0.00	0.00	2.50	18.38	5.00	0.15	
72	1/Y2	Mahakirimetiyawa	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.38	5.00	0.00	Excluded
73	7/Y4	Hettuwewa	6	4	1.28	0.76	0.21	1.64	0.00	0.00	3.31	0.04	0.19	0.58	0.00	0.00	8.01	18.38	5.00	0.47	
74	6/Y4	Kon Wewa	3	3	0.96	0.19	0.35	1.23	0.00	0.00	2.22	0.11	0.09	0.41	0.00	0.00	5.56	18.38	5.00	0.33	
75	5/Y4	Ithalwatuna Wewa	13	11	3.52	0.01	1.17	4.51	0.00	0.00	13.60	0.14	0.18	1.34	0.00	0.00	24.47	18.38	5.00	1.45	
76	4/Y4	Maha Hammillewa	32	28	8.96	0.29	1.49	11.48	0.00	0.00	11.94	0.37	0.30	1.82	0.00	0.00	36.65	18.38	5.00	2.17	
77	3/Y4	Moragahadigiliya	13	11	3.52	2.25	1.56	4.51	0.00	0.00	5.14	0.17	0.04	0.96	0.00	0.00	18.15	18.38	5.00	1.07	
78	2/Y4	Pemorakewa	27	20	6.40	2.84	1.49	8.20	0.00	0.00	14.47	0.32	0.76	1.17	0.00	0.00	35.65	18.38	5.00	2.11	
79	1/Y4	Patanaya	4	4	1.28	0.49	0.50	1.64	0.00	0.00	0.92	0.00	0.00	0.26	0.00	0.00	5.09	18.38	5.00	0.30	
80	2/Y5	Nilla Wewa	48	39	12.48	3.12	1.34	15.99	0.00	0.00	53.56	0.77	0.59	3.92	0.00	0.00	91.77	18.38	5.00	5.43	
81	4/Y5	Rathmala Wewa	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.38	5.00	0.00	Excluded
82	1/Y5	Ralapanawa	23	14	4.48	1.88	1.34	5.74	0.00	0.00	11.46	0.00	0.33	1.58	0.00	0.00	26.81	18.38	5.00	1.59	
83	1/Y6	Hammillawa	22	12	3.84	1.09	1.19	4.92	0.00	0.00	10.11	0.00	0.35	1.12	0.00	0.00	22.62	18.38	5.00	1.34	
84	5/Y6	Dutu Wewa	4	3	0.96	0.72	0.38	1.23	0.00	0.00	3.14	0.00	0.00	0.83	0.00	0.00	7.26	18.38	5.00	0.43	
85	2/Y6	Kapugollewa Ela	16	8	2.56	1.63	0.89	3.28	0.00	0.00	7.19	0.00	0.30	1.89	0.00	0.00	17.74	18.38	5.00	1.05	
86	3/Y6	Wagollakada	3	3	0.96	0.13	0.16	1.23	0.00	0.00	0.44	0.00	0.00	0.38	0.00	0.00	3.30	18.38	5.00	0.20	
87	9/MA1	Maha Wewalkadawala	33	30	9.60	0.58	0.98	12.30	0.00	0.00	4.66	0.66	0.31	1.01	0.00	0.00	30.10	18.38	5.00	1.78	
88	10/MA1	Walahawidda Wewa	6	6	1.92	0.38	0.38	2.46	0.00	0.00	0.83	0.05	0.00	0.14	0.00	0.00	6.16	18.38	5.00	0.36	
89	11/MA1	Ulpathagama Wewa	8	2	0.64	0.96	0.17	0.82	0.00	0.00	0.61	0.00	0.01	0.08	0.00	0.00	3.29	18.38	5.00	0.19	
90	12/MA1	Ulpotha	1	1	0.32	0.00	0.00	0.41	0.00	0.00	0.70	0.00	0.00	0.15	0.00	0.00	1.58	18.38	5.00	0.09	
91	13/MA1	Kiriketu Wewa	2	2	0.64	0.35	0.20	0.82	0.00	0.00	0.78	0.10	0.10	0.04	0.00	0.00	3.03	18.38	5.00	0.18	
92	15/MA1	Mahatikka Wewa	11	9	2.88	0.75	0.77	3.69	0.00	0.00	7.19	0.00	0.40	0.54	0.00	0.00	16.22	18.38	5.00	0.96	
93	14/MA1	Elapattewa	8	7	2.24	0.57	0.65	2.87	0.00	0.00	1.92	0.00	0.07	0.62	0.00	0.00	8.94	18.38	5.00	0.53	
94	16/MA1	Gallewa Wewa	7	4	1.28	1.93	0.00	1.64	0.00	0.00	2.75	0.00	0.24	0.12	0.00	0.00	7.96	18.38	5.00	0.47	
95	8/MA1	Ihala Thammennawa	14	13	4.16	0.54	0.21	5.33	0.00	0.00	3.18	0.18	0.00	0.78	0.00	0.00	14.38	18.38	5.00	0.85	
96	7/MA1	Kiulekada Wewa	12	11	3.52	0.54	0.00	4.51	0.00	0.00	1.96	0.29	0.00	0.49	0.00	0.00	11.31	18.38	5.00	0.67	
97	6/MA1	Ayiyatige Wewa	23	22	7.04	2.78	1.43	9.02	0.00	0.00	30.42	0.83	0.51	2.29	0.00	0.00	54.32	18.38	5.00	3.22	
98	5/MA1	Palupuliyam Kulama	8	7	2.24	0.70	0.00	2.87	0.00	0.00	4.27	0.08	0.24	0.23	0.00	0.00	10.63	18.38	5.00	0.63	
99	4/MA1	Ithalwiddawa Wewa	11	11	3.52	1.17	0.26	4.51	0.00	0.00	3.75	0.23	0.14	0.71	0.00	0.00	14.29	18.38	5.00	0.85	
100	3/MA1	Mahanettiyawa	4	4	1.28	0.16	0.25	1.64	0.00	0.00	2.88	0.14	0.00	0.28	0.00	0.00	6.63	18.38	5.00	0.39	
101	2/MA1	Olugaskada	11	10	3.20	0.17	0.95	4.10	0.00	0.00	6.45	0.30	0.07	0.93	0.00	0.00	16.17	18.38	5.00	0.96	
102	10/MA2	Sinhaya Ulpotha	1	1	0.32	0.00	0.00	0.41	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.82	18.38	5.00	0.05	
103	1/MA1	Pahala Herath Mamillew	2	2	0.64	0.23	0.00	0.82	0.00	0.00	0.96	0.16	0.00	0.17	0.00	0.00	2.98	18.38	5.00	0.18	
104	9/MA2	Medagama Wewa	1	1	0.32	0.02	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	18.38	5.00	0.04	
105	7/MA2	Kunchuttuwa	4	3	0.96	0.67	0.35	1.23	0.00	0.00	0.78	0.04	0.02	0.58	0.00	0.00	4.63	18.38	5.00	0.27	
106	8/MA2	Puliyan Kulama	7	7	2.24	0.55	0.11	2.87	0.00	0.00	2.62	0.37	0.06	0.34	0.00	0.00	9.16	18.38	5.00	0.54	

Attachment 8.2-6: Summary of Flood Damage Cost

Cas_ID	Symbol	Cascade Name	Total tanks	Benefit tanks	Head works	Irrigation Canal	Farm Road	Loss of Paddy Harvest	Flood Area	Public Facility	House	Main Road	Secondary Road	Other Rd.	Railway	Well	Flood Damage Cost Subtotal	Cost Escalation	Occurrence Probability	Total	Remarks
					(LKR Million)												(LKR M.)	(%)	(%)	(LKR M.)	
107	6/MA2	Maha Ralapanawa	7	5	1.60	0.26	0.49	2.05	0.00	0.00	3.44	0.14	0.00	0.99	0.00	0.00	8.97	18.38	5.00	0.53	
108	5/MA2	Migakada Wewa	2	2	0.64	0.14	0.25	0.82	0.00	0.00	2.44	0.06	0.00	0.70	0.00	0.00	5.05	18.38	5.00	0.30	
109	2/MA2	Viharahalmillawa	5	2	0.64	0.22	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	1.85	18.38	5.00	0.11	
110	1/MA2	Nikawewa	2	1	0.32	0.00	0.00	0.41	0.00	0.00	0.87	0.00	0.00	0.17	0.00	0.00	1.77	18.38	5.00	0.10	
111	5/PAR1	Puthuk Kulam	21	17	5.44	4.45	1.84	6.97	0.00	0.00	108.96	0.55	0.50	5.02	0.00	0.00	133.73	18.38	5.00	7.92	
112	4/PAR1	Putuk Kulam	7	5	1.60	0.36	0.34	2.05	0.00	0.00	4.05	0.00	0.11	1.34	0.00	0.00	9.85	18.38	5.00	0.58	
113	3/PAR1	Periya Kulam	3	1	0.32	0.55	0.00	0.41	0.00	0.00	4.79	0.00	0.22	0.65	0.00	0.00	6.94	18.38	5.00	0.41	
114	2/PAR1	Kollamutamadu Kulam	8	5	1.60	1.10	0.72	2.05	0.00	0.00	2.00	0.00	0.15	0.65	0.00	0.00	8.27	18.38	5.00	0.49	
115	1/PAR1	Chinna Kulam	6	6	1.92	1.12	0.87	2.46	0.00	0.00	4.58	0.00	0.45	0.77	0.00	0.00	12.17	18.38	5.00	0.72	
116	6/PAR1	Parandikallu	25	24	7.68	2.98	1.59	9.84	0.00	0.00	17.08	0.25	0.23	2.89	0.00	0.00	42.54	18.38	5.00	2.52	
117	6/PAR4	Periyakada	18	13	4.16	2.24	1.72	5.33	0.00	0.00	19.44	0.00	0.31	3.60	0.00	0.00	36.80	18.38	5.00	2.18	
118	7/PAR4	Kidachchuri	4	3	0.96	0.47	0.59	1.23	0.00	0.00	2.62	0.00	0.24	0.25	0.00	0.00	6.36	18.38	5.00	0.38	
119	8/PAR4	Mullaik Kulam	2	2	0.64	0.14	0.14	0.82	0.00	0.00	5.71	0.00	0.20	0.68	0.00	0.00	8.33	18.38	5.00	0.49	
120	7/PAR1	Karunkalisinna Kulam	15	9	2.88	1.68	1.43	3.69	0.00	0.00	9.98	0.00	0.47	2.76	0.00	0.00	22.89	18.38	5.00	1.35	
121	3/PAR2	Marutan Kulam	14	10	3.20	0.00	0.82	4.10	0.00	0.00	11.59	0.09	0.14	1.70	0.00	0.00	21.64	18.38	5.00	1.28	
122	4/PAR2	Naveli Kulam	15	13	4.16	0.91	0.71	5.33	0.00	0.00	5.01	0.14	0.07	1.13	0.00	0.00	17.46	18.38	5.00	1.03	
123	5/PAR2	Kasawapulaiyan Kulam	2	2	0.64	0.22	0.17	0.82	0.00	0.00	0.83	0.00	0.05	0.14	0.00	0.00	2.87	18.38	5.00	0.17	
124	6/PAR2	Alankulam	3	3	0.96	0.39	0.18	1.23	0.00	0.00	0.48	0.00	0.04	0.45	0.00	0.00	3.73	18.38	5.00	0.22	
125	7/PAR2	Podun Kulam	4	4	1.28	0.75	0.41	1.64	0.00	0.00	1.79	0.00	0.14	0.23	0.00	0.00	6.24	18.38	5.00	0.37	
126	8/PAR2	Palaimoddalk Kulam	1	1	0.32	0.28	0.05	0.41	0.00	0.00	3.31	0.00	0.12	0.35	0.00	0.00	4.84	18.38	5.00	0.29	
127	7/MGA1	Chamalan Kulam	10	8	2.56	2.00	1.53	3.28	0.00	0.00	2.18	0.00	0.36	2.41	0.00	0.00	14.32	18.38	5.00	0.85	
128	4/PAR2	Naveli Kulam	10	10	3.20	2.64	1.30	4.10	0.00	0.00	8.50	0.00	0.23	3.00	0.00	0.00	22.97	18.38	5.00	1.36	
Total			1185	955	305.60	74.44	65.78	391.55	0.00	0.00	763.48	10.58	19.63	106.93	0.00	0.00	1,737.99			102.87	

Source: Study Team

Attachment 8.5-1 Risk Management Framework

Project Name: Cascade System Development Project Country: Sri Lanka
Sector: Irrigation & Agriculture

Officers in charge:

- Operational staff: To be appointed
- Engineering staff: To be appointed
- Country office staff: To be appointed

Potential project risks	Assessment
1. Stakeholder Risk	Probability: H
(Description of risk) Risk of the project cancellation or suspension resulting from change in the devlopment priority of new government Appraisal stage / Implementation stage	Impact: H Analysis of probability and impact: The Project is consistent with the national policy of Sri Lanka. The master plan prepared by CSDPP has been officially approved, and the Project would be a high priority project in Sri Lanka as a part of North Central Province Canal (NCPC) project under Mahaweli Water Security Investment Program (ADB). Since the government has been changed, a development priority of new government shall be closely watched. If the risk occurs, it may lead to the project cancellation or suspension, and there may be cases that the project effect is zero. Mitigation measures: 1) To hold regular high-level policy meeting at the timing of the next fiscal year's budget request (Responsible organization: a lender) 2) To monitor the policy trends of the new government of Sri Lanka and the position of the project in the development plan so as to take actions before the risks occurs. (Responsible organizations: ID/MOI, a lender). Action during the implementation: 1) To hold regular high-level policy meeting at the timing of the next fiscal year's budget request (Responsible organization: a lender) 2) To monitor the policy trends of the new government of Sri Lanka and the position of the project in the development plan so as to take actions before the risks occurs. (Responsible organizations: ID/MOI, a lender). Contingency plan (if applicable): N/A
2. Executing Agency Risk	
2.1. Capacity Risk	Probability: M
(Description of risk) Risk of decrease of benefit, increase of cost, unachieved development target and delay of the project resulting from the lack of technical and operational staff in PID and DAD for the implementation of external ODA Loan Project. Appraisal stage / Implementation stage	Impact: M Analysis of probability and impact: ID/MOI has the experience in implementing donors' projects including external ODA loan projects. For this reason, ID/MOI has basic knowledge and know-how on the implementation of the external ODA loan project. However, the number of staff of PID and DAD would not be sufficient to implement the Project. If the risk occurs, it may lead to certain impact of the unachieved development target and delay of the Project. Mitigation measures: 1) To appoint consultants to support PID and DID for the project management, survey and design, and construction supervision as part of the project components. (Responsible organization: ID/MOI, a lender) 2) To plan appropriate project components, project organization structure and implementation schedule in consideration of the lack of technical and operational staff in PID and DAD. 3) To support ID/MOI by a lender for project implementation before the consultants mobilize. (Responsible organization: Study Team, a lender) Action during the implementation: 1) To appoint the consultants for project implementation. 2) To support ID/MOI for project implementation before the consultant mobilize.(Responsible organization: Study Team) Contingency plan (if applicable): N/A

Attachment 8.5-1 Risk Management Framework

Project Name: Cascade System Development Project
Country: Sri Lanka
Sector: Irrigation & Agriculture

Officers in charge:
- Operational staff: To be appointed
- Engineering staff: To be appointed
- Country office staff: To be appointed

2.2. Governance Risk	Probability: L
(Description of risk) Risk of delay of the project resulting from the improper decision-making process of related organizations including PSC. Appraisal stage / Implementation stage.	Impact: M
	Analysis of probability and impact: The establishment of a Project Steering Committee (PSC) is proposed to coordinate the Project. The decision-making is made based on the coordination between the ID/MOI, MOA and other relevant government organizations through this committee. A project management unit (PMU) and project implementation unit (PIU) are planned to be established for the project implementation. Authority will be transferred according to the decision-making level. If this risk occurs, it is assumed that there is a slight delay of the project, but it is not expected to have a significant impact on the effects of the Project.
	Mitigation measures: 1) To clarify the decision-making system (authority and responsibility) before starting the Project. 2) To make an appropriate improvement proposal to ID/MOI by a lener or the consultant during the implementation period, if there is a problem with decision-making system. (Responsible organization: ID/MOI, a lender, the consultant)
	Action during the implementation: 1) To make an appropriate improvement proposal to ID/MOI by a lender or the consultant during the implementation period, if there is a problem with decision-making system.(Responsible organization: ID/MOI, a lender, the consultant)
	Contingency plan (if applicable): N/A
2.3. Fraud & Corruption Risk	Probability: L
(Description of risk) Risk of increase of cost and unachieved development target, delay of the project resulting from fraud of procurement of the Project. Implementation stage	Impact: M
	Analysis of probability and impact: The procurement implemented by ID/MOI has a mechanism in which a third-party committee intervenes, and there is little possibility of arbitrary bidding. If the risk occurs, it will increase costs and delay the project, but it is not expected to have a significant impact on the effects of the Project.
	Mitigation measures: 1) To adopt the current procurement system of ID/MOI for the Project. 2) To monitor properly procurement by the consultants. (Responsible organization: ID/MOI, the consultant)
	Action during the implementation: 1) To monitor procurement properly by the consultants. (Responsible organization: ID/MOI, the consultant)
	Contingency plan (if applicable): N/A

Attachment 8.5-1 Risk Management Framework

Project Name: Cascade System Development Project
Country: Sri Lanka
Sector: Irrigation & Agriculture

Officers in charge:
- Operational staff: To be appointed
- Engineering staff: To be appointed
- Country office staff: To be appointed

3. Project Risk	
3.1. Design Risk	Probability: L
(Description of risk)	Impact: M
Risk of delay in the implementation of the Project in case that procurement plan is not properly designed in considering of technical and management capacity of PID and DAD, availability of capable and responsible local contractors in addition to the nature of the Project (the large number of target cascade systems scattered in two provinces). Appraisal stage / Implementation stage	Analysis of probability and impact: Procurement plan is proposed in due consideration of the project nature, district balance and available local resources. Consequently, the number of contracts for civil works will be large. In this case, the number of staff in-charge of the procurement in PID and DAD may be insufficient to manage the procurement timely and properly. If this risk occurs, civil work contracts may be delayed.
	Mitigation measures: 1) To appoint a consultant to support PID and DAD in procurement procedure. 2) To apply the advance procure to minimize a time for the concurrence. (Responsible organization: ID/MOI, a lender)
	Action during the implementation: 1) To support ID/MOI by a lender to accelerate the procurement of the consultants. 2) To apply the advance procure to minimize a time for payments to the contractors. (Responsible organization: ID/MOI, a lender)
	N/A
3.2. Program & Donor Risk	Probability: L
(Description of risk)	Impact: L
Risk of overlapping between the target cascade systems and environmentally sensitive areas resulting from unclear boundaries. Appraisal stage / Implementation stage	Analysis of probability and impact: The Project is planned without overlapping between the target cascade systems and environmentally sensitive area on the project GIS map. It is however some risk of the overlapping with forest reserves may be found because those boundaries would not be clear. Although the risk is low, it should be confirmed through the field investigation by the government authorities.
	Mitigation measures: 1) To make field investigation with the government authorities at the beginning of the Project if the boundaries are not clear. (Responsible organization: PMU, the consultant)
	Action during the implementation: 1) To conduct field investigation with the government authorities in case the overlapping is grey. (Responsible organization: PMU, the consultant)
	Contingency plan (if applicable): N/A

Attachment 8.5-1 Risk Management Framework

Project Name: Cascade System Development Project
Country: Sri Lanka
Sector: Irrigation & Agriculture

Officers in charge:
- Operational staff: To be appointed
- Engineering staff: To be appointed
- Country office staff: To be appointed

3.3. Delivery Quality Risk	Probability: M
(Description of risk) Risk of decrease of benefits resulting from improper operation and maintenance activities by FOs and CMOs. Appraisal stage / Implementation stage	Impact: M
	Analysis of probability and impact: FOs are responsible for operation and maintenance of irrigation schemes in Sri Lanka. FOs in general have a long experience in the operation and maintenance. These days, however, operation and maintenance of old tank irrigation systems is getting a heavy burden for farmers on one hand, and farmers are getting low farm incomes from traditional farming on other hand. Once old tank irrigation systems would be rehabilitated, it is expected for FOs to undertake proper operation and maintenance.
	Mitigation measures: 1) To include activities for strengthening of operation and maintenance by FOs and CMOs as a project component. (Responsible organization: Study Team, the consultant) 2) To provide continuous support for strengthening of operation and maintenance of FOs and CMOs. (Responsible organization: PMU, PIU, the consultant)
	Action during the implementation: 1) To exchange MOU between FOs and PID/DAD for operation and maintenance of tank irrigation systems prior to the rehabilitation. 2) To provide continuous support to FOs/CMOs for strengthening of operation and maintenance by PID and PAD. (Responsible organization: PMU, PIU, the consultant)
	Contingency plan (if applicable): N/A
4. Other Risk	Probability: -
(Description of risk) N/A	Impact: -
	Analysis of probability and impact: N/A
	Mitigation measures: N/A
	Action during the implementation: N/A
	Contingency plan (if applicable): N/A
5. Overall Risk Rating	Probability: M
(Overall comments)	Impact: M
The relatively critical risks are assumed to be (1) the risk of the project cancellation or suspension resulting from major policy change of the government of Sri Lanka and (2) the risk of delay in project implementation resulting from the lack of staff in PID and DAD to implement the Project. It is especially important to take actions to prevent the occurrence of these risks including appropriate support to ID/MOI by a lender.	

1/ Descriptions in the risk management matrix can be brief and concise. In order to record the description of each risk as well as the evidence for the team's assessment, a separate sheet should be prepared to describe the details.

Attachment 8.7-1: Cash Flow Table and Calculation of EIRR, NPV and B/C

Non-disclosure information