Government of the People's Republic of Bangladesh

Ministry of Local Government, Rural Development and Cooperatives

Local Government Division

Local Government Engineering Department

Guidelines for

Small Scale Water Resources Development Project

G8 Operation and Maintenance

November 2017

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DOCUMENT ARCHITECTURE OF THE NEW SETS OF GUIDELINES FOR SSWRD PROJECT

[Small Scale Water Resources Development (SSWRD) means, from physical points of view, implementing appropriate water management subprojects of small sizes, not exceeding 1000 hectare benefited area by the current definition, to resolve existing water management constraints to agriculture that in turn enhance rural employment leading to reduction of rural poverty. Implementation of SSWR subprojects involve long process from proposal of a subproject from Local Government Institutions (Union Parishad and Upazila Parishad) to its final selection, study of feasibility from different considerations (social, environmental, technical, economical), preparing detailed design and costing, constructing required physical works to standard quality and finally its operation and maintenance by its beneficiaries. The process has multiple facets too. It needs to be comprehensively beneficiaries' and other stakeholders' participatory, acceptable to people of widely varying social and socio-economic conditions, friendly to the surrounding environment, etc. Thus, Guidelines for SSWR Development is, of necessity, complex.

The long and complex process has been divided into major distinguishable steps and separate Guidelines for works and activities involved in those major steps have been developed. Environmental study applies to the subproject as whole and is of different nature. So, Guidelines for Environmental Assessment is made a separate document. Following this principle, the Ten (10) Guidelines with Alpha-numeric ID Numbers and Names as below constitute the Documentation of Guidelines for SSWR Development.

This list will appear in all the individual Guideline Documents with highlight of the current Document name for the user to refer when necessary]

THE LIST OF NEW SETS OF GUIDELINES FOR SSWRD PROJECT

G1	Policy and Development Process
G2	Identification of Subprojects
G3	Participatory Rural Appraisal of Subprojects
G4	Feasibility Study of Subprojects
G5	Environmental Assessment of Subprojects
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G9	Monitoring and Evaluation
G10	Integrated Rural Development Plan between SSWR and Rural Road/Market

AMENDMENT AND UPGRADATION RECORDS

This document "Guidelines for SSWR Development: G8 Operation and Maintenance of Subprojects" has been issued following amendments and up-gradations as outlined below:

Revision	Description	Date
	Operation and maintenance of SSWRD subprojects implemented under the first ADB-assisted SSWRDSP (1995-2002) was by the WMCA in a participatory basis and necessary Guidelines for the purpose were, in fact, on the development during the period of the project. The first comprehensive "Water Resources Operation and Maintenance Guidelines (October 2007)" was prepared and put to use under the *Second* SSWRDSP (2002-10).	October 2007
A	As the completed subprojects were on increase, the ADB undertook a detail "O&M Study" under the second SSWRDSP (2002-2010) which was completed in 2008. Subsequently, a report "SSWR Support Strategy and O&M Manual, October 2009" was submitted by the study group.	October 2009
B	Later, the ''Operation and Maintenance Guidelines for Water Resources Infrastructure, 2013'' was issued incorporating the findings and recommendations of the above studies. This document did not include O&M of Buried Pipe Irrigation Subprojects (CAD subprojects) though a good number of these subprojects, using uPVC pipes had been implemented under the JICA-assisted SSWRDP (2009-15).	July 2013
C	This "Guidelines for SSWR Development: G8 Operation and Maintenance of Subprojects" is the *Eighth* Document of a series of Guidelines for SSWR Development finalized and approved by a Working Group of LGED Professionals with proven experience in SSWR development with assistance from Specialist WRD Consultants under a JICA-LGED Technical Co-operation Project. The Document *adapts the existing ''Operation and Maintenance Guidelines for Water Resources Infrastructure, 2013'' to the standard set of Guidelines for SSWR Development* and incorporates O&M of CAD subprojects with buried PVC pipeline irrigation systems and also lessons learned over the time.	August 2017

GLOSSARY

Aman	Rice grown during the wet season (Kharif), and harvested late (Nov-December). Yields: (i) Broadcast, deep water 1.5t/ha; (ii) Transplanted, local variety 2.2t/ha; (iii) Transplanted, high yielding variety, 3.25t/ha
Aus	Rice grown during the wet season (Kharif), and harvested early (July-August). Yields: (i) Broadcast 1.25t/ha; (ii) Transplanted, high yielding variety, 2.5t/ha
Beel	Saucer shaped low-lying area with pond of static water as opposed to moving water in rivers and canals.
Boro	Irrigated rice grown in the early dry season (Rabi). Transplanted in December-January and harvested in April-May. Yield: Transplanted, high yielding variety, 4.25t/ha
District	Second administrative unit of the government comprising 6-9 Upazilas. There are 64 districts in Bangladesh.
Haor	Haor is a wetland ecosystem in the north eastern part of Bangladesh. Physically a bowl or saucer shaped shallow depression, also known as a back-swamp
Integrated Water Resources Management Unit	Unit comprising two sections: (i) planning & design, and (ii) operation & maintenance, with a mandate to guide LGED's activities in the water sector with specific responsibility to assist in enunciation of policies, formulation of strategies and plans, preparation of new projects, inter-agency coordination and with external agencies, undertake studies and to provide long term support to the completed projects
Khal	Natural or man-made water channel (canal)
Kharif	Wet (monsoon) season
Local Stakeholder	Local Stakeholders are inhabitants of an area directly or indirectly affected by water management, be it as beneficiaries or as "project affected people".
Project Affected People	People negatively impacted by investment in water management projects and / or subprojects or by the manner in which water regulating infrastructure is managed.
Project Consultants	Project implementation consultants working with the PMO
Project Management Office	A unit comprising LGED staff appointed to manage implementation of a Project
Rabi	Dry / winter cropping season (November to March)
Stakeholder Groups	Stakeholder groups are collections of individuals who have similar interests concerning water. Among others, such stakeholder groups are men and women, farmers (low, medium low, medium high and high land farmers), fishers, boatmen, landless, elected representatives, LGED employees, BWDB employees, employees of other government departments, contractors, consultants, and development partners.
Union	Subdivision of Upazila and the lowest governance institution in the country.
Union Parishad	Local government institution at Union level. The Union Parishad consists of an elected council & chairman, and is the oldest government institution in Bangladesh
Upazila	Administrative unit, sub-division of District and lowest administrative tier of the government.
Upazila Parishad	2nd tier of local government institution at Upazila. According to the Upazila Parishad Act 2009, Upazila Parishad consists one elected Chairman and two Vice-chairmen, Chairmen of UPs and Mayor of Municipality within each Upazila including representatives from line agencies with an Upazila Nirbhai Officer as the Secretary. The election of the Upazila Parishad was held on 22 January 2009. Upazila Parishad runs the local administration.

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AE	Assistant Engineer
BWDB	Bangladesh Water Development Board
CA	Community Assistant (Project Based – Subproject Level)
CO	Community Organizer
CPO	Community Participation Officer (Project based, District level)
CS	Construction Supervisor (Project Based – Upazila Level)
DAE	Department of Agricultural Extension
DDM	Detailed Design Meeting
DLIAPEC	District Level Inter-Agency Project Evaluation Committee
DOC	Department of Cooperatives
DOF	Department of Fisheries
DWRA	District Water Resources Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Mitigation Plan
FMC	First Management Committee (of WMCA)
FSDD	Feasibility Study and Detailed Design
GoB	Government of Bangladesh
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
ICM	Integrated Crop Management
IWRMU	Integrated Water Resources Management Unit (of LGED)
LCS	Labour Contracting Society
LGED	Local Government Engineering Department
MC	Management Committee (of WMCA)
MEP	Member Education Program
MIS	Management Information System
MLGRDC	Ministry of Local Government, Rural Development and Cooperatives
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
PAP	Project Affected Person
PE	Performance Enhancement
PEA	Performance Enhancement Appraisal
PM	Planning Meeting
PMO	Project Management Office
PRA	Participatory Rural Appraisal
QC	Quality Control
SAE	Sub-Assistant Engineer
SAPROF	Special Assistance for Project Formulation
SP	Subproject
SSWR	Small Scale Water Resources
SSW-1	SSWR Development Project Phase I (ADB), 1996-2002
SSW-2	SSWR Development Project Phase II (ADB), 2002-2009
SSW-3	SSWR Development Project (JBIC), 2009-2016
SSW-4	Participatory SSWR Project (ADB) 2010-2017
TA	Technical Assistance
UDCC	Union Development Coordination Committee
UE	Upazila Engineer
UP	Union Parishad (local council)
UzP	Upazila Parishad
WMCA	Water Management Cooperative Association
XEN	Executive Engineer (usually used in LGED)

FARM, LAND AND SUBPROJECT CATEGORIES

FARM CATEGORIES

Land Holding		Farm Category
(ac)	(ha)	
<0.51	< 0.21	Landless
0.51 – 1.00	0.21 - 0.40	Marginal Farmer
1.01 – 2.49	0.41 – 1.00	Small Farmer
2.50 – 7.49	1.01 – 3.03	Medium Farmer
>7.50	>3.03	Large Farmer

LAND CATEGORIES

Depth of Average Monsoon Flooding		Land Category
(m)	(ft)	
<0.3	<1.0	Highland
0.3-0.9	1.0-3.0	Medium Highland
0.9-1.8	3.0-5.9	Medium Lowland
>1.8	>5.9	Lowland

SUBPROJECT CATEGORIES AND TYPES WITH USUAL WORKS AND OBJECTIVES

Category		Type		Typical Works with Objectives
I	Simple (without Regulation of Water Flow)	DR	Drainage	Re-excavate drainage *khals* to increase capacity of drainage systems to benefit agriculture as well as fisheries and local navigation
		TI	Tidal Irrigation	Re-excavate existing *khals* to enhance tidal flux (volume and propagation) in the *khals* in dry season to benefit irrigated agriculture in fresh water tidal areas as well as fisheries and local navigation (also increases drainage capacity)
II	Complex (with Regulation of Water Flow using gated or other kind of structures)	FM	Flood Management	Rehabilitate and construct embankments and/or sluices/regulators to reduce extent and duration of flooding of farmland inside the subproject
		FMD	Flood Management and Drainage	Rehabilitate and construct embankments, sluices/ regulators and re-excavate *khals* to reduce extent and duration of flooding of farmland and increase drainage capacity of khal system of the subproject
		FMDTI	Flood Management, Drainage and Tidal Irrigation	Rehabilitate and construct embankments, sluices/ regulators and re-excavate *khals* to reduce extent and duration of flooding of farmland, increase drainage capacity and tidal flow capacity of khal system of the subproject. Sluices/regulators of these subprojects will have arrangements of

Category		Type		Typical Works with Objectives
				automatic flow of drainage and tidal inflow at the gates.
		WC	Water Conservation	Develop water retention capacity of existing *haors*, *beels* and *khals* to increase availability of surface water for irrigation in dry season by installing gated water retention structures (also *Rubber Dams* at appropriate sites) and by re-excavating *khals* and suitable water bodies
		FMDWC	Flood Management, Drainage and Water Conservation	Combination of works involved in FMD and WC type of subprojects outlined above
		CAD	Command Area Development	Development of existing irrigation schemes by providing better water distribution systems over the command area and, as agreed, pumping facilities. Works may include: improved canal network, lining of canals, installation of buried pipelines, installation of control structures, construction of pump house, etc.
		DRCAD	Drainage and Command Area Development	Development of existing irrigation schemes by providing better water distribution systems including drainage improvement measures for the command area and, as may be agreed, pumping facilities. Works may include: improved canal network, lining of canals, installation of buried pipelines, installation of control structures, construction of pump house, headwater tanks, regulators/sluices in drainage khals, etc..
		FMDCAD	Flood Management, Drainage and Command Area Development	Development of existing irrigation schemes by providing better water distribution systems together with flood management and drainage improvement facilities forr the command area and, as may be agreed, pumping facilities. Works may include: improved canal network, lining of canals, installation of buried pipelines, installation of control structures, construction of pump house, headwater tanks, etc and construction / rehabilitation of embankments, sluices /regulators in drainage khals, etc..
III	Performance Enhancement	Any Type of Existing Subprojects		Any of the above described works for existing (developed and handed over) subprojects for which additional works are desirable to consolidate planed benefits / result in additional benefits

Introduction

1. Proper and skilful operation is indispensable to obtain benefit from any physical structure. On the other hand, timely and appropriate maintenance is required for the sustainability of physical structure. In general picture of operation and maintenance after implementation of subproject is not bright. Major reasons identified are lack of interest and participation of local people, weak organization, inefficient management and lack of availability of operation maintenance fund. LGED was involved in water resources activity from 1960s in works program under Camilla Model. Later on, through Canal Digging and ISP program started to implement water resources development scheme. In water policy ownership of FCD and FCDI projects with command area of 1000 ha or less has been entrusted to Local government Engineering Department/ Local Govt. Division. LGED is implementing this type of subprojects form 1995 and number of such scheme are increasing day by day although Government fund for maintenance is not available as per need. Consequently, after completion of the subprojects as per plan sustainable water resources are rarely achieved.

2. If after the construction of subproject infrastructure can be kept functioning with proper operation and maintenance, the beneficiaries can obtain expected benefit of water resources development. Need for infrastructure operation and maintenance to be discussed during planning so that operation can be done smoothly. The Water Management Association (WMCA), which is formed by beneficiaries, assumes operation and maintenance responsibility after subproject implemented by LGED is handed over. However, LGED helps the WMCA and provide fund for maintenance.

3. LGED by implementation of small scale development sector project (1995-2002), small scale development sector project (2002-2010), small scale water development project-JICA (2009-2015) and Participatory small scale water development sector project (2009- 2017) will handover about 1100 subprojects to WMCA. In addition, 30 Rubber dams have been implemented from GoB fund and few are under construction. Guidelines are essential for the proper operation and maintenance of infrastructure.

4. For proper operation and maintenance, a stable institution and infrastructure is needed. For this reason, during preparation of the guideline proper weightage has been given to institution and technical aspect. As for example for providing fund for maintenance and for performance improvement (additional or rehabilitation) Priority list should be prepared.

5. The revised Guideline has been prepared with additional information as below:

   - LGED's maintenance funding strategy including the use of GoB funds to support maintenance and detailed description of the maintenance process that now includes prioritization of use of funds by technical and institutional grading assessments of handed over subprojects.
   - Operation and maintenance for Command Area Development (CAD) subprojects, particularly buried pipe system, as well as for rubber dams.
   - Differentiation is made between the O&M needs of simple (usually drainage) subprojects which have no structures, the more complex one with regulatory structures and CAD subprojects which are most in need of competent operation structures. Subproject operations, particularly for controlled flow and CAD subprojects are now covered in detail.
   - Finally, substantial investments in some completed subprojects may be required, for example to reconstruct failed structures, or to build additional structures and further improve performance. These performance enhancement works are also covered by these Guidelines.

Objectives

i) Provide a clear understanding of the operation and maintenance needs of the different types of SSWR subprojects.

ii) Ensure understanding and application of the maintenance process and funding arrangements of different categories of maintenance (simple, periodic and emergency).

iii) Promote the active participation of beneficiaries in O&M and build up a long term partnership between LGED and WMCA

iv) Ensure participation of beneficiaries in O&M activities of SP.

v) Duties and responsibilities LGED's officials and WMCA and increase their performance.

vi) Ascertain the need for O&M, preparation of annual plan, implementation and resolve the monitoring problem.

vii) Ensure sustainable operation and maintenance of subproject.

Main Infrastructure of Small Scale Water Resources Subprojects

6. This chapter outlines the main infrastructures of SSWRD Subproject.

1.1 Flood Control Embankment

1.1.1 Full Flood Embankment

7. The embankment which is constructed at the required height to keep the subproject area flood free is known as flood control embankment or bundh. Sluice gate or regulator is constructed to control water within and outside the embankment. The height of flood control embankment is generally higher than that of normal road. The embankment is designed (height, width etc.) and implemented in accordance with the flood data. In SSWRS the embankment is designed with a 20 years flood frequency.

Figure-1 Flood Management Embankment

1.1.2 Submersible Flood Embankment

Submersible flood embankment is generally constructed in Haor Area. This embankment goes under water throughout the monsoon period. The embankment is designed with water level of Mid-may with flood frequency of 10 years. This embankment saves boro crop. To control water level of in and out sluice/regulator

1.2 Khals: Drainage, Water Conservation, Tidal Water Supply

8. Khal (channel) is an existing, mostly natural but may also be excavated, water course for drainage of runoff. These khals may be re-excavated according to required design to drain out an area when water-logging damages crop during pre-monsoon and/or monsoon seasons. The re-excavated khals will also conserve water during post-monsoon season for irrigation use. Sometimes, tidal khals are re-excavated to increase both volume and propagation of tidal water more inside the subproject area for use in irrigation.

Figure-2 Drainage/Conservation Khal

1.3 Hydraulic Structures

9. Different types of hydraulic structures are required to construct in the water resources subprojects. Each structure has different function. A brief description of each type of structure is given below.

1.3.1 Regulator

10. Regulator is used both for flood control and drainage of water. Arrangements are made to operate regulator gate vertically. The operator can operate the gate easily and control water i.e., gate can be opened or closed, as a result required water level can be maintained with the control of water flow within and outside the subproject. Occasionally, operation of the gate is not required when water level remains the same within and outside the subproject area due to the local or regional hydrological system, flooding characteristics and location of the subproject. However, this situation continues for a short period. With reduction of the river water level the gate is opened for the drainage of floodwater from within the subproject area.

Figure-3 Regulator

1.3.2 Sluice

11. Sluice is constructed to give tidal flood protection in tidal areas and normal flood protection in non-tidal areas. Usually, flap gate is attached with the sluice gate which is operated automatically. The gate closes automatically when water level in the riverside is higher than in the subproject side. On the other hand, when the water level at subproject is higher the gate opens automatically with the water pressure. Generally the number of vent is single or multiple for each type of sluice gate. Gates are fixed with the sluice head wall.

Figure-4 Sluice

1.3.3 Flushing sluice

12. The sluice or regulator with which arrangement is made to bring in water from outside is known as flushing sluice. In general, the flushing sluice is constructed in relatively higher part of the subproject area. Usually, the flushing sluice is useful to conserve tidal water for irrigation in the subproject area in tidal flooding zone.

1.3.4 Water Retention Structure

13. Generally, this type of structure is constructed in relatively higher and tidal flood free zone. Water retention structure is useful for the conservation of monsoon water, supplementary irrigation in aman rice crop fields and after that for the conservation of water in the post-monsoon season to irrigate non-rice and boro rice crops in the winter season. Gate of this structure can be raised vertically and manually operated (open and close) with ease.

Figure-5 Water Conservation Structure

1.3.5 Culvert

14. If any road obstructs flow of water from the subproject area, culvert is constructed at appropriate location to protect land from water logging. Culvert is also constructed on the excavated or re-excavated khal for the local people for their movements across the both banks.

Figure-6 Culvert

1.4 Irrigation Structure

15. The project implements another type of subproject to increase water availability for irrigation. It is categorized as command area development (CAD) subproject. The components of this subproject are different. The descriptions of the components are as follows.

1.4.1 Irrigation Canal

16. Water distribution canals of the irrigation subprojects are categorized into two types. The canal which is constructed from the main source of water (generally river) to the field is called as main canal and which are constructed from the main canal to carry water to the fields considered as a branch canals. Both types of canals are pucca (lined). Besides, there are some earthen canals which are considered as field canals.

Figure-7 Irrigation Canal

1.4.2 Aqueduct

17. Aqueduct is constructed over a drainage channel when it obstructs water distribution through irrigation canal. The aqueduct conveys water over the drainage channel to irrigation area. This can be called as bridge for the conveyance of irrigation water. This type of structure is should be pucca.

Figure-8 Aqueduct

1.4.3 Syphon

18. Generally, if any road or embankment obstructs the irrigation canal, pipe of box culvert type structure is constructed under the road or embankment for the conveyance of water. Siphon and aqueduct can be considered as opposite to each other, but their functions are different. Siphon can be also used for drainage.

Figure-9 Syphon

1.4.4 Buried Irrigation Pipe System

19. In this system with the help of pump water is lifted in the header tank and is distributed to area through the underground pipe system. In this system for supply of irrigation water no land is lost. Though implementation cost is high but considering long term application this system is less costly. During water supply as there is little loss of water during irrigation water can be supplied to larger area. Although irrigation cost with PVC pipe is high but there is advantage

in using PVC pipe. For manufacturing of pipe there is no loss of time in field for which there will be less time required for laying pipes. Easy to maintain quality control and there is no chance of constructing low quality pipe. As weight of PVC pipe is less compare to concrete it is easy for transportation of pipe and easy to make joint. If implemented correctly there is little chance of leakage of pipe through pipe joint.

1.4.4.1 Header Tank

20. Header Tank is a concrete structure. There may be more than one chamber depending on off taking pipe lines. There is provision of steel ladder and gate in the chamber. In the header tank primarily silt can be deposited and arrangement is kept for flushing. Water level of Header tank should be such that it can command the whole area. There will be arrangement for gate regulation so that water can flow through all the pipelines.

1.4.4.2 Standpipe (Air Vents)

21. Standpipe is to be raised from top of PVC pipe line. Standpipe is to be provided in between two outlets due to air vent air inside the pipeline can be able to come out and pressure of pipeline can be kept as per design. Height of standpipe should be 60 meter above the energy line. There is no need to operate air vents.

Figure-10 Air vents & Riser

1.4.4.3 Outlet (Riser)

22. Riser pipe starts from PVC pipeline. Alfalfa valve is located here. Over the riser pipe distribution box is set and flow of water is controlled. Water is distributed from pipeline through the outlet. Outlet is set at an Average distant of 200 to 500m. Alfalfa valve is regulate so that each irrigation unit can get water as per requirement.

1.4.4.4 Overflow Standpipe

23. At the place of pipe layout from PVC pipeline straight pipe is added. With the help of outflow standpipe additional water can be released without any damage. Adding Piezometric Pipe in escape pressure can be measured. After monitoring of pressure in pipe line operator can be instructed to increase or decrease the flow and arrangement of drainage can be made. Height of standpipe is kept 0.30m above pressure line.

1.4.4.5 Washout

24. Washout is control valve with PVC pipe off take or concrete access box which is placed at low pocket of pipeline. Washout is added for flushing, repair or silt cleaning.

1.5 Rubber Dam

25. At the bed of medium or Small River Rubber Bag is attached with concrete structure and is inflated by air or water to form Rubber Dam. When deflated it


Figure-11 Rubber Dam

sits in the river bed and can be inflated again if required. Rubber Dam is a flexible Dam. Rubber Dams can be up to 100m in single units and units can be added one after another separated by concrete piers. However, height of Rubber Dams is presently limited to about 5 m. In our country, Rubber Dams are used to conserve water in small to medium rivers for dry season irrigation and to protect Haor area crops from inundation damage by preventing pre-monsoon floods entering through khals/rivers up to about the third week of May.

Operation of Infrastructure

26. Infrastructure of FMD and WC subprojects are operated – meaning that gates of the hydraulic structures are opened or closed - to ensure judicious control of water level and/or quantity of water in the subprojects to achieve maximum benefit. Drainage and Tidal Irrigation subprojects do not involve operation activities. Operation of gates differs with type of structures and also with tidal and non-tidal zones. Operation of infrastructure of FMD and WC subprojects are discussed in sections below.

27. For CAD (irrigation) subprojects, operation activities are characteristically different – involves distribution and management of irrigation water over the whole subproject area requiring fulltime involvement of system operators. Operation (and also maintenance) of irrigation systems of CAD subprojects are discussed separately in Appendix *G8-A: O&M of Buried Pipe Irrigation (CAD) Subprojects* appended to this document.

1.6 Gate of Water Control Structure

28. Flood is controlled or water is conserved with the help of gate. Gate has an important role to achieve the subproject objective and expected benefit is not achieved without the proper its operation. Two types of gates are used for regulators and sluices in LGED water resources development project. These are vertical gate and flap gate. Vertical gate is opened or closed with the help of handle and flap gate automatically.

Figure-12 Vertical Gate

1.7 Vertical gate

29. Operation of this gate requires an operator. Flood can be controlled and water can be conserved during the pre-monsoon, monsoon and post-monsoon seasons with the operation of this gate. Moreover, in tidal flooding zone this gate is useful to bring river water into the subproject area for conservation. Seal is affixed with the gate on the downstream side during the water conservation.

1.7.1 Vertical gate lifting system

30. With the support of mechanical system and use of handle vertical gate is opened or closed manually to control flood, conserve water i.e., maintain water level within the subproject area.

Figure-13 Raising of Vertical Gate

1.7.2 Flap gate

Figure-14 Flap Gate

31. This gate is designed so that it is opened automatically with the water pressure developed due to higher water level within the subproject area than in the riverside initiating drainage of water. The rise of water level downstream closes the gate protecting the subproject area from flooding. This gate at the ending part is hanged across the upper part of the barrel. Rubber seal is affixed with the flap gate on the subproject side. The flap gate does not function automatically to bring water from the riverside to the subproject area. It can be opened manually by fixing a chain with the hook attached with the gate frame

1.7.3 Flap gate lifting system

Figure-15 Flap gate lifting system

32. Although the flap gate is operated automatically, manual operation is required to lift for flushing of water from the riverside to the subproject area. This can be done by fixing a chain with the hook of the gate frame.

1.8 Flood control and water drainage structure

33. This type of structure has flap gates on the riverside. As the operation of this gate depends on the water level upstream and downstream, it opens and closes automatically without employment of fulltime operator. However, the WMCA sub-committee should give overall responsibility for the gate operation to a WMCA member. The member will instantaneously inform the sub-committee if there arises any trouble related to the operation of the gate and take necessary step for immediate solution.

1.8.1 Flood control, water drainage and water conservation structure

34. This type of structure has a vertical gate as well as a flap gate. The water level within the subproject area is maintained with the operation of vertical gate. Following information are required for the operation of this structure:

- Description of land related to extent and elevation within the subproject area;
- Decision on the level of water to be retained after the rainy season;
- Decision on the level of water to be maintained for water conservation if required during the rainy season; and
- Arrangement for the operation of gate during the rainy season.

1.8.2 Water retention structure

35. This type of structure has vertical gates. Water is conserved in the subproject area with the operation of the vertical gate. But, care should be taken so that water retention does not impede drainage. Following information are required for the preparation of gate operation guidelines:

- Description of land related to extent and elevation within the subproject area;
- Decision on the level of water to be retained; and
- As water is retained at the beginning of the rainy season, during the rainy season and at the end of the rainy season with this structure, decision should be taken about when the gate should be closed.

1.8.3 Flushing Sluice/Regulator

These types of structures may have flap or vertical gates. The main purpose of water flushing is conservation of water within the subproject area for irrigation. Following information are required for the operation of these structures.

- Description of land related to extent and elevation within the subproject area;
- Decision on the time of flushing; and
- Specific decision regarding the water conservation level.

1.9 General rules for the operation of water control structure

36. When and at what level of water should be retained in the subproject area can not be decided in a single operation. It is an iterative process and requires several years of operation to decide required water level and timetable. For this purpose, gate operation data should be recorded in a registrar for each gate.

37. The general rules for the operation of water control structure are as follows:

- Before operation of the structure, condition of gate hoisting system should be checked to ensure that it functions properly and the gate moves easily;
- Close the gate and check any leakage of water through the gate;
- Vertical gate should be opened slowly to prevent excess water flow through the structure;
- During the flow of water the difference between upstream and downstream water levels should not be more than 30 cm;
- At the beginning, gate should be opened slowly to increase water level downstream;
- During the opening of gate attention should be given to the velocity of water flow so that it cannot damage the khal downstream or protective blocks;
- The gate opening speed can be increased with the rise of water level downstream. But care should be taken so that there is no damage of khal downstream;
- Flushing sluice gate is operated on the basis of water demand and availability. Care should be taken so that the water level difference between subproject side and riverside is not more than 30 cm and less difference is better;
- If the number of vent is more than two, middle gate has to be opened first. Sudden opening of gate from any side could cause sharp and oblique water flow which may damage

protective blocks downstream. Similarly sudden opening of all gates may damage the protective blocks due to excessive flow of water;

- Gate has to be closed slowly when water level reaches at the required level within the subproject area, sudden closing of the gate may damage the structure;
- In the coastal area gate has to be operated with integration between shrimp farming and crop production;
- During the operation of structure attention should be given to the fish production. For example opening of gate in the beginning of the rainy season will allow fish and fingerlings migration and floodwater carry spawn into the subproject area;

Figure-15 Water Level Gauge

- WMCA/sub-committee will decide about the operation of gate in consultation with all beneficiary farmers and in consideration with crop patterns and land elevation;
- If required gate operation guidelines should be changed from the experience in preceding year; and
- Certainly, gates should be operated according to the decision by the WMCA/sub-committee.

1.10 Water level gauge

38. Gauge is set up with cement plaster pointing to measure water level in the subproject area and riverside when gate remains closed or opened. Adjusting with floor level of the infrastructure the scale of gauge should be set with respect to PWD meter and written in Bengali. Proper attention should be given to set up the gauge accurately, since water level after the implementation of the subproject could not be determined without it. The gauge should be painted for the clear and easy visibility.

1.10.1 Measurement of water level and operation of structure

39. Preparation of comprehensive operation plan is essential to achieve subproject objectives properly and ensure maximum benefit. Water retention time and level should be decided in line with the beneficiaries demand and occupational interests so that no conflict arises between them. Information should be collected on the area of land at different elevations and how different occupational use the water resources to decide water level desired in the water conservation subprojects. The collection of the same information is required for structure constructed only for water conservation. In sluice there are vertical gates at the downstream of the flap gate for water conservation. Flap gate is elevated to bring in water from the river for conservation into the subproject area with the help of vertical gate. This process is slightly complicated. If there is rain during the water conservation, the gate may be opened for the drainage of water. Gate should be operated in consideration with water demand and availability. Conservation of water may be required during the pre-monsoon, monsoon and post-monsoon seasons. The level of conserved water should be decided according to the subproject area elevation curve to so there is no adverse impact within the subproject area. For conservation of water at the end of the rainy season it should be checked that drainage has been ensured up to the required level for subproject benefit. Gate operation calendar and determination of water level depends on the requirement of subproject and diversity of climate. An operation calendar should be prepared before the rainy season starts in consideration of the existing crop pattern and fisheries activities. This should be finalized with the field level

examination. At least after three years operation a realistic operation policy could be prepared. It can be mentioned that, from the general policy a written operation index has to be prepared separately for each structure within a subproject area. When there are several structures within a subproject, the operation index of each structure should be coordinated with others so that there is no adverse impact within the subproject.

1.11 Beneficiary Participation in Operation of Subproject Structures

1.11.1 Agreed Optimum WL in Subproject Basin

40. Water management in subprojects having FMD and WC functions amounts to maintaining an optimum water level in the subproject basin by operating gates of hydraulic structures such that farmers of the basin area have a general agreement to that water level. As crop lands have different elevations, this optimum water level is difficult to define in a straightforward way. It is to be arrived at by considering crops in the field and opinion and understanding of the crop owners. Nevertheless, the desirable water levels in subprojects are to be evolved during a few years of subproject operation through crop practice planning (planning different crops in different land elevations based on achievable subproject water level) and experiences gathered over the years. That is to say, continuous participatory efforts will be necessary for having an effective water management established in a subproject.

1.11.2 Operation Calendar of Subproject

41. An initial operation calendar of a subproject is usually provided for the WMCA during design of the subproject. Two such operation calendars – one for subprojects with purposes of flood control and water retention and the other for subprojects of water retention purpose only are given in Exhibit G8-6 and Exhibit G8-7 respectively for reference. The initial operation calendars will be used in operation of the structures during first year joint O&M of the subproject and noting carefully the results and experiences thereof. These will be discussed in the WMCA, particularly by the O&M subcommittee with participation of the Village Representatives and beneficiary farmers and necessary modifications if considered necessary in timing of gate operation and/or in water levels maintained for use in next season. At the same time, crop practice planning should also be considered based on experience learned. It is expected that a reasonably stable water management practice would be established in the subproject in 2-3 years.

1.11.3 Record Keeping of Subproject Operation

42. For each hydraulic structure of a subproject, a register for Operation Records will be maintained. All records like (i) Date and Time, (ii) Opening of gate below the gate bottom by Gate No (for a closed gate opening will be zero), (iii) WL at upstream, (iv) WL at downstream, (v) Reason for increasing or decreasing opening or closing gate, (vi) comment on condition of crops in the field at the time of gate operation, (vii) Person giving instruction to operate the gate, etc will be recorded. The records will be used in subsequent review of operation Calendar and other purposes.

1.11.4 O&M Subcommittee and Village Representatives Co-ordinate on Gate Operation

43. As can be understood from section 5.7.1 above, there may always be people who will have feeling that the operational WL decided and maintained by the subproject management is not favourable for them. Accordingly, there remains the apprehension that someone or a group may try to tamper gate operation in their favour. To avoid such mischievous activity, O&M Subcommittee should remain in alert and maintain close co-ordination with Village Representatives of different villages which will enhance co-operation, understanding and vigilance to avoid such unwanted happenings.

Table 0-1: Subproject categories and O&M needs

Number	Category of subprojects	O&M Needs	Implications
1.	Uncontrolled Flow: Any type of SPs where only LCS works were carried out and there are no gated structures. Applies to 20% to 30% of SPs	Operation: None Maintenance: Walkthroughs, Khal desilting, embankment rain-cut repairs, etc, and funding arrangements.	Relatively simple: separate training proposed for concerned WMCA/ O&M committee members; low level of project support required with few site visits. Data entered into MIS.
2.	Controlled Flow: SP with one or more structures to control flows and / or water levels. May be any combination of Drainage Improvement, Flood management and Water Conservation	Operation: gates according to operation plan/ strategy prepared by WMCA Maintenance: greasing of spindles and gears, painting of gates, concrete including block protection repairs, khal desalting, embankment rain cut repairs etc and funding arrangements	Relatively complex; separate training proposed for concerned WMCA/O&M Committee members; medium level of project support required with 1-2 site visits per year with data entered with MIS
3.	Command Area development, CAD- pumped water distributed by buried pipe/ open channel	Operation: pumping, flow control and rotations, irrigation applications Maintenance: pumps, pipe line and structures, open channels. Fund collection and funding arrangements	Most complex: Separate training proposed for concerned WMCA/O&M Committee members; high level of project support with site visits for mentoring O&M activities. Data entered into MIS

Table 0-2: Type of Subprojects, Impacts and Operation Procedure

Category of SP	Subprojects	Infrastructures	Impact	Operation Procedure	Period of operation
Simple, no water control arrangement	Drainage	Drainage Canal or canal for supplying irrigation water from outfall river	During pre-monsoon period crops will be saved from rain induced flood. During post-monsoon there will be quick drainage and field will be ready for cultivation in time. Tidal water will be available in dry period due to canal re-excavation and de-silting activity.	No operation needed	Year round
Controlled water management	Water conservation	Drainage canal and water conservation structure	Improvement of drainage. Conservation at the end of dry period for irrigation During monsoon if there is prolong draught, arrangement of flushing of water for supplementary irrigation	To fix water level as per need after discussion with all users To fix water level so that there is no conflicts among the users During supplementary irrigation if there is rain arrangement for drainage so that crops are not inundated. During conservation in post-monsoon period if there is sudden rainfall drainage should be done by opening of gate so that there is no damage to crops Operation calendar to be prepared as per requirement of water infield	Mid July-Mid September Mid-October to mid-April
	Flood Embankment, Drainage Canal and regulator	Flood Embankment, Drainage Canal and regulator	To reduce impact of Flood in SP during pre-monsoon or monsoon periods. To conserve water after monsoon period In case of emergency to conserve water	To fix water level as per need after discussion with all water users To fix water level so that there is no conflicts among the users If there is prolong drought during monsoon water should be flushed inside and conserve by gates. During supplementary irrigation if there is rain arrangement for drainage so that crops are not inundated. During conservation in post-monsoon period if there is sudden	

Category of SP	Subprojects	Infrastructures	Impact	Operation Procedure	Period of operation
			during monsoon for irrigation	rainfall proper drainage should be done so that there is no damage to crops Operation calendar to be prepared as per requirement of water infield	
	Rubber Dam	Rubber Dam, Inlet, Regulator and khal	To supply irrigation water	The Dam is inflated and water is conserved for supplying water for irrigation. During the end of dry period when there is no need of water Dam is deflated so that it does not interfere with flood flow. From reservoir of Dam water is supplied inside the subproject for irrigation. There is arrangement of Regulator/ check structure for supplying regulating flow.	Mid-October to mid- April
CAD subproject	Irrigation CAD Schemes (Open channel system, Buried Pipe System)	Water distribution network by earthen/brick irrigation channel or buried pipe system	Distribution of water for irrigation and extension of the area by regulated water management	To pump from river as per requirement and to arrange water distribution after discussion with the farmers Clarity and consensus of operating procedures as per discussion with the beneficiaries Infrastructures to control water management To collect tax for irrigation based on land holding. To divide irrigation area into rotation units To divide rotation unit into irrigation unit varying from 5 to 15 hectare To form O&M CAD scheme committee involving member from Rotation Unit For operation of Pump set and irrigation System 1-2 system operators to be appointed Cost is to borne by the beneficiaries At downstream of pipe outlet farmers would be expected to organize themselves into irrigation groups to manage water distribution from distribution boxes along field channels to their field.	Water can be supplied throughout the year if required but generally water is supplied in dry period.

Subproject Maintenance

44. Activities involved in maintenance of CAD (buried pipe irrigation) subprojects are not similar to the maintenance activities of other subprojects because the structures are not similar. However, maintenance of CAD subprojects is presented in *Appendix G8-A: Operation and Maintenance of Buried Pipe Irrigation (CAD) Subprojects* along with operation activities and maintenance of infrastructure of other subprojects (Dr, TI, FMD, WC and Rubber Dam) are presented here below.

45. The maintenance works help to keep subproject infrastructure functional. If in any case maintenance works are delayed, the overall damage increases in future. For that reason arrangement for the maintenance is essential immediate after the construction of infrastructure is complete. Usually, the maintenance at the beginning involves minor work to keep the subproject operational, nevertheless if it is not initiated in time the structure may require huge maintenance works afterwards. Maintenance is a regular work throughout the year. It should be carried out in coordination with the operation of infrastructure. Maintenance work is generally divided into three types: (i) regular, (ii) seasonal, and (iii) emergency.

1.12 Regular maintenance

46. Regular maintenance is also known as routine work. If this work is completed regularly, volume of seasonal maintenance reduces. Preventive maintenance continues throughout the year and is implemented when required. Infrastructure should be inspected regularly to check maintenance requirements and accordingly maintenance work is to be undertaken. The following activities are carried out under the routine maintenance.

1.12.1 Regular maintenance of khal

47. The routine or regular khal maintenance works include: (1) weeding and cleaning of hyacinths in khal, and (2) repair of any damage due to raining. Regular maintenance works for khal are shown in Figure 18 and Figure 19.

1.12.2 Regular maintenance of embankment

48. Routine or regular maintenance works of embankment are: 1) repair of rain cuts, (2) repair of rodent dens, (3) repair of ghogs, 4) turfing on the embankment side slopes. Routine maintenance works of embankments are shown in Figure 21 and Figure 22.

1.12.3 Regular maintenance of structure

49. Routine maintenance works of structure are: (1) painting of gates, (2) preventing of leakage of water through gate and fall boards, (3) Earth filling and compaction at wing wall and return wall on subproject side for the erosion or displacement of soil, (4) replacement and repairing of protective works in upstream and downstream side of structure. Regular maintenance works of structure are shown in Figure 37 and Figure 38.

1.13 Periodic maintenance

50. In the end of rainy season, embankment, khal and structure should be visited to undertake maintenance works. After the rainy season visit is very important because major damage occurs during this time. Thus, maintenance works should be undertaken immediately after the rainy season. The seasonal maintenance works include the following.

1.13.1 Periodic maintenance of khal

The periodic maintenance works of khal include: (1) clearing of silt from khal, and (2) repairing of khal slopes. Khal maintenance works undertaken seasonally are shown in Figure 17 and Figure 18.

1.13.2 Periodic maintenance of embankment

51. Periodic maintenance works of embankment include: (1) reconstruction of eroded slope, (2) repair of embankment's side slope due to soil slide; (3) repair of crack of embankment, and 4) repair of erosion on embankment side slopes. Seasonal maintenance works of embankment are shown in Figure 31 to Figure 35.

1.13.3 Periodic maintenance of structure

52. Periodic maintenance works of structure include: (1) repairing of damaged protecting works of structure including filter, (2) repairing of gate and hoisting system and replacement of rubber seal, (3) greasing, (4) painting of gate and (5) repairing of damaged concrete works. Seasonal maintenance activities on structure are shown in Figure 30.

1.13.4 Emergency maintenance (including major seasonal maintenance)

53. Rehabilitation of embankment or structure when caused by sudden tidal surge and flooding is identified as urgent maintenance work. Generally, embankments are designed for 20-year highest flood level. Flooding above this level can damage embankment and structure which if not repaired on an emergency basis may cause huge damage to the subproject structure. Usually, emergency maintenance works are completed form the technical point of view. For this reason, WMCA should carry out the emergency maintenance work with the support of LGED.

Table 0-1: Type of Damage, Impact and Rehabilitation Method

Subproject component	Type of Damage	Adverse impacts	Rectification measures
Flood control embankment	Excessive slide of the crest and side slopes	Water can overflow in the subproject making the SP ineffective for flood control. Makes the embankment vulnerable and interrupts communication if the embankment is used for communication	Rehabilitation of embankment, benching cut of slope at 30 cm height, earth filling by 15 cm layer, compaction, dressing and turfing.
	Side slope cut	Stability of the embankment reduces and subproject becomes vulnerable	Plantation at toe, refrain farmers from slope cut, earth filling from 15 cm layer, compaction and dressing and grass turfing.
	Slide of side slope	Makes the embankment vulnerable and reduces stability	Filing by 15 cm layer, compaction and dressing
	Rutting or grooving by cart	Communication is interrupted, embankment stability may reduce	Earth filling from 15 cm layer, compaction and dressing.
	Ghogs (cavity or hole through the embankment)	Water flow from riverside into the subproject area replaces soil making the hole through the embankment making it vulnerable	Re-excavation of ghogs at 1 m depth on riverside and filling up with clay soil, earth filling by 15 cm layers, compaction and dressing and turfing
	Erosion of side slope from water flow or wave action	Reduces stability of embankment due to reduce slope and make the subproject vulnerable	To excavate the damage part by steps. Earth filling in 15 cm layer, compaction and re-built as per design, dressing and close grass turfing.
	Breaking of Embankment	Subproject activities stop temporarily	The damage portion is to be re-excavated up to a depth of 30 cm in steps with 60 degree angle.

			Each 15 cm layer is to be compacted separately and re-excavated part is to be filled with suitable earth. River side slope is to be made with mild slope and re-built. After proper dressing close grass turfing to be done.
Drainage Khal	Growth of excessive weeds or aquatic plants and silt deposition	Impedes drainage of water, constricts khal section, reduction of water flow	Removal of weeds and cleaning silt
	Erosion of side slope	Changes of section and interruption in water flow	Rebuilt the khal by reducing side slope
Water Control structure	Leakage through gate	Hampers in water conservation and problem in gate operation	Cleaning of gate grove. Replacement of rubber seal if required
	Erosion of soil at wing wall and return wall on subproject side	Leakage of water through wing wall and return wall side can damage the structure	Earth filling with 15cm layer at the back of wall and compaction
	Partial or complete damage of khal protection work at the downstream of structure	Excessive displacement of khal bank or bed's soil can damage cut-off-wall and make the infrastructure vulnerable	Removal of blocks from side slope for earth filling, compaction, replacing of filter, putting back the blocks again.
Irrigation Canal (Pucca)	Breaking of wall/crack and leakage	Leakage of water	To repair with close supervision
Buried Pipe (Concrete)	Leakage of joint	Problems with distribution of water	To remove the top soil and repair with concrete
Header Tank	Siltation in bed. Stoppage of Silt extraction Pipe	Problem of storage and distribution of water	To clean Tank and Extraction pipe
Alfalfa Valve	Tempering and leakage of water	Due to leakage of excessive water crops of low land is submerged. In addition there is scarcity of water for d/s plots.	To be repaired on emergency basis. If it is not possible to repair should be replaced.
Pump and Electric line	Damage of Pump and Electric Line	Problems with pumping ultimately affect on water supply	Pump is to be repaired as per need. Electricity supply line to be repaired and switch Fuse and other accessories to be kept in store.
Rubber Dam	Deposition of sand and silt over Dam	Problem with inflating Dam.	Before inflating the Dam silts/sand and other debris to be removed without damaging the bag
	Deposition of sand and silt in intake point of pumping Bag	Adequate water will not be available in Pump. Pump may be damaged. Silt may be deposited inside the bag during pumping	Intake point to be cleaned. Servicing of filling pump to be done

Plantation and nursing

54. The main objective of plantation along the embankment in subproject is the conservation of environment. Moreover, plantation program is undertaken along the banks of the excavated or re-excavated khal. Initially, plantation is supported by the Project fund. However, beneficiaries and landowners should ensure the plantation, nursing and conservation through the WMCA.

Figure-16 Plantation

Maintenance of drainage khal

1.14 Growth of aquatic plants and siltation in khal

55. Description of the damage: Excess growth of weeds and aquatic plants and siltation decrease khal section, reduces water flow and impedes drainage. Water flow reduces with the increase of density of weeds. Weeds create barricade at the downstream of structure's gate. This also changes direction of water flow. As a result water hit khal's slope. In general, excess growth of plants restricts water flow which impedes drainage system (Figure 17).

Figure-17 Drainage Canal

56. Cause of the damage: Low flow of water or reduction of depth of khal.

57. Inspection: Step should be taken for the maintenance of khal through regular inspections. Two types of maintenance works should be carried out. These are regular and seasonal maintenance. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist. The maintenance work should be completed according to the plan before the rainy season.

58. Maintenance system: (a) cleaning of aquatic plan and other debris, (b) regular cleaning of khal and weeding, and cleaning of silt.

1.15 Slide of side slope

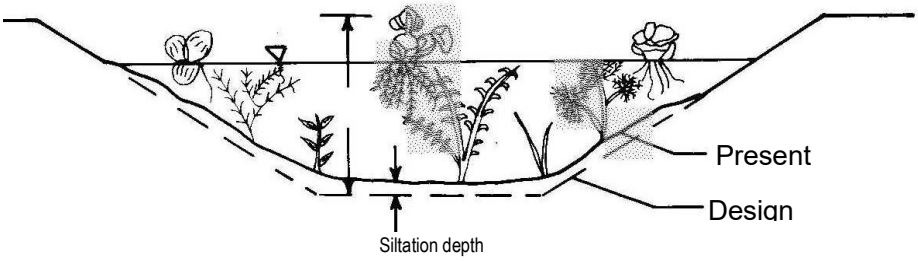

Fig.18: Aquatic plants and siltation

59. Description of the damage: Excessive erosion of khal slope and slide afterward (Figure 2).

60. Cause of the damage: Khal slide slope is not according to the soil type, actual slope is steep than the designed.

61. Inspection: Action should be taken for the maintenance of khal through regular visit and inspection. Maintenance works should be completed in two phases of regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

62. Maintenance system: (a) re-excavation of khal with side slope, and, (b) rebuilding of banks by reducing side slope.

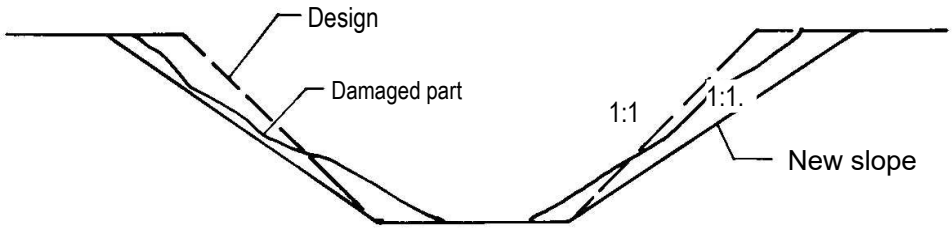

Fig. 19: Very steep side slope

Maintenance of flood control embankment

1.16 Excessive settlement of crest and side.

63. Description of the damage: In many cases there could be settlement of crest and side slope resulting in partial failure embankment to control flooding. Communication along the embankment is disrupted (Figure 20).

Figure-20 Settlement of Crest and side slope

64. Cause of the damage: Inadequate compaction of soil during the construction of the embankment or weak soils used for the construction of the embankment.

65. Inspection: Actions should be taken for the maintenance of the embankment through regular inspection. Maintenance works should be carried out in two phases of regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

66. Maintenance system: Embankment should be rehabilitated with the increase of height. During the rehabilitation works settlement of the existing embankment should be taken into account, and the following rehabilitation works should be undertaken:

a) Uprooting of existing grasses to preserve for re-plantation (1).
b) Benching of the side slopes in 30 cm height (2).
c) Earth filling in 15 cm layers and compaction of each layer separately (3).

d) Dressing of the top of the embankment and grass turfing. Bamboo stick should be used to fix the grass turf with the slope (4).
e) Planting of new grass seedlings and nursing and watering until the grasses grow up to 10 cm high.

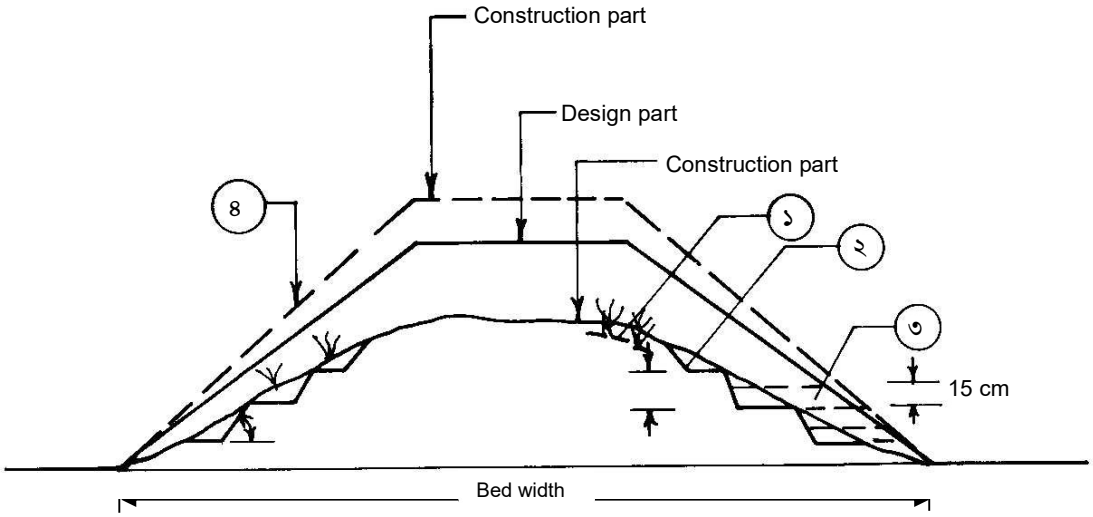

Fig. 21: Excessive subsidence of embankment crest and slope

1.17 Embankment's side slope cut

67. Description of the damage: In many cases cut at the adjacent of toe of the embankment's slope is observed. The extent of cut in many cases is found to be wide (Figure 22).

68. Cause of the damage: Embankment slope cut by farmer to increase size of the plot for dwelling or cultivation.

69. Inspection: Action should be taken for the maintenance of the embankment through regular inspection. Regular and seasonal maintenance works should be undertaken. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

Figure-22 Cutting of Toe of Embankment

70. Maintenance system: Plantation or installation of concrete pillars at the toe of the embankment, and discouraging of farmers in cutting slopes and undertaking of following rehabilitation works.

a) Initially, cutting of the toe at an angle of 60^0 (1).
b) Earth filling with 15 cm layer and compaction of each layer separately (2).
c) Dressing and grass turfing on rehabilitated part of the embankment and use of bamboo stick to fix the grass turf with the slope to protect from dislocation (3).

d) Planting of new grass seedlings and nursing and watering until the grasses grow up to 10 cm high (4)

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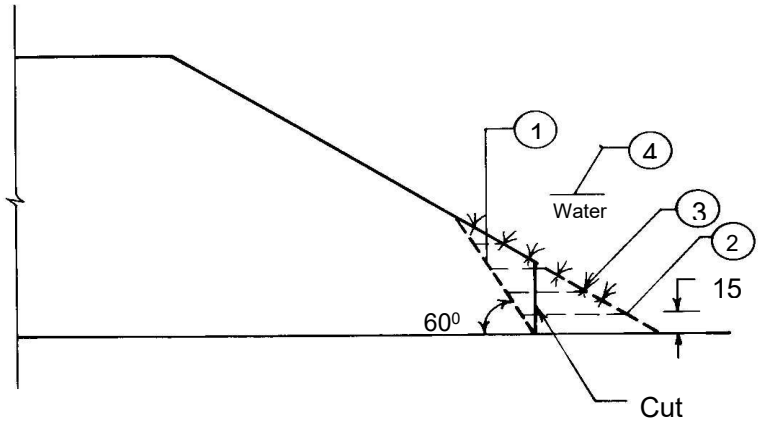


Fig.23: Cutting at side slope of embankment

1.18 Erosion of side slope by water flow

71. Description of the damage: In many cases erosion is observed on the side slopes of the embankment due to water flow (Figure 24).

72. Cause of damage: Water flow with high velocity.

73. Inspection: Appropriate measure should be taken for the maintenance of the embankment through regular inspection. Regular and seasonal maintenance works should be undertaken. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

74. Maintenance system: If flow is not high, embankment should be rehabilitated with bamboo mat pillars. Tree and weeds should be grown on embankment slopes. If flow is high, temporary protection measure can be taken with brick pitching and setting sand bags. Brick or CC blocks can be placed for long-term protection. The embankment rehabilitation activities include the following.

a) Initially, the eroded vertical edge should be cut at an angle of 60^0 with the horizontal line (1).
b) Bamboo mat fence (torja) should be constructed vertically along the horizontal line of the eroded embankments (2).
c) Filling of eroded part with 15 cm earth layer and compaction of each layer separately (3).
d) Dressing of the rehabilitated part of the embankment and grass turfing, use of bamboo stick to fix the grass turf with the slope (4).
e) Regular nursing and watering until the grasses grow up to 10 cm high.

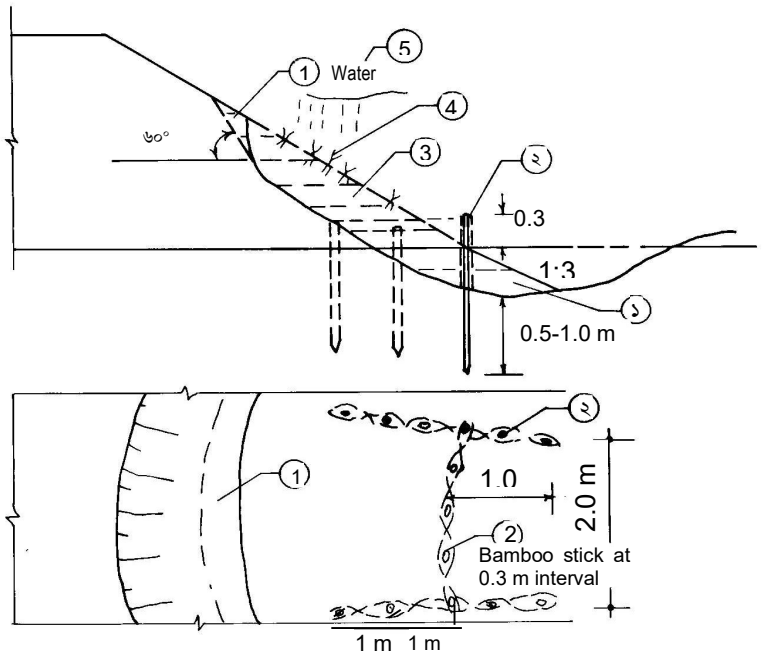


Fig. 24: Erosion of side slope for water flow

1.19 Erosion of side slope by wave action

75. Description of the damage: Flood control embankment can be eroded by wave action. This erosion ultimately damages the embankment (Figure 25).

76. Cause of damage: Generation of strong wave for wind.

77. Inspection: Appropriate measure should be taken for the maintenance of the embankment through regular inspection. Maintenance works should be undertaken in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season starts.

78. Maintenance system: Embankment should be rehabilitated. Brick or CC blocks should be placed to protect from strong wave action. The embankment rehabilitation activities include the following.

a) Initially, the eroded steep should be cut at an angle of 60^0 with the horizontal line (1).

b) Filling of eroded part with 15 cm earth layers and compaction of each layer separately (2).

c) Dressing of the rehabilitated part of the embankment and grass turfing, use of bamboo stick to fix the grass turf with the slope (3).

d) Construction of bamboo mat fencing (torja) along the toe (4).

e) Development of 1 m wide cover planted with dhaincha (*Sesbania*) to reduce erosion of slope on the riverside.

Note: Generally, the sandy soils piled at the bottom of embankment are not suitable to reuse.

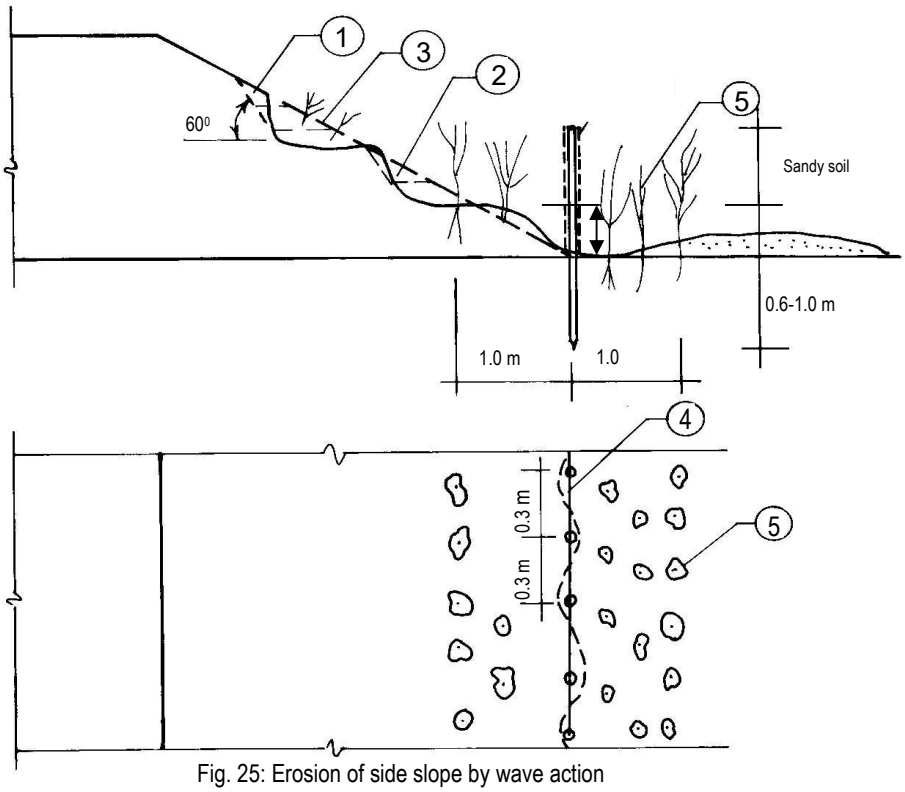


Fig. 25: Erosion of side slope by wave action

1.20 Slide of side slope

79. Description of the damage: Generally, slide of side slope of embankment is observed. Excessive rainfall or faulty construction is the root of subsidence which weakens embedment (Figure 26).

80. Cause of damage: Use of weak and wet soils in the construction of embankment. Improper compaction of soil can cause the subsidence during the rainy season. Too steep side slope can be also the cause of slide.

81. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

82. Maintenance system: Embankment should be rehabilitated with less steep slope. The roots of slope erosion should be identified. Care should be taken that sufficient time is allowed to dry wet soils before filling. The embankment rehabilitation activities are as follow.

a) Eroded soil should be removed (1).
b) Initially, the vertical part should be cut at an angle of $60^{0 \text{with}}$ the horizontal line (2).
c) Reconstruction of eroded part based on the original design with 15 cm layer and compaction of each layer separately, i.e., recasting of side slope at proper height (3).
d) Dressing of the new slope and grass turfing, use of bamboo stick to fix the grass turf with the slope (4 and 5).
e) Regular nursing and watering until the grasses grow up to 10 cm high.

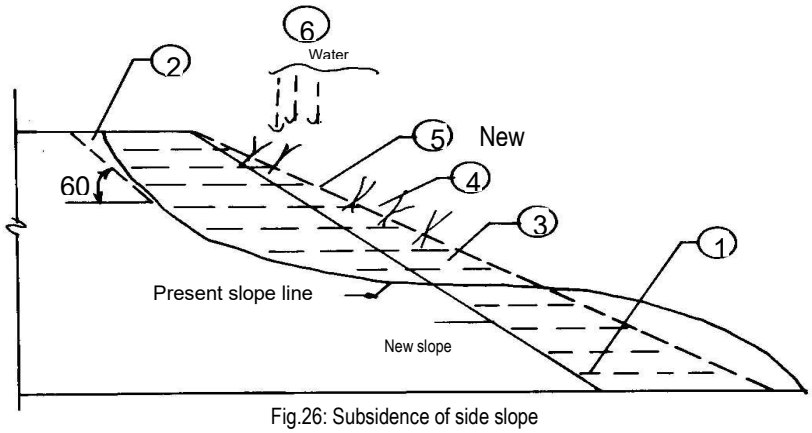


Fig.26: Subsidence of side slope

1.21 Rain cut

83. Description of the damage: In many cases soil at the slope of embankment could be displaced. This may weaken the embankment. The embankment can be damaged if it is not rehabilitated properly (Figure 27).

84. Cause of damage: Heavy rainfall or water flow with high velocity toward lowland can cause the cut

Figure-27 Rain cut

85. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment. Maintenance works should be undertaken in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

86. Maintenance system: Embankment rehabilitation activities are as follow.

a) Benching of the damaged part of the embankment and removal of total loose and sandy soils (1).

b) Reconstruction of eroded part based on the original design with 15 cm layer and compaction of each layer separately.

c) Dressing of the rehabilitated slope and grass turfing, use of bamboo stick to fix the grass turf with the slope (3).

d) Regular nursing and watering until the grasses grow up to 10 cm high (4).

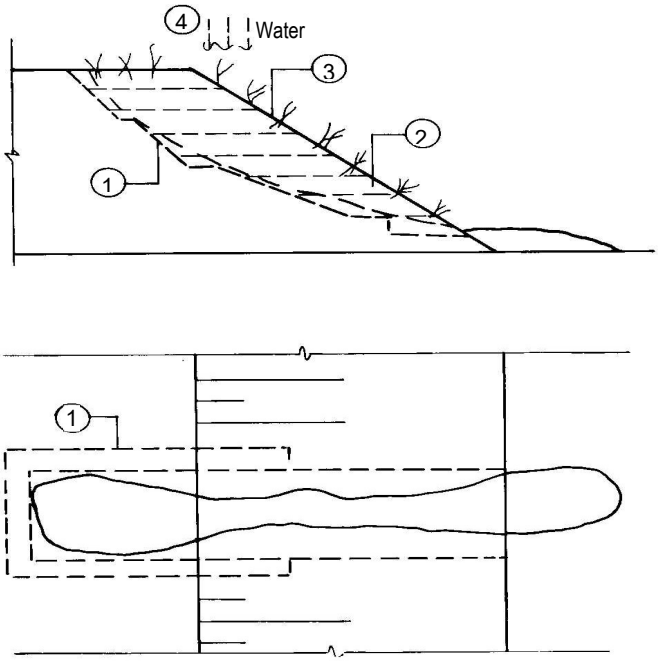


Fig. 28: Rain cut on embankment

1.22 Rutting and hole due to soil displacement

87. Description of the damage: Creation of whole for rutting on embankment, soil displacement or for any other reasons. Water accumulates in the hole and the hole expands due to the traffic damaging the embankment (Figure 29).

88. Cause of damage: Motor vehicle or any animal can create hole on the embankment or its slope if the compaction works are not done properly.

Figure-29 Rut Holes

89. Inspection: Appropriate measure should be taken to carry out the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

90. Maintenance system: The embankment rehabilitation activities are as follow.

a) Displacement of loose soils completely (1)

b) Regular nursing and watering until the grasses grow up to 10 cm high

c) Filling of the holes with 15 cm layer with required soils and compaction of each layer separately, watering if required (2 and 3)

d) Dressing and grass turfing.

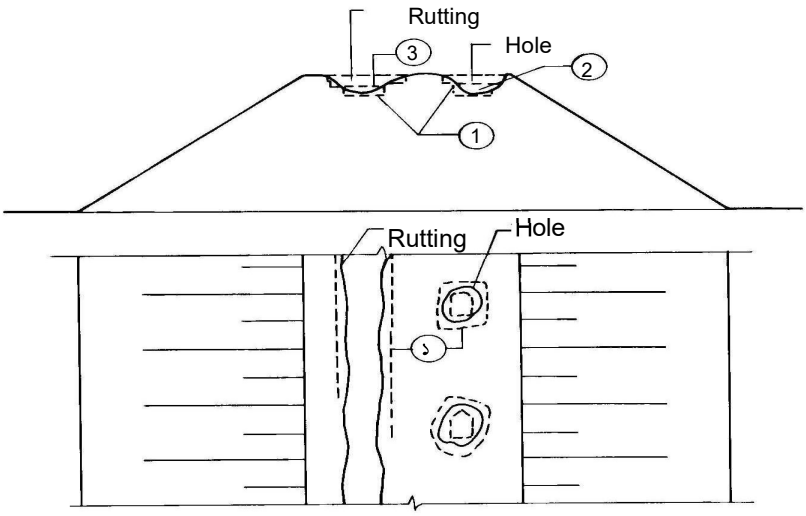


Fig. 30: Rutting and hole

1.23 Ghogs (hole through the embankment)

91. Description of the damage: Rats or any other animal can make hole into the slope extending from the subproject side to the riverside. If ghogs are not repaired timely embankment could be breached due to seepage through it (Figure 31).

Figure-31 Ghogs

92. Cause of damage: Rat or any other animal or inadequate compaction is responsible for it. Moreover, if soil clods are not broken during the construction of embankment may also make ghogs.

93. Inspection: Appropriate measure should be taken to carry out the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

94. **Maintenance system:** The embankment rehabilitation activities are as follow.

a) Re-excavation of the ghogs towards river side at a depth of 1m (1).

b) Filling of the ghogs with mud soils at a depth as much as possible (if possible on both source sides) (2).

c) Filling of the re-excavated part with appropriate soils with compaction by 15 cm layers (3).

d) Dressing of the rehabilitated part of the embankment and grass turfing, bamboo sticks should be used to fix the grass turf with the slope.

e) Regular nursing and watering until the grasses grow up to 10 cm high.

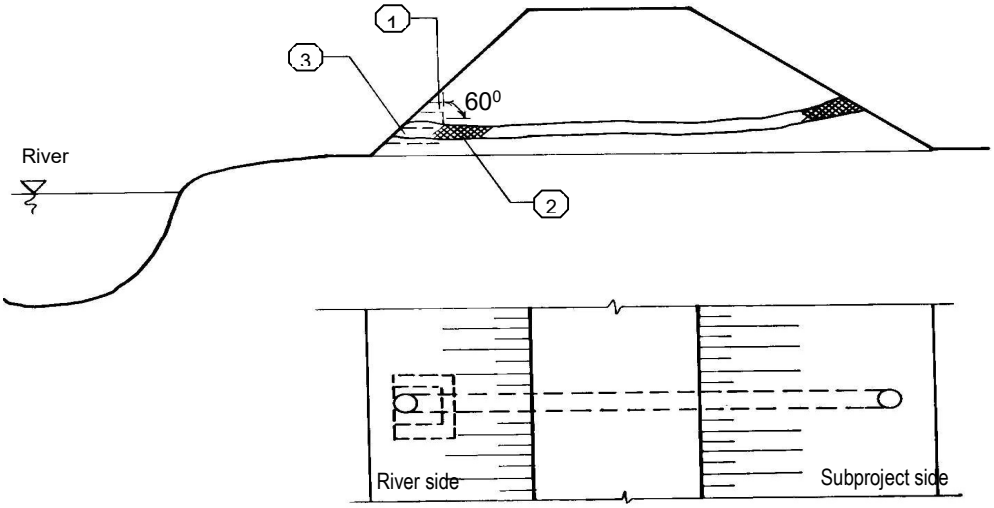


Fig. 32: Ghogs on embankment

1.24 Embankment breaching

95. Description of the damage: Flood control embankment can be breached suddenly for high water pressure or if ghogs are not repaired timely. The size of the breaching gradually enlarges from smaller to bigger. The breaching can cause serious damage to the embankment if it is not repaired immediately (Figure 33).

Figure-33 Embankment Breaching

96. Cause of damage: Sudden floods, flow of floodwater with high velocity, rainfall-runoff, flash floods, rapid rise in flood levels or if embankment is not rehabilitated for long time can cause the breaching.

97. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment. If the embankment id repaired during the flow of water, the level of water (high or low) should be determined and accordingly necessary step should be taken. Regular and seasonal maintenance works can reduce the risk of breaching.

98. Maintenance system: Maintenance work of the breached embankment can be three types- (a) repair in dry condition, (b) repair during low flow condition, and (c) repair during high flow condition. The embankment rehabilitation activities are as follow.

a) Repair in dry condition (Figure 34).

- Benching at 30 cm depth and at an angle of 60^0 at the breaching part of the embankment (1).
- Re-sectioned part should be filled with appropriate type of soils with 15 layers and compaction of each layer separately (2).
- Leveling of slope on the river side with additional soils (3).

- Dressing of the upper part and grass turfing on the slope, bamboo sticks should be used to fix the grass turf with the slope.
- Regular nursing and watering until the new seedlings grow up to 10 cm high.

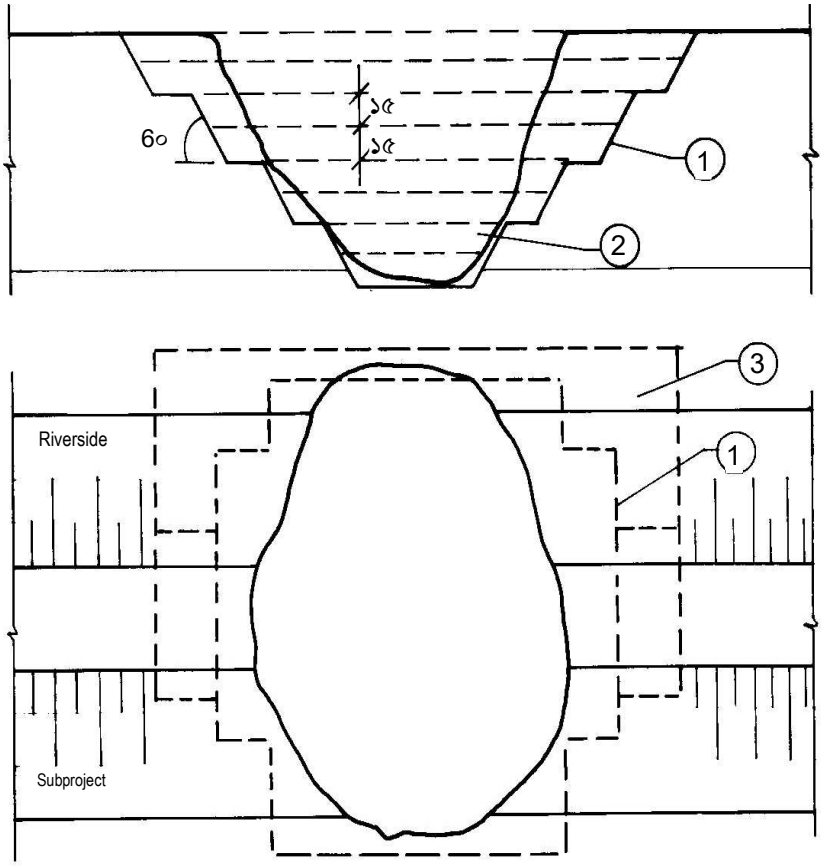


Fig.34: Breaching of embankment: repair in dry condition

b) Repair during water low flow condition (water level difference of < 10 cm) (Figure 35).

- Ring embankment at the breached part with bamboo and torja (1).
- Two rows of bamboo pillars 1 m apart at a height lower than the embankment crest level tied with bamboo mat (torja) (2).
- Water flow should be stopped placing sacks filled with soil and plant residues inside the chamber (3).
- Construction of embankment reducing the side slopes on the river side (4).

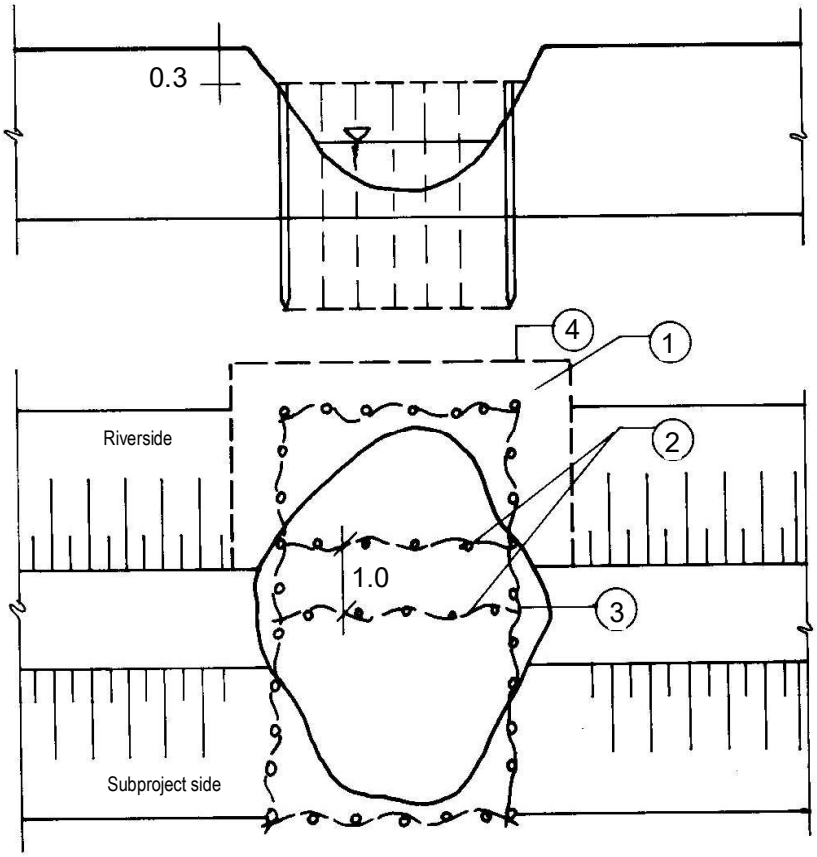


Fig. 35: Repair during low flow condition (water level differences of < 10 cm)

c) Repair during high flow condition (water level difference of > 10 cm) (Figure 36).

- 2-3 rows of ring embankments on the subproject side with bamboo and bamboo mat (torja) (1).
- Dumping of sacks filled with soil and brush wood (2).
- Re-construction of new embankment on dry condition (3).\
- Filling with 15 cm layer and compaction of each layer separately.
- Dressing of the upper part and grass turfing on the slope, fixing of the grass turf with the slope using bamboo sticks.

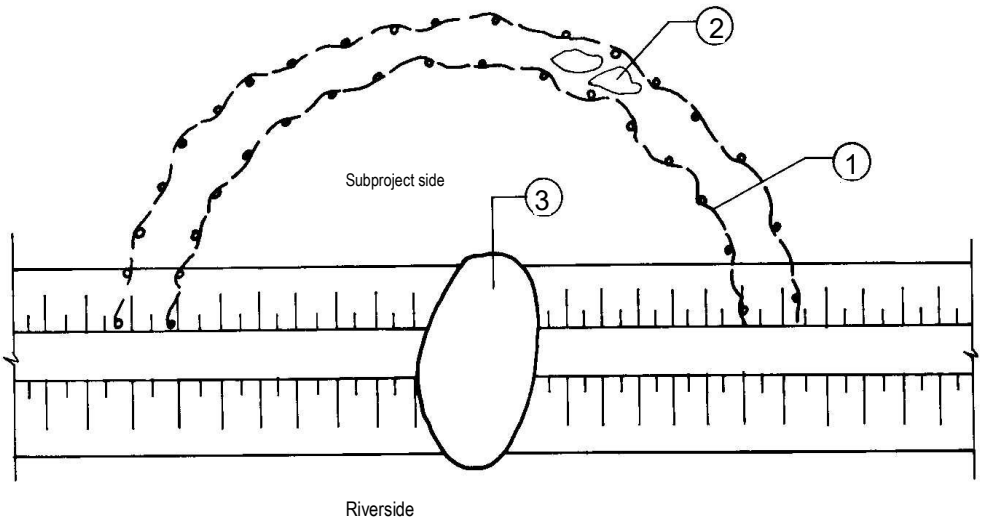


Fig. 36: Breaching of embankment: temporary protection during water flow condition and repair after the rainy season

Maintenance of water control structures & Rubber Dams

1.25 Poor drainage for the aquatic weeds

99. Description of the damage: Usually, drainage is impeded for the aquatic plants. Inadequate drainage of rainwater causes adverse impacts in the subproject area.

100. Cause of the damage: Growth of aquatic plants, particularly hyacinth at the gate downstream. Thickness and density increase for not eradicating in time. Water flow is impeded during the operation of the gate and drainage period prolongs. Consequently, depth of water increases on subproject side.

Figure-37 Water Weeds d/S of Structure

101. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of the embankment. Maintenance works should be carried out in two phases: regular and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

102. Maintenance system: (a) Preventive and seasonal maintenance works should be undertaken so that aquatic plants cannot grow at the downstream of the gate, (b) Weeds and other residues should be removed in the rainy season.

1.26 Leakage through the gate

103. Description of the damage: Leakage of water through the gate is commonly observed. If the leakage increases volume of conserved water decreases.

104. Cause of the damage: Alignment of the gate is not correct. Partial close of gate for debris at gate groove and breaking of rubber seal.

105. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases: preventive and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

106. Maintenance system: Repairing and greasing of gate hoisting system, (b) replacement of rubber season, and (c) cleaning of gate groove.

1.27 Partial damage of protective works at the downstream of structure.

Figure-38 Damage of Protective Works in River Side

107. Description of the damage: Protective blocks at downstream of structure can be displaced, which ultimately may cause adverse impacts on structure.

108. Cause of the damage: There can be many reasons. For example, size of the structure is smaller than the requirement, for which velocity of water flow is higher and blocks can be dislocated. In addition, if invert level is kept at higher level than that required, gate is not operated properly and opening of gate rapidly during the period when water level is high can also cause damage of protective blocks.

109. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases: routine and seasonal. According to the check list prepared during the inspection after the rainy season, a work plan and budget for maintenance should be prepared and implemented before the rainy season.

110. Maintenance system: (a) no rehabilitation will require when only launching apron is dislocated; (b) compaction with soil and re-construct of the slope will be required when protective blocks are dislocated. Thereafter filter should be placed and put back the blocks on it; (c) if protective blocks are dislocated, concrete apron is under threat and quick erosion is observed in downstream of khal. Then causes should immediately be identified to take rectification measure and arrangement should be made for implementation.

1.28 Displacement of soil at the wing wall and return wall of structure

111. Description of the damage: In many cases soil from the wing wall and return wall of structure is displaced. Excess displacement can cause damage of structure.

112. Cause of the damage: Inadequate compaction of soil at the back of wall and subsidence due to leakage of water during flooding.

113. Inspection: Appropriate measure should be taken for the maintenance works through regular inspection of structure. Maintenance works should be carried out in two phases: routine and seasonal. Particularly, with the inspection after the rainy season a work plan and budget should be prepared for the maintenance work according to the checklist before the rainy season.

114. Maintenance system: Compaction at the back of wall with 15 thick layer using required soil, and (b) placement of filter at the connecting point of wing and return walls.

Preparation and implementation of maintenance plan

1.29 Preparation of Priority List

115. To consider annual maintenance program, a priority list of subprojects to be prepared based on importance. A priority list of district to be prepared following prescribed Grading Formats (Exhibit G8-1, Format A, B & C) and based on the marks scored. For getting maximum utilization of the Fund the list should be finalized. Executive Engineer will prepare priority list in his district and will send to regional SE by 30, June. Regional SE after getting the priority list will review the list in monthly meeting and prepare a priority list under his jurisdiction and will send to IWRM by 15, July with recommendation. IWRM will review the priority lists from all the Zonal SE's and will prepare a tentative list of maintenance works for execution and preliminary allotment of fund and will send to Zonal SE and Executive Engineer by 10, August. It is to be noted that maintenance of structure to be given priority but for earthwork clear justification for its implementation should be given.

1.30 Grading

116. Grading can be considered as success of implementation and indicator of future investment. As request for government fund is much higher than fund available, the selection should be done based on grading. Those subprojects will secure Excellent (A) and Good (B) will get priority for the fund. Grade consideration will secure the distribution of fund to achieve optimum benefit.

117. Decision for allotment of fund for subprojects will be taken based on the results of Grading. Those subprojects which will receive 'Excellent' and 'Good' grading will be considered eligible to receive GoB fund. Those subprojects which will receive 'Medium' or 'Bad' Grading will try to rectify their defects and involve themselves in O&M activities. Less priority will be given to weak subprojects as application for fund will increase if fund is provided to weak WMCAs. Grading criteria are given below:

Table 0-1: Subproject Grading and allotment of GoB Fund

Grade		Score	Activities
A	Excellent	80-100	WMCA is performing well and taking responsibility for routine maintenance and any operation. Subproject is likely to be demonstrating sustainable benefits and GoB Funds for maintenance are likely to be well used
B	Good	60-79	WMCA is performing quite well and undertaking (some) routine maintenance. Subproject is likely to be demonstrating sustainable benefits and Gob funds for maintenance are likely to be well used.
C	Medium	40-59	WMCA is performing and may be eligible for GoB financial support but would be advised to address shortcomings first and reapply the following year. Priority in allocating Gob funds for maintenance should be given to A and b grade subprojects.
D	Bad	<40	Fundamental problems with WMCA and attitudes to routine O&M need to be addressed before any funding support from GoB

118. After receiving of subprojects list targeted for implementation from IWRM steps for implementation to be taken.

119. For maintenance work first step is to be taken to estimate the quantity of work and prepare budget. To estimate the quantity of works following steps are to be taken:

- After monsoon the O&M sub-committee will visit khal, embankment and structure. This committee will identify the damages in infrastructures during monsoon.
- Following the Exhibit G8-2, Format A, Format B, Format C, Format D, Format E and Format F the committee will assess the damage and prepare possible estimate for rectification of damages as identified (Appendix 18.3)
- Following Exhibit G8-2 the committee will estimate quantity of works and prepare budget
- After preparing budget they will prepare time frame (Exhibit G8-4) of implementation of works.

Field level joint inspection of infrastructure

120. Field level inspection is important to know the overall condition of the subproject for the preparation of subproject maintenance plan. LGED officials and WMCA operation and maintenance committee members jointly conduct this inspection twice annually, before and after the rainy season. LGED Assistant Engineer, SSWRDSP-2 and Sub-Assistant Engineer, SSWRDSP, or two Sub-Assistant Engineers from Upazila LGED office and four WMCA O&M sub-committee members will participate in the joint inspection.

1.31 Inspection of infrastructure after the rainy season

121. Objectives – (a) Identification of the damages of various infrastructure and maintenance activities, (b) preparation of estimate and budget, (c) arrangement for fund collection, and (d) preparation of implementation schedule.

1.32 Inspection of structure before the rainy season

122. Objective – (a) Check that the maintenance works which were identified according to the plan are implemented, (b) identification of faults which can make the subproject vulnerable in the rainy season and take appropriate measure for repairing immediately if necessary, and (c) check that gate of the structure function properly and repairing of the gate if there is any fault.

Operation & maintenance subcommittee

123. A sub-committee should be formed under WMCA for the implementation of operation and maintenance works in time and properly. This sub-committee will be known as the operation and maintenance committee. The committee should be formed before the completion of infrastructure completes. This committee will be accountable to the WMCA for the operation and maintenance of subproject infrastructure. The sub-committee shall be formed consisting of 9 to 12 members including president, general secretary, treasurer and 6 to 9 members. This committee should include three members from the WMCA management committee and three members among the women. The other members should be among the subproject beneficiary members particularly from the landowners and fishers. However, priority should be given to the personnel who are experienced and interested on supervision and construction works. Priority should be given to include members from "monitoring of construction committee" because they have already gained some experience during the subproject construction. The remaining members should be selected according to the guidelines provided in this chapter. This committee will use the WMCA operation and maintenance fund as require with the approval by the management committee and submit detailed report to the management committee at the end of the year. Matters related the sub-committee formation for the operation and maintenance and fund collection should be included in the bye-laws of every WMCA. If there is any change in WMCA management committee through the election, the

operation and maintenance committee can also be reorganized. However, new operation and maintenance committee should include three members including treasurer among the members of the old committee. The treasurer will be able to provide information about the fund. WMCA will carefully form the operation and maintenance committee according to the following considerations.

- Water users form the major villages should be represented;
- Priority should be given to those who are interested in operation and maintenance works and experienced in motivating.
- Representation of all types of farmers and occupational;
- Maximum number of members should be 12 and should include three members among the WMCA management committee and three members among the women.
- Members of supervision and construction committee can be included in the committee as convenient.

124. WMCA will take initiative for the formation of operation and maintenance committee. The WMCA shall call a general meeting to form the committee according to the considerations as described above. The WMCA Chairman will chair the meeting. The steps involved in the process of committee formation are as follow.

- WMCA will inform chairman/members of the relevant union parishad (council) about the formation of the committee;
- At least two weeks before the place, date and time of the meeting should be decided according to discussion with the local people. The meeting should be held at a convenient place within the subproject area.
- Facilitator and Community Organizer will support WMCA in organizing the meeting.
- WMCA will inform Upazila Engineer about this and Socio-economist and Assistant Engineer at district level will present in the meeting.
- WMCA will distribute a leaflet containing brief description of the subproject and operation and maintenance needs in the meeting supported by the Facilitator and Socio-economist.
- WMCA will arrange to publicize place, date and time of the meeting at a nearest market/bazaar by beating tom-tom or if possible by miking.
- The committee should be formed before the construction of structure completes.
- At least 70 percent of the subproject beneficiaries should be present at the meeting to be organized for the formation of the operation and maintenance committee. If the attendance is found to be less than 70 percent the second meeting should be organized and committee can be formed whatever the attendance is.
- The duration of the sub-committee shall be two years and new committee should be formed when the tenure ends.

125. The committee should be formed with common understanding, unanimously and based on democratic principles. The following discussion should be held at the meeting.

- Subproject infrastructure and function
- Importance of operation and maintenance.
- Responsibility of the committee related to operation and maintenance.
- Role of Government/LGED/WMCA on operation and maintenance.

- Government/LGED/Project's guideline on the collection of fund for operation and maintenance.
- Detailed clarification about the transfer of users' ownership of the infrastructure to the WMCA and matters related to handover.

126. The operation and maintenance sub-committee should be formed according the rules as specified above. Community Organizer, Facilitator and Socio-economist will fully support the WMCA in the whole process. The committee will be announced formally at the meeting. Signature of the participants of the meeting should be collected. The proceeding of the meeting including the list of the elected members should be sent to the Upazila in the following format.

Subproject name and number	Upazila	Date of O&M sub-committee formation	Name of O&M sub-committee members	Occupation (agriculture, fisheries, teaching, etc.)	Designation (President/ secretary/ treasure/ member

127. Sub-committee activities: The sub-committee will implement all the activities related to the operation and maintenance through the WMCA. The specific responsibilities and functions of the committee will be as follow.

- Updating of beneficiaries list;
- Preparation of beneficiary map;
- Regular inspection of subproject infrastructure and identification of problem;
- Assessment of the volume of the required maintenance works before and after the rainy season and accordingly preparation of budget every year;
- Involvement with all works related to operation and maintenance including planning, implementation and supervision of infrastructure;
- Preparation of work plan for the collection of operation and maintenance fund and support to WMCA for its implementation;
- Implementation of plantation program on the subproject embankment;
- Recommendation for the appointment of operator for the operation of structure;
- Regular submission of report on all activities (progress/problem/proposal) related to subproject operation and maintenance to the WMCA and at the general meeting or at special meeting;
- Communication with WMCA or relevant supporting organization (Project/LGED/NGO/Union parishad/upazila parishad) for technical or any other support;
- Support WMCA in organizing special meeting on maintenance with the inspection of subproject after the rainy season every year and related matter;
- Inform WMCA and Union Parishad for the resolution of conflict if there arises in case of operation.

Subproject beneficiary map

128. Preparation of subproject beneficiary map and listing of beneficiaries are interrelated. Beneficiary map is the first step of the process to determine appropriate number of beneficiaries of the area and size of lands according to the types. This map will be useful to easily determine the number of plots owned by beneficiaries and area of the plots. This will

help to clearly determine the number of beneficiaries and ownership of land per household. As a result, fund for operation and maintenance can be collected accurately and timely. The map will be new addition of the mauza map of that area (subproject) showing new homesteads and other infrastructure. The map will provide a clear perception about subproject lands and other infrastructure through this type of technical and educational activities.

129. At the beginning all the mauzas in the area should be identified. The subproject may cover one or more mauzas or part of the mauzas. Again, there can more than one sheet for each mauza. This indicates all the sheets of identified mauzas will be required to collect. The collected sheets should be put together. The size of the map will be bigger. Now the subproject index map (showing subproject boundary and other infrastructure) should be placed on this new map. After that, boundary and important infrastructure from the subproject map including main road, khal, water bodies (which are not shown in the new map) should be shown in the new map. Now, the additional or unnecessary part (beyond the subproject boundary) of the map can be ripped. The size of this map will depend on the subproject size. However, by any means the size of the mauza map should not be reduced. Because, the plots shown on the map are small in size and any reduction will make the plots further smaller. Accordingly, it will be difficult to work with the reduced map.

Subproject beneficiary list

130. Each subproject should have separate beneficiary list so that beneficiaries can be involved with the operation and maintenance works along with other activities. This will help to collect operation and maintenance fund easily on the basis of the size of the land owned by the individual beneficiaries. Without the accurate beneficiaries' list land ownership can not be determined. This may originate conflict among the beneficiaries and obstruct collection of contribution. Therefore, beneficiary list should be prepared according to the specific procedures.

131. The subproject beneficiary's map can be divided as convenient into several parts. Beneficiaries list should be prepared for each part with visit and in consultation with the local people. The local people should be informed before the visit so that they can be present and express their opinions. The preparation of the list should be started from a particular plot and information from the owner of the adjacent plot should be recorded in the attached format (Exhibit G8-5). Date and time should be fixed for each part of the map. Generally, rural people are acquainted about the area of their neighboring plots. Thus, the attending landowners will provide the information about his plots as well about the plots of his neighbors if they fail to be there. When preparation of list of a part will be complete, next plot will be selected for it following the same procedure. Project's Facilitator, Community Organizer, WMCA and operation and maintenance subcommittee members will participate in the preparation of the list. Two types of list can be prepared from the information to be collected from the beneficiaries. For example:

- Direct beneficiaries.
- Indirect beneficiaries.

132. Direct beneficiaries: The owners of land within the subproject area will only be considered as the direct beneficiaries. The list will again include men and women beneficiaries. If any household is headed by woman in this case her name should be listed. However, in some cases fishers can be the main beneficiaries. Accordingly, the list should be finalized with precise identification of landowners, farmers and fishers.

133. Indirect beneficiaries: There could be many households without owning any agricultural land within the subproject boundary. However, they can be benefitted in one form or another for the subproject implementation. For example, employment generation, increase in crop production, opportunity for marketing, improvement of communication, and so on which may provide more employment opportunity and increase incomes. Indirect beneficiaries may

include landless, small businessmen, fishing community (fishers), boatmen and other communities and occupational people. These occupational people should be listed and they can be members of WMCA. However, they are not obligated to provide fees for the operation and maintenance activities excepting fishers in especial case. It can be mentioned that other procedure can be used if this list can not be prepared from the beneficiaries map.

Collection of operation and maintenance fund

134. The main objective of the formation of Water Management Cooperative Association (WMCA) in this project is to ensure proper operation and maintenance of infrastructure. Each member has participation or share in WMCA. Moreover, every member contributes monthly to the WMCA saving fund. Again, the members also share the WMCA expenditures through the contribution of fees to miscellaneous funds. The WMCA capital fund is formed through the shares and saving by the members. WMCA makes profit with the investment of this capital and distribute the profits among the members. In this way all the existing cooperative associations in the country operate various activities to create the capital and make profits. In addition to current activities the Water Management Cooperative Association has the responsibility of operation and maintenance of water management infrastructure such as khal, embankment, sluice gate, and regulator and so on. Accordingly, there are some differences in the procedures for fund collection to carry out these activities. Maintenance works can not be undertaken utilizing the fund which will be collected through share and savings.

135. It should be noted that the primary responsibility for the maintenance related works rests with WMCA. Excepting the regular (routine) maintenance, WMCA will undertake minor type of urgent maintenance work from its own fund. However, it can receive support from the government revenue fund for major type of urgent maintenance works. A guideline should be followed to get support for this type of fund. The availability of fund will depend on the WMCA organizational capability and maintenance skill.

136. In general, this fund will be developed primarily with the contribution from among the subproject beneficiaries. Land owners or cultivators within the subproject area and landowners who directly benefit for the subproject infrastructure, or increased income for the fisheries within subproject structure, even he is not a member of the association, is identified as main or direct beneficiaries of subproject in accordance with the Project concept. The operation and maintenance committee to be formed comprising beneficiaries and management committee members will prepare operation and maintenance budget and develop a fund with the fixation of beneficiaries' contribution rate to implement the plan according to the budget.

137. The operation and maintenance fund will be collected from the following sources:

a) The contribution collected from the beneficiaries before the implementation of the subproject;

b) Monthly collection of fees to be fixed at certain figure (in addition to share-savings) from beneficiaries members;

c) Collection of produce at certain rate during the harvest period;

d) Fixation of rate according to the size of land benefits for flood control and drainage system;

e) Profit made by the association for the investment on various economic or income generation projects, for example some associations invest on micro-credit, duck-poultry farming and other sector, part of profit margins from this type of investment;

f) Part of income from fisheries if there is any opportunity for fisheries in the subproject area;

g) Contribution from any local organization, local government institution;

h) Income from plantation within the subproject area;

i) Collection of fees at a fixed rate from the beneficiary if he irrigates water from the khal within the subproject area; and

j) Fund allocated by the government.

138. The beneficiaries should deposit the total fund on account of "contribution" before the small scale water resources subproject work starts. However, this contribution fund will be not be used directly for the implementation of structure. A reserved fund will be created using this fund for the purpose of operation and maintenance according to the following procedures:

a) Fixed-deposit of the beneficiary contribution to a schedule bank account opened by Executive Engineer and WMCA President/Secretary. The name of the account should be "Operation and Maintenance Fund". The receipt of this account will be retained by the Executive Engineer until the handover of the subproject.

b) This fund will not be required to use in the first three years, therefore fixed-deposit at the primary stage will be useful.

c) At the end of the construction works, an account in the name of "Operation and Maintenance Fund (Operating account)" should be opened for the maintenance in a schedule bank with joint signatures of WMCA President and Secretary. Fund from beneficiaries should be collected and deposited to this account for the maintenance. In this saving account cumulative amount of interest obtained during handover and later on annual interest from fixed deposit should be directly placed. Instruction should be given regarding issue during opening of fixed deposit account with Upazila Engineer and WMCA.

d) In the subproject handover meeting, the receipt of the fixed-deposit should be handed over to transfer the fund excluding the total profit in the saving account operated in the name of "operation and maintenance fund" jointly by Upazila Engineer and WMCA President/Secretary.

e) Operation and maintenance sub-committee will collect fund every year from the beneficiaries after the preparation of annual maintenance budget. However, effort should be made to raise the fund collection equal to the contribution money as the maintenance cost can increase later compared to that at the beginning.

139. Generally, the annual operation and maintenance fund is collected at a rate of 3% of the total cost for earthworks and 1.5% of the total cost for the construction of structure. Although volume of maintenance works will not be bigger in 1 to 2 years in the completed subproject, equal amount of contribution should be collected from the beneficiaries. The fund should be collected on the basis of the proportion of land owned by the individual beneficiaries. Specially, step should be taken particularly during the harvest season as an appropriate time for the fund collection.

140. The rate of contribution or fees should be decided from the beneficiaries list in the general meeting. Fees can be better decided on the basis of per acre of land benefits. Later, subproject can be divided into several small parts. One member from each of WMCA management committee and operation and maintenance committee can be given responsibility of each part of the subproject area for the collection of fund. They should discus about the fund collection with the beneficiary farmers in a meeting. Produce for the maintenance fund can be collected corresponding with the crop season, at least twice in the year (mid April to mid May and mid December to mid January).

Management of operation and maintenance fund

141. An account should be opened in the name of "Operation and Maintenance Fund (Operating Account)" in a schedule bank with joint signatures of WMCA President/ General Secretary. Fund can be withdrawn from the account operated in the name of "operation and maintenance fund" over the joint signature by WMCA President and General Secretary. This fund can be used for the operation and maintenance of subproject infrastructure and on account of remuneration for gate operator. The fund should be used according to the following guidelines:

a) The total contribution by the beneficiaries should be fixed-deposited in joint account opened by Executive Engineer and WMCA before work starts (1st fixed account).

b) During the handing-over the total amount of 1st fixed account excluding profit should be deposited in another joint account opened by the Upazila Engineer and WMCA. This fixed account will be considered as reserved O&M fund (2nd fixed account).

c) After the completion of the subproject, beneficiaries list should be updated by the WMCA during the period of joint operation and maintenance (before the handing over) to collect contribution from the beneficiaries for the operation and maintenance. This can be discussed in a general meeting before the collection of contribution.

d) A joint savings account (Operating Account) is to be opened jointly by WMCA, President and Secretary to deposit the collected fund. Accumulated interest obtains from 1st fixed deposit account during handover and subsequent annual interest to be directly placed in this account. This fund can be used for routine maintenance and remuneration for gate operator etc can be paid. Instruction should be given during opening of 2nd fixed deposit account.

e) To bring the existing WMCAs under the same system following steps to be taken. For those subprojects showing maturity and capability in O&M and institutional activities, Upazila Engineer can send recommendation to Executive Engineer to transfer the reserved fund account to existing O&M account (Operating Account). Executive Engineer will thoroughly review and examine the case. If the recommendation from UZ Engineer is found justified Executive Engineer will give instruction to transfer the total reserved fund of the WMCA to O&M Account (Operating Account). Gradually all the O&M Account (Operating) will come under same type fund management.

Guidelines for the use of government fund

142. The responsibility for the regular activities related to maintenance of subproject infrastructure rests with WMCA. However, additional fund may be required to repair the subproject infrastructure for the damage by natural disaster. This fund can be available from the government. The fund to be available from the government should be used according to the following guidelines:

a) This fund can be used for the repair of infrastructure which have been properly operated and regularly maintained through the beneficiaries' contribution in the subprojects constructed under small scale water resources project, rubber dam and other water resources infrastructure/scheme implemented by LGED.

b) This fund can be used only for the major type of seasonal and emergency maintenance works.

c) Priority will be given to the subprojects in which WMCAs have been collecting operation and maintenance fund regularly and participating actively in operation and regular maintenance and minor type of emergency maintenance works.

d) Priority will be given to the subprojects where the WMCAs spend a share of profits from the income generation activities for operation and maintenance of infrastructure.

e) The fund can be available for the repair of the embankments which are on the brink of breaching for the proximity of river. However, the fund can not be used if there will any possibility of breaching of the embankment every year. Thus, the nature of river and possibility of breaching of the embankment should be checked before the utilization of fund.

f) There should be a joint fixed account in the name of "operation and maintenance fund" by Upazila Engineer and WMCA.

g) There should be a joint savings account opened in the name of "operation and maintenance fund (operating account)" by WMCA chairman and secretary.

h) At the rate of 10 percent for up to Taka 100,000 and at the rate of 5% for the additional amount should be deposited in "operation and maintenance fund" account before the maintenance works start using the government fund. This could be later used for regular maintenance work.

i) The fund will be available in the subprojects where the beneficiaries have received the ownership of subproject infrastructure for their use, but fund for silt removal can not be given within three years from handover.

j) During silt removal a bed block should be constructed at every km of khal (see Exhibit G8-8A)

143. Before the maintenance work starts, operation and maintenance committee should discuss with the WMCA management committee for the allocation of budget and approval. Every year, the operation and maintenance committee should submit a report after the completion of maintenance work. The WMCA will call a general meeting to present the report to the beneficiaries. The operation and maintenance committee will be responsible jointly with WMCA management committee for the implementation of maintenance work.

1.33 Preparation of estimate for maintenance

144. The initial requirement for the preparation of maintenance plan and budget is the assessment of the volume of maintenance work and estimate. Primarily, LGED and WMCA shall jointly visit every khal, embankment after the rainy season and assess the extent of damage. An estimate and budget should be prepared with the determination of applicable rehabilitation system for the annual maintenance of flood control embankment, drainage khal and water control structure.

a) **Regular (routine) maintenance:** Estimate of this type of maintenance work will jointly be prepared by Upazila Engineer office and WMCA and will be implemented by WMCA. Bill of implemented work will be paid from WMCA own fund.

b) **Periodic and emergency work:** In this case Upazila Engineer Office and WMCA will jointly visit the infrastructure and prepared the estimate and will send to district Executive Engineer, LGED. Executive Engineer considering the field condition will make a priority list and will send to Zonal Superintending Engineer with recommendation. Estimate sent by Executive Engineer will be scrutinized by Zonal SE office and estimated amount above 10 lac will be sent to IWRM Unit for approval. Estimate below Tk. 10 lac will be approved by Zonal SE.

c) For allotment of GoB fund there should be O&M plan. Moreover, additional money should be deposited in O&M fund within January at the following rate every year depending on amount of allotment of fund.

- At the rate of 10 percent for up to Taka 100,000.
- At the rate of 5 percent for the amount in addition to Taka 100,000.

d) The cost for the removal of silt will be provided from the government fund. However, according to silt removing guidelines, the WMCA will identify the khal in O&M plan earlier for the removal of silt and complete the work with 50 percent of the total cost or volunteer labor. Fund will be available from the emergency fund to complete the remaining part.

e) The portion of khal from where the WMCA needs to remove silt should be specified in the O&M plan and shown in map by chainage. Usually, it is observed that WMCA changes the decision on the removal of silt. As a result problem arises on the use of O&M fund. Thus, decision on the removal of silt should be taken with the discussion among the beneficiaries and finalized during the preparation of O&M plan.

f) No cash will be available from the emergency fund for the procurement of gate or any of its part when stolen.

g) The gate paining, greasing, hoist system servicing, smaller rain cult repairs, embankment grass turfing and minor emergency works should be completed as a routine responsibility of WMCA and to be done from WMCA own fund. The description of these works should be sent in the specific format.

h) Emergency fund will be available once for change of rubber seal later on WMCA will use their own fund for changing rubber seal.

i) Two copies of the maintenance work estimate using the fund from irrigation infrastructure should be sent for approval.

1.34 Fund allocation

145. Fund form the government revenue budget will be distributed to the district level by the IWRM Unit at LGED headquarters for the maintenance of subprojects constructed under the small scale water resources development sector according to the specific principles. It should be noted that the allocation against a district will depend on the actual requirement in the district, WMCA maintenance skill which will be decided reasonably in consideration with the actual situation. The following should be considered with importance for the allocation of this fund to the district levels:

- Priority list as per grading.
- To give priority to maintenance of structure. For maintenance of earthwork proper justification should be given.
- If earlier allotment is taken from GoB fund, a report on amount of fund received and statement of expenditure to be provided.
- Role of WMCA in maintenance work and fund collection.

1.35 Preparation of annual procurement plan

146. Annual procurement should be prepared by the Executive Engineer of the relevant district for the current financial year within two weeks after the availability of fund from “irrigation infrastructure” account for the repair of small scale water resources infrastructure. The plan should be sent to the IWRM Unit.

147. For this O&M plan should be reached at IWRM Unit from the field within 30 November. This will be reviewed to provide fund within December. In continuity, annual procurement plan should be received by the IWRM Unit as latest as second week of January.

1.36 Implementation method

148. In course of activities related to water resources infrastructure operation and maintenance opportunity for the participation of local people or LCS should be identified in supporting the poverty reduction effort by the Project. The following works with a total cost of 500,000 or less can be carried out through the LCS.

a) Block making, leveling, dressing and placement with filter material;

b) Gate repair, replacement of rubber seal, increase of gate height, repairing of shaft and hoist system, changes of skin plate, and so on;

c) Repairing of parts of regulator; and

d) Gauge marking and painting on regulator.

149. The number of LCS member should be 10-25 for earthworks and 5-15 for pucca works. The pucca work with a cost of more than Taka 500,000 cannot be divided to distribute among the LCSs. In accordance of this decision, water resources infrastructure operation and maintenance works should be carried out. District Executive Engineer should prepare annual procurement plan within 2 (two) weeks after the receiving fund in each financial year to send at LGED headquarters for approval. Step should be taken for implementation after the approval. LCS management guidelines should be followed for the LCS formation and payments.

150. Moreover, relating to the LCS formation the section number 69 in the LCS management guidelines will be considered as corrected according to the subsection 18.6.1 in the present guidelines.

151. WMCA and LGED jointly implement the subproject operation and maintenance works. The maintenance of structure has to be implemented following the Public Procurement Regulations 2008 through contractor and LCS. The total earthworks have to be carried out by LCS. However, the structure maintenance can be implemented by LCS if the cost limits within Taka 500,000 as mentioned in subsection 18.6.1. For works costing above Taka 500,000 should be implemented through contractor as in the past following public procurement rule 2008.

152. Upazila Engineer will discuss concerned WMCA members for the preparation of a realistic estimate to implement the work as described in 18.6.1 above through LCS. The estimate has to be sent to district Executive Engineer. The Executive Engineer will thoroughly review the estimate for approval and will send to zonal Superintending Engineer for approval.

153. The general maintenance works have to be completed within May. Only turfing work can be carried out between May end to mid-June so that grass can grow well from the rainfall. WMCA O&M committee will oversee the maintenance works and on behalf of LGED Upazila Engineer, Upazila Assistant Engineer, Upazila Sub-Assistant Engineer/CS and technical person engaged in Small Scale Water Resources Project will directly be involved in this activity. District Socio-economist and those involved in institutional development work in district and upazila (CPO, Socio-economist, CA/ Facilitator) be involved for the monitoring of this work.

154. It can be mentioned here that after handing-over, WMCA will carry out the joint inspection with LGED twice in a year (before and after the rainy season). Later WMCA with its own initiative will inspect structure twice in a year and send a report on it to the IWRM. The specified format for this inspection has to be sent to every WMCA from IWRM Unit. WMCA can take help from LGED field level officials for this work.

155. Progress report: The report on the progress this work should be sent within fifth day of each month.

156. Upazila Engineer shall be fully responsible for the satisfactory progress of work maintaining the quality of all works at upazila level. Executive Engineer will regularly supervise the maintenance activities in the district and ensure proper implementation of this program. LGED zonal Superintending Engineer will review the progress and implementation quality. He will provide necessary instruction at the field level.

157. Completion of work: The entire work should be completed before 30 April. In consideration with this a work plan should be sent to IWRM Unit with operation and maintenance plan for the implementation of this work.

1.37 Quality control of maintenance work

158. Especial attention should be given to the quality control of maintenance work. If there is any negligence in maintaining quality the concerned officer/staff will be responsible for it. Use of hammer for the compaction of earth works on embankment and in the rehabilitation of embankment with 15 mm layers should be observed at the field level and the result should be known with laboratory test. Bill should not be paid if the work is found to be unsatisfactory. O&M committee will supervise the work on behalf of WMCA for quality control and complain to LGED if necessary. In this regard, the booklet on "Role of subproject construction monitoring committee" (2010), published by Integrated Water Management Unit should be followed.

1.38 Bill preparation and payment

a) In case of regular Maintenance:

159. The offices at Upazila level will record the work implemented under WMCA in MB (measurement book) specified by the government and accordingly prepare bill and submit to the Upazila Engineer's office with the signature by WMCA chairman/ secretary and operation and maintenance committee chairman/secretary for the payment of bill. Upazila Engineer will check the bill according to the rules and pay it. The bill should be paid through bank check jointly signed by WMCA chairman and secretary from the bank account operated in the name of "Operation and Maintenance Fund". All records regarding quantity of works and bill will be preserved by WMCA for audit.

b) In case of emergency and periodic maintenance:

160. Bill for periodic and emergency maintenance to be prepared after joint inspection by WMCA and official in-charge in Upazila level, will entered in Govt. measurement book (MB), will prepared the bill in bill form and will send to Upazila Engineer with recommendation. Upazila Engineer/Assistant Upazila Engineer will review and examine the bill as per rules and regulation and will send to Executive Engineer with recommendation who after scrutiny and review will arrange for payment.

Subproject handover process

1.39 Handover process of subprojects implemented under SSWRD Projects

161. It can be mentioned that participation of beneficiary people is the characteristic of the Small Scale Water Resources Development Project. Because the ownership for the use of completed subprojects is handed over to the beneficiaries and beneficiary people take the responsibility for subproject maintenance. Thus, on principle the matter of subproject handover process should be undertaken on the basis of participation (Exhibit G8-9). The process which to be followed to handover the subprojects implemented under the Small Scale Water Resources Development Project is described below.

A. Completion of subproject construction works and joint inspection

162. As soon as Contractor completes construction of all works of the subproject, Executive Engineer will undertake a joint inspection of the subproject with Upazila Engineer, Project Consultants, Management Committee of WMCA including Construction Monitoring Committee and O&M Subcommittee and the Contractor. The joint inspection will particularly focus on construction of hydraulic structures and their gates – their easy and flawless lifting and closing and leak-proof water sealing and appropriate painting, greasing, etc. For hydraulic structures, if defects/outstanding works are such that the structures cannot be put to immediate use due to those, the defects/outstanding works shall be grouped as "immediate rectification works" and must be rectified by the Contractor immediately making the structures fully fit-for-use. Dates for completion of these rectifications will be agreed and recorded in the inspection report. Any other defects/ outstanding works to be rectified in the maintenance (defects liability) period shall also be identified and their committed dates of rectification, decided based on functioning of the structures, shall be mentioned in the joint inspection report.

163. The Contractor will undertake the required "immediate rectification works" first and complete them within the specified dates. These works will again be inspected and if found properly done, the works can be considered substantially complete and the handover process will be undertaken.

B. Handover ceremony

164. The subproject handover process should be completed in a public-function. WMCA will be the organizer of this function. LGED will provide all support to the WMCA. The Deputy Commissioner / Zonal Superintending Engineer, LGED/ /Upazila Chairman/ Upazila Nirbahi Officer or any other respected elite person can be invited as chief guest in this function. In addition, the district and upazila officers of agriculture, cooperative, fisheries, land administration, Water Development Board and other government agencies should be invited. WMCA will ensure all arrangement so that the WMCA general members can participate in the public-function spontaneously. The program of the function as usual should be informed to the project headquarter.

165. Purpose of SSWRD projects in general, description and objectives of the subproject, procedure of O&M and purpose of the handover agreement will be disseminated in the meeting and the handover deed will be signed in the meeting in public..

C. Joint O&M

166. The 1-year LGED-WMCA joint O&M of the subproject will commence from the date of hand over of the subproject to the WMCA. For this, Executive Engineer will circulate a notification about the joint operation and maintenance. In this notification he will clearly describe the specific responsibilities of Upazila Engineer and WMCA operation and maintenance sub-committee and mention when the tenure of joint operation and maintenance will end. The Upazila Engineer's responsibilities will include arranging training for the operation and maintenance sub-committee, preparation of operation and maintenance budget and fund collection.

167. The main activities of the joint O&M period are as follow:

- Training of O&M sub-committee on operation and maintenance by LGED.
- Inspect infrastructure jointly and prepared operation and maintenance plan.
- Start joint operation and maintenance and rectify all the infrastructure faults.
- Opening of joint operation and maintenance account (Operating Account) and collection of fund from various sources.

- O&M Subcommittee prepare for undertaking O&M responsibilities by themselves
- Contractor performs all defects liability maintenance during this period.

Responsibilities of different local governments in subproject O&M

168. Different bodies are involved in the implementation of operation and maintenance activities of subproject infrastructure in various ways. Although the main responsibilities with the beneficiaries. Still many individuals/groups/organizations have numerous responsibilities to provide technical, financial, management and related supports. In fact it is not that other works will not be implemented by the concerned individual/bodies beyond those described here. The responsibilities of the concerns' are separately described below.

1.40 LGED

169. LGED will provide all the technical supports and guidance in subproject operation and maintenance. The extent of responsibilities of the officer and staff at district and upazila levels involved in subproject operation and maintenance are given below.

170. Superintending Engineer (Region): By optimum utilization of water resource to increase agriculture and fish production and thereby with an aim to socio-economic development O&M aspect of SSWRDP, duties of Superintending Engineer is as follows:

- Monitoring of O&M of Small Scale Water Resources Subproject and activities of WMCA.
- Review the priority list as received from district and prepare a priority list for onward transmission to IWRMU
- Each year from list of subprojects finally selected by IWRMU for O&M, approval of estimate and implementation to be awarded costing less than Tk. 10 lac.
- Estimates which cost over Tk. 10 lac to be send to IWRMU for approval.
- To review the O&M activities in monthly meeting and provide proper guidance to Executive Engineer and Upazila Engineer in this regard.
- To monitor that in O&M activities environment, gender development, climate change, national water policy and guidelines of participatory water management are followed.
- Provide guidance and collect information whether handed over of SPs and O&M activities of handed over subprojects being monitored properly by district and upazila officials.
- To ensure that annual O&M activities are being completed as per plan and report of progress and other related issues to IWRMU unit.
- To ensure the quality of works and inspects at lest 10% of works and submit the report to IWRMU
- To resolve the conflicts in O&M activities.

171. **Executive Engineer**: According to the Project arrangements overall responsibilities related to operation and maintenance rest with Executive Engineer. The responsibilities of Executive Engineer for the operation and maintenance activities in general will be as follow:

- Each year to prepare a priority list for maintenance works from Grading list and other related information sent by Upazila offices and will ensure to send list to Zonal Superintending Engineer office with recommendation.
- Ensure to send the maintenance plan and estimate prepares as per O&M Guidelines to Zonal Office.

- Ensure quality of maintenance works and examine measurement of at least 15% of works.
- To co-ordinate all works regarding O&M.
- To ensure that WMCA/O&M sub-committees to receive technical guideline from LGED.
- To provide advice to Upazila Engineer/Project Staff regarding O&M work.
- Monitor all works of O&M under his district and send monthly report to Head Quarter with overall evaluation of the work and provide necessary recommendation.
- Take initiative in Hand over of sub-projects. In this regard will give necessary advice to Upazila Engineer.
- To take step of cooperation from other agency in the field of operation and maintenance work.
- To ensure that all works are being done following the O&M Guidelines published from IWRMU

172. **Senior Assistant Engineer:** Planning implementation and operation and maintenance program is carried out with the technical mater of all subproject activities in consideration with socio-economic, agriculture, environment, fisheries and other matters. In the context of implementation of operation & maintenance activities duties and responsibilities of Senior Assistant Engineer are as follows:

- To assist Executive Engineer to prepare list of priority subproject as per plan of the district.
- To ensure quality of works examine at list 25 percent of works.
- To assist Executive Engineer to monitor O&M works of Upazila Engineers.
- To provide technical Assistance and advise WMCA/O&M Sub-committee.
- To take instigative and assist Upazila Engineer if required.
- To ensure use of O&M guideline in O&M activities.
- To co-ordinate each year after monsoon for measurement of the volume of subproject maintenance works, prepare estimate and co-ordinate implementation works as per plan.
- To give proper guidance for O&M works as per plan and carefully monitor quality of works.
- To monitor O&M works to take initiative for sending to head quarter.
- To ensure works in O&M works socio-economic, climate change, gender and development aspect are been followed.
- Arrange training for the person (operator) responsible for O&M and provide technical guidance and assists in this matter if any problems arise.

173. **Assistant Engineer:** For O&M activities for Small Scale Water Resources subproject duties of Assistant Engineer, in District Executive Engineer LGED is as follows:

- To assist in planning and O&M activities considering Socio-economic, Agriculture, Environment, Fishery and Climate Change aspects.
- Following O&M Guidelines to select Subprojects for maintenance activities.
- To co-ordinate in each year following monsoon measurement of the volume of subproject maintenance work, preparation of estimate and implementation works.

- To ensure quality of maintenance works of different schemes.
- To assist in handover process of subprojects.
- To assist in WMCA and other project officials for preparing monthly report and inform Executive Engineer in this regards.
- To attend in different meetings regarding O&M issues and provide advice in technical matters and assist in O&M activities.
- Arrange training for the person (operator) responsible for operation and maintenance and provide technical guidelines and assist in this matter.
- To ensure quality of works and examine at least 25% of works in field.
- Collection of data and information regarding O&M, prepare data base and management of the same.
- To provide technical guidelines to WMCA as and when required.

174. **Sociologist/Socio-economist**: The Project Socio-economist at district level is responsible for overall socio-economic activities in the subproject. His major responsibilities on subproject operation and maintenance in particular are described below:

- To Ensure that Socio-economic activities in consider in O&M works;
- Take overall initiative to assist beneficiaries about the formation of subproject WMCA/sub-committee/village committee;
- Arrange training for WMCA//sub-committee and participate as trainer;
- Integration of activities related to preparation of subproject beneficiary map and beneficiary list;
- Integration of activities related to fund collection from the beneficiaries for the operation and maintenance provide necessary guidance to the committee responsible for this activities;
- Integration of activities of the Facilitators responsible operation and maintenance works and accordingly provide necessary guidance/assistance;
- Take necessary step for strengthening of operation and maintenance activities as well as subproject socio-economic activities; and
- Preparation of monthly report regularly collecting information regarding O&M activities from Upazila levels.

175. **Upazila Engineer:** Upazila Engineer will involve himself in all activities related to O&M of subprojects. Duties of Upazila Engineer in brief will be:

- Ensure that for O&M the prescribed grading format field up with information will be sent to Executive Engineer office in due time.
- To coordinate in technical aspect in planning, design, implementation and O&M activities of Small Scale Water Resources subprojects.
- To assist technical aspect regarding O&M to concern WMCA/O&M sub-committee.
- To provide proper guidance to Sub-Assistant Engineer, Surveyor and Community Organizer regarding O&M activities.
- To Ensure quality of works and examine measurement of at least 50% of works.
- To take initiative in handing over of subproject in ceremonial manner and coordinate with XEN regarding the same.

- To implement the O&M works as per instruction from District Executive Engineer, Zonal Superintending Engineer and Head Office.
- To ensure that in O&M works socio-economic, climate change, Gender and Development aspects are followed:
- Provide necessary direction and assistance to the project's other officials/staff and integrate their works.

176. **Upazila Assistant Engineer:** In consideration with subproject operation and maintenance and other technical matters and assistance to the subproject works the responsibilities are as follow:

- Measurement of the volume of maintenance works of subproject infrastructure after the rainy season each year, preparation of estimate and provide assistance in implementation;
- to coordinate with Upazila Engineer for maintenance each year;
- To maintain the quality control of works and check measurement of at least 50% of works.
- Assist in quality control of subproject operation and maintenance works;
- Guidance to the WMCA/sub-committee on the subproject operation and maintenance;
- Assist WMCA and Project's other officials in preparing monthly report including other;
- Assist Upazila engineer in taking initiative to handover the subproject;
- Attend meeting at various level on matters related to operation and maintenance and provide guidance and assistance on technical and institutional matters;
- Take initiative for the execution of necessary instructions as given by the Executive Engineer and headquarters;
- Provide training to the person responsible for operation of regulator/sluice gate and necessary step to resolve any technical problem when arises; and
- Provide necessary directions and assistance on this to the Project's other official/staff and integrate their works.

177. **Sub-Assistant Engineer**: The duties of the Sub-Assistant Engineer at Upazila Engineer office are as follow:

- With the involvement of subproject activities supply of all types of engineering data and survey such as plane table, geodetic, and leveling information;
- Attend sub-soil boring and supply underground water level and land elevation data;
- Clear conception about structural design and to maintain quality of work, supervise implementation works. This supervision is also applicable for earthworks;
- Involvement with technical matter of operation and maintenance and provide assistance to the WMCA in the implementation of such work;
- Provide technical instruction in consultation with Upazila Engineer to the WMCA if any problem arises on the operation and maintenance;
- Ensure soil compaction of flood control embankment in order to maintain 90% dry density;

- Ensure dressing and turfing on the side slopes of the flood control embankment;
- Assist Upazila Engineer according to his instruction in resolving any problem related to subproject.
- Ensure quality control of the work ensure entering measurement book of works completed and prepare bill and submit to Upazila Engineer.
- To collect all information regarding O&M in database.

178. **Community Organizer:** Community Organizer at Upazila level is responsible for providing support to socio-economic activities in various projects of LGED. To perform all activities regarding O&M, the Community Organizer will have following responsibilities:

- With Project's other official ensure formation of WMCA/sub-committee/village committee and provide necessary support according to the plan;
- Preparation of beneficiaries list and take initiative for the collection of operation and maintenance fund;
- Ensure communication between officer/staff at Upazila level and subproject WMCA and other committee to provide support on operation and maintenance activities;
- Initially as an observer attend the training courses on operation and maintenance for WMCA/sub-committee/village committee and later participate as a trainer;
- Assist Project's other officials in the preparation of monthly report and later participate to implement those activities on own initiative.
- Preparation of regular report on operation and maintenance;
- Motivation and inspiration of beneficiaries for the collection of operation and maintenance fund including providing of necessary suggestions;
- Assist in resolution of conflict among the WMCA/sub-committee/village committee;
- Preparation of regular (monthly) report on the operation and maintenance;
- Identification of problem/limitation and so on and preparation of necessary and potential recommendations; and
- Assist WMCA/committee in preparing subproject beneficiaries map and list.
- Assist in the preparation of household list in subproject area, preparation of list of beneficiaries and affected person and co-ordinate in arranging meeting in village or para for raising awareness on O&M.
- To help WMCA in all respect for signing implementation agreement.
- During implementation to help WMCA/LGED in forming LCS groups.
- After completion of infrastructure assist in capacity development of WMCA for O&M activities before & after handover.
- Monitoring of WMCA office and accounting activities.
- To assist increasing share & saving of WMCA.
- To ensure holding of weekly meeting and monthly meeting of Management committee.
- To monitor the micro-credit activities of WMCA and update the information.
- To assist WMCA in preparation of poverty reduction plan and implementation of the same.

1.41 Water Management Cooperative Association (WMCA)

179. WMCA is the authorized user right of all infrastructure constructed, re-constructed and rehabilitated by the Small Scale Water Resources Development Project. WMCA also contribute a small percentage for O&M before implementation of the subproject and play an important role in controlling quality of construction works. On the basis of implementation agreement before the beginning of project activities and ownership agreement after the completion of construction between LGED and WMCA, the latter will be responsible for the operation and maintenance of infrastructure.

180. The main objective of the WMCA is operation and maintenance and to complete it correctly. WMCA should give attention to the following for the proper operation and maintenance.

General:

- Formation of operation and maintenance sub-committee.
- Raise the O&M issue in monthly meeting as an agenda.
- Arrangement to deposit profit from micro-credit operation and the income generation activities to operation and maintenance fund.
- Responsible for sending expenditure for O&M by WMCA from its own fund and through volunteer labor.
- Contact to LGED for emergency maintenance.
- Collection of O&M fund for regular and minor emergency maintenance every year.
- Identification of sources for the collection of O&M fund.

Operation:

- Before the rainy season ensure that gate can be raised properly.
- Appointment of get operator.
- Preparation of operator calendar in water conservation subproject and operation of the gat according to the time of water requirements.
- Recording of water level during gate operation in register.
- Arrangement of meeting to resolve conflict if arises among the beneficiaries during the irrigation water supply.

Maintenance:

- Field inspection of infrastructure after and before the rainy season each year.
- Preparation of maintenance plan and budget on the basis of inspection after the rainy season.
- Identification routine and emergency works.
- Attention to the timely completion of maintenance works.
- Work as observer to check that emergency work with the use of government fund is carried out properly.
- Initiative for removing water weeds as routine activity and removal of silt with volunteer labor.
- Take initiative to arrange a special meeting on operation and maintenance.

- Presentation of details of maintenance works carried at a special meeting so that beneficiaries can be involved in operation and maintenance.
- Duties of gate operator employed by WMCA
- Ensure security of water control structure (sluice gate/regulator etc.);
- Operation of gate as decided by WMCA/ operation and maintenance sub-committee;
- Use of fallboard (where applicable) with care and store it on own responsibility;
- If structure found to be vulnerable for flooding or any other reason, inform WMCA/O&M sub-committee about it immediately and take necessary action; and
- Recording of water level.

1.42 Union Parishad

181. Union Parishad will be involved from the beginning of subproject proposal to operation and maintenance in any way. Concerned Union Parishad Chairman will play an important role on the subproject operation and maintenance activities. The major responsibilities are:

- Active participation in organizing of people for WMCA formation activities;
- Identification of conflict if arises any on structure operation and provide possible support to WMCA/sub-committee to resolve it;
- Support to the preparation of beneficiary map, beneficiaries list (collection of mauza map and all information);
- Support to collection of required contribution fund for the operation and maintenance;
- Participation in training organized by the Project;
- Allocation of fund by the Union Parishad for emergency repair;
- Communication to Upazila Development Committee and other organizations for emergency repairing and provide support about it.
- To include representative of WMCA as member of UDCC.

1.43 Upazila Parishad: Conflict resolution committee

182. If there arises any conflict between beneficiaries and affected persons on subproject operation and maintenance, the aggrieved party will first attempt to solve the matter with direct discussion between both parties. If it is not resolved through the discussion, then resolve the dispute at the Upazila Parishad according to the notification (Exhibit G8-10) issued by the Local Government Division (No. Pro:Au:-2/Pani-5/2001/418 (2347), dated: 23-04-2002 Eng).

Table 0-1: Annual maintenance Activities, duties and time-table

Sl. No.	Activities		Duties	Time-table
	All information regarding Small Scale Water Development Sub-project (Filled-up Grading Format) to be sent to Executive Engineer of concerned district		Concerned Upazila Engineer, Assistant Upazila Engineer and Sub-Assistant Engineer	Each year within 31 May
	Preparation of priority list of schemes based on data as received from Upazila and send the same to Zonal Superintending Engineer		District Executive Engineer	Each year within 30 June
	From the priority list and information as received from district preparation of maintenance requirement and priority list for sending to Superintending Engineer, O&M		Zonal Superintending Engineer	Each year within 15 July
	Reviewing the priority list as received from Zonal Superintending Engineer, IWRMU will finalize the priority list with tentative allotment of fund and send to Zonal Superintending Engineer and district Executive Engineer offices		IWRM Unit	Each year within 10 April
	As per final list Upazila Engineer will visit the subprojects and send the estimates to District Executive Engineer		Upazila Engineer	Each year within 30 September
	To review the estimates as available from Upazila Engineer and send to Zonal Superintending Engineer		District Executive Engineer	Each year within 15 October
	To review and approved the estimates (for each subprojects up to cost of Tk. 10 lac by Superintending Engineer and above Tk. 10 lac the estimate to be sent to Superintending Engineer, IWRMU		Zonal Superintending Engineer	Each year within 31 October
	Review the estimates and approved estimates above Tk. 10 lac		Superintending Engineer (O&M), IWRM Unit	Each year within 10 November
	Formation of LCS Groups		Concerned Upazila Engineer and Sub-Assistant Engineer	Each year within 15 November
	Call Tender (Where required)		District Executive Engineer	Each year within 15 November
	Contract agreement with LCS/Selected contractor		District Executive Engineer	Each year within 15 December
	Start of Works		District Executive Engineer/Upazila Engineer	Each year within 1 January
	Closing of Works	Earth Work	District Executive Engineer/Upazila Engineer	Each year within 30 April
		Pucca/Concrete Works	District Executive Engineer/Upazila Engineer	Each year within 31 May
	To send monthly progress of work to LGED Headquarter and Zonal Superintending Engineer		Executive Engineer	monthly progress of work by 5 of next month
	Regular monitoring of implementation of maintenance work and for implementation of scheme with high quality to visit scheme and provide guidance to district and upazila level		Zonal Superintending Engineer/ Additional Chief Engineer (Division)	Regularly
	To send completion report to headquarter		Executive Engineer	Each year within 10 June

Note: To verify the estimate Sub-Assistant Engineer will check 100%, Upazila Engineer/Upzaila Assistant Engineer 50%, Senior Assistant Engineer/Assistant Engineer from Executive Engineer Office 25%, Executive Engineer 15% and Zonal Superintending Engineer will visit 10% of schemes.

Operation and Maintenance Plan

The format of Operation and Maintenance Plan is shown in the Exhibit G8-13.

EXHIBIT G8-1, FORMAT-A GRADING FOR ALLOTMENT FROM "GOB FUND FOR MAINTENANCE OF IRRIGATION STRUCTURES"

Type of Subproject: Uncontrolled water flow, grading indicators

Sl. No.	Indicators	Marks	Marks Obtain	Remarks
	Institutional Grading= Total marks =30			
1.	Members of Subproject: (HH= 70% to 80%=4, 81-90%=5, above 90%=6	6		
2.	Meeting of WMCA Mangement Committee for last 12 months (If no meeting =0, 1 to 4 meetings=2 , 5-8=3, 9 or above meeting =5)	5		
3.	Capital of WMCA (Share+ Savings +Others) total: (Capital/person below 150=2,150- 300=4 above 300=7	7		
4.	Type of Mangement committee? Adhoc committee (Date expired)=0, Ad-hock=3, Elected= 6	6		
5.	Women member percentage less than 33%=0, 33 to 40%=3, above 40%=6	6		
	Total	**30**		
	O&M Grading=Total No.=70			
6.	What is the percentage of last year collected O&M Fund with respect to O&M contribution collected before implementation. (Up to 15%= 2, 16- 30%=3, and 31 or above =5)	5		
7.	Last year O&M fund collected below tk100 /member=1, 101 -200=3, 201 and above	5		
8.	In the last year for routine maintenance how many man days works have been done on voluntary basis. (Up to 10 days=2, 10-20; and above 20 days=5)	5		
9.	In routine maintenance how many days work done? Up to 10 days work=1;10to 20 days=3; 21 or above working days	5		
10.	Participation in Joint walkthrough by members of O&M in monsoon or pre-monsoon periods (Only pre-monsoon=3, Both pre and post monsoon=6)	6		
11.	Whether there is monitoring of activities of O&M and reviewed in Mangement Committee's meeting ? No=0, Yes=4	4		
12.	Whether WMCA maintains in the Register all information of maintenance works done out of WMCA fund. (No=0, Irregularly=3 (no=0,irregularly=3, regular basis=5)	5		
13.	Whether in annual meeting there is discussion about O&M Fund? (No=0, Yes=5)	5		
14.	Whether there is annual O&M Plan prepared? No=0, Yes=5	5		
15.	If there is any entrepreneur activities by WMCA, no=0,cost effective=3 and worth followed=5	5		
16.	Involvent of WMCA in routine works: a) Is there is siltation in bed Major=2, Minor=5 b) Whether there are water weeds Major=2, Minor=1 c) Whether bank of canal is well maintained? No=2, yes=5 d).Whether there is reference lined section? No=0, Yes=5	20		
	Total	**70**		

Signature :	Signature :	Signature :
Name :	Name :	Name :
Designation:	Designation:	Designation:

EXHIBIT G8-1, FORMAT-B GRADING FOR ALLOTMENT FROM "GOB FUND FOR MAINTENANCE OF IRRIGATION STRUCTURES"

Type of Subproject: Controlled water flow, grading indicators

Sl. No.	Indicators	Marks	Marks Obtain	Remarks
	Institutional Grading= Total marks =30			
1.	Members of Subproject: (HH= 70% to 80%=4, 81-90%=5, above 90%=6	6		
2.	Meeting of WMCA Mangement committee for last 12 months (If no meeting =0, 1 to 4 meetings=2 , 5-8=3, 9 or above meeting =5)	5		
3.	Capital of WMCA (Share+ Savings +Others) total: (Capital/person below 150=2,150- 300=4 above 300=7	7		
4.	Type of Mangement committee? Adhoc committee (Date expired)=0, Ad-hock=3, Elected= 6	6		
5.	Women member percentage less than 33%=0, 33 to 40%=3, above 40%=6	6		
	Total	**30**		
	O&M Grading=Total No.=70			
6.	What is the percentage of last year collected O&M Fund with respect to O&M contribution collected before implementation. (Up to 15%= 2, 16- 30%=3, and 31 or above =5)	5		
7.	Last year O&M fund collected below tk100 /member=1, 101 -200=3, 201 and above	5		
8.	In the last year for routine maintenance how many man days works have been done on voluntary basis. (Up to 10 days=2, 10-20; and above 20 days=5)	5		
9.	In routine maintenance how many days work done? Up to 10 days work=1;10to 20 days=3; 21 or above working days	5		
10	Participation in Joint walkthrough by members of O&M in monsoon or pre-monsoon periods (Only pre-monsoon=3, Both pre and post monsoon=6)	6		
11.	Whether there is monitoring of activities of O&M and reviewed in Management Committee's meeting ? No=0, Yes=4	4		
12.	Whether WMCA maintains in the Register all information of maintenance works done out of WMCA fund. (No=0, Irregularly=3 (no=0,irregularly=3, regular basis=5)	5		
13.	Whether in annual meeting there is discussion about O&M Fund? (No=0, Yes=5)	5		
14.	Whether there is annual O&M Plan prepared? No=0, Yes=5	5		
15.	If there is any entrepreneur activities by WMCA, no=0,cost effective=3 and worth followed=5	5		
16,	Involvent of WMCA in routine works: a) Is there is siltation in bed Major=1, Minor=3 b) Whether there are water weedsMajor=1, Minor=3 c)Whether there is rain cuts embankment ? Yes=0., No=3, yes d).Whether weeds from embankment cleared? No=0, Yes=3 e).Is there reference lined section in bed : No=0, Yes=3 f). Whether hoist system is properly greased? N0=0, Yes=3 g). Whether water level gauges are painted? No=0, Yes=2.	20		
	Total	**70**		

Signature :	Signature :	Signature :
Name :	Name :	Name :
Designation:	Designation:	Designation:

EXHIBIT G8-1, FORMAT-C GRADING FOR ALLOTMENT FROM "GOB FUND FOR MAINTENANCE OF IRRIGATION STRUCTURES"

Type of Subproject: Underground pipe irrigation supply, grading indicators

Sl. No.	Indicators	Marks	Marks Obtain	Remarks
	Institutional Grading= Total marks =30			
1.	Members of Subproject: (HH= 70% to 80%=4, 81-90%=5, above 90%=6	6		
2.	Meeting of WMCA Management committee for last 12 months (If no meeting =0, 1 to 4 meetings=2 , 5-8=3, 9 or above meeting =5)	5		
3.	Capital of WMCA (Share+ Savings +Others) total: (Capital/person below 150=2,150- 300=4 above 300=7	7		
4.	Type of Mangement committee? Adhoc committee (Date expired)=0, Ad-hock=3, Elected= 6	6		
5.	Women member percentage less than 33%=0, 33 to 40%=3, above 40%=6	6		
	Total	**30**		
	O&M Grading=Total No.=70			
6.	What is the percentage of last year collected O&M Fund with respect to O&M contribution collected before implementation. (Up to 15%= 2, 16- 30%=3, and 31 or above =5)	5		
7.	Last year O&M fund collected below tk100 /member=1, 101 -200=3, 201 and above	5		
8.	In the last year for routine maintenance how many man days works have been done on voluntary basis. (Up to 10 days=2, 10-20; and above 20 days=5)	5		
9.	In routine maintenance how many days work done? Up to 10 days work=1;10to 20 days=3; 21 or above working days	5		
10	Participation in Joint walkthrough by members of O&M in monsoon or pre-monsoon periods (Only pre-monsoon=3, Both pre and post monsoon=6)	6		
11.	Whether there is monitoring of activities of O&M and reviewed in Management Committee's meeting ? No=0, Yes=4	4		
12.	Whether WMCA maintains in the Register all information of maintenance works done out of WMCA fund. (No=0, Irregularly=3 (no=0,irregularly=3, regular basis=5)	5		
13.	Whether in annual meeting there is discussion about O&M Fund? (No=0, Yes=5)	5		
14.	Whether there is annual O&M Plan prepared? No=0, Yes=5	5		
15.	If there is any entrepreneur activities by WMCA, no=0,cost effective=3 and worth followed=5	5		
16,	Involvent of WMCA in routine works: a) Condition of Pumping Equipments: Medium=2, Good=4 b) Whether WMCA has own Pump No=0, Yes=4 c)Whether alternate arrangements for power; No=0, Yes=4 d) Is there is tempering of Alfalfa Valve? Yes=0, No=.2 e). Condition of field channel Bad=2. Good=6	20		
	Total	**70**		

Signature :	Signature :	Signature :
Name :	Name :	Name :
Designation:	Designation:	Designation:

EXHIBIT G8-2, FORMAT-A WATER DRAINAGE/CONSERVATION KHAL MAINTENANCE FORMAT

Subproject name: SP No.: Name of khal: Place: Date:

Date of Inspection	Observed part Start .....End	Damaged part	Description of Damage	Description of maintenance works	Quantity of work (cubic meter/ square meter)	Rate	Cost (Tk) (6×7)	Date of maintenance work completion
1	2	3	4	5	6	7	8	9
				Total				

For WMCA (Chairman/Secretary)
Signature :
Name :
Designation:

For LGED
1. Signature :
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature :
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-2, FORMAT-B FLOOD EMBANKMENT MAINTENANCE FORMAT

Subproject name: SP No.: Name of khal: Place: Date:

Date of Inspection	Observed part Start .....End	Damaged part	Description of damage	Description of maintenance works	Quantity of work (cubic meter/ square meter)	Rate (cubic meter)	Grass plantation Turfing (square meter)	Rate (square meter)	Cost (Tk) (6 ×7+8×9)	Date of work completion
1	2	3	4	5	6	7	8	9	10	11
				Total						

For WMCA (Chairman/Secretary)

Signature :
Name :
Designation:

For LGED

1. Signature :
   Name :
   Designation: Sub-Assistant Engineer (Seal)

2. Signature :
   Name :
   Designation: Upazila Engineer (Seal)

EXHIBIT G8-2, FORMAT-C WATER CONTROL STRUCTURE MAINTENANCE FORMAT

Subproject name: SP No.: Name of khal: Place: Date:

Date of Inspection	Name and size of observed structure	Description of damage	Description of maintenance works	Rate	Cost (Tk)	Date of completion of maintenance works
1	2	3	4	5	6	7
			Total			

For WMCA (Chairman/Secretary)
Signature :
Name :
Designation:

For LGED
1. Signature :
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature :
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-2, FORMAT-D WATER DISTRIBUTION PIPE LINE AND PIPE SYSTEM STRUCTURE MAINTENANCE FORMAT

(uPVC pipe line☐/Concrete pipe line ☐/ Header Tank ☐/ Riser ☐/ Escape ☐/ Washout ☐

Subproject name: SP No.: Upazila: District: Date:

Item	Date of Inspection	Name of structure & size	Description of Damage	Description of maintenance works	Quantity of work (cubic meter/ square meter)	Rate	Cost (Tk) (6×7)	Date of maintenance work completion
1	2	3	4	5	6	7	8	9
uPVC pipe line								
Concrete pipe line								
Header Tank								
Riser								
Escape								
Washout								
					Total			

For WMCA (Chairman/Secretary)
Signature :
Name :
Designation:

For LGED
1. Signature :
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature :
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-2, FORMAT-E REFERENCE LINED SECTION MAINTENANCE FORMAT

Subproject name: SP No.: Upazila: District: Date:

Date of Inspection	Name of Khal & Location of Lined Section	Description of Damage	Description of maintenance works	Quantities of Works (cubic meter/sq meter)	Rate	Cost (Tk) (5x6) or LS	Date of completion of maintenance works
1	2	3	4	5	6	7	8
Total							

For WMCA (Chairman/Secretary)
Signature:
Name :
Designation:

For LGED
1. Signature:
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature:
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-2, FORMAT-F WMCA OFFICE MAINTENANCE FORMAT

Subproject name: SP No.: Location: Upazila: District:

Date of Inspection	Description of damage	Description of maintenance works	Quantities of Works (cubic meter/sq meter)	Rate	Cost (Tk) (4x5) or LS	Date of completion of maintenance works
1	2	3	4	5	6	7
Total						

For WMCA (Chairman/Secretary)
Signature:
Name :
Designation:

For LGED
1. Signature:
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature:
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-3 ESTIMATE OF MAINTENANCE WORKS AND BUDGET PREPARATION FORMAT

(Khal/Embankment/Structure/CAD)

Upazila: District: Date:

Subproject Name: SP No.:

Sl. No.	Structure	Type of work	Unit	Quantity	Rate	Estimated cost	Routine	Periodic	Emergency
1	Khal	Cleaning of silt	M^3						
		Cleaning of aquatic plants	M^2						
		Other	-						
2	Embankment	Earth work	M^3						
		Turfing	M^2						
		Other	-						
3	Structure (Regulator, sluice, water conservation structure)	Gate paining	LS						
		Greasing	LS						
		Replacement of protective blocks	LS						
		Replacement of rubber seal							
4	CAD								
	Water supply pipe line	Earthwork	M^3						
		Repair of Leackage	LS						
	Header Tank	Cleaning	LS						
		Repair of Regulating Gates	LS						
	Riser	Repair of Alfafal Valve/Change	LS						
	Escape	Repair if needed	LS						
	Washout	Repair if needed	LS						
5.	WMCA Office	Painting of Wall	LS						
		Repair of door, window & painting	LS						
6.	Reference Lined Section	Siltation							
		Replacement of side slope brick/settlement of bricks							
7.	Others								
Total									

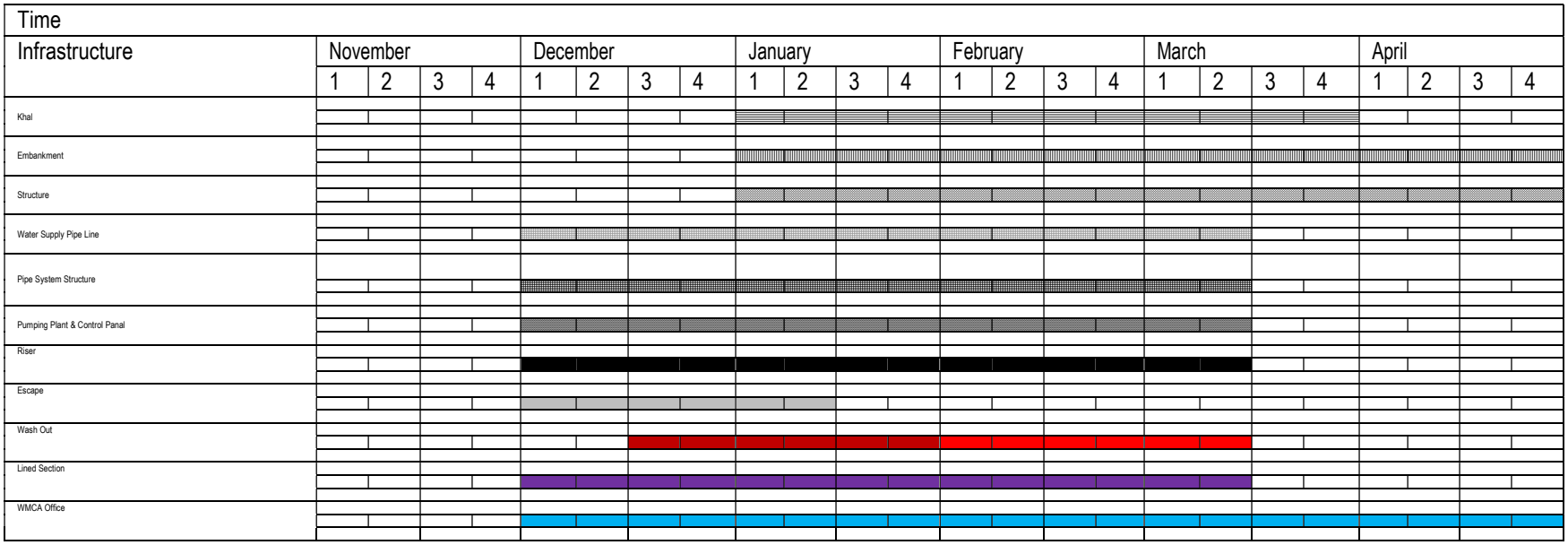
For WMCA (Chairman/Secretary)
Signature:
Name :
Designation:

For LGED
1. Signature:
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature:
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-4 MAINTENANCE WORKS IMPLEMENTATION PROGRAM

Subproject Name: SP No.: Upazila: District: Date:



	Khal Maintenance		Riser Maintenance
	Embankment Maintenance		Escape Maintenance
	Structure Maintenance		Washout Maintenance
	Water Supply Pipe Line Maintenance		Lined Section Maintenance
	Pipe System Structure Maintenance		WMCA Office Maintenance
	Pumping Plant & Control Panal Maintenance		

All maintenance works should be completed within 30 April.

For WMCA (Chairman/Secretary)
Signature:
Name:
Designation:

For LGED
1. Signature:
Name:
Designation: Sub-Assistant Engineer (Seal)

2. Signature:
Name:
Designation: Upazila Engineer (Seal)

EXHIBIT G8-5 BENEFICIARIES' LIST PREPARATION FORMAT

Subproject Name: Upazila:

Subproject No.: District:

SL. No.	Name of beneficiary	Father's & Mother's name	Village	Union	Area of land within subproject (acre)					Comment
					High	Medium	Low	Not cultivated (pond, forest, etc.)	Total	
Total										

For WMCA (Chairman/Secretary)
Signature:
Name :
Designation:

For LGED
1. Signature :
Name :
Designation: Sub-Assistant Engineer (Seal)

2. Signature :
Name :
Designation: Upazila Engineer (Seal)

EXHIBIT G8-6 SUBPROJECT OPERATION CALENDAR

(Water Conservation and Drainage)

Subproject Name: Subproject No.:

Name of structure: Year:

Month		Cropping Pattern	Vertical Gate		Purpose	Water level (m)		Remarks
English	Bangla		Open	Close		SP side	River side	
Mid April-Mid May	Baishak				Drainage for harvesting			
Mid May-Mid June	Jaishta				Entry of natural fish fingerlings			
Mid June-Mid July	Ashar	T Aman			Irrigation for Transplantation of Aman crops			The gate should be opened time to time to drain the water depending on the rain condition
Mid July-Mid August	Shrabon				Drainage			
Mid August-Mid September	Bhadra				Water conservation for Supplementary Irrigation to T Aman Crops			The gate should be opened time to time to drain the water depending on the rain condition
Mid September-Mid October	Ashwin							
Mid October-Mid November	Kartik							
Mid November-Mid December	Agrahayan				Water conservation for Boro cultivation			The gate should be opened time to time to drain the water depending on the rain condition
Mid December-Mid January	Poush	HYV Boro						
Mid January-Mid February	Magh							
Mid February-Mid March	Falgun							
Mid March-Mid April	Chaitra							

EXHIBIT G8-7 SUBPROJECT OPERATION CALENDAR

(Flood Management, Drainage and Water Conservation)

Subproject Name: Subproject No.:

Name of structure: Year:

Month		Major Cropping Pattern	Flap Gate		Vertical Gate		Purpose	Water level (m)		Remarks
English	Bangla		Normal/ Lifted	Close	Open	Close		SP side	River side	
Mid April-Mid May	Baishak						Drainage			Flap gate is normal Vertical gate is opened
Mid May-Mid June	Jaishta						Entry of natural fish fingerlings			Flap gate is lifted Vertical gate is opened
Mid June-Mid July	Ashar						Flood control & Drainage			Flap gate is normal Vertical gate is opened
Mid July-Mid August	Shrabon									
Mid August-Mid September	Bhadra	T Aman								
Mid September-Mid October	Ashwin						Water conservation for Boro cultivation			Flap gate is normal Vertical gate is closed The gate should be opened time to time to drain the water depending on the rain condition
Mid October-Mid November	Kartik									
Mid November-Mid December	Agrahayan									
Mid December-Mid January	Poush									
Mid January-Mid February	Magh	Boro								
Mid February-Mid March	Falgun									
Mid March-Mid April	Chaitra									

Exhibit G8-8 Fund collection with the own initiative by WMCA and Format of annual accounts of operation and maintenance expenditure

(1 July 30 June)

1. Fund collection

Sl No.	Source	Rate	Total collection
(a)	Additional charge with monthly fees		
(b)	Collection of produce in crop season		
(c)	Collection from fisheries		
(d)	Profit earned micro credit		
(e)	Other sector		
Collection Taka			

Balance in last year Total Collection=

2. Maintenance Works

A) Removal of Silt

Sl No.	Name of khal and length	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				
2.				
3.				
4.				

B) Cleaning of hyacinth

Sl No.	Name of khal and length	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				
2.				
3.				
4.				

C) Embankment rehabilitation

Sl No.	Name of embankment and length	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				
2.				
3.				
4.				

D) Grass plantation on embankment slopes

Sl No.	Name of embankment and length	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

E) Gate painting

Sl No.	Name of structure and number	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

F) Gate repairing

Sl No.	Name of structure and number	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

G) Gate greasing

Sl No.	Name of structure and number	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

H) Repairing or replacement of rubber seal

Sl No.	Name of structure and number	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

I) Gauge marking and painting

Sl No.	Name of structure and number	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

J) Block making and placement

Sl No.	Name of structure and Volume of Works	Expenditure form own fund	Volunteer (Tk)	Total expenditure
1.				

For WMCA (Chairman/Secretary)

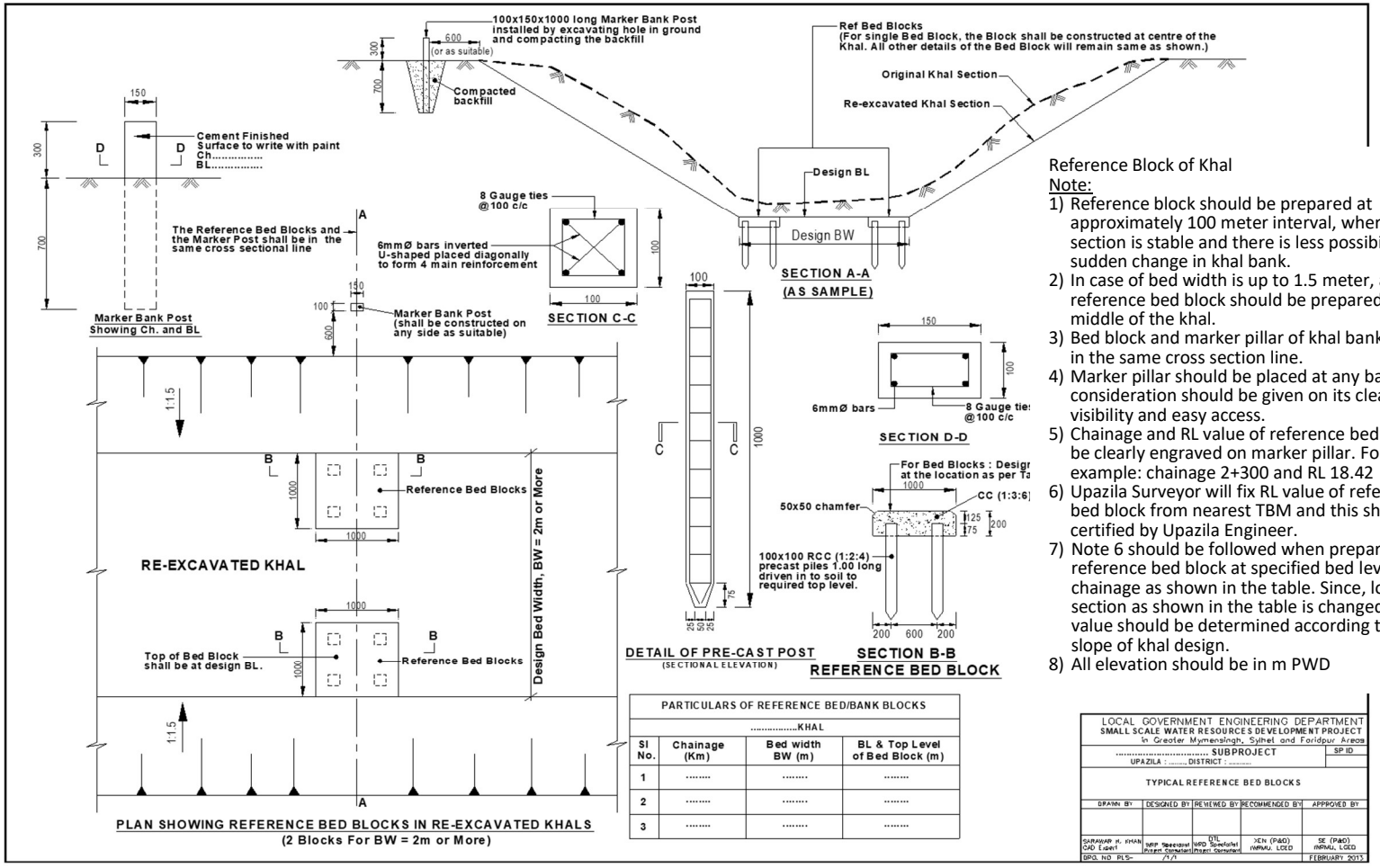
Signature :
Name :
Designation:

For LGED

1. Signature :
   Name :
   Designation: Sub-Assistant Engineer
   (Seal)

2. Signature :
   Name :
   Designation: Upazila Engineer
   (Seal)

EXHIBIT G8-8A REFERENCE LINED SECTION



PARTICULARS OF REFERENCE BED/BANK BLOCKS			
.....KHAL			
Sl No.	Chainage (Km)	Bed width BW (m)	BL & Top Level of Bed Block (m)
1	.....	.....	.....
2	.....	.....	.....
3	.....	.....	.....

Reference Block of Khal

Note:

1) Reference block should be prepared at approximately 100 meter interval, where khal section is stable and there is less possibility of sudden change in khal bank.
2) In case of bed width is up to 1.5 meter, a reference bed block should be prepared at the middle of the khal.
3) Bed block and marker pillar of khal bank should in the same cross section line.
4) Marker pillar should be placed at any bank, but consideration should be given on its clear visibility and easy access.
5) Chainage and RL value of reference bed should be clearly engraved on marker pillar. For example: chainage 2+300 and RL 18.42
6) Upazila Surveyor will fix RL value of reference bed block from nearest TBM and this should be certified by Upazila Engineer.
7) Note 6 should be followed when preparing reference bed block at specified bed level of chainage as shown in the table. Since, location of section as shown in the table is changed, RL value should be determined according to long slope of khal design.
8) All elevation should be in m PWD

LOCAL GOVERNMENT ENGINEERING DEPARTMENT SMALL SCALE WATER RESOURCES DEVELOPMENT PROJECT in Greater Mymensingh, Sylhet and Faridpur Areas				
..... SUBPROJECT UPAZILA : ..... DISTRICT :				SP ID
TYPICAL REFERENCE BED BLOCKS				
DRAWN BY	DESIGNED BY	REVIEWED BY	RECOMMENDED BY	APPROVED BY
SARWAR H. KHAN CAD Expert	WRP Specialist (Project Consultant)	(T) WRD Specialist (Project Consultant)	>EN (P&O) MMMU, LGED	SE (P&O) MMMU, LGED
DRG. NO PLS-	/1/1			FEBRUARY 2013

EXHIBIT G8-9 HANDOVER AGREEMENT

HANDOVER AGREEMENT

This…… SUBPROJECT IMPLEMENTATION AGREEMENT is made on the ……. day of ……. 140……. Bengali/ …… 200……AD between the following two parties.

Local Government Engineering Department (hereinafter referred to as "LGED") represented in this AGREEMENT by the Executive Engineer by virtue of his office (he himself or any other officer in his place or any entrusted person or whichever when applicable) hereinafter called the person to handover of the first party

-and-

……Water Management Cooperative Association (WMCA) under the district of ……..Upazila……..Union…….represented in this AGREEMENT by the Chairman of WMCA Executive Committee by virtue of his office (he himself or any entrusted person or person in his position or whichever when applicable) hereinafter called the receiver of the second party

Whereas, LGED is responsible for the development and management of physical infrastructure through the Small Scale Water Resources Development Sector Project;

Whereas, LGED with its engineering skill and experiences has completed physical structures as described in schedule-2 in the subproject as described in schedule-1;

Whereas, local people as well as subproject beneficiaries organized under a WMCA and deposited Taka…….. in bank account for the maintenance of infrastructure as constructed under the subproject and agreed for the management, operation and maintenance of the constructed infrastructure;

NOW, THEREFORE, for the handover of the physical infrastructure constructed under the subproject as stated mutually agree to sign the agreement in consideration of the clauses as follows:

Duties and responsibilities of LGED

Artcle-1 The first party will handover all physical infrastructure of the subproject to the second party as included in this deed and according to the attached schedules 1, 2, and 3 for the use by WMCA members,

Article- 2 The first party will organize training courses for the WMCA Management Committee members and later for the operation and maintenance sub-committee for the operation and maintenance of physical infrastructure.

Article- 3 If major repair is required for flood, storm, surge and other reasons the first party will arrange the rehabilitation and repair of damaged physical infrastructure.

Article- 4 The first party will provide technical guidance and support as required on annual inspection related to operation and maintenance, identification of maintenance needs, preparation of maintenance plan and design, use of different machinery.

Duties and responsibilities of WMCA

Article- 5 The second party will have the ownership right of the physical infrastructure as described in schedule 2 on behalf of their beneficiary members and according to the agreement will be fully responsible for the operation and maintenance of subproject infrastructure for the entire period.

Article- 6 The second party will be responsible for the seasons and post-monsoon especial maintenance of physical infrastructure as described in schedule 2.

Article- 7 For the implementation of entire maintenance works the second party will form an 'operation and maintenance sub-committee' including women members.

Article- 8 Operation and maintenance sub-committee will plan implement and evaluate the following activities on behalf of the second party i.e., WMCA.

a) Preparation of schedule for the regular inspection of infrastructure and taking of measure for preventive maintenance on the basis of inspection.

b) Preparation of operation and maintenance plan according to the guidelines for the operation and maintenance of infrastructure, arrangement of fund for the implementation of the plan and preparation of a budget for this purpose.

c) During the implementation of plan, control of water flow and height as required in critical times in different seasons and ensure that physical infrastructure are properly used and operated.

d) Assessment of repair needs of infrastructure after the rainy season every year.

e) Preparation of and implementation of detailed plan to mobilize resources for the implementation of maintenance plan with the collection of cash money and crop produces from the beneficiaries including volunteer labor and other arrangements as applicable and convenient.

Article- 9 The second party will deposit the fund collected for the operation and maintenance to the account opened jointly by WMCA and Upazila Engineer and limit use of this fund only for operation and maintenance works.

Article- 10 The second party will employ one or more operation and maintenance assistants for part time or fulltime for the implementation of operation and maintenance works and WMCA will provide the total expenses for the staff.

Article- 11 The second party will ensure employment of poor and destitute women in the subproject area in earthworks and in all other preventive maintenance works and plantation activities.

TERMS

Article- 12 The unstipulated matters in this agreement including project's operation and maintenance guidelines and other documents and projects policies and rules will be considered as the party of this agreement and both first and second party will be obligated to comply those guidelines and policies and rules. No change will be made in the agreement for the changes in the second party i.e., in WMCA Management Committee or members of the committee or for the changes of Chairman/secretary. That is the agreement will be unchanged although if there are any changes of individual and its terms will be effective as before.

Article- 13 If any of the parties signed this agreement considers that the other party has violated and defied any particular term or terms then, affected or aggrieved party will initially take initiative to resolve the matter through direct dialogue and discussion among the both parties. If it is not resolved through the dialogue and discussion, then the Local Conflict Resolution Committee as formed according to the notification no. Pro:Au:-2/Pani-5/2001/418 (2347), date: 23-04-2002 issued by the Local Government division as provided in Annex-7, will resolve the dispute. The decision of the committee will be considered as final.

IN WITNESS WHEREOFF, the parties hereto have affixed their signatures on the date first written above.

For LGED	For WMCA
Executive Engineer	Chairman
Witness	Witness
Upazila Engineer	Secretary

Schedule-1

Subproject Description

1. Subproject Name :
2. Subproject No :
3. Location : Union :
   Upazila:
   District:
4. Name of WMCA :
5. WMCA Registration No. :
6. Subproject Area : Total area (hectare) :
   Benefit area (hectare):
7. Date when construction of subproject physical infrastructure started:
8. Date when construction of subproject physical infrastructure:

Schedule-2

Detailed description of physical infrastructure

Serial No	Name of infrastructure	Location of infrastructure (name of mauza, plot number, etc.)
1.	Khal	
	Khal	
	Khal	
	Khal	
	Khal	
2.	Embankment	
	Embankment	
	Embankment	
	Embankment	
	Embankment	
3.	Sluice gate	
	Sluice gate	
	Sluice gate	
	Sluice gate	
	Sluice gate	
4.	Culvert	
	Culvert	
	Culvert	
	Culvert	
	Culvert	
5.	Water body	
	Water body	
6.	Other	
	Other	

Schedule-3

Subproject map showing location of the infrastructure

EXHIBIT G8-10 NOTIFICATION

Government of the People's Republic of Bangladesh

Ministry of Local Government, Rural Development and Cooperatives

Local Government Division

Section- Pro:Au:-2

No. Pro:Au:-2/Pani-5/2001/418 (2347) Date: 23-04-2002

Notification

The Government forms Local Conflict Resolution Committee at the upazila level consisting of the following members to resolve any conflict arises at the local level for the proper implementation of the Small Scale Water Resources Development Sector Project implemented by Local Government Engineering Department (LGED) under the Local Government Division.

Upazila Nirbahi Officer	-	Chairperson
Assistant Commissioner (Land)	-	Member
Upazila Cooperative Officer	-	Member
Upazila Fisheries Officer	-	Member
Subproject concerned Union Parishad Chairman	-	Member
Subproject concerned Union Parishad Woman Member	-	Member
Chairman of the concerned Water Management Cooperative Association	-	Member
Representative of affected people of the concerned subproject area	-	Member
Upazila Engineer	-	Member Secretary

The responsibilities of this committee will be resolution of any conflict if created during the implementation and after the implementation of any subproject under the Project and consideration of other relevant matters. For this purpose the committee will assemble in meeting when required.

This order is circulated in the public interest and shall come into force with immediate effect.

Sd/
(M.Sultan Mahmud Khan)
Deputy Secretary
Local government division

Distribution:

1. Chief Engineer, Local Government Engineering Department, Agargaon, Dhaka.
2. Registrar, Department of Cooperatives, Motijheel, Dhaka.
3. Director General, Department of Fisheries, Matsya Bhaban, Dhaka.
4. District Commissioner, District…….
5. Upazila Nirbahi Officer, Upazila……..……, District…….
6. Assistant Commissioner (Land), Upazila……., District…….
7. Upazila Engineer, Upazila…….....……, District…….
8. Upazila Cooperative Officer, Upazila……, District…….
9. Upazila Fisheries Officer, Upazila…….……., District…….

EXHIBIT G8-11 MONTHLY PROGRESS REPORT OF MAINTENANCE OF IRRIGATION STRUCTURE

Name of District: Date:

Sl. No.	Upazila	SP Name	SP ID	Fund Allotment (Lac taka)				Fund Released (Lac taka)				Date of start of work	Date of completion of work	Physical Progress	Financial Progress	Remarks
				Embankment	Khal	Structure	Total	Embankment	Khal	Structure	Total					

Note: If there is any Problem in implementation of maintenance work, remarks should be given.

Signature of Senior Assistant Engineer
Official Seal

Signature of Executive Engineer
Official Seal

EXHIBIT G8-12 COMPLETION WORK FORMAT OF IRRIGATION STRUCTURE MAINTENANCE

(Financial Year.....)

Name of District: Date of Report:

Sl. No.	Upazila	Name of Subproject & ID No.	Approved Work		Quantity of Implementation Work	Estimated Cost
			Type	Quantity		
1	2	3	4	5	6	7
			a) Embankment b) Khal c) CAD d) Infrastructure			

Contract Cost	Date of Start of Work	Date of Completion of Work	Fund Received	Implementation Cost	Remarks
8	9	10	11	12	13

Note: Quality of works, implemented works, unspent money (if there is), evaluation of works or if there is any problem that should be clarified in remarks Colum/

Signature:	Signature:	Signature:
Name:	Name:	Name:
Designation: Upazila Engineer (with seal)	Designation: Senior Assistant/Assistant Engineer, Executive Engineer Office (with seal)	Designation: Executive Engineer, LGED, District:..... (with seal)

EXHIBIT G8-13 FORMAT OF OPERATION AND MAINTENANCE PLAN

I. Brief Description of Subproject and WMCA

A. Area of Subproject

B. Inventory of Subproject Infrastructure

C. Objective and Benefit

D. Profile of WMCA

1) Beneficiary Households

2) Total WMCA members

3) WMCA Capital: Share: Savings:

4) WMCA's O&M Fund:

Initial FDR Amount: O&M Fund (Operating Account):

E. Map of the Subproject

II. Operation Plan

A. Subproject Operation Calendar

(Follow the Format in Exhibit G8-6 & 7)

B. General Rules for Operation of Water Control Structures

(Refer to the description in 5.5 in the main text.)

C. Operation Cost

Area of Expense	Type of work	Name of Structure	Unit	No	Allowance per month (TK)	Total Amount (TK)
Gate Operator-1	Gate Operation	WRS-1	month	12		
Gate Operator-2	Gate Operation	WRS-1	month	12		
Gate Operator-3	Gate Operation	WRS-1	month	12		
Total						

III. Maintenance Plan

A. Categorization of Maintenance Work

Sl. No.	Infrastructure	Types of Maintenance Work		
		Regular	Periodic	Emergency
1.				
2.				
3.				

B. Maintenance Work

(Follow the Format in Exhibit G8-2)

C. Maintenance Work Implementation Schedule

(Follow the Format in Exhibit G8-4)

D. Long Term Maintenance Plan

Sl. No.	Name of Infrastructure	Type of work	2018	2019	2020	2021	2022	2023	2024	2025	2026
1.	Channel	Silt removal				———				———	
2.	WRS-1	Repairing					———				
3.	WRS-2	Repairing					———				
4.	WMCA Office	Repairing									———

E. Estimation of Maintenance Cost

(Follow the Format in Exhibit G8-3)

IV. Fund Management Plan

1. Revenue		
Sources		Amount (TK)
a.	Annual Profit from FDR	
b.	Annual subscription from the Beneficiaries	
c.	Monthly subscription	
d.	A portion of profit from micro-credit	
e.	A portion of profit from fish culture	
f.	Contribution from Concerned Parties	
g.	GOB fund allotment	
h.	Others (mention)	
	Total	
2. Expenditure		
Area of Expenditure		Amount (TK)
a.	Operation Cost (as estimated in II. C.)	
b.	Maintenance Cost (as estimated in III. E.)	
c.	Others	
	Total	
	Balance (2018)	

Annexes

Annex-1 Beneficiaries' List (Follow the Format in Exhibit G8-5)

APPENDIX G8-A

OPERATION AND MAINTENANCE OF BURIED PIPE IRRIGATION (CAD) SUBPROJECTS

This forms a part of the Documentation of Guidelines that inform

Small Scale Water Resources Development in Bangladesh

APPENDIX G8-A O&M OF BURIED PIPE IRRIGATION (CAD) SUBPROJECTS

A. INTRODUCTION

To achieve sustainable benefits from the investment in engineering infrastructure effective management, operation and maintenance is vital. Previous guidelines[1] do not cover the specific management, operation and maintenance needs of CAD irrigation subprojects. To some extent this lack is addressed by this Chapter which describes the operational challenges facing farmers of CAD subprojects, and their operation and maintenance features and requirements.

Challenges facing the farmer operators are considerable and usually stem from:

i. Variation in irrigation demands within a season and from year to year due to weather variations, particularly rainfall and plant stages of growth.
ii. The variation in land types (and also possibly soils) in the command area. Low lying areas may be wetter than high lying areas requiring less and / or delayed irrigation supply.
iii. A range of different crops being cultivated requiring differing irrigation intervals and application depths.
iv. Fluctuation in electric power supply (unless farmers have diesel pumps) restricting pumping times.
v. Time taken to fill the pipe distribution system whenever irrigation is resumed after an interval and to attain usual operation flows and pressures in the system.
vi. Sedimentation.
vii. Wash out / failure of part of the pipe delivery system.
viii. Tampering of alfalfa valves and/ or theft of water.

To help farmers meet these challenges is good design and provision of appropriate or "*enabling*" engineering infrastructure, including:

i. A control structure at the head of each rotation unit enabling: (i) adjustment and measurement of irrigation flows; and (ii) pipeline isolation and maintenance without closing down the whole system. Note: this function is often carried out by the header tank.
ii. Standpipes constructed to correct height (ie 0.3 m freeboard for escapes and 0.6 m freeboard for air vents) and supplied with small clear plastic piezometric tubes attached to the standpipes to monitor pressures within the distribution pipe system.
iii. Alfalfa values in outlets which may be protected from tampering by a lockable grill.
iv. Selection of pump sets to maximize efficiencies and minimize power requirements and operating costs.
v. Washouts to allow periodic flushing / drainage of the pipe system.

The relatively large capital investment for CAD subprojects (with uPVC pipelines) justifies preparation of subproject specific O&M strategies and intensive training of farmers to ensure good performance. Exchange visits to successful CAD subproject are recommended.

[1] LGED "*Water Resources Infrastructure O&M Guidelines*" 2007 and the "*Small Scale Water Resources Support Strategy and O&M Manual*" 2009

B. OPERATION

1. Operation Objectives

Suggested operation objectives are:

i. To supply sufficient irrigation water to meet crop water requirements with reasonable flexibility to meet fluctuating demand.
ii. To supply water while minimising pumping (energy) costs.
iii. To meet all farmers demands with reliable, transparent and equitable water distribution.
iv. Beneficiaries (farmers) meeting O&M costs.

Meeting these objectives requires:

i. Clarity and consensus to operating procedures among WMCA members and farmers.
ii. Formation of appropriate farmer institutions, specifically: (a) the O&M subcommittee; (b) Rotation Unit beneficiary groups; and (c) Irrigator beneficiary groups.
iii. Appointment of system operators for O&M of the pumps and distribution of water by controlling flows (and pressures) in the pipelines – these may be directly appointed or though an outsourcing agreement with a third party.
iv. Adoption of agreed charges for irrigation water and procedures for collection, use and accounting for O&M funds.

2. Water Distribution below the Pipe Outlet

The buried pipe and field channel (or plastic hose) distribution system is designed to meet the peak crop demand.

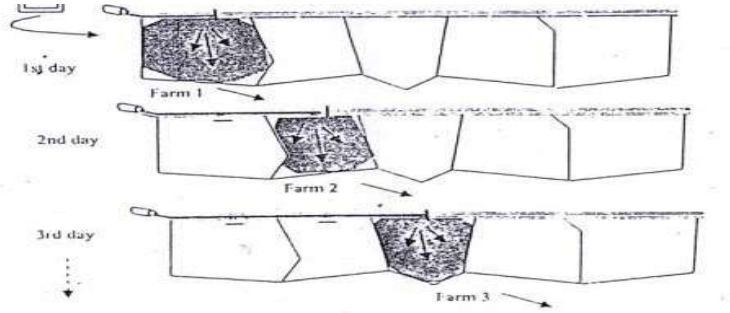
Flows from the outlets along each field channel (or by hose) to farmers' fields will be managed by Irrigator Groups. The field channels will be constructed and / or hose purchased by farmers themselves.

Particularly for non-rice crops, plastic hose / tubing may be used to convey water from the outlets to the fields. In this case the sequence of irrigation may be more flexible and based solely on farmer demand / need as losses will be minimal as water supply is switched between farmers.

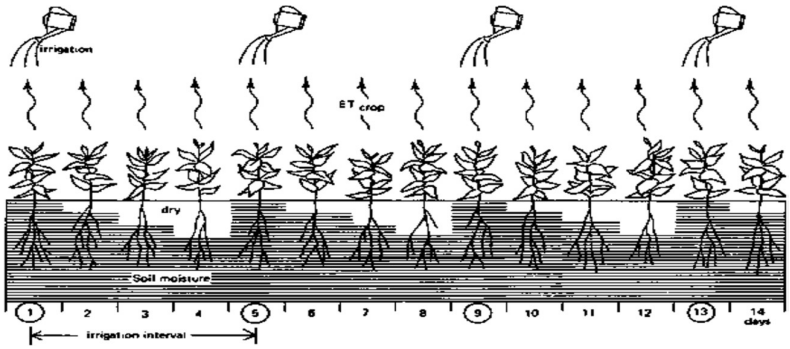
For field channel conveyance the delivery pattern should arrange the sequence in which each farmer receives his turn in the irrigation cycle. Ideally the movement of water along a field canal will be systematic, going from head to tail, or the reverse, but not haphazard. This reduces water losses due to prism storage and perimeter wetting. However it is recognised that other factors influencing the irrigation sequence may be more important. For example, has the farmer paid for the water, or is water needed urgently by one farmer to prevent crop loss.

For field channels rotational distribution to farmers by turn according to a predetermined time schedule specifying the day, time and duration of supply is suggested. However farmers are free to adopt any method they wish and a more flexible system may be appropriate.

Figure-1: Irrigation Interval and Irrigation Sequence



Ideal delivery pattern along field channels is in sequence to minimize operational & conveyance losses. However other factors influencing irrigation sequence may be more important. For example, has the farmer paid for water? Is water needed urgently to prevent crop loss.



Irrigation of crops occurs at intervals depending on crop, soil and land type, etc. For example, 6 to 10 days for Boro, and 7 to 14 days for Onion is likely to appropriate.

Irrigation depths, intervals and total (gross) water requirements for a range of crops are given below. These figures are indicative as they depend on the conveyance / operating efficiency of the conveyance system, as well as the District climate and soil type. In general the irrigation amounts decrease from east to west across the country, refer Chapter.

Table-1: Indicative irrigation amounts and intervals for range of crops

Name of crop	Per application (mm)*		Interval (day)		No. of Irrigation		Total Requirement (mm)*
	Low-land	High-land	Low-land	High-land	Low-land	High-land	
HYV Boro	50	75	10	6	12	18	600- 1200
Aman	50	75	20	10	2	3	100 - 225
Wheat	40	50	21	14	3	6	120 – 300
Potato	25	40	14	7	5	10	125 – 400
Maize	50	75	21	14	4	6	200 – 450
Mustard	30	40	20	14	2	4	60- 160
Brinjal	20	40	14	7	8	11	160- 440
Tomato	30	40	7	5	6	10	180- 400
Onion	25	40	14	7	6	7	150- 280
Chili	25	40	14	7	8	13	200- 520
Jute	30	40	10	5	3	6	90- 250
Sugarcane	50	75	20	14	10	14	500- 1050

The duration and amount of water received by each farmer would be set by the Irrigator Group taking into account the crop(s) grown and irrigation flow. However indicative durations have been calculated below for Boro cropping adopting a design (gross duty) of 0.65 l/s/ha (5.6 mm/day) at the field level; 0.81 l/s/ha (7.0 mm/day) from the pipe riser outlet. These are based on a 7-day rotation period with continuous (day and night) irrigation.

Table-2: Rotational Water Distribution Downstream of Outlet

Nr	Item	Units	Quantities
	Step 1: Irrigator Group Design Flow		
1	Design duty at field level	l/s/ha	0.65
2	Watercourse efficiency	%	80%
3	Design duty for pipe system	l/s/ha	0.81
4	Net irrigation area	ha	313
5	Nr of outlets	Nr	31
6	Area supplied by Outlet	ha	10.1
7	Design flow provided from Outlet	l/s	8.2
	Step 2: Rotation of supply to irrigator group members		
1	Rotation period	days	7
2	Number of hours of group supply each day	hrs	24
3	Number of hours of group supply in rotation period	hrs	168
4	Nr of group farmers to receive water at same time	Nr	1
5	Flow provided to each farmer (irrigator flow)	l/s	8.2
6	Time available per ha with design irrigator flow	hrs/ha	16.6
7	Time for typical marginal farmer with 0.1 ha	hrs	1.7
8	Time for typical small farmer with 0.6 ha	hrs	10.0
10	Time for typical medium farmer with 2.0 ha	hrs	33.3
	Step 3: Volume of water supplied to farmers fields		
1	Volume supplied to group farmers in rotation period	m^3/ha	490
2	Watercourse efficiency	%	80%
3	Depth supplied to fields in rotation period	mm	39
	Puddling / Land Preparation		
1	Puddling Requirement	mm	180
2	Puddling volume (no losses)	m3	1,800
3	Puddling volume (with 20% losses)	m3	2,250
4	Design flow for irrigation unit	l/s	8.2
5	Time to satisfy puddling requirement	hrs / ha	76
		days / ha	3.2
	(for irrigator unit & whole scheme)	days	32.2

The following may be concluded from this exercise:

i. The typical outlet flow of 8.2 l/s should be used to irrigate 1 field at a time – splitting this flow to two farmer fields will increase water losses.

ii. For one field irrigated at a time the duration of irrigation would be about 16.6 hours per ha. For smaller / larger fields the duration would be decreased / increased according to their areas;

iii. In the 7-day irrigation period a depth of 39 mm would be applied with this flow to each field in the Irrigation Unit.

iv. Assuming that land preparation / puddling requires 180 mm of water then land preparation will take about 32 days.

3. Pipe Flows and Pumping to meet Irrigation Requirements

Water demand varies from month to month depending on rainfall, crops cultivated and planting dates. Peak water demands occur early in the Rabi season for land preparation and puddling of soils (for Boro), and again in March to meet peak crop evapotranspiration.

The height of the header tank and standpipes should be sufficient to meet the *peak* (1-month) water requirement. In addition a small free board may be provided. However the more usual operating scenario is for lower discharges and operators must therefore adjust the pumped flow to match demand from day to day / week to week. Very simply, as the alfalfa values at riser outlets are opened or closed the number of pumps operational is adjusted to match supply to demand and prevent overtopping of the standpipe escapes / air-vents.

As the pipe distribution system is capable of carrying meeting *peak* requirements, whenever water requirements are less, the lower discharges and pipe friction losses will result in lower pressures and water levels in the header tank. As energy requirements are directly proportion to the pumping head costs also reduce if high pipeline flows are avoided.

To minimize operating costs the following is recommended:

- Irrigate both day and night.
- Provide flows to all three pipelines, providing that flows are not so small that irrigation becomes inefficient or sedimentation occurs. If high flows are maintained in pipelines by rotating supply to rotation units then pumping head and costs will remain high and this is therefore not recommended.
- In periods of medium irrigation demand, rotate flows along each pipeline to different outlets. For example flow may be supplied to odd outlets and then even outlets in turn, or alternatively to the upstream and then downstream outlets along of the pipeline. This will prevent outlet (irrigator) flows becoming too small.
- In period of low demand flows may be rotated between Rotation Units (pipelines) to avoid very low pipe flow velocities which may result in pipe sedimentation.

Options for pipe system operations are tabulated below, **Error! Reference source not found.**. The pressure head at the header tank has been calculated for a 2,000 m long pipeline supplying 100 ha, and with a design flow of 81 l/s. Four similar pumps are provided to meet *peak* flows.

During periods of peak water demand all 4 pumps are required and pumping (energy) costs will be high – *Option A*. As water demand reduces, the number of pumps reduces. For 3 pumps operating it is suggested that flows to each irrigation unit (outlet) are reduced by adjustment of the alfalfa valves – *Option B*. In case any irrigator unit is short of water the 4th pump would have to started-up. For just 2 pumps operating, rotations to outlets along each pipeline are proposed as this is easier than adjusting the flows from each outlet, and also this avoids very low irrigation flows which are not efficient – *Option C*. If the same depth of water was supplied to each field, farmers would receive water every 2-weeks rather than each week. For very low demand periods, just one pump would be operated or the system closed - *Option D*. This is likely following rainfall in the command area.

On resuming irrigation supply, the time taken to fill the pipe distribution system and / or return to normal (design) operating pressures may be minimized by initially closing the control valves / outlets and only opening them when operating pressures are reached.

Table-3: Suggested Pipe System Operation

Option	Description	Suggested Supply / Rotations along Pipeline	Pressure at Header Tank (m)	Remarks
A	Design flow in pipeline (±10%) to meet peak water requirements	No rotations practiced during land preparation and peak crop ET periods	Design (maximum) head of about 4.5 m	All 4 pumps operating. High flow and high head means that pumping costs are high.
B	75% of design flow in pipeline (±10%) as crop water requirements reduce.	No rotations practiced during these reasonably high demand periods. However it is expected that on average irrigation flows will be reduced to 75% of design flow.	Reduced head of about 3.2 m	3 pumps operating. Reduced flow and lower head means that pumping costs are reduced
C	50% of design flow in pipeline (±10%) as crop water requirements reduce. Farmers receive water every second week (or other agreed irrigation interval)	1 by 2 rotation practiced along each pipeline as follows: Period 1: Upper half receives water Period 2: Lower half receives water Irrigation design flows provided.	Head varies: (i) about 2.4 m for head end supply; and (ii) 3.3 m for tail end supply	2 of 4 pumps operating. Reduced flow and lower head means that pumping costs are reduced
D	Closure / Semi-closure	Supply to irrigator groups in need of water	Minimal	No / little pumping

Closure of the whole system is particularly sensible following rainfall in the command area. A rough rule of thumb for the period of system closure for various rainfall events is tabulated below.

Table-4: Rainfall and duration of Closure

Daily Rainfall (mm)	Days of Closure Suggested
20	2
20 – 25	3
25 – 30	4
30 – 35	5
35 – 45	6
45 – 55	7
55 – 70	8
70 - 80	9
80 and above	10

4. Farmer O&M Institutional Arrangement

To facilitate operation each scheme is divided into Rotation Units about 80-120 ha in area by consideration of topography /hydraulic boundaries, refer Chapter. Each Rotation Unit should be supplied with a regulated and measureable amount of irrigation water. In turn each Rotation Unit is divided into smaller Irrigator Units, each 5-15 ha in area and receiving irrigation water from a riser outlet.

A 9-12 person O&M sub-committee should be formed for the subproject and should comprise the following:

- 3 members from the WMCA Management Committee.
- At least 2-3 representatives from each Rotation Unit.
- 3-4 (25%) women members.

The O&M sub-committee has overall responsibility for scheme O&M under the WMCA Management Committee, including distribution of flows as far as the pipe outlet and funding arrangements. For day to day management of pump sets and water distribution well trained and paid (by the WMCA through farmer contributions) staff are required comprising: (i) 1-2 Pump Operators; and (ii) 1-2 Pipe System Managers per Rotation Unit.

Downstream of the pipe outlet farmers would be expected to organise themselves into Irrigator Groups to manage water distribution from the pipe outlet along field channels to their fields. If outlets for pipes (rather than for open channel) structures are provided then plastic hose / tubing directly fixed to the pipes may be used.

Depending on the crop(s) grown the duration each farmer receives irrigation water would be set by the irrigator group, and the group would manage rotation of irrigation supplies to farmers.

Suggested institutional O&M arrangements and staffing are tabulated below.

Table-5: Scheme Layout, Institutions and O&M Staff

Nr	Unit	Typical Area (ha)	Institution	Flow Control & Measurement	Typical Nr of Irrigator HHs assuming 0.15 ha/ HH*[1]	O&M Staff
1	Rotation Unit	80 - 120	O&M sub-committee with 1-2 representatives from each RU reporting to the WMCA	By adjusting valves and V-notch weirs in Header Tank	200-250	Paid Pump operator (1-2 Nr), Pipe System Managers (1-2 / rotation unit)
2	Irrigator Unit	5-15 ha	Irrigator Groups managing supply to farmers fields from each outlet	By adjusting (alfalfa) valves at each outlet. No accurate flow measurement.	15 – 25	Unpaid Irrigator Group Manager.

*[1] Note: CAD irrigation subprojects typically are dominated by small and medium land holders with a proportion of landless. Average net irrigation land holding is likely to be about 0.4-0.5 ha.

Farmers in small scale water resources subprojects developed by LGED comprise the following land owning groups:

i. Land less (LL)
ii. Marginal farmers (MRF): 0.01 to 0.49 ac
iii. Small farmers (SF): 0.50 to 2.49 ac
iv. Medium Farmers (MF): 2.5 to 7.49 ac
v. Larger farmers (LF): > 7.5 ac

The overall average landholding is typically about 1-1.3 ac (0.40 to 0.53 ha)

C. MAINTENANCE

1. Categories of Maintenance

In any irrigation development which is either new, or substantially expanded or changed, farmers do not initially appreciate maintenance needs, activities and costs to keep the engineering infrastructure in good working order. If maintenance is not carried out, or frequently deferred, the scheme will deteriorate resulting in its inability to perform as designed.

Considerable efforts are therefore required to build awareness of maintenance requirements, support development of a maintenance strategy that has the broad approval of farmers, and develop farmer (institutional) capacity to implement the strategy.

Maintenance requirements for engineering infrastructure fall into the following categories: (i) Preventative Maintenance; (ii) Routine Maintenance; (iii) Periodic maintenance; and Emergency repairs.

Routine maintenance is carried out as required and at least annually and includes for works identified by observations and inspections as well as those required to ensure smooth functioning of the system. Examples are lubrication / greasing of pump bearings and valve spindles, painting of metal work, sediment removal from the header tank, repair any of (pipe) joint leaks and covering of any exposed lengths of pipeline, and weed cutting and minor earthwork dressing for field irrigation channels.

Periodic maintenance addresses major repair works that are carried out every few (3-5) years. Works may include flushing of the pipeline, replacement of any failed lengths of pipeline, replacement of leaking / damaged alfalfa valves and pumping equipment, and repairs to structures.

Emergency repairs are those not foreseen and which must be undertaken immediately to avoid partial or complete system shutdown and subsequent loss of agricultural production. Examples include burnout of an electric motor, bursting of a pipe, etc.

2. Maintenance Requirements

a. Pumping Plant

Maintenance of the pumping plant, including the control panel, electrical connections & motors / diesel engines and the pumps themselves is essential to keep them operational and to retain high pumping efficiencies.

Moving mechanical parts need greasing, while operation of electric motors at low / high voltage should be avoided to reduce likelihood of motor and / or transformer burn-out. Procedures proscribed (by the supplier of the equipment) for startup and shut down must be followed.

Associated fixtures and fittings include the (steel) suction and pressure pipes, screen and foot valve, pump priming arrangement and control valves. Maintenance works include painting exposed steel work, greasing of bolts, removal of debris caught in screen, and replacement of seal in the foot valve.

Security of equipment and of the electric transmission line and transformer is always a concern, and is to be ensured by the WMCA and community.

b. Major Structures

Major structures include the header and any flow control tanks, and the pump house if provided. For these usual maintenance work comprises: (i) addressing any leakage due to pipe / structure differential settlement / movement – this may require removal and resetting of the connecting pipe; (ii) cement plaster work to reduce any seepage through tank walls; (iii) greasing of spindles / valves; (iv) painting of exposed steel work; (v) seasonal removal of sediment; (vi) periodic replacement of damaged / rusted steel work, for example access ladders.

c. Leaks from Concrete Pipelines

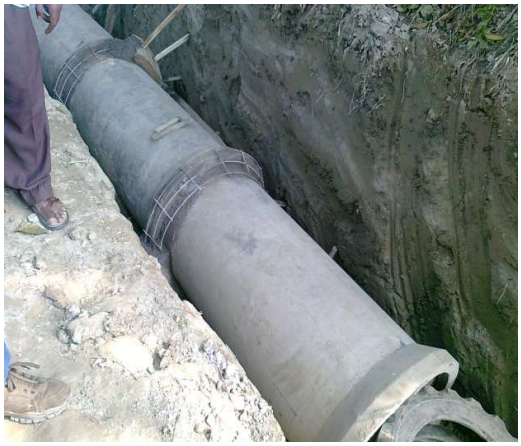
Leaking concrete pipe joints is a severe problem for many of the CAD subprojects constructed prior to 2012. These pipe joints were sealed by: (i) filling gaps with hessian cloth soaked with bitumen; and (ii) placement of a mortar / concrete surround.

Leaks often tend to be most acute in the upper part of the pipelines where water pressures are highest and / or where pipe settlement has occurred and the joints have opened up.

For localized, non-extensive leaks from joints, individual repair is recommended, using cement mortar and / or a fit-for-purpose joint sealant such as Bidco C56-Butyl Mastic. For more severe and extensive leaks the following strategy is recommended:

- For pipes 550 mm or larger, remove 1-2 pipes to allow internal inspection at intervals of about 50-75 m. If pipes have not badly settled then rake out joints and seal using fit-for-purpose joint sealants such as Bidco C56-Butyl Mastic or as appropriate. Sealing should be done from the inside of the pipes. For sections that have settled it is necessary to remove and relay the pipes, and then seal the joints. To avoid future settlement of the re-laid pipes they may be placed on a gravel or sand bed.
- For pipes, 500 mm or smaller, which are too small to be sealed from the inside, replacement with uPVC pipes may be considered, or “slip-lining” by introduction of a smaller carrier pipe or HDPE loose fit liner into the larger concrete pipe. Alternatively removal, relaying and jointing with gravel / sand bedding to prevent settlement may be considered. A propriortary joint sealant should be used in addition to / instead of a cement motor surround.

Note: unless working pressures are less than (about) 2 m then packing clay around the pipe is unlikely to be effective in sealing leaks.



Placement of concrete surround to joints with concrete mortar / bitumen in the joints

Sealing a pipe joint from the inside with activated oakum (jute fibers soaked with a resin)

d. Leaks from uPVC Pipelines

For uPVC pipes should be little leakage from the solvent cement joints providing they have been connected properly. However if leaks do occur then a "patch" may be effected from the outside.

e. Distribution System Structures

Distribution system structures include outlet boxes, air-vent standpipes, escapes and washouts.

Usual maintenance work comprises: (i) repair of any leakage – usually at joints due to pipe / structure differential settlement / movement; (ii) greasing of alfalfa valve spindles, and replacement as required; (iii) painting of exposed steel work; (iv) end of season flushing of the pipe system to remove sediment; (v) structural works such as plastering / pointing and repair of damaged masonry / concrete sections.

Any tampering of the outlet (alfalfa) valves will result in imbalance and inequitable water distribution, and for this reason all valves may be provided with a lockable cover. The alfalfa valves are robust but periodic replacement will be necessary.

Pipe crossings of low land areas including any drainage lines (streams, etc) are particular vulnerable points. During floods empty uPVC pipes have been known to "*float*" if not buried properly to sufficient depth. Also erosion can expose the pipeline to sunlight and physical damage. Immediate repair of such damage and re-covering of pipelines is essential.

Earthen field channels kept in good order, with seasonal prism shaping and cutting of grass and vegetation.

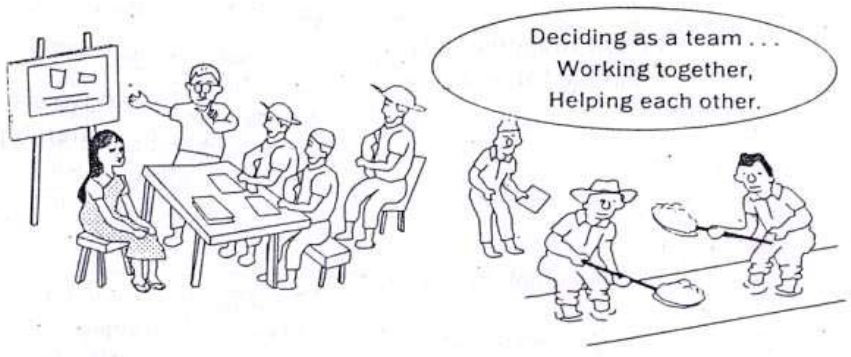
f. WMCA Office

The office will require both routine (eg painting) and periodic maintenance (eg replacement of galvanized iron roofing sheets).

3. Maintenance Process

a. Preparation of Maintenance Plan and Budget

Each year the WMCA and O&M Subcommittee should prepare a Maintenance Plan and Budget. In most years only minor (routine) maintenance will be planned and carried out, while in other years more major works will be required.



Each year WMCA and O&M Subcommittee plan maintenance works to be done

The O&M subcommittee will consult with their operating staff and carry out inspections to assess the condition of the infrastructure and determine maintenance requirements. The Maintenance Plan should differentiate between routine, periodic and emergency maintenance.

Table-6: *Determination of Maintenance Works*

Infrastructure	Description of Maintenance Works by Type		
	Routine (Annual)	Periodic (2-5 years)	Emergency
WMCA Office			
Pumps and accessories			
Pump House			
Header Tank			
Flow Control Structure			
Buried Pipe Line			
Standpipe Air vents			
Outlets (risers)			
Escapes			
Washouts			
Other			

Once the required works are identified the cost of the planned works will be estimated as indicated in **Error! Reference source not found.**. The rates (costs) for the work will be determined by the O&M committee following discussions with those who will carry out the works and / or after checking of costs for necessary materials.

Table-7: *Cost of Planned Maintenance Works*

Infrastructure	Description of Works	Units	Quantity	Rate	Cost
WMCA Office					
Pumping Equipment					
Header Tank					
Flow Control Structure					
Buried Pipe Line					
Standpipe Airvents					
Outlets (risers)					
Escapes					
Washouts					
Other					

Preparation of Estimate by:
Name :
Designation :
Signature :
Date :

Assisted by:
Name :
Designation :
Signature :
Date :

b. Joint Walk-Through

To assist the preparation of the maintenance plan and budget an annual "*Joint Walk-Through*" inspection by officials from LGED together with members of the WMCA and O&M sub-committee to jointly inspect engineering infrastructure is done in the early years following subproject handover.

The joint walkthrough will usually be done by the District Assistant Engineer (AE) together with the Upazila Sub-Assistant Engineer (SAE) and at least four members from the O&M sub-committee. Project retained staff may also attend.

c. Post and Pre Irrigation Season Inspections

Post and Pre irrigation season inspections by the O&M subcommittee are recommended, whether or not they are attended by anyone from LGED / Project.

The post-irrigation season inspection will: (i) assess condition of infrastructure and identify maintenance requirements; (ii) prepare the maintenance plan and budget; (iii) arrange funding / collection of funds; and (iv) plan / arrange for implementation of maintenance works.

The pre-irrigation season inspection will check that the system is in good working order and that maintenance has been properly carried out. This inspection will particularly focus on pumps, motors and accessories.

d. Public Meetings

Public meetings to discuss O&M arrangements and present the annual O&M plan and budget should be held at least once a year.

D. PUMP AND SYSTEM OPERATORS

To manage the pump sets, water distribution to each pipeline and outlet as well as routine maintenance, well trained and paid (by the WMCA) staff are required comprising: (i) 1-2 Pump Operators; and (ii) 1-2 Pipe System Mangers per Rotation Unit.

Options for procuring these operating staff / services for day to day subproject operations include:

i. Direct appointment by the WMCA / O&M committee who will oversee their work and pay salaries / expenses for day to day subproject operations; or
ii. Indirect appoint by outsourcing day to day subproject operations to a third party. The precise scope and payment made under any outsourcing arrangement should be decided by the WMCA / O&M subcommittee.

The tasks and duties of these Operators are summarised below.

Table-8: Tasks / Duties of Operators

Operator	Tasks / Duties
Pump Operator(s)	• Pump and motor operation and maintenance. • Measurement of water levels in header tank and flow over V-notch weirs as required to check pipe system is operating correctly – usually just at the start of each irrigation season. • Adjustment of flows into each pipeline and number of pumps working on a daily / weekly / monthly basis. • Maintaining records of pumping time, pump & motor maintenance carried out and any rotation of flows into each pipeline. • Keeping in close communication with System Operators (by mobile phone) • Reporting to the O&M Subcommittee / WMCA committee
System Operators	• Regulation / control of flows to each Irrigator Group by opening / closing / adjustment of outlet alfalfa valves. If a system of rotation has been adopted (in the bylaws) then implementation of the rotation would be managed by the System Operator. • Checking pressure in pipelines – in particular if any standpipe is spilling water. • Requesting the Pump Operator to increase / decrease supply to their Rotation Unit (ie adjust number of pumps operating) to match demand. • Checking for any unauthorised tampering of alfalfa valves or pipeline. • Resolving petty conflicts concerning flows. • Taking part in annual maintenance walkovers / inspections. • Collection of water fees (charges) from farmers as required by the bylaws. • Reporting to the O&M Subcommittee / WMCA committee.

a) O&M Costs and Funding Arrangements

i. Operation Costs

Operation costs include for energy (electric / diesel) for pumping, plus payments made to the operating staff.

Pumping costs are likely to be about: (i) BDT 6-7 / dc[2], US$ 18-22 / ha for electric pumps; and (ii) BDT 30-40 / dc, US$ 90-120 / ha for diesel pumps.

Operating staff costs assuming salaries of BDT 6,000 / month for a pump operator, and BDT 4,000 / month each for three linesmen, will be about BDT 1-2 / dc, US$ 3-6/ha.

The major cost is therefore for energy. To minimize the pumping costs the following is recommended:

- Do not pump if water is not required.
- Consider growing wheat / maize / pulses / vegetables, etc in Rabi.
- Reduce pumping head: eg use 1 or 2 pumps, not all of them. Also split pumped flow between all off-taking pipelines (Rotation Units) - even when crop requirements are quite low - by rotating flows along a pipeline (eg 1 week to even numbered outlets and one week to odd numbered outlets).
- Select the right pump for the job so that it operates efficiently (eg at 70-80% rather than 40-50%).
- Convert to electric pumps if possible.

While diesel pumps increases costs significantly, they have the advantage of insulating farmers from erratic electric supply and load shedding. Also it may not be easy to secure an electrical connection from the Rural Electricity Board.

The cost to hire pumping equipment may have to be included. If pumps are hired from BADC the charge is about Tk 3,000 / cusec for the season (2013 rates) plus a deposit.

ii. Maintenance Costs

Little data are available, but maintenance yard sticks are suggested below allowing maintenance costs to be estimated for a 313 ha subproject[3]. These are likely to be about BDT 36,700 each year for routine maintenance, plus about BDT 230,000 every 4-5 years for periodic maintenance. This is for a subproject with uPVC pipes – maintenance for a subproject with concrete pipes are likely to be larger due to leakage problems.

Table-9: Indicative Maintenance Costs

Nr	Item	Unit	Quantity	Yardstick for Routine Maintenance (BDT)	Cost (BDT)	
					Routine	Periodic
1	WMCA Office	Nr	1.0	3,000	3,000	10,000
2	Pumping Equipment (& pump house)	sum			5,000	100,000
3	Pipe line					
	- uPVC Pipeline	m	8.335	2	16,670	50,010
	- concrete pipeline	m	0	10	0	0

[2] *Note: 1 decimal = 1/100th of an acre, 1 acre = 0.4047 ha*

[3] Maintenance costs are determined for Mongalpur, SP33097

Nr	Item	Unit	Quantity	Yardstick for Routine Maintenance (BDT)	Cost (BDT)	
					Routine	Periodic
4	Pipe System Structures					
	Header Tank	Nr	1.0	1,000	1,000	3,000
	Flow Control Structure	Nr	1.0	600	600	1,800
	Standpipe Air vents	Nr	24	200	4,800	14,400
	Outlets	Nr	31	200	6,200	18,600
	Escapes	Nr	7	300	2,100	6,300
	Washouts	Nr	8	300	2,400	7,200
	Totals				**41,770**	**211,310**
	Cost per ha (BDT)				133	675
	Cost per decimal (BDT)				0.5	2.7
	Cost per ha (US$)				1.7	8.4
	Percentage of capital cost				0.2%	0.9%

Note: capital cost from feasibility report (excl contingencies, etc) was BDT 24.0 million

iii. Total O&M Costs

Annual O&M Costs are tabulated below and are likely to average about BDT 9.2 / dc, US$ 28/ha for electric pumping and about BDT 37.7/ dc, US$ 116/ha for diesel pumping. The cost of energy for pumping is the major cost, particularly if diesel pumping is adopted without any subsidy.

Table-10: Annual O&M Costs

Nr	O&M Costs (BDT)	Annual O&M Costs (BDT/dc)	
		Electric Pumps	Diesel Pumps
1	Pump and System Operators	1.5	1.5
2	Pumping Energy costs – Electricity / Diesel	6.5	35.0
3	Routine (annual) maintenance costs	0.5	0.5
4	Periodic Maintenance Costs (assume every 4 years)	0.7	0.7
	Totals	**9.2**	**37.7**

iv. Funding Arrangements

It is suggested that water charges are levied on farmers according to the Rabi crop type and area irrigated. Annual irrigation charges should be roughly as follows:

- Electric pumping: (i) Tk 10 / decimal for rice; and (ii) Tk 7 / decimal for non-rice crops.
- Diesel pumping: (i) Tk 40 / decimal for rice; and (ii) Tk 28 / decimal for non-rice crops.

The water charges should be reviewed from time to time in light of actual operating costs.

To enable water charges to be collected from farmer users, a Beneficiary List by Irrigator Group should be compiled by the WMCA O&M committee and updated as required each season. Each beneficiary would be required to pay O&M costs according to crop type and land area irrigated.

LGED funding assistance may be available for emergency maintenance and for any new works needed to improve the system. LGED may also provide some matching funds for periodic maintenance on a cost sharing basis with the WMCA. The WMCA may request funding assistance from LGED – IWRMU via the concerned staff at Upazila and District levels.

b) WMCA Bylaws, O&M Accounts and Record Keeping

Bylaws must be adopted by the WMCA to enable good functioning of the subproject and would cover the following:

- Meetings (annual & monthly) for discussion and setting of irrigation charges, planning of irrigation and planting dates, election of office bearers and O&M staff, etc.
- WMCA shares and share management.
- Duties of WMCA and O&M committee members, pump and system operators (linesmen), accountant, and remuneration (if any) to be paid to them.
- The Beneficiary list for the subproject, arranged by Irrigator and Rotation Unit to enable collection of irrigation charges.
- Book keeping and records of: (i) Irrigation Charges collected; (ii) Accounts of income and expenditure; (iii) Pumping hours; (iv) Maintenance planned / carried out; and iv) Records of meetings, etc.
- Annual Audit of WMCA Accounts by the DoC.
- Micro-credit activities (if any).

The WMCA is required to open an “Operating Account” to manage all funds collected and spent for operation and maintenance. This Account is usually separate from the O&M Reserve Fixed Deposit Account in which the up-front contribution was deposited, and also separate from the “Capital / Micro Credit Account”.