Initial Environmental Examination

Project Number: 45207
February 2014

BAN: Irrigation Management Improvement Project

Prepared by TA 8154: Preparing the Irrigation Management Improvement Program

CONTENTS

EXECUTIVE SUMMARY

1. During country programming consultations held in April/May 2012 between the Government of Bangladesh (GOB) and ADB it was agreed to develop a $46million Project for Muhuri Irrigation project modernization. The original feasibility study of the Muhuri Irrigation Project (MIP) was in 1973 with construction completed in 1986. In addition to irrigation, the MIP provides flood control and protection against the intrusion of tidal water. The design enabled dry season irrigation as well as supplemental wet season irrigation by constructing the Feni Closure Dam and Regulator to create a reservoir downstream of the confluence of the Feni, Muhuri and Kalidash-Pahalia rivers. The original design area for the Muhuri Irrigation Project was 23,000ha

2. The main issue for Muhuri is the gradual loss of area under irrigation. Analysis by the project preparatory technical assistance (PPTA) of the 2011 boro cropping using satellite analysis estimated the irrigated area in the Muhuri Irrigation Project to be about 11,800ha of which 8,400ha is from surface water and 3,400 from groundwater[1]. The main causes of the reduction in irrigated area are complex but include:

(i) Major siltation of the khals and rivers resulting in much of the irrigation area having no or limited access to khal water.
(ii) Over the 29 years, since construction the reservoir, storage has significantly decreased due to siltation. The original reservoir storage was about 32Mm3 but this has reduced to about 7Mm3. The current overall storage in reservoir, rivers and khals is 54Mm3 of which 18Mm3 is live storage.
(iii) There appears to have been reduction in the river flows as a result of increased abstractions in India. Heavy abstraction of ground water is also likely to be reducing the natural recharge to the rivers.
(iv) There are large annual climatic variations which is affecting water availability. Recent cold winters and changes in agricultural practice are delaying the planting dates of Boro rice to late January and February which puts additional pressure on the scarce water resources during the critical February and March periods.
(v) The low prices of rice and high prices of inputs including pumping has resulted in many farmers not planting rice.
(vi) Pump operators find it too expensive to provide water to plots located far from the pumps and most of the irrigated land is a nucleus around each pump.
(vii) There is a significant drop in the number of operational pumps and the irrigated areas. Pump inventories in 2013 show there are only about 440 operational pumps from an original 800 pumps. The irrigated area from surface water based on 2013 satellite imagery is estimated to be 8400ha in the MIP reduced by 60% from the original target of 23,000ha

3. Other issues include deterioration of the coastal embankment and associates structures which are causing salinity intrusion and impediments to drainage as well as risk from sea water inundation during periods of high sea level.

4. To support the expansion of the irrigated area requires water conservation and increased water use efficiency. An integrated approach to improved access to water through

[1] This does not include Muhuri Kahua

desilting of the khal to increase access to wider area combined with water conservation through; (i) increasing the efficiencies of water distribution to reduce the water losses; (ii) reducing water use by farmers through more precise irrigation and the volumetric basis of charging; (iii) reducing the quantity of water lost through the boundary of the project through boundary water retention structures and (iii) promoting the diversification from rice to other lower water use crops. The project will also take up pilots and demonstrations of rice cultivation techniques that are less water intensive.

5. The development of pipe distribution systems is proposed to reduce the water losses through improved application, distribution and operational efficiencies. The change from a fixed rate to a volumetric charging system by using prepaid meters has shown significant reduction in water use in the Barind project. The estimated change in cropping is shown below

		Current Area Boro ha			Future Area of Boro Rice and Non Rice/4					
					Surface Water			Ground	Total	
	Cultivable Area/1	Surface water rice/3	Ground water rice/2	Total rice/1	Total	Rice	Non Rice	water rice	Surface and GW	
Muhuri	24,800	8,400	3,400	11,800	13,000	11,050	1,950	3,400	16,400	54% increase in area irrigated by Surface Water
Muhuri Kahua	13,800	2,900	3,200	6,100	4,000	3,400	600	3,200	7,200	38% increase in area irrigated by Surface Water
Total	**38,600**	**11,300**	**6,600**	**17,900**	**17,000**	**14,450**	**2,550**	**6,600**	**23,600**	
Notes	1/ Data from 2011 Satellite Imagery 2/ Data from Upazilla statistics 2011 3/ 8400ha is the estimated current irrigable area from surface water (based on water balance analysis) 4/ Analysis by PPTA given in Appendix 3									

6. The project will involve an investment in civil works of $30.45 million as shown below

Nr		Item	Total Tk million	Total $ million	%
1	Coastal Flood Protection				
	1.1	Rehabilitation of coastal embankment Polder 60	66.625	0.833	2.7
	1.2	Rehabilitation of Coastal Protection/Drainage Structures	14.364	0.180	0.6
	1.3	New Coastal Protection/Drainage Structures	44.621	0.558	1.8
2	Main River System				
	2.1	Repairs to Water and Flood Control Structures	12.890	0.161	0.5
	2.2	New Water and Flood Control Structures	198.562	2.482	8.2
	2.3	New River bank protection Bhulukia	34.0	0.425	1.4
3	Excavation of khals		806.248	10.078	33.2
4	Repair of BWDB Offices,stores		15.000	0.188	0.6
5	Modernization of Farmer Canal Systems		961.600	12.020	39.6
6	Upgrading of electrical distribution system		273.700	3.421	11.3
	Total		2,427.6	30.345	100.0

7. Currently the Muhuri water is managed by about 475 individual private pump operators who sell water to farmers without regulation. BWDB operates the main regulator and undertakes maintenance work within the limitation of available funds. WUA provide some coordination and liaison activities.

8. To rationalise and improve the efficiency of the operation and maintenance of the irrigation system it is proposed that a third party Irrigation Management Operator (IMO) is

contracted by the BWDB to manage the Muhuri Irrigation Project (MIP) on behalf of the government and water users. For Muhuri it is proposed that the IMO will initially be contracted to manage, operate and maintain the Level 2 infrastructure (the khals and minor water control structures) and Level 3 infrastructure (the tertiary systems including the low lift pumps and the proposed pipe water distribution system). The IMO will also supervise all the investment works and will prepare the participatory design of the pipeline, low lift pumps and electrification.

9. The management of the Level 1 infrastructure – the main regulator, closure dam, coastal embankment, main rivers would remain with BWDB with the exception of small regulators in the coastal and river embankments which would be assigned to the IMO. The vulnerability of the coastal embankment to natural disasters and large size of the closure dam and regulator make it less appropriate to assign to the IMO at this stage; but could be considered in the future. The operation of the reservoir would follow agreed operation rules to be developed by the BWDB and the IMO in coordination with the Implementation Coordination Committee (ICC).

10. The project, aims at improving the agricultural production in the IMIP area by means of rehabilitation of the irrigation infrastructure and related facilities. In summary, the project can be described as an irrigation and flood protection rehabilitation project aiming at improving agricultural production in the Muhuri Irrigation Project. The main negative impacts of the project and the identified mitigation measures are summarized in the table below.

Main Negative Impacts and Proposed Mitigation Measures

Negative impacts	Proposed mitigating measures
Hazards and environmental impacts related to construction activities including: o Worker accidents o Air, water and soil pollution o Conflicts with local population o Risk of road accidents o Loss of valuable flora along khals	o Adherence to laws and regulations o Watering of unpaved access roads o Covering of trucks to prevent dust emission o Minimize activities during prayer time/rest hours o Provide sanitary facilities to workers o Design a waste collection system for construction wastes/ wastes from worker camps o Recruit workers locally o Strict enforcement traffic rules o Minimize destruction of bank vegetation o Schedule works not to disrupt irrigation water supplies
Some loss of natural vegetation in the waterways during the excavation activities may affect fish stocks.	o Impacts would be temporary o Management of the fisheries. Fisheries management through lease of the khal and reservoir supported by stocking is being considered to help support some of the cost recovery for OM. If found viable this would be implemented through the IMO. Feasibility studies will be developed by the IMO.
Water quality of surface waters and groundwater due to increased agro-chemical use including fertilizers and pesticides	Agriculture extension to support timely and correct advice on pesticide application Introduction of integrated pest management

11. The summary table shows that the number of negative impacts is limited. The main positive impacts of the project are summarized below. The rice production in the area will

increase considerably. However, overall agricultural production will increase and this may lead to a regional socio-economic uplift.

Main Positive Impacts of the Project

Project activity	Related positive impacts
Improved supply of irrigation water to agricultural lands	Increased paddy production Improvement of socio-economic conditions of farmers Socio-economic uplift of the region
Construction activities	Creation of temporary job opportunities

12. The project is primarily an increment of the existing irrigation systems and the environmental issues are primarily a function of the original scheme construction 30years ago and not the proposed additional interventions under the IMIP.

13. In general terms the positive impacts are expected to outweigh the negative impacts, on the condition that the project rehabilitation activities are carefully planned and that due attention is given to the social aspects and risks of project implementation. If the environmental management plan (EMP) is carefully implemented and due attention is paid to the proposed mitigating measures, the project will not have unacceptable impacts and a complete EIA is not thought to be necessary.

I. PROJECT DESCRIPTION

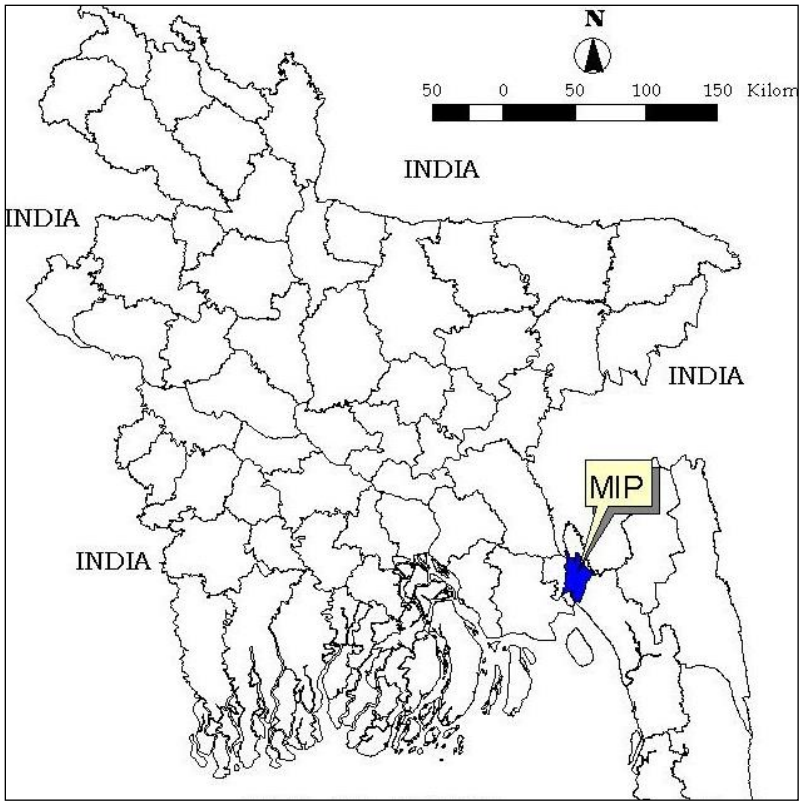
A. Introduction

1. An Initial Environmental Examination (IEEs) has been carried out for the Muhuri Irrigation Project modernization and has been performed to make the project environmentally sustainable including assessment of the impacts of climate change. The IEE study has been developed based on both primary and secondary data.

B. Description of the Current Project

2. The MIP is located in the middle of the South-Eastern Region of the country around the confluence of the Feni, Muhuri and Kalidaskhali rivers in the coastal belt of the Bay of Bengal. The project area covers six Upazilas; Feni sadar, Sonagazi, Fulgazi Chagalnaiya, Parsuram and Mirsarai. Mirsarai upazila lies in the Chittagong district the other 5 Upazilas lie in Feni District. The gross project area measures about 40,000 ha, the cultivated area is 28,600 and the irrigable area is 14,050 ha. The MIP is one of the larger irrigation projects in Bangladesh. The location is shown in Figure 1below.

Figure 1 Muhuri Project Location



3. The Muhuri Irrigation Project (MIP) has been created in early 1980s by the construction of the Feni Dam and Regulator downstream of the confluence of the Feni, Muhuri and Kalidash-Pahalia rivers. The Feni dam is an earthfill embankment sets up the water level and creates a reservoir. The reservoir formed by the earth fill embankment and gated regulator structure provides a source of permanent fresh water, enabling water to enter the natural channels and canal network by gravity. The water is then lifted to agricultural land by small Low Lift Pumps

(LLP). The scheme was designed for dry season irrigation as well as supplemental wet season irrigation. In addition, flood control and protection of tidal water are ensured by the scheme.

4. The World Bank appraisal for the original project implementation estimated an increase of the boro rice area from about 6,000ha to 20,000ha. Preventing overland seawater intrusion would bring about 1,200ha of additional uncropped land into cultivation. The backwater from the barrage enables water to enter the natural channels (khals) and canal network by gravity. The water would be then lifted to irrigate the fields by about 800 privately operated low-lift pumps each of 5-7 hp serving about 18ha, allowing for at least one irrigated rice crop a year. Following completion of the project rice production was forecast to increase by 60% providing increased income for about 45,000 families most of whom are small farmers with land holdings of about 0.65ha. Annual rice production would increase from about 73,000 tons to about 145,000 tons at full development.

5. In 1996 the expansion of the Muhuri project was studied and the Mahuri-Kahua Irrigation Project was developed which partly overlaps the Muhuri Irrigation project. The Muhuri and Muhuri-Kahua project areas are shown in Figure 3 below.

6. Initially, farmers experienced major improvement in production and were able to cultivate much larger areas with rice, however siltation of the reservoir and khals has reduced the benefit over the years. The BWDB operates the Feni Regulator the coastal and river embankment and drainage sluices and is also responsible for removing silt from the khals to ensure adequate drainage as well as providing adequate access to water for irrigation. The low lift pumps and the farmer canal systems are currently managed by about 475 private sector pump operators.

C. Current Issues

7. The main issue for Muhuri is the gradual loss of area under irrigation. Analysis by the project preparatory technical assistance (PPTA) of the 2011 boro cropping using satellite analysis estimated the irrigated area from surface water in the Muhuri Irrigation Project (including the Muhuri Kahua) to be about 11,300ha. Groundwater provides an additional 6,600ha of boro rice. The main causes of the reduction in irrigated area are complex but include:

(i) Major siltation of the khals and rivers has resulted in much of the irrigation area having no or limited access to khal water.
(ii) Over the 29 years since construction the reservoir storage has significantly decreased due to siltation. The original reservoir storage was about 32Mm3 but this has reduced to about 7Mm3. The current overall storage in reservoir, rivers and khals is 54Mm3 of which 18Mm3 is live storage.
(iii) There appears to have been reduction in the river flows as a result of increased abstractions in India. Heavy abstraction of ground water is also likely to be reducing the natural recharge to the rivers.
(iv) There are large annual climatic variations which is affecting water availability, recent cold winters and changes in agricultural practice are delaying the planting dates of Boro rice to late January and February which puts additional pressure on the scarce water resources during the critical February and March periods.
(v) The low prices of rice and high prices of inputs including pumping has resulted in many farmers not planting rice.
(vi) Pump operators find it too expensive to provide water to plots located far from the pumps and most of the irrigated land is a nucleus around each pump.

(vii) There is a significant drop in the number of operational pumps and the irrigated areas. Pump inventories in 2013 show there are only about 440 operational pumps from an original 800 pumps. The irrigated area from surface water based on 2013 satellite imagery is estimated to be 8400ha in the MIP reduced by 60% from the original target of 23,000ha

8. Other issues include deterioration of the coastal embankment and associates structures which are causing salinity intrusion and impediments to drainage as well as risk from sea water inundation during periods high sea level.

D. The Proposed Project

1. Strategy

9. Increased water use in the upper catchments in India and in Bangladesh has led to some loss of supply. Loss of storage through sedimentation also reduces the water availability. It is likely that increased groundwater abstraction has also reduced the recharge to the rivers. The storage currently only supports about 2,000ha of irrigation.

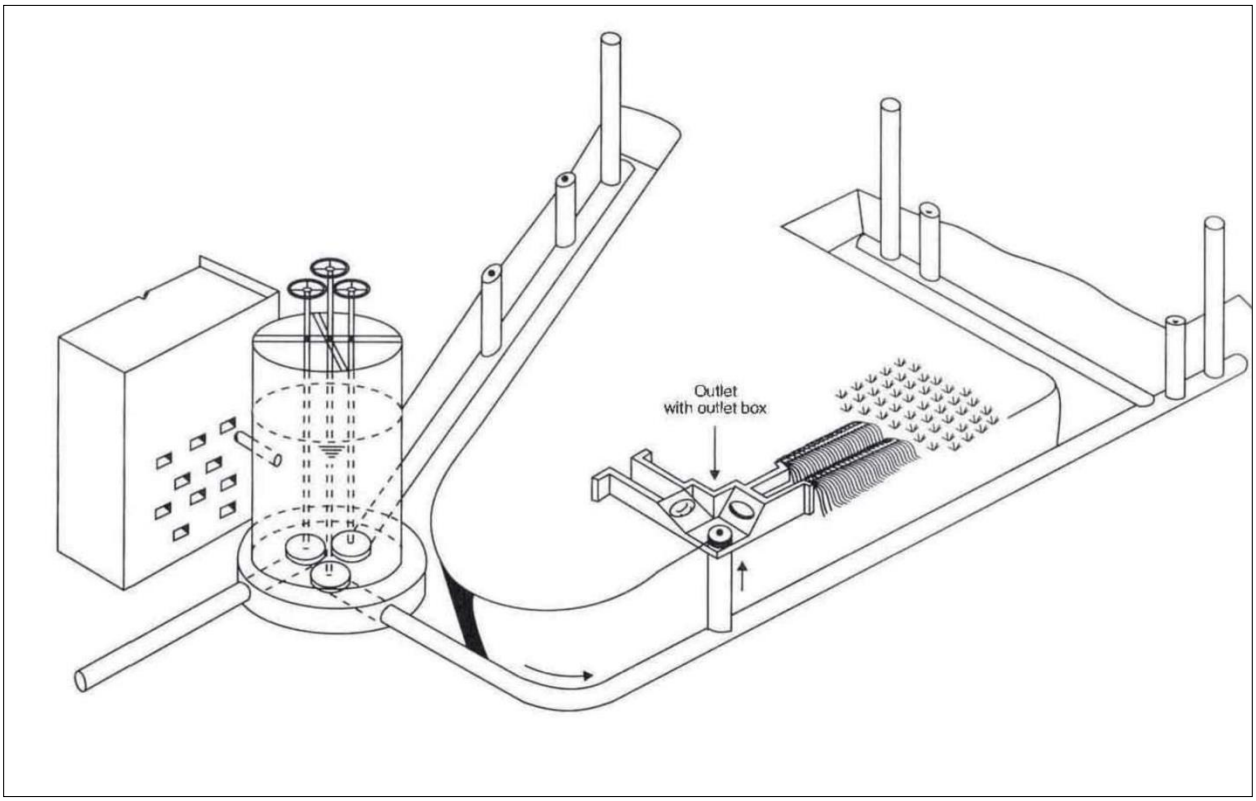
10. The limitation of water resources is a major constraint as there is no potential to increase the supply. The role of groundwater has been examined but is already heavily over exploited and no development of groundwater is proposed under the project; there are also environmental issues which need to be considered. Further studies are however proposed to assess the viabilities of improved conjunctive management of the surface and the groundwater. Most of the tubewells are privately owned which limits the scope for groundwater management.

11. Desilting of the khal will allow many areas to access surface water which are currently unable to irrigate. The increased demand from expansion of the irrigated area through desilting must however be supported be initiatives to reduce water loss and improved water use efficiencies to ensure the supply and demand remain in equilibrium. With current levels of water use efficiencies and storage availability it is estimated that surface water is only sufficient to irrigate about 11,300 ha over both Muhuri and Muhuri Kahua.

12. To support the expansion of the irrigated area requires water conservation and increased water use efficiency. An integrated approach to improved access to water through desilting of the khal to increase access to wider area combined with water conservation through; (i) increasing the efficiencies of water distribution to reduce the water losses; (ii) reducing water use by farmers through more precise irrigation and the volumetric basis of charging; (iii) reducing the quantity of water lost through the boundary of the project through boundary water retention structures and (iii) promoting the diversification from rice to other lower water use crops. The project will also take up pilots and demonstrations of rice cultivation techniques that are less water intensive.

13. The development of pipe distribution systems is proposed to reduce the water losses through improved application, distribution and operational efficiencies. The change from a fixed rate to a volumetric charging system by using a prepaid meters, among users, has shown significant reduction in water use in the Barind project. A schematic showing the typical layout of the pipe distribution system is shown in Figure 2 below.

Figure 2 Typical Arrangement of the Pipe Distribution



14. The introduction of prepaid smart card system through the project in conjunction with a buried pipe tertiary distribution system and improved pumping equipment is expected to result in the following:

(i) Water use efficiency gains of around 39 % from reduced conveyance and operational losses and improved field irrigation practices. The change of basis of charging from a fixed rate per unit area to a volumetric basis is significant to the water use efficiencies.

(ii) Flexible on-demand irrigation supply to farmers resulting in increased yields as well as support crop diversification.

(iii) A 15 % shift from rice grown under puddled conditions into non-rice crops, including vegetables. In addition promoting early planting of vegetables to minimise the water demand during the critical month of March.

(iv) Pumping (energy) efficiency gains accruing from newer more efficient pumps and motors, and use of pumping equipment that operates efficiently for the discharge and average pumping heads expected for each system.

(v) 100% cost recovery for OM costs from water users (farmers) by use of prepaid meters with charges based on volume used instead of a fixed rate.

(vi) Elimination of any exploitation by pump owners and operators or corruption or loss of funds by eliminating cash payments.

(vii) To allow presently unirrigated areas to have access to irrigation water.

(viii) The introduction of on demand irrigation with pumps permanently available, opens opportunities for supplementary irrigation during the whole Rabi and Kharif seasons in addition to irrigation for the boro crop.

15. These in turn will enable: (i) about 50% expansion in cropped area; (ii) reduced pumping volumes and costs; (iii) a variety of crops with different planting dates, crop durations and irrigation water requirements, to suit individual farmers; (iv) improved crop yields arising the individual farmers being able to control timing and amounts of irrigations; and (v) sustainable funding for operation and maintenance.

16. The estimates of current and with-project irrigation volumes and cropped areas are that with the project the net (rabi) irrigation area could potentially increase from around 11,300 ha to 17,000ha based on: (i) an increase in water use efficiency from 36% to 50%; (ii) a possible crop diversification with 15% of the Rabi cropped area being non-rice; (iii) khal excavation so that all parts of the command have access to water.

17. Over and above the estimated water savings, the project will also provide agricultural support initiatives to help farmers improve production levels as well as develop water saving initiatives; these would include the use of water saving technologies including system of rice intensification (SRI) and alternate wet and dry irrigation, developing improved cropping patterns and mechanisation. These initiatives will be piloted and demonstrated during years 1 to 4 of the project.

18. **Long term sustainability**: siltation of the reservoir will continue but as the reservoir is now only contributing 12% of the live storage further loss of storage will be less significant. Storage in the rivers provides 76% of the storage which would be reasonably stable due to flushing as well as abstraction of sand. The khals which contribute 12% of the live storage will continue to silt but the proposed program of effective maintenance will ensure the storage is maintained. The upstream catchment lies in India so there is no specific scope for catchment management to reduce the level of siltation. Long term irrigation abstractions in the upstream catchment in India will probably not increase significantly due to the lack of available irrigable land; some increase in water supply abstractions are likely to happen but these are very small relative to irrigation demand. The main long term mitigation strategy for the project is to continue to diversify from rice to lower water consuming crops such as vegetables and pulses as well as ensuring adequate routine maintenance of the khal.

19. The investment plan was developed based on close consultation with the Feni Circle of the Bangladesh Water Development Board (BWDB) who prepared estimates of the requirements. It has not been possible to address all of the needs; prioritisation has been applied to measures to increase the irrigation productivity and sustainability. Cost estimates have been prepared based on an analysis of volumes and applying the 2013 unit rates based on the BWDB schedules. The proposed investment incorporates:

(i) Repair of the original design section of the 22.6 km coastal embankment of polder 60 running from the Feni regulator to the new Little Feni regulator.

(ii) Rehabilitation of four coastal water control structures and construction of 2 new coastal water control structures.

(iii) River and khal Systems; rehabilitation of 3 water control structures and 5 new water control structures.

(iv) Excavation of 3.8 million m^3 from the 460km of khals to ensure the whole project area has access to water in the Khals during the boro season as well providing improved drainage.

(v) Development of 17,000ha of a modern and highly efficient piped farmer water distribution system to improve timely access to water and reduce water losses. The water savings from the increased efficiency will allow an increased area of irrigation.

(vi) Provision of prepaid card meters to allow water allocations to be based on a volumetric basis and ensure full and transparent payment and accounting.

(vii) Full electrification of the pumping to reduce the operational costs and increase management flexibilities. The electrification includes conversion of diesel pump sets to electric and replacement of old electric pumps as well as extension of the grid network to allow connection of pumps.

(viii) Pilot solar panels and pumps for 30ha

(ix) Rehabilitation of office space for use by the BWDB and the proposed Irrigation Management Operator

20. The investment plan is designed to increase the productivity and long term sustainability of the MIP. The investments have been targeted to improve the irrigation performance and cost recovery is shown in Table 1. The estimated current and future irrigated areas are shown in Table 2 below.

21. The project area is shown in Figure 3 below. The main project works including the khal excavation, pipe distribution and electrification are spread over the whole project area. The repairs to the coastal embankment are focused on the west side between the Feni Regulator and the little Feni Regulator.

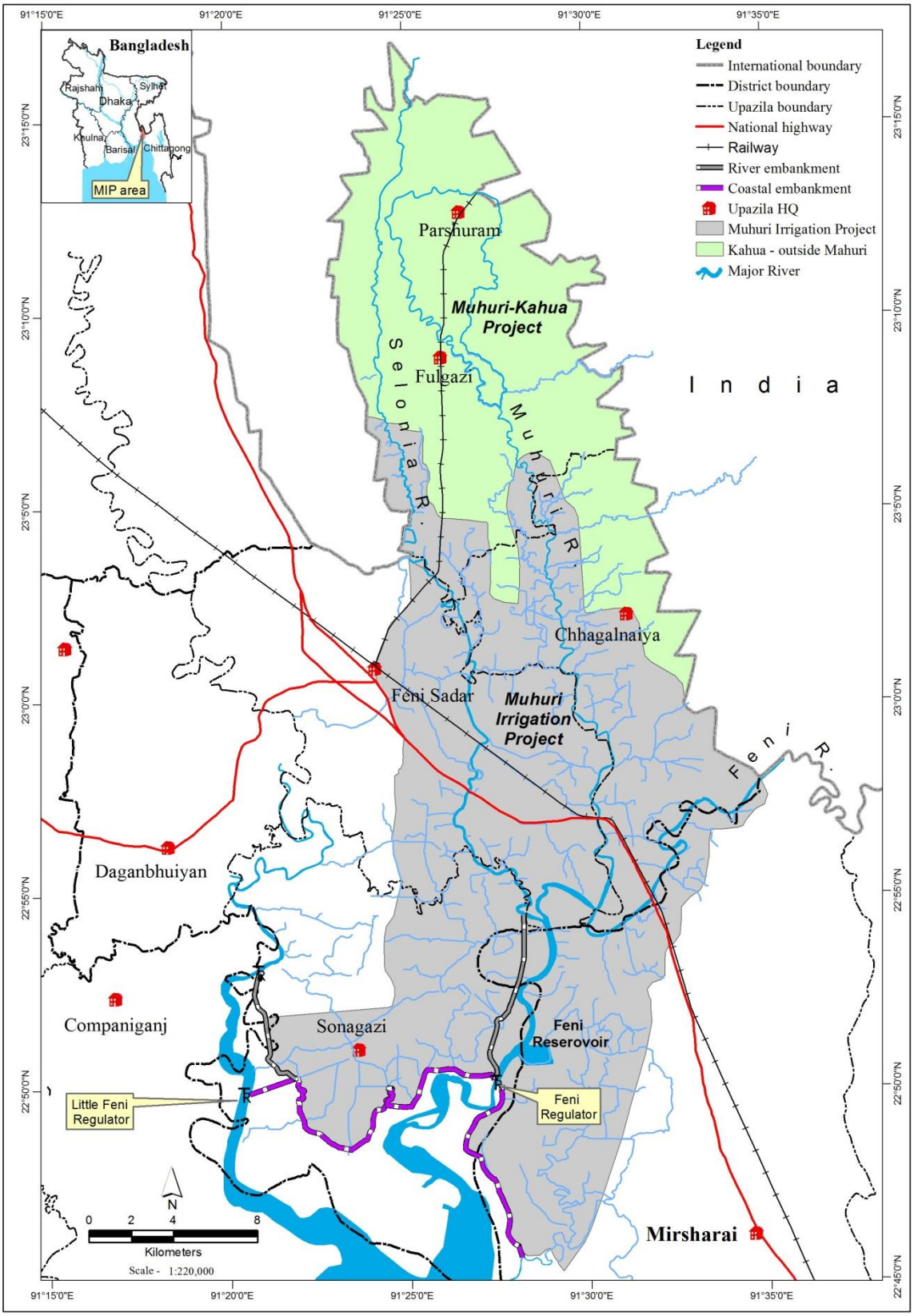
Table 1 Proposed Investment for MIP

Ref		Item	Unit	Qty	Cost (Tk Million)	Cost ($ Million)	Sub Total Tk million	Sub Total $ million	%
1		**Coastal Flood Protection**							
1.1		**Repairs to the coastal embankment Polder 60**	m3	325,000	66.625	0.833	66.6	0.8	2.7
1.2		**Coastal Flood Protection Stuctures**							
	1.2.1	**Rehabilitation of Coastal Protection/Drainage Structures**							
	1	Polder 60 Sluice 05 Rehabilitation	nr	1	0.826	0.010			
	2	Polder 60 Sluice 06 Rehabilitation	nr	1	0.839	0.010			
	3	Polder 60 Sluice between 6 and 7 Rehabilitation	nr	1	1.774	0.022			
	4	Polder 60 Sluice 08 Rehabilitation	nr	1	10.925	0.137			
	1.2.2	**New Coastal Protection/Drainage Structures**							
	1	Polder 60 Sluice 07 New 2 Vent	nr	1	23.485	0.294			
	2	Polder 60 Sluice 09 New 2 Vent	nr	1	21.136	0.264	59.0	0.7	2.4
2		**Main River System**							
2.1		**Repairs to Water and Flood Control Structures**							
	2.1.1	Feni Regulator Structure-gate and lifting system	Ls	1	9.900	0.124			
	2.1.2	Little Feni River Sluice 10 Rehabilitation	nr	1	2.640	0.033			
	2.1.3	Little Feni River Sluice 11 Rehabilitation	nr	1	0.350	0.004			
2.2		**New Water and Flood Control Structures**							
	2.2.1	North Daulatpur New 2 Vents	nr	1	23.340	0.292			
	2.2.2	South Daulatpur New 4 Vent	nr	1	42.639	0.533			
	2.2.3	Bhalukia New 2 Vent	nr	1	28.340	0.354			
	2.2.4	Madhya Khal New 4 Vent Water Retention Structure	nr	1	41.672	0.521			
	2.2.5	Ichakhali Khal New 7 Vent Water Retention Structure	nr	1	62.571	0.782	211.5	2.6	8.7
3		**Excavation of khals**	m3	3,825,000	688.500	8.606	688.5	8.6	28.4
4		**Repair of BWDB Offices,stores**	Ls	1	15.000	0.188	15.0	0.2	0.6
5		**Farmer Canal Systems**							
5.1		New low lift pumps with electric motors	ha	17,000	81.600	1.020			
5.2		Buried UPVC Pipe and associated structures	ha	17,000	952.000	11.900			
5.3		Prepaid meters and system	ha	17,000	68.000	0.850			
5.4		Pilot solar pumps and panels	ha	60	14.400	0.180	1,116.0	14.0	46.0
6		**Upgrading of electrical distribution system**							
6.1		Upgrading of electrification	ha	17,000	272.000	3.400	272.0	3.4	11.2
		Total			**2,428.562**	**30.357**	**2,428.6**	**30.4**	**100.000**

Table 2 Estimated Current and Future Irrigation Areas

		Current Area Boro ha			Future Area of Boro Rice and Non Rice					
					Surface Water					
	Cultivable Area/1	Surface water rice/3	Ground water rice/2	Total rice/1	Total	Rice	Non Rice	Ground water rice	Total Surface and GW	
Muhuri	24,800	8,400	3,400	11,800	13,000	11,050	1,950	3,400	16,400	54% increase in area irrigated by SW
Muhuri Kahua	13,800	2,900	3,200	6,100	4,000	3,400	600	3,200	7,200	38% increase in area irrigated by SW
Total	**38,600**	**11,300**	**6,600**	**17,900**	**17,000**	**14,450**	**2,550**	**6,600**	**23,600**	
Notes	1/ Data from 2011 Satellite Imagery									
	2/ Data from Upazilla statistics 2011									
	3/ 8400ha is the estimated current irrigable area from surface water (based on water balance analysis)									

Figure 3 Muhuri and Muhuri Kahua Irrigation Project



22. The MIP scheme consists of the elements indicated in Table 3 below

Table 3 Key Project Elements

Project Components	Unit/Quantity
1.Closure Dam length	3, 411 m
2.Regulator:	
Feni Regulator	40 gates, size 3.65 m x
Highest Pond Level	3.65 m
Dead Storage	+3.81 m (SOB)
Design (flood) discharge	+2.59 m (SOB)
Highest water level Intake	2,718 m3/s
regulator	12.95 m
3. Drainage Sluice	8 Nos
4. Canals and natural canals	598 km
5. Bridges and Culverts	74 Nos
6. Access Road	38.96 km
7. Low Lift Pumps	Currently about 500

E. New Initiatives for Irrigation Management for Muhuri Irrigation Project

23. Investing in the rehabilitation and modernization of MIP will only be beneficial if physical improvements are accompanied in parallel with significant strengthening of irrigation management including putting into effect a long-term strategies for OM including: (i) adequate funding; (ii) introduction of new and highly efficient and cost effective operation and maintenance; and (iii) establishment of an efficient and sustainable management organization.

24. For the large scale irrigation schemes the current approaches of Participatory Irrigation Management (PIM) through Government and the water users is proving ineffective, Options for large scale irrigation schemes were examined in 2011 under the ADB TA DIAMMIS which developed proposals for long term sustainable management of the MIP and presented the conceptual framework for the use of third party management operators to address the current short-comings.

1. Proposed Approach for Muhuri Project under IMIP

25. Currently the Muhuri water is managed by about 475 individual private pump operators who sell water to farmers without regulation. BWDB operates the main regulator and undertakes maintenance work within the limitation of available funds. WUA provide some coordination and liaison activities.

26. To rationalise and improve the efficiency of the operation and maintenance of the irrigation system. It is proposed that a third party Irrigation Management Operator (IMO) is contracted by the BWDB to manage the Muhuri Irrigation Project (MIP) on behalf of the government and water users. For Muhuri it is proposed that the IMO will initially be contracted to manage, operate and maintain the Level 2 infrastructure (the khals and minor water control structures) and Level 3 infrastructure (the tertiary systems including the low lift pumps and the proposed pipe water distribution system).

27. The management of the Level 1 infrastructure – the main regulator, closure dam, coastal embankment, main rivers would remain with BWDB with the exception of small regulators in the

coastal and river embankments which would be assigned to the IMO. The vulnerability of the coastal embankment to natural disasters and large size of the closure dam and regulator make it less appropriate to assign to the IMO at this stage; but could be considered in the future. The operation of the reservoir would follow agreed operation rules to be developed by the BWDB and the IMO in coordination with the Implementation Coordination Committee (ICC).

28. It is proposed to develop the management of MIP scheme in two stages; (i) a performance based Management Design, Supervision and management contract through an Irrigation Management Operator (IMO) over a five year period; and (ii) followed by a lease contract also through an irrigation management operator (IMO) for a period of around 15 years.

2. Proposal for the Stage 1 Management Contract

29. The Irrigation Management Operator (IMO) of the MIP under the first stage from years 1 to 5 would be contracted by BWDB to a private company or consortium through international competitive bidding. The contract will be for a five year period with the IMO responsible for the OM for MIP including the establishment efficient revenue collecting through the prepaid meter systems. In addition the IMO would be responsible for the (i) supervision of construction of all the investment contracts; (ii) the design for tertiary level infrastructure (farmer canalization and low lift pumps) and (iii) the development of pilot agricultural demonstrations and cost recovery activities. In addition the IMO will be responsible for the supervision of implementation of the environmental management plan.

II. DESCRIPTION OF THE ENVIRONMENT

A. Agro-ecological Zone

30. The physiographic unit of the project at upstream is: Chittagong Coastal Plain (AEZ# 23), sub-regions are Piedmont Plains and River Flood plain(23a) and Young Tidal Floodplain(23b) with general soil type Non-Calcareous Grey Floodplain Soils(non-saline) in both of the sub-region soils. The soil texture in both of the sub-region soils is loamy. The landscape of the area-comprised of mainly medium high land to high land. The soil type pre-dominates with Non-Calcareous Grey floodplain soils(no-saline).

31. The physiographic unit of the project at the mid and downstream of the project Old Meghna Estuarine Floodplain (AEZ#19), sub-region is High (19a) with general soil type is Non-Calcareous Dark Grey Floodplain Solis with texture loamy. The landscape is highland. The O.M. is medium(1.7% to 3,5%) and general land fertility is moderate(District Agriculture Census 2001) throughout the project areas,

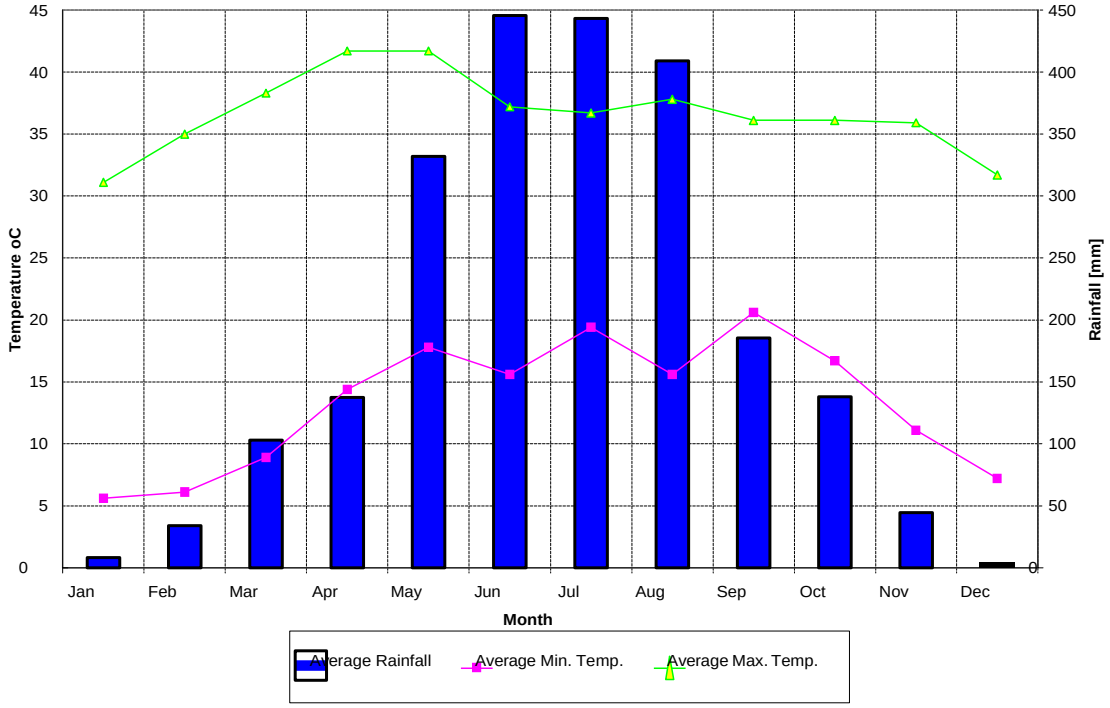
B. Climate

32. In this region there are three main seasons.

- The Southwest Monsoon: May to October- 90% of the annual rainfall occurs during this period and relative humidity is high.
- The Northeast Monsoon: It lasts from November to March.
- The Hot Season: This hottest season extend from about late March to May. The highest daily temperatures generally occur at this time, and Flash floods often occur from the rivers entering the eastern part of the region from the Tripura Hills.

33. **Rainfall:** The highest rainfall occurs in the south of the region, particularly around Ramgati. The mean annual rainfall at Noakhali is 3,200 mm and decreasing northwards to about 2,271 mm at Comilla. According to the data available for the station Parashuram (1192 – 2002 the average monthly rainfall varies from 3 to 445 mm. At this station, the average annual total amount is 2,285 mm. The rainfall (Parashuram) and temperature (Comilla) characteristics are presented in graphical form in Figure 4.

Figure 4 Average Rainfall (Parshuram and Temperature Comilla)



34. **Evapo-transpiration*:*** Evapotranspiration reaches its maximum level in April when temperature, sunshine and wind are all at, or close to, their maximum levels for the year. Potential evapo-transpiration data for 4 stations of the Region are presented in Table 4

Table 4 Monthly Potential Evapo-transpiration (mm)

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEA
CHANDPUR	68	82	129	146	139	107	109	112	103	101	77	62	1235
COMILLA	71	89	138	152	144	120	118	122	111	103	81	64	1314
FENI	72	89	130	143	145	115	113	117	110	106	81	68	1288
MAIJDEE	67	83	125	145	141	106	106	115	104	101	78	66	1238

Source: NWRD, WARPO (2000) from BWDB data.

35. The topographical levels of the project area vary from 7-8 m public works datum (PWD) in the north to 4-4.5 m PWD in the south and 4.50 -5.25 in the west to 5-6 m PWD in the east. The area occupies an almost level landscape of smooth, broad ridges and basins which are underlain by deep silty deposits. In some basins, those silts have been buried by a layer of clay which usually is less than 50 centimeter thick. Seasonal flooding is mainly by stagnation of excess rainwater. Soils are relatively uniform within this region, both between adjoining ridges and basins. They are deposited as alluvium, having low to

medium ranged permeability. Silty soils predominate, but there are significant proportions of silty clay or clay basin soils in Feni and east of Comilla districts.

C. Water Resources

36. Major rivers within the project area are the Feni, Kalidas-Pahalia, and Muhuri rivers, in addition, there are many Khals located in the area. Other rivers outside the project area such as Titas, Gumti, Dakatia and Meghna act as the main drainage collectors. Flow data are available for the Muhuri River (at Parshuram) and in the Feni River (at Kaliachari).

D. Assessment of Water Resources

1. Introduction

37. The project area lies in the flood plain of Feni, Muhuri, and Kalidas-Pahalia rivers which flow north to south and fall into Feni reservoir. Surface water irrigation is from the three rivers supported by storage in the rivers, drains and reservoir in the backwater from Feni Regulator. There is a significant level of groundwater.

38. An assessment of the available surface water to the Muhuri irrigation area (excluding Muhuri Kahua) has been carried out based on BWDB flow gauging data supported by some direct measurement of flows during March and April 2013. Flow and water level measurements are constrained by the very low velocities in the rivers which increases the inaccuracies of measurement. The 20years of flow data is shown in Table 5 which shows a number of inconsistencies. The 75% dependable flow which is norm for Bangladesh has been estimated to provide a total of 180 Mm^3 over the period December to April. The total flows from the three rivers are summarised in Table 6 below. There is no flow measurement of the available water to the Mahuri Kahua irrigation area

Table 5 Flow Data 1991-2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	20.2	14.0	11.0	16.7	147.3	170.3	293.0	212.9	206.1	126.3	52.0	34.9
1992	21.8	19.3	119.9	13.3	15.4	113.6	49.9	132.5	96.6	57.8	22.5	9.5
1993	16.4	18.0	25.3	18.1	83.1	56.1	190.3	90.7	120.9	76.7	53.2	35.7
1994	30.2	23.5	4.5	27.7	47.8	100.6	277.6	146.5	111.8	80.8	47.5	42.8
1995	25.0	17.8	49.3	16.4	197.4	127.1	245.3	327.8	66.8	69.3	26.6	28.9
1996	16.1	14.4	12.0	12.2	74.9	154.0	60.0	128.0	41.0	99.0	166.7	19.7
1997	19.3	15.8	14.5	26.8	48.1	68.6	138.8	158.5	112.1	39.8	13.0	15.4
1998	32.2	31.7	24.3	43.4	86.1	256.6	112.7	176.2	197.3	69.2	49.0	26.4
1999	32.4	17.5	24.2	28.5	28.5	94.8	70.4	134.3	93.4	84.4	50.0	38.2
2000	25.2	34.1	43.8	48.9	122.5	143.2	184.1	245.8	125.4	90.8	92.6	77.3
2001	43.8	35.2	34.2	53.7	19.3	28.1	22.9	35.4	43.6	37.6	23.0	8.1
2002	4.1	1.7	1.1	1.0	2.2	32.2	222.9	72.7	23.4	23.0	9.3	4.1
2003	1.8	0.9	1.1	3.5	0.9	48.1	11.0	25.3	29.7	27.0	20.1	4.7
2004	1.3	0.8	0.7	10.5	0.7	72.7	107.8	363.6	236.3	250.1	174.9	144.5
2005	69.5	12.9	14.7	18.0	73.9	135.7	147.9	224.4	163.1	203.6	160.3	119.3
2006	85.8	82.0	81.7	95.4	90.1	169.1	214.3	313.1	137.2	117.4	90.2	83.7
2007	77.4	15.8	30.8	53.0	179.9	227.1	82.7	20.8	89.0	74.2	-	-
2008	21.4	14.7	15.1	14.1	19.4	31.5	52.2	114.0	104.9	103.3	102.2	100.7
2009	3.3	2.1	2.5	3.2	7.2	5.9	79.6	213.0	166.7	110.8	110.0	104.8
2010	40.7	11.6	7.4	7.3	27.2	89.5	76.4	86.5	76.4	91.9	55.1	34.1
2011	38.5	39.5	44.1	44.7	48.1	46.8	111.4	227.5	107.1	47.9	24.2	35.9
2012	33.0	27.9	33.5	34.0	106.6	119.1	99.5	-	-	-	-	-
Average	30.0	20.5	27.1	26.8	64.8	104.1	129.6	164.3	111.9	89.6	63.9	46.1
75% dependable	16.5	11.4	10.0	14.1	21.1	58.3	68.8	105.2	61.9	50.4	30.5	20.1

Table 6 Dependable Supply to Muhuri m3/s

River	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feni	13.2	9.2	7.4	11.6	15.7	31.9	42.1	69.7	39.2	31.4	18.5	14.9
Muhuri	2.1	1.4	1.6	1.6	3.4	16.5	16.7	22.2	14.2	11.9	7.5	3.3
Kalidash Pahalia	1.2	0.8	1.0	1.0	2.0	9.9	10.0	13.3	8.5	7.1	4.5	2.0
Total	**16.5**	**11.4**	**10.0**	**14.1**	**21.1**	**58.3**	**68.8**	**105.2**	**61.9**	**50.4**	**30.5**	**20.1**

2. Long Term Impacts of Upstream Abstractions

39. The area of the catchments in India and Bangladesh based on 1977 feasibility studies are shown in Table 7 below.

Table 7 Catchment Areas

	India		Bangladesh		Total
	Km2	%	km2	%	km2
Selonia	166	62%	101	38%	267
Muhuri	787	71%	316	29%	1,103
Feni	539	37%	927	63%	1,466
Total	1,492	53%	1,344	47%	2,836

40. The water sharing agreement for the Feni river remains under discussion. Bangladesh has agreed to allow 1.82 cumec (60 cusec) of water withdrawal by India for drinking purposes and there is an offer is to share the Feni river resources 50:50 basis, but this has not been ratified. The irrigation areas in India relative to Bangladesh are relatively small; of the order of 2000ha compared with the proposed 17,000ha in Bangladesh. The irrigation is upland irrigation and return flows about 50% might be expected from both irrigation and drinking water. Agreements for the Muhuri and Selonia rivers are still pending.

41. Without assessment of the total water resources and current abstractions in India and implementation of a rainfall runoff model, it is difficult to assess the implications of different water sharing scenarios. The flow monitoring data indicates no decline of water coming from India but the quality of the monitoring needs to be upgraded.

a. Adaptation Strategy.

42. The proposed irrigation area is based on 75% dependable flow measured at two measuring locations in the Feni and Muhuri rivers. There remain uncertainties in the quality of the historic data as well predicting the future flows. The proposed area of 17000ha has however has been based on conservative estimates of efficiency and the crop water requirements. Some additional efficiencies through the change to a volumetric system would further increase the efficiencies but these have not been quantified and are not incorporated into the water balance.

43. The strategy to meet any future reduction of flows is to support diversification to non rice crops during the Rabi season together with development of more efficient scheduling of crops to match the water availability. February and March are the critical months with the river flow recovering quickly to the rains in April. Under a scenario if the inflows were cut by 50% then 17,000ha of irrigated non rice crop could be supported during the January to March. This could be followed immediately by an Aus rice crop once the flows recover in April. Use of improved shorter period rice varieties with access to irrigation and improved drainage could allow for two

to three rice crops during the period of adequate water availability April to December. About 30% of the project investment will be to excavate the khal which will support access to irrigation as well as improve the drainage which will open significant opportunities to intensify the cropping during the periods April to December.

44. There are many constraints to adjusting cropping and diversification. From experience it has been demonstrated that farmers will be more open to changes in agriculture practices when they face critical water shortage situations and change is supported through demonstrations and training in improved agricultural practices. A key part of the terms of reference for the Muhuri Irrigation Management Operator will be to improve the quality of flow monitoring as well as develop and promote long term and sustainable cropping systems.

45. More detailed studies on the upstream hydrology and the potential risks from increased abstraction in the upper catchment are ongoing and will be presented in the PPTA Final Report.

2. Storage

46. The estimated storage has been assessed based on surveys by DIAMMIS during 2011 and IMIP during 2013. The overall storage of the project including the reservoir, rivers and khal is 54Mm^3 of which 17Mm^3 above level 3.0m PWD is live storage. Significant sedimentation has occurred since the construction of the project 29 years ago mainly in the reservoir which has lost about 24 Mm^3 or 80% of its total storage as well as the khals which have lost about 3.5Mm^3 or 30% of their total storage. Storage is currently contributing to about 2,000ha of the irrigation. The loss of storage is expected to stabilise as storage in the reservoir is already largely lost and the rivers which now provide most of the storage are largely self-flushing. Storage in the khals will be preserved through periodic desilting which will also increase irrigation access currently not possible over much of the scheme due to sedimentation in the khals.

3. Groundwater

47. There is currently heavy use of groundwater for irrigation which is used to support the shortfall of surface water. Shallow groundwater is available within 2 to 4m below the ground surface in the project area but its quality it is not good and availability is variable. The groundwater is exploited by shallow tubewells for irrigation and deep tubewells with hand pumps for drinking water. There are a few deep tubewells where good quality water can be abstracted at a depth of greater than 150m for irrigation these can potentially provide yields of about 20 l/s.

48. Recharge of groundwater in the project area occurs by slow vertical percolation of rain irrigation water, seepage loss of the run–off the rivers and stored water in canals, khals, streams and rivers in groundwater. There is net groundwater inflow from the uplands to the north which may be a main source of recharge. The rate of percolation of water derived from rainfall to the aquifer is retarded due to thickness and impermeability of the upper clay layer. Recharge begins from the month of May peaks during August; the upper water bearing horizons quickly become saturated and due to the heavy surface soils much of the potential recharge is rejected.

49. The Master Plan Organization (MPO) in 1993 estimated the recharge for most of the country based on groundwater modelling studies and is still considered to be the best and the most reliable assessment. The total estimate of useable recharge by the MPO of the five Upazilas is estimated to be 57Mm^3 per year The groundwater is already heavily overexploited with current total annual abstraction within the Muhuri and Muhuri Kahua is estimated to be 92 Mm^3 irrigating around 6600ha; this is nearly three times the estimated sustainable abstraction

volume. The net water requirements for rice even with some element of conjunctive use are high and around 11,000m^3/ha or 11 Mm^3/1000ha. Consequently, the use of groundwater is not proposed as an option to meet the estimated shortfall in water required to irrigate the entire command area. Although the immediate use of groundwater is not considered appropriate under the IMIP project 1 some further studies and modelling are proposed to help get a better understanding of groundwater, including the implications of current abstractions and development of long term management strategies for surface and groundwater.

4. Land Use and Cropping

50. The Muhuri project area actually consists of the Muhuri project area and the Muhuri Kahua project area to the north. The projects overlap and there is an estimated 12,820 ha of cultivated area lying inside both Muhuri and Muhuri-Kahua projects. The estimated areas of Muhuri and Muhuri-Kahua are shown in Table 6 below.

Table 8 Current Land Use and Cropping

Irrigation Project	Land Use (ha)				Rabi Season Cropping (ha)		
	Total	Settlements	Cultivated	Other	Boro Rice	Fallow	Other
Muhuri Project	43,892	15,265	24,776	3,851	11,843	9,773	3,160
Muhuri Kahua Project	21,731	7,168	13,783	780	6,108	7,136	539
Total	65,623	22,433	38,559	4,631	17,951	16,909	3,700

Source: Analysis of 2011 satellite imagery prepared for the project by CEGIS 2013

5. Water Balance

51. To estimate the future irrigable area reference has been made to the water balance as well as the estimated area of crops from the satellite imagery as well as data on groundwater abstraction from Upazila data. There are some issues of data quality and where possible cross referencing of different data sources is used. The present and estimated future irrigable areas are shown in Table 7. There is currently only very minimal non rice crop, in the future with-project a change to 15% non-rice is estimated.

Table 9 Estimated Current and Future Irrigable Areas (ha)

		Current Area Boro ha			Future Area of Boro Rice and Non Rice/4					
					Surface Water					
	Cultivable Area/1	Surface water rice/3	Ground water rice/2	Total rice/1	Total	Rice	Non Rice	Ground water rice	Total Surface and GW	
Muhuri	24,800	8,400	3,400	11,800	13,000	11,050	1,950	3,400	16,400	54% increase in area irrigated by Surface Water
Muhuri Kahua	13,800	2,900	3,200	6,100	4,000	3,400	600	3,200	7,200	38% increase in area irrigated by Surface Water
Total	**38,600**	**11,300**	**6,600**	**17,900**	**17,000**	**14,450**	**2,550**	**6,600**	**23,600**	
Notes	1/ Data from 2011 Satellite Imagery									
	2/ Data from Upazilla statistics 2011									
	3/ 8400ha is the estimated current irrigable area from surface water (based on water balance analysis)									
	4/ Analysis by PPTA given in Appendix 3									

52. Rice prices are currently very low and the margins for rice farming are minimal. To increase the financial returns agricultural support services will be provided under the IMIP project and will be implemented by the Irrigation Management Operators (IMO) with the objective of enabling small farmers to take up more efficient water use, crop diversification and adjusted cropping calendars through sustainable practices or developing opportunities for more commercial farming or agribusiness. The IMO as a private service provider can potentially offer a nucleus to provide a variety of self-financing on the ground-services either directly or interacting and engaging with existing government and non-government organisations. Pilot programs will be investigated and developed during the first five years under the Project to assess viabilities and response to the agriculture support programs before upscaling.

6. Water Quality

53. Some sampling of water quality is presented in table 8. Iron in water from the shallow tubewells is quite high and farmers report some problems; in some cases they use a mixture of tubewell water and river water. The surface water is of suitable quality for irrigation. The sediment load from the 2 eastern rivers, coming down from the hills in India, is very high during the rainy season. This is likely to be attributed to deforestation in the upstream sections of the respective catchments. The Southeast region is one of the hot-spots for high arsenic concentrations in groundwater. The shallow aquifer has high arsenic concentrations in Chandpur, Noakhali and Lakshmipur districts. The most affected aquifers lie beneath the Meghna floodplains.

Table 10 Water Quality

Parameter	Limit for irrigation	Groundwater Shallow Tube well			Surface Water: Khal from Muhuri River		
		SP1	SP2	SP3	Dharmo Khal	Koriya	Highay Borrowpit Khal
	Water Quality mg/l						
Total Hardness (as $CaCO_3$)	60	36	45	44			
Chloride (Cl^-)	<150	26	69	32	15	12	9
Nitrate (NO_3)	5	0.33	0.71	0.61	0.62	0.96	0.7
Sulphate	250	1	<1	1	<1	2	1

(SO_4)							
Arsenic (As)	0.1	0.007	0.018	0.007			
Calcium (Ca)		9	10	9	14	12	13
Iron (Fe)	<1.5 recommend <4 upper limit	3.8	4.1	4.2			
Magnesium (Mg)		6	8	7	8	7	7
Potassium (K)		3.3	4.1	4	3.2	3	3.1
Sodium (Na)	70	50.6	87.3	53.7	25.7	21.3	22.5
pH	6.5-8.4	6.45	6.86	6.98	7.75	8.07	7.21
Zinc (Zn)	1	<.08	<0.08	<.08			
Boron (B)	0.5	0.2	0.2	0.22			
EC(µs/cm)	750	247	426	308	173.8	142.8	144.1

54. Arsenic contamination of groundwater is the prime concern in the region. The problem was first discovered at the end of 1993; it is very much an issue in the Southeast region. The shallow aquifer has high arsenic concentrations including the, Feni districts.

55. Recent studies by the Department of Public Health Engineering reveal that excess use of ground water for both irrigation and household use have lowered the ground water table. But recharging of ground water table is not occurring simultaneously due to delaying of rainfall, which could be attributed to climate change. The increased draw down in the ground water table has resulted in an increase in arsenic contamination due to increase in oxidation-reduction potential in the ground water table at shallow level. Summary of arsenic testing of water wells in the region is presented in Table 11, shows that the most affected aquifers lie beneath the Meghna floodplains.

Table 11 Contamination of Wells by Arsenic

Division	District	Number of Tests Carried Out				% of Wells Contaminated by			
		Field Tests	Pre-existing	Regional	All Tests	Field Tests	Pre-existing	Regional	All Tests
Chittagong	Brahmanb	536	51	51	638	42.9	43.1	37.3	42.5
	Chandpur	696	179	58	933	83.6	73.2	89.7	82.0
	Comilla	583	65	110	758	31.7	69.2	65.5	39.8
	Feni	80	38	50	168	42.5	28.9	34.0	36.9
	Lakshmipu	336	300	34	670	66.1	83.0	55.9	73.1
	Noakhali	679	430	48	1157	52.7	80.7	70.8	63.9

Source: DPHE, 1999.

Notes: 1/ The % of wells contaminated by arsenic refers to the Bangladesh Standard for Drinking Water (0.05 mg/l). 2/ The field tests and pre-existing laboratory test combine available data from all agencies described in Volume S. 3/The 'Regional Survey' is the project Systematic Regional Arsenic Survey of 41 districts described in Volume S1

E. Natural Environment

1. Aquatic Biology

56. **Wetlands:** Originally the project area was part of an estuarine environment, where 3 rivers joined and entered into the sea (Sandwip Channel). Most of the land that is now under agricultural production was under tidal influence, or at least irregularly inundated by sea water. The area was dissected by a multitude of tidal creeks (khals), as well as small rivulets entering the estuary from the hills on the East side. Since the construction of the Feni Barrage, the marine influence has ceased; a fresh water lake has formed behind the Feni Barrage, representing a 'man-made' wetland. In ecological terms, the area has lost much of its value (tidal mud flats, mangrove). A new fresh water environment has replaced the marine conditions.

57. The aquatic habitats of the rivers, khals, canals, ponds, dighis, ditches, water bodies and the beels have usual aquatic plants and weeds and the fauna include fishes, turtles and crustaceans in the total project areas. The new fresh water environment is the habitat for new species of fish such as *Boal, Rui, Koi, Magur, Singi*, and herring. Ecologically the most interesting zones in the project area now are the khals, from which irrigation water is pumped. Their banks are generally densely vegetated, providing shelter and food to a variety of birds and other animals.

58. **Fisheries:** The fishery habitats include the Beels, river, Khal and ponds. In rainy season and during high tide saline water fishes migrate from the sea into the project areas through the Kalidas-Pahalia khal due to broken/damaged regulator no.5 and regulator no.10 at Kazirhat as well as through the breached embankment at the downstream. From the seasonal and perennial water bodies of the total project areas the fish species are found carps (*rui, katla, mrigal, silver carp, grass carp, karpio etc.), barbs (putis), Chitol, Folai, catfish (Tengra, Singi, Magur, Boal, Pungus),* Snakehead (*Shol, Taki*), bele, etc. and varieties of prawn (*chingri*). There are more than 1000 ethnic fishers, approximately 3000 neo-fishers (Muslims), more than 4000 subsistence fisher families, more than 800 genuine fish farmers and more than 500 subsistence fish farmers in the total project areas.

2. Terrestrial Habitats

59. The wildlife like frogs, toad, snakes, lizards, tortoise, local birds, jackals, rats, shrew, squirrel, wild cats, mongoose, beaver, foxes, mesobag, porcupines and bats are common in the area. Among the birds, moyna, parrots, magpie, cranes, dove, weaver, water hen, kingfishers, woodpeckers and migrating birds are also seen during winter season.

60. **Rare and Endangered Species:** There are no rare and endangered species of flora and fauna are seen in the subproject.

61. **Protected areas:** There are no nature reserves or sanctuaries are located within of in the vicinity of the MIP area.

F. Socio-Economic Development

1. Industry

62. The project zone is an agricultural zone. There are no important industries, other than rice processing (part-boiling and drying) plants.

2. Infrastructure facilities

63. In the project area, people use Hand Tubewells and pond water for household purpose. In the dry season water availability of domestic use is quite often insufficient. Sanitation facilities at the communities have been improved over the years but coverage is still limited. Solid waste and sewage management systems are not present in all the area.

64. The irrigation infrastructure is not functioning in an optimum way due to the siltation of the irrigation canals (originally drainage canals or tidal creeks). These canals need upgrading and re-excavation (which is one of the objectives of the current project). Irrigation facilities in the project area are at present such that there is insufficient water for irrigation; this is caused by raised bottom levels of the canals due to siltation.

65. During receding water levels in the Feni reservoirs, the canals fall dry which mainly affects users at the ends of the canals.

3. Transportation

66. The main Dhaka-Chittagong highway passes through the project area. Also, the Dhaka - Chittagong rail corridor passes through the project area connecting stations of Brahmanbaria, Akhaura, Comilla, Laksham, Feni and Mirerswari. There are branch lines to Noakhali and Chandpur leaving the main line at Laksham. All railways in this eastern part of Bangladesh are meter gauge.

4. Power supply

67. Towns and their adjacent areas receive power supply from Bangladesh Power Development Board (BPDB). The towns are subject to load sharing, resulting to power failure for 1 to 1.5 hour once or twice a day. In the rural areas power availability is estimated to be around 12 hours in 24. In the project area about 55 % houses are connected to electricity.

5. Land use and agriculture

68. This sub-project uses surface water irrigation water during Rabi or Winter season. Cropping intensity is 178%. Triple cropping coverage is 22%, double cropping covers 37% and single cropping is practiced on 41 % of the net irrigable area. The cropping patterns of the IMIP sub-project are highly dominated by rice. The area for expansion for other crop production is limited due to climatic and agronomic conditions. IMIP has changed the traditional rain fed farming to intensive irrigated farming. High yielding varieties of field crops are now practiced along with local varieties. Normally, in the IMIP, MIP water is used for winter irrigation. HYV rice is the main irrigated crop of this sub-project. Pulses, oilseeds, winter vegetables are also cultivated in small areas. Farmers normally grow HYV Aman in Kharif–II season and HYV Aus in Kharif-I by their own managements. Broadcasted Aus, Local improved variety Aus and summer vegetables are also grown.

G. Social and Cultural Resources

1. Population and communities

69. Some of the outcomes of the "Feasibility Study: Irrigation Management Improvement Investment Program (IMIP,)Socio-economic and Agricultural Survey) are listed below:

(i) The total estimated population of the 5 Upazilas consists of 479,000 persons
(ii) Average size of household is 5 persons. The total household no. is 95,800.The main irrigated crops are rice (HYV Boro and HYV transplanted Aman), and others crops are chili, potato, sweet potato, ground nut, wheat, winter vegetables, pulses and oil seeds.
(iii) The incidence of (extreme) poverty has been estimated at 18 %, while about 12 % of the population is considered moderately poor.

2. Indigenous people

70. Indigenous people constitute a very small proportion of the command area population from the statistics indigenous people form 1.3% of the population. Most of the indigenous people live in Mirsherai division mainly in the foothills outside the project area. There are only one or two small settlements on the plain where the inhabitants are well integrated with the local Muslim Bengali population and speak Bengali. Since the indigenous do not demonstrate livelihoods systems which are unique, the ADB Indigenous Peoples Safeguards is not triggered. The project is therefore classified as C for indigenous peoples.

3. Cultural, historical, archaeological sites

71. No historical or cultural sites of national importance are present in and around the project area.

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. National Laws and Policies

72. Bangladesh has a wide range of laws and regulations related to environmental parameters. The most recent and the most important of the environmental laws are the Environment Conservation Act (ECA) of 1995, Environment Conservation Rules (ECR) of 1997 and Environmental Court Act of 2000. The ECR spells out rules and regulations for the enforcement of the ECA. Under the ECR, various development interventions are grouped into three main categories: Green (no environmental assessment required), Orange A (IEE required), Orange B (IEE required) and Red (EIA required) – in accordance with increasing potentials for adverse environmental impacts. Following consultations with the DOE it has been agreed that the project has low environmental impacts and the DOE would provide a provisional no objection to the project which will allow the project processing and approval of the DPP. The BWDB is currently applying for this no objection certificate from the DOE. Once the application is received the DOE will make a judgement of the category of the project and request the preparation of the necessary documentation (IEE if category orange and EIA if category red). BWDB will be responsible for the preparation of the IEE or EIA which will be developed based on the IEE developed to the ADB standards.

73. Both the ECA and the ECR cover a wide range of environmental issues, but they are neither fully comprehensive nor clear, and comprised of ad hoc rules. A more recent legislation for enforcement has been the formulation of the Environment Court Act of 2000, which is authorized to try cases related to offences under the ECA/ ECR. The Cabinet has also approved the Environment Court Bill 2010.

74. Since the mid-1980s, there had been a growing awareness and understanding in Bangladesh that the natural resources and the environment of the country are being degraded. The Government of Bangladesh recognizes the importance of environmental sustainability as the basis for long term development in the country. Bangladesh is a signatory to Agenda 21 of the 1992 Earth Summit, and it is committed to implement the international legal instrument in its national policies and programs. A National Conservation Strategy was prepared by the Government in 1991, which formed the basis for the formulation of the National Environment Policy (NEP) in 1992.

75. The Government has so far signed, ratified and acceded to over 25 environment-related international conventions, protocols and treaties. Some of the notable ones are the Ramsar Convention on Wetlands, Montreal Protocol on Ozone Layer Depletion, Agenda 21, United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol, Convention on Biological Diversity, and Convention to Combat Desertification. The close relationship between environment and national development planning is embodied in the National Environment Management Action Plan (NEMAP), completed in 1995 with assistance from the United Nations Development Program (UNDP). As a follow-up of the NEMAP and to concretize its vision, the Government executed a UNDP funded Sustainable Environment Management Program (SEMP) between 1998 and 2004, which emphasized several capacity building components of environmental management.

76. The Government has prepared a National Adaptation Program of Action (NAPA) in 2005 and further revised in 2009, which outlines several climate change adaptation options for the country. A more comprehensive document on climate change, titled „Bangladesh Climate Change Strategy and Action Plan" (BCCSAP), released in 2008 and further revised in 2009 with 44 programs under six thematic areas. The Government has set up climate change cells in several relevant ministries and line agencies to monitor the activities to mitigate climate change impacts and suggest remedial programs. The Government is planning to set up a climate change department under the MOEF.

B. ADB Policy on Environmental Assessment

77. According to the guideline of the ADB, the project is classified as a Category B project, requiring an initial environmental examination (IEE). ADB's Safeguard Policy Statement (2009) provides guidance for conducting environmental assessments.

C. Legal Framework Specific to Water Programs.

78. The Water Act passed in May 2013 incorporate various existing water laws related to ownership, development, appropriation, utilization, conservation, and protection of water resources and resolve inconsistencies and conflicts among these. Including the legal basis for ensuring equitable water rights that take account of all uses of water

79. National Water Policy In article 6, the National Water Policy notes that setting the appropriate legislative framework is fundamental to effective implementation of the water policy.

This policy will be given effect through a National Water Act or Code, which will accommodate the vision and provisions of the water policy and thereby facilitate its implementation.

80. The BWDB Act (2000): The act covers power and responsibility of the Board, function of the Board, Board general Administration, composition of the Board of Directors, power and responsibility of the Directors and Director General, implementation and management of future projects, transfer of the ownership and management of the existing projects, budget etc. The act requires BWDB to perform the following structural and non-structural functions.

81. Structural functions include; (i) river & river basin management; (ii) development and construction or erection of reservoir, barrage, embankment, regulator and other infrastructure for flood control; (iii) drainage improvement, irrigation and drought prevention;(iv) augmenting water flows for irrigation, pisciculture, navigation, wildlife conservation, reforestation and overall environmental enhancement, re-excavation of river ways, canal/khal/beels etc. for optimum changes of water ways; (v) estuary control for land reclamation, accretion and conservation; (vi) river bank erosion control for protection of towns, growth centers, places of historical & national importance; (v) construction and protection of coastal embankment; (vi) prevention of salinity intrusion and mitigation of desertification; and (vii) rain water harvesting for irrigation, environment and water supply.

82. Non-structural and supportive functions: (i) flood and drought forecasting and warning; (ii) hydrological investigation data collection, compilation and dissemination; (iii) reforestation and fisheries program in BWDB projects, in cooperation with relevant government agencies; (iv) road construction on embankment; (v) research and application; and (vi) organize and ensure local stakeholders participation for sustainable management of BWDB projects.

83. The Act was promulgated at a time when it was recognized that there was a need for change in the way the water sector business was carried out. The Act was a response to this and adequately defines the revised roles and responsibilities of BWDB. The issues that relate to the functioning of BWDB and its ability to deliver its defined services in the water sector are not with the Act itself.

D. National Environmental Network

84. The national Environmental Monitoring Network, managed by Department of Environment (DoE), was established at the end of 1985. This network comprises a number of locations where environmental quality is regularly tested. These locations include environmental hotspots such as industrial zones, large cities and environmentally sensitive ecological regions. The parameters monitored are basic parameters for air, water, coastal environment, solid waste, noise, acid deposition; Monitoring frequency is 2-3 times per year. The DoE under the Ministry of Environment and Forest (MoEF) has the responsibility for producing a yearly State of the Environment report. The BWDB under the Ministry of Water Resources is responsible for water resources management. It has also the mandate to monitor both surface and groundwater (quantity and quality).

E. Application for Environmental Clearance Certificate

85. BWDB will be responsible for obtaining regulatory approval of the project from the Directorate of the Environment. The projects under IMIP which is rehabilitation of an existing schemes is normally considered as a Category Orange project, i.e. category ‘B’ as per Department of Environment (DoE),Bangladesh but might be Category Red depending on the

scale of the proposed works. For Category Orange and IEE study would be required or an EIA study if the project is classed as category red. The procedures for clearance are summarised below.

(i). BWDB submit an application to the DG DOE for the environment clearance. A copy of the Feasibility Study DPP would be submitted with the application.
(ii). The DOE will specify what level of clearance is required and will prepare the TOR for any necessary environment studies which maybe IEE for category orange or EIA for category red.
(iii). DOE would provide an interim no objection certificate which would all the DPP to be processed
(iv). BWDB will prepare the necessary environmental studies (EIA or IEE) as specified in the TOR prepared by the DOE
(v). The BWDB will submit the IEE and EIA for approval including the Submission of the Appropriate Fee for the Environmental Clearance Certificate.
(vi). DOE will provide the necessary environmental clearance once the necessary studies are approved. No physical works can commence until environmental clearance is received

IV. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Construction Impacts

86. The following construction activities are proposed

(i) Repair to the original design section of the 22.6 km coastal embankment of polder 60 running from the Feni regulator to the new Little Feni regulator. This will incorporate bringing the embankment back to its original section. Houses and buildings and any roadway along the top of the embankment will be unaffected and some adjustments to the section maybe required in locations where there are roads and housing/businesses. The repair of the coastal embankment would require 300,000m^3 of fill. Material would be sourced from the 50m wide strip of land owned by the BWDB on both sides of the embankment

(ii) Rehabilitation of four coastal water control structures and construction of 2 new coastal water control structures.

(iii) River and khal Systems; rehabilitation of 3 water control structures and 5 new water control structures.

(iv) River protection works over 0.4km to provide protection of communities to erosion.

(v) Excavation of 3.8 million m3 from the 460km of khals to ensure the whole project area has access to water in the Khals during the boro season as well providing improved drainage. Spoil from the excavation will be placed on the khal banks where there is existing BWDB land. Where there is insufficient land the spoil will be given to farmers and spread on their fields (the material is very good fertile soil) or given to support raising of land for buildings.

(vi) Development of 17,000ha of a modern and highly efficient piped farmer water distribution to system to improve timely access to water and reduce water losses. The water savings from the increased efficiency will allow an increased area of irrigation.

(vii) Provision of prepaid card meters to allow water allocations to be based on a volumetric basis and ensure full and transparent payment and accounting.

(viii) Full electrification of the pumping to reduce the operational costs and increase management flexibilities. The electrification includes conversion of diesel pump sets to electric and replacement of old electric pumps as well as extension of the grid network to allow connection of pumps.

(ix) Pilot solar panels and pumps for 30ha

(x) Rehabilitation of office space for use by the BWDB and the proposed Irrigation Management Operator

87. Over and above the specific impacts of each activities there will be some generic environmental issues during the construction phase including (i) soil erosion; (ii) localised surface and groundwater contamination; (iii) air (dust) and noise pollution; (iv) contamination from storage and transportation of construction materials;(v) hygiene sanitation and safety of construction workers; and (vi) community disharmony or cultural problems. The mitigation of these generic environment measures will be incorporated into the environmental management plan and incorporated into the contractor's contracts. Mitigation measures will include: (i) ensuring spoil is properly placed with slopes that will not erode; (ii) removal and disposal of waste fuel and oil away from the site; (iii) proper storage and transport of materials; (iv) establishment of proper worker camps with good hygiene facilities, and (v) good liaison is kept with the community by the supervisor

B. Operational Impacts

88. The main operational impacts are the increased use of pesticides and fertiliser which can cause some contamination of the groundwater

C. Summary of Possible Impacts

89. A summary of possible areas of environmental concern are summarized in Table 12 with an impact evaluation given in Table 13.

Table 12 Summary of Possible Impacts

	Possible Areas of Environmental Concern	**Present Condition**	**Possible Impact**
A	Physical Environment		
1	Regional hydrological regime, flood pattern, etc.	Water scarcity appears in the project areas during dry season/lean period, generally in the upstream and midstream areas. Inundation occurs in monsoon and water logging in pre and post-monsoon is the general hydrological feature. Saline water intrusion occurs through	Re-excavation of khals, reconstruction and rehabilitation of the regulators and water retention structures will reduce water scarcity in dry season/lean period in the subproject areas. Inundation and saline water intrusion will be reduced through drainage

	Possible Areas of Environmental Concern	Present Condition	Possible Impact
		the broken and damaged regulators, breached embankment into the project at downstream areas during rainy season and full tide, damaging standing crops	improvement through re-excavation of the khal. Broken structures in the embankment will be repaired reduce saline intrustion, positive impact is assessed.
2	Natural flushing	The upstream and downstream areas are prone to natural flushing in the monsoon.	The project will not create obstacle against natural flushing during the monsoon. Regulated flushing will take place. No impact is anticipated.
3	Ground water table	Groundwater table is at normal level as there is no significant abstraction.	No additional groundwater abstraction proposed. Improved expanded surface water availability may reduce groundwater use and can increase the recharge. Not likely to be disturbed as plenty of water will stand in subproject area in monsoon. Likely to have no impact.
4	Water quality	Not known to be polluted	Increased agriculture intensification proposed may lead to increased use of fertilizers/pesticides which could increase ground water pollution. Project will include. Agriculture support activities to provide training and awareness and promote the correct dosing of agro-chemical
5	Water logging and drainage	Some of water logging and drainage is the problem near the upstream and downstream of the project areas.	Water logging and drainage will be reduced significantly by re-excavation of the khal and drainage improvement. Positive impact is anticipated.
6	Erosion and siltation	No erosion but slow siltation of river and Khals	The project will address siltation of the khals through periodic excavation. Immediately after excavation work there maybe some loose soil which may be eroded into the khals and rivers. Siltation of the reservoir will continue but this is not affected by the project.

	Possible Areas of Environmental Concern	Present Condition	Possible Impact
			Dumping of loose soils/spoils/wastes from the re-excavated river, khals and canal may deposit on nearby croplands. Small negative impact is assessed. Silt will be analysed to ensure there is no contamination
7	Soil characteristics/ fertility	Silty clay occupies most parts of the project areas. Soils are moderately fertile.	Increased cropping intensity/crop production will be supported by integrated crop management (ICM).
B	Biological Environment		
1	Wetland and aquatic habitat	The rivers, khals, canals, beels and the ponds are the major aquatic habitats.	The desilting of the khal will make temporary impacts to the aquatic habitats through removal of some vegetation, removal of benthos on the beds and some increased levels of sediment during the construction. This will be temporary and it is estimated that the natural vegetation and benthos will be return in 6-12months. Repairs to small drainage/ salinity control gates in the coastal embankment will reduce the ingress of salt water which will protect crops but may result in some minimal loss of fish movements.
2	Terrestrial habitat	Social forestry within the project areas are present and developed. Vegetation of trees and bushes has increased.	Implementation of the project will require no major clearance of vegetations/trees. Some trees on the BWDB land may require to be cut No impact on terrestrial habitat.is estimated. If any trees are to be cleared, replanting will be done at 1:3 ratio.
3	Natural and culture fishery	Natural (capture) fishery in the river, khals, canals and beels, and culture fishery in the ponds.	There maybe some temporary disruption to the natural fisheries during construction but the volume and area of waterways will increase which will help support increased natural fisheries.

	Possible Areas of Environmental Concern	Present Condition	Possible Impact
4	Wildlife and bio-diversity	Moderate wildlife and bio-diversity in the project areas.	No impact on wildlife and biological diversity is expected as the works will be confined to existing canals/ khals
5	Unwanted aquatic weeds and hyacinth	Unwanted aquatic weeds and water hyacinth is minor problem and will expand due to siltation of khals.	Project will regularly clear weeds and re-excavate the khal. Positive impact
6	Natural forests and plantation	There is no natural forest in the project areas but moderate vegetation of trees, bushes and social forestations are present.	There is scope for social forestry on the embankment sides as well as the khal banks which will be taken up. Implementation of the project will have no impact on natural forests and plantation. Small positive impact is expected.
C	Social Environment		
1	Land acquisition/ land loss	BWDB owned land is available for river, khal re-excavation, rehabilitation of regulators, sluices	No land acquisition will be required for the project. Although there are several houses, businesses residing on BWDB owned land along the khals it is estimated there is adequate cross section of the drains without having to relocate any houses or businesses. For the coastal embankment it is proposed to repair the embankment to its original section which will provide adequate level of protection without removal of any houses.
2	Agricultural development	Saline water intrusion effects on Aman crops at the downstream areas and water scarcity delays boro cultivation and rabi crops at the upstream and midstream areas.	Agri-crop production will increase due to improved irrigation efficiencies and reduction of water scarcity during dry season/lean period. Inundation will be improved by drainage improvement. Impact will be positive.
3	Waterways and road transport	Metal as well as earthen roads exist/inside the subproject area. Vans/rickshaw/motor cycle/cars/buses/lorries the main mode of transport. Railway track is present in the	No impact on transport system is anticipated. It is proposed to create a track along one khal bank to support use of mechanical excavation. This can help improve communications.

	Possible Areas of Environmental Concern	Present Condition	Possible Impact
		project areas.	
4	Employment scopes	Agriculture is main source of employment. Some income generation activities (IGAs), small business, fisheries also support employment.	The project will create 750,000 person days of agriculture. In addition there will be 500,000 person days of skilled and unskilled required during the construction period.
5	Health and nutrition	The landless and destitute have poor health and nutrition status	Due to increased crop production and income generation, health and nutritional status will improve. Project will support the expansion of the grid electricity to areas presently with no access. Impact is positive.
6	Community impact	There are more than 1000 ethnic fishers, approximately 3000 neo fishers, more than 4000 subsistence fishers, more than 800 families genuine fish farmers and more than 500 subsistence fish farmers in the project areas	No significant change. The loss of vegetation due to clearing of khal will quickly return. Increased and expanded network of khal due to excavation will support fisheries No negative impact is expected.
7	Culture and heritage sites	No cultural and recreational centre and heritage spot within the project area.	May be enhanced cultural activities due to increased economic activity.

Table 13 Impact Evaluation

Nr	Selected IECs	Relative Impact					
		Positive Impact			Adverse/Negative		
		Unknown	Beneficial	No change	Small	Medium	Large
A	Physical Environment						
1	Regional hydrological regime, flood pattern, etc.		√				
2	Natural flushing			√			
3	Ground water table			√			
4	Water quality		√				
5	Water logging and drainage		√				
6	Erosion and siltation				√		
7	Soil characteristics fertility		√				

Nr	Selected IECs	Relative Impact					
		Positive Impact			Adverse/Negative		
		Unknown	Beneficial	No change	Small	Medium	Large
B	Biological Environment						
1	Wetland and aquatic habitat			√			
2	Terrestrial habitat			√			
3	Natural and culture fishery				√		
4	Wildlife and bio-diversity			√			
5	Unwanted aquatic weeds and hyacinth			√			
6	Natural forests and plantation			√			
C	Social Environment						
1	Land acquisition/land loss			√			
2	Agricultural development		√				
3	Waterways and road transport			√			
4	Employment scopes		√				
5	Health and nutrition		√				
6	Community impact		√				
7	Culture and heritage		√				

90. Only two quite minor impacts identified which simple mitigation is proposed as below.

(i) Clearing of drain may disturb the natural vegetation which helps stabilize banks. To help stabilize the banks social forestry along the khal banks is proposed.

(ii) Clearing of the vegetation from the drains may impact on the natural refuge areas for fish; this is quite minor and the vegetation will quickly re-establish. There is significant scope for managed fisheries in the khal river and reservoir and this is proposed to be taken up as a component of the project.

D. Impacts Relating to Specific Aspects of the Project

1. Impacts Relating to Project Location

(i) **Encroachment into forests and wetlands**: The project is an irrigation and flood protection infrastructure rehabilitation project, and most of the project components are located at the same sites of the existing constructions. The project will not encroach any forest. The excavation of khals may damage the densely vegetated banks, and with this, fauna will lose its habitat *[minor temporary impact].* The vegetation is bushes and grasses and small trees which will quickly reestablish. The project will support social forestry along the khal banks. Periodic maintenance once every six years will result in disruption so fast

growing species to be promoted. If any trees need to be logged, replanting will occur at 1:3.

(ii) **Impediment to movement of wildlife, cattle and people:** Most structures already exist and will only be upgraded at their present location. The khals destined for excavation are mostly natural creeks or drains. By implementing the works, no additional impediments to the movement of wildlife will be created, other than existing in the original situation. Cattle do however graze in the rice fields during the boro season which may be reduced if expansion of boro rice is taken up.

(iii) **Impediment of historical/cultural monuments, buildings and values** No historical/cultural monuments and buildings of value are known to exist near the construction sites in the project area. In execution of the work, the contractor has to avoid damaging or harming in any way cemeteries and the Hindu shrines that may be in the vicinity of the works.

(iv) Conflicts in water supply rights: In the current situation there are no conflicts in water rights. Implementation of the project will not give rise to any such problems.

(v) Regional flooding/drainage hazards: Drainage will be improved by excavation of the kahl. The rehabilitation of the coastal embankments will reduce the risk of flooding.

Downstream impacts: Since the IMIP scheme is situated on the downstream end of a system of 3 joining rivers, the diversion of water does not affect any downstream user functions. The main relevant issue is sedimentation of the channel downstream of the regulator. If water is not released from the regulator for flushing, the regulator becomes clogged by the downstream sedimentation, deposited there by the in- and out flowing tide. During the dry months, water is conserved in the reservoir to provide irrigation water; flushing through the regulator is minimized. Sometimes the sediment has to be removed (mechanically) because the gates can no longer be operated. This aspect is primarily a water management issue that can be managed by timely flushing. By implementation of the IIIP, the storage of fresh water in the system will increase. It is anticipated that the irrigation demand will not affect the availability of water for flushing after the end of boro season. The project will develop operation procedures for the reservoir and gates to optimize the water use and also help support flushing.

2. Impacts and Mitigating Measures Related to Oversight in Planning and Design

(i) Suitability of water quality for irrigation: The quality of the water taken from the inflowing Rivers is suitable for irrigation purposes *[no significant impact].*

(ii) Downstream water quality problems: Increase and intensification of the irrigated agriculture in the project area will lead to increased use of agrochemicals: fertilizers, herbicides and pesticides. At present, no serious problems are known with respect to the water quality of drainage water. The proposed project is estimated to lead to a modest increase in cropping intensity the load of

agrochemicals is also likely to increase accordingly. The Ministry of Agriculture, through its extension services, stimulates the farmers to adopt a more rational mode of application of agrochemicals. The project will also introduce improved training and awareness on improved agricultural practices including introduction of integrated pest management (IPM) *[small to moderate significant impact]*.

(iii) The availability of fertilizer and agrochemicals are sometimes limited (due to an inadequate distribution and delivery system; the system is state controlled). When the products become available, the farmers may tend to compensate for the late application by excessive use. A timely availability of agrochemicals in sufficient quantity would avoid such behavior. Therefore, the system of distribution and sale of agro-chemical should be improved, possible by full privatization. The efforts by the extension services of the Ministry of Agriculture to teach farmers an optimum use of agrochemicals should be continued, and possibly extended.

(iv) Adequacy of drainage planning: The technical design of the drainage facilities will be based on full technical analysis including requirements for climate change. During the last 10-20 years a number of drainage problems have appeared. A component of the current project is to address and resolve these problems *[positive impact]*.

(v) Land use conflicts No land use conflicts are expected to arise, since no land acquisition will be required.

(vi) Inequities in waterr distribution: The project aims at improving the canal system of the command area. At present water supply is insufficient due to low conveyance capacity of canals (bed level has risen due to siltation). Furthermore, due to inadequate water management procedures, the tail ends of the system regularly face shortages. Extension and upgrading of the canal system will improve this situation and the water will be distributed more evenly over the area, decreasing inequities between farmers *[positive impact]*.

(vii) Canal maintenance: OM of irrigation works in Bangladesh has in recent years generally been poor, largely due to inadequate funding. The project will establish improved and more efficient operation and maintenance systems by reorganizing the institutional setting [positive impact]. This will ensure that sufficient funds are made available for maintenance of the canals and on canal structures. Operational and maintenance arrangements have to be adapted in accordance with the requirements.

3. Impacts and Mitigating Measures related to the Rehabilitation/Construction works.

91. The various risks and nuisances related to construction works can be considered as small to moderate. The Contractor should be responsible for implementation of the “Environmental Management Plan”, including an “occupational health and safety program” for construction workers, and for provision of medical facilities on the site.

(i) Erosion control: The proposed project interventions will not lead to relevant erosion problems. On the other hand, the excavation and reshaping of the

different canals will produce large volumes of sand, and silt. This material will have to be disposed of. Sand in Bangladesh is used for raising platforms of houses, construction of roads or filling low lying areas. Silt if of the correct constituency can be used on the fields to support agriculture. It is expected that the material produced by the works can be utilized if the soil is suitable and not contaminated. There is no indication that the materials to be excavated are polluted however samples of material will be tested for any contaminants prior to disposal [*often positive, locally small significant impact]*.

(ii) Rehabilitation/construction stage nuisance, pollution and hazards: Rehabilitation/construction activities in the project area are of a large scale, but will not be concentrated in a limited area, with the exception of the new construction of some small regulators. All other rehabilitation/construction activities, mainly excavation of khals and the development of piped irrigation are spread out over a large area and are located in areas with few people living nearby. The works will be temporary, affecting limited areas at the same time. Although hazards and nuisance will be temporary, they maybe some limited air pollution near the construction areas. Most of the work will be by manual labor. Dust production can be reduced by periodic watering of construction sites (important in the dry season) and paving of access areas. Vehicles transporting construction material (sand, cement, stones) should be covered to prevent dust dispersion. Concrete batching plants have to be located over 200 m from residential sites.

(iii) At present, noise levels in rural areas in the MIP are low and meet the Bangladesh Noise Standards (ECR, 1997). During the construction phase noise may be caused by generators, construction equipment, vehicles used for material transport. Noise of this type of equipment can reach 90 dBA each at 15 meters distance, which is above the Bangladesh ECR permissible noise levels in public and residential areas. However as stated above, construction will generally not take place in public or residential areas. Vehicles and construction equipment have to be checked for operational noise levels, vibration and gas emissions to meet the Bangladesh Standards (ECR, 1997). Mufflers should be installed and maintained as necessary to meet these standards. The routes used for material transport should avoid densely populated areas as much as possible and when needed vehicles should proceed at reduced speed. Transport and construction have to be minimal during prayer and rest times, the major potential sources of vibration are heavy vehicles. The routes used for material transport will not pass through densely populated areas. Therefore, this impact will be negligible.

(iv) Earthworks will be localized with no haulage of spoil. Spoil would put on the khal banks but set back from the waterway to avoid land slip. Spoil over and above the safe capacity of the banks would be either spread on the nearby fields or transported to support fill for houses. The transporting of silt would only be required in areas of housing and would be minimal. The routes used for material transport will not pass through densely populated areas. Therefore, this impact will be negligible.

(v) During construction there is some risk of pollution of soil, surface water and/or groundwater. The principal potential sources of pollution include: (i) surface run-off water from construction sites; (ii) leakage/spillage of combustibles and

greases from equipment and storage tanks; (iii) discharge of domestic wastewater and solid waste at construction workers camp sites. Water pollution at construction sites can be minimized by avoiding disposal of solid waste (construction waste, sand, stones etc.) and waste grease and oil from construction equipment to agricultural field, ponds, rivers or wells. Wastes should be collected and transported to the approved disposal sites. Excavation has to be minimized to reduce sediment entrainment as much as possible. The Contractor has to install adequate separate sanitation systems (for example mobile toilet facilities) for male and female workers or require them to use public sanitation facilities to prevent untreated domestic waste discharge. Wastewater has to be collected by temporary gas tank and treated mechanically before being discharged to rivers, ponds or the soil. Any accidental oil spill should be reported and cleaned. The contractor will be required to comply with these requirements and present as part of his bid the measures he will take to avoid contamination.

(vi) The main health and safety issue during the rehabilitation/construction phase is accidents to construction workers who are at risk at the workplace because they work with and near machinery and improper facilities at worker camps. Risk for accidents due to traffic is not unconceivable. Traffic is expected to increase; especially in areas where people are not used to such traffic, road accidents are a serious risk. Construction stage hazards and severity and frequency of accidents can be reduced considerably when construction equipment is well maintained and safety regulations and procedures are strictly *implemented and enforced* in conformity with the prevailing Labor Law, safety gear is issued or worn, and when construction workers are trained on safety procedures. The contractor should have first aid kits on site. Sanitation facilities for construction workers should be provided to minimize the risk of transmission of diseases. To avoid problems between construction workers and local people, construction workers should be recruited as much as possible locally

(vii) Conflicts between construction workers and local people may be caused by differences in customs, traditions and differences in income. Problems are not expected since most of the workers will be recruited from the local area and will be familiar with customs and traditions.

(viii) Soil for the coastal embankment would be sourced from the existing BWDB owned land along sea and country side of the embankment. The volume requirements are not as large as the embankment works are restricted to repairs. However, all borrow sites will be rehabilitated.

(ix) Disruption of irrigation water supply: Improper timing of the rehabilitation/construction activities associated with canal excavation and lining reinforcement may negatively affect drainage and water supply. The planning is to execute all earthworks affecting the water flow to the farmers, during the period end November till end March. It will be necessary to develop rigid rehabilitation/construction timetables for canal reinforcement to minimize disruption to the beneficiaries. In addition, consultation with all affected parties will be required to reach agreement on exactly how the works will proceed. During this period irrigation should be applied so that the disruption of water supply will be minimal.

(x) Damage to ecosystem due to construction works: The main impact on flora and fauna may be caused by the excavation works of the khals. The work may lead to destruction of the flora of their banks. It is recommended to execute the excavation works with utmost care, with conservation to the extent possible of the bank vegetation. The re-excavation works and reshaping of irrigation canals will temporarily affect the fish shelter in the canals. Therefore the damage to the ecosystem in the canals and canal banks is deemed to present a small significant impact.

4. Impacts and mitigating measures related to operation

(i) Canal maintenance: Operation and maintenance (O&M) of irrigation works in Bangladesh has generally been poor in recent years, due to inadequate funding and poor operation and maintenance. The project will put in place efficient and sustainable OM systems including cost recovery. The IMO will be responsible to manage the tertiary systems.

(ii) Adverse soil conditions: There may be an intensification of agricultural activities due to reliable supply of irrigation water. The project will introduce training and awareness on improved agricultural practices including introduction of integrated pest management.

(iii) Change in ground water hydrology. The proposed project is beneficial for the ground water resources. The better availability of irrigation water and the increase in irrigated area will increase the recharge. Moreover, when surface water irrigation from the project becomes more readily available reliance on groundwater will decrease.

(iv) Change in drainage. The excavation of khals will lead to a better availability of irrigation water. But the same interventions will cause an increased drainage capacity during period of excess rainfall.

(v) Increasing the irrigated area may increase the breeding habitat for insects. As such, the project may have a negative impact on the public health, since the incidence of vector-borne diseases like malaria and dengue fever may increase. However, the proposed project activities, such as excavation of the khals will improve the drainage conditions in the IMIP. Education and awareness raising programs may also help to reduce the risk of vector-borne diseases.

(vi) Downstream Impacts: The MIP scheme is situated on the downstream end of a system of 3 rivers prior to entering the sea. The diversion of water does not affect any downstream user functions. The main relevant issue is sedimentation of the channel downstream of the regulator. If no water is released from the regulator for flushing, the regulator becomes clogged by the downstream sedimentation, deposited there by the in-and out-flowing tide. During the dry months, water is conserved in the reservoir to provide irrigation water and no flushing through the regulator is minimized. Sometimes the sediment has to be removed (mechanically) because the gates can no longer be operated. It is proposed that operation procedures for the barrage are developed to ensure the water conservation and environmental needs are managed effectively.

(vii) Operation of the Barrage: There are some issues of the operation of the barrage; fishermen want water released to catch fish, farmers want water retained for agriculture and fish cage operators want water retained. The operator will have to discuss with all users to develop procedures for the operation of the barrage. During the critical boro cultivation period the barrage requires to be kept closed to conserve water.

5. Impacts of Climate Change

92. Bangladesh is one of the most vulnerable countries to climate variability and change due to its geographic location, low deltaic floodplain, very large inflows from major trans-boundary rivers and the influence of erratic monsoon rainfall. Despite the wide consensus on climate change there are wide ranging estimates on the quantification of the changes in climate parameters and the time scale over which changes will occur. A review of climate change impacts on the Muhuri Irrigation Project has been carried out to determine levels of resilience to be incorporated into the design of the project. Coastal cyclones from the Bay of Bengal and upstream river floods during monsoon season pose significant impacts on the project area. In particular, cyclones in coastal zone of Bangladesh accounted for several of the world's worst natural disaster in the twentieth century. The main climate change impacts and the proposed adaptation measures are described in Linked Document Climate Change: Project Adaptation Report and summarised below.

a. Sea Level Rise and Storm Surge

93. The Muhuri project area lies at the apex of the Bay of Bengal and coastal cyclones together with upstream river floods during monsoon season pose significant impact on the project area. The MIP is protected by the coastal embankment of Polders 60 and 61. The embankment needs strengthening including provision of adequate protection from storm surges and wave impacts under the impacts of climate change including sea level rise. The embankment provides for the safety of properties, lives and livelihood of the local communities inside the MIP.

94. The coastal embankment the Coastal Embankment Improvement Project (CEIP)[2] has carried out extensive studies of the Polders in the South West of Bangladesh and report provides a basis of estimating climate resilience for the Muhuri Irrigation Project. No specific studies storm surge studies have however been implemented for the eastern Bangladesh. Recommendations in the CEIP report which are now adopted as a standard for Bangladesh include:

(i) Design storm surges need to be based on the historic data of 38 cyclone situations including 19 actual events but assuming the cyclones hit at high tide level.

(ii) Embankment designs would be based on the situation in 2050 with climate change and be based on the IPCC predictions for 2050 which require

[2] Ministry of Water Resources, Bangladesh Water Development Board Detailed Design Report for Flood Embankments Drainage Canal, Protection Works and Hydraulic Structures May 2012.

consideration of +0.50m sea level rise and a 10% increase in wind speed in every cyclone.

(iii) The norms for coastal flood protection incorporate a 1:20 year flood, where agricultural damage is predominant and a 1:100 year flood where loss of human lives, properties and installations are predominant. The CEIP found that the embankment sections become impractical and uneconomic, when 1 in 100 years frequency storm level is selected for the design of embankment in addition to the requirements for climate change resilience. The CEIP study therefore proposes a surge level of 25 years return period in addition to the rise in storm surge due to the impact of climate change. Subsequently for areas where human lives are predominant it is also recommended to consider some additional approach, when 1 in 25 years frequency is selected to minimize the losses of lives etc. by providing adequate number of cyclone shelters distributed throughout the vulnerable zone and ensuring that the cyclone warning system works efficiently and reliably.

95. **Studies and Evaluation for Muhuri**. Some preliminary analysis of coastal climate change impacts were carried out for Muhuri.

(i) The current embankments are designed for historic assessment of sea levels including high tides, historic storm surges and allowance for waver run up. The current design crest level is 7.93m PWD. The current embankment has suffered 2-3 occurrences localised and some overtopping in the last 20 years but these have not caused any breaches. These have resulted in some local flooding and loss of crop and minor damage to homesteads.

(ii) The Polder 60 embankment is set back from the sea; preliminary assessments by the IWM indicate a 1m increase in crest height may be required to meet the needs of long term climate resilience.

(iii) The Polder 61 embankment is directly exposed to the sea and preliminary estimates indicate a 5m increase in embankment height may be required to meet the long term needs of climate resilience.

(iv) The assessments are indicative and need to be supported by detailed hydrodynamic modelling. For Polder 60 there is also a need to review the alignment. There is now about 3km of reclaimed land on the sea side of the existing embankment. The on-going river training work downstream of the Feni barrage may increase the extent of this reclaimed land. The future embankment should consider whether the climate resilient embankment should incorporate the reclaimed land which includes a number of settlements.

(v) The required embankment crest levels need to be reconfirmed by full mathematical modelling of flood flows, tidal surge and sea levels with updated bathymetry.

(vi) The engineering design of the new embankment and structures is complex and the cost increases would be very significant. Detailed planning is required to reassess the alignment as the existing alignment excludes quite large areas of land outside the existing embankment. Land acquisition requirements for the embankment would be very extensive requiring extensive consultation and mitigation measures.

(vii) Parts of the embankment are used as roads-raising the crest would require demolition of the roads or creating a new embankment butting onto the existing embankment.

(viii) Climate proofing one portion of the embankment and leaving other parts without climate proof may limit the protection due to flood inflow from the parts without climate resilience.

(ix) The climate resilience can in most cases be added to the existing embankment without requirement for demolition. The exception is where there are asphalt or brick roads where the option is demolish the road or build a new embankment butting onto the road.

96. **Conclusions**: Climate proofing the coastal embankment requires major investment and will involve significant design work and would result in significant resettlement and is not proposed to be taken up under the IMIP project. The requirements for climate proofing the coastal embankment for Muhuri should be taken up as part of the overall climate proofing the eastern coastal zone of Bangladesh. `Climate change is gradual and the existing embankment has only overtopped once or twice with minor damage in the last 30 years. The embankment in Polder 60 is in poor condition in many parts and it is concluded rehabilitation to the original design is the first step and will provide a high degree of protection. In Polder 61 the embankment has recently been rehabilitated and the land inside the embankment is fish ponds and will provide a good buffer from storm surge. Provision of climate resilience should be taken up as soon as possible preferably within the next 5 years but the immediate requirements can be met by the original design section. The climate proofing requires detailed modelling of storm surge and flood levels, complex engineering design, a review of the alignment and significant land acquisition.

b. Changes in Rainfall and Rainfall Patterns

97. The IPCC predictions are for an overall increase in annual rainfall, higher variability in the rainfall patterns is also predicted. Global Circulation Models (GCM) with their relative course grid-cell resolution(several 100km) have reasonable skill in reproducing temperature characteristics however their capacity to reproduce and predict precipitation varies considerably and the accuracy must be taken with caution.

98. Various down scaled climate change models for Bangladesh as well as the catchments in India[3] indicate increased monsoon precipitation between 0-20%. The IPCC estimates that variability and extremes of the rainfall patterns will increase.

99. The Muhuri project is totally dependent on the monsoon rainfall and an increase under climate change will be generally beneficial. Monsoon variations however will need to be incorporated into the water management plan to be prepared by the IMO. The proposal for Muhuri is the low lift pumps would be installed and available for supplementary irrigation throughout the year which will provide a significant level of resilience to climate variations for the Kharif and Aus cropping which presently have no access to surface water irrigation. Periodic reduction in the monsoon rainfall can be expected which will impact on the winter flows to Muhuri and affect the boro season cropping especially rice. Monitoring of monsoon rainfall patterns including sourcing data from the Indian catchments can provide a key input to advise farmers on the prospects for boro cropping. Improved water management including

[3] ADB TA 7417 Support for the National Action Plan for Climate Change India Support to the National Water Mission

mechanisms to reduce rice water requirements and crop diversification to lower consuming crops are key adaptation measures which will be promoted under the project.

100. **Increased Rainfall Intensity**. Studies by IWM[4] assessed the impacts of climate change on drainage performance of the existing drainage networks of polders in the south west Bangladesh. The study incorporated simulation incorporating considering climate change-induced parameter (change in rainfall, sea level rise). The rainfall is assessed to increase by 26% for the month of March, April and May and 13% for the months of June, July and August in accordance with 4th IPCC report. In addition 50cm sea level rise was simulated at the downstream boundaries.

101. The design parameters for the re-excavation of the Khal have been prepared. The accuracy of climate change impacts relating to extreme rainfall events remains quite poor but it is estimated the frequency and quantity of extreme rainfall events will increase. Currently the standard drainage modulus for non-urban drainage is for a 1 in 10 return period storm. This has been discussed with the BWDB and it has been proposed to increase the drainage modulus to a 1 in 25 return period to incorporate the likely increase in rainfall intensity from climate change. This is considered adequate as significant over excavation can result in increased rate of sedimentation. The drains will be routinely excavated once every 5-7 years and additional section can be added quite easily when the climate change information becomes more reliable.

c. Temperature

102. Projections for increased temperature under climate change are reasonably robust. The results from the various climate change downscaling using PRECIS[5] indicate temperature increases of mean annual air temperatures of around 2^0C by 2030. Increased temperatures need adaptation measures to select the optimum rice varieties. Increased evapotranspiration will increase the crop water requirements.

103. In recent years cold winters have resulted in crop damage and there is a trend for farmers to plant later; planting appears to be delayed by about 1 month. The delayed planting does affect crop water balance and puts more pressure on the water demand during March which is the critical period for the water availability-demand balance. Further studies will be taken up under the Muhuri Management contract to better assess the impacts of delayed planting of boro rice and the options for adaptation. Crop diversification including more use of cold resistant crops is a proposed adaptation response. The project will support agriculture support services which will include piloting and demonstrating new cropping which can provide increased returns, reduced water requirements as well as resilience to climate change.

104. Long term and increased temperatures can affect rice yields.

d. Climate Adaptation Response and Recommendations

105. The project will incorporate the following measures to meet the potential impacts of climate change.

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[4] Institute of Water Modelling (IWM) Studies for Drainage in Polders in South West Bangladesh

[5] Providing Regional Climates for Impact Studies

(i). Increase the drainage design modulus from 1:10 year return period to 1:25year return period as a response the likely increase rainfall intensities.

(ii). Increase the irrigation efficiency by 39% by through the use of piped distribution and pre-paid meter systems. Together with a 15% diversification to non rice crops will increase the irrigable area from 11,300ha to 17,000ha.

(iii). Provide access to irrigation on demand throughout the year for 17,000ha to help meet current and future climate uncertainties. Currently irrigation only available during period January to April.

(iv). The project will provide agricultural support services to promote the diversification from rice, water saving methods, training and extension to support the establishment of sustainable and climate resilient cropping systems.

(v). Repair the coastal embankment to restore it to its original design section as an interim measure prior to the implementation of the 2nd Stage of the Coastal Embankment Improvement Project (CEIP) to be implemented by the Government as a follow on program under the CEIP1 project which is currently working in the western part of Bangladesh.

6. Overall Environmental Criteria

(i) Unwarranted losses of precious resources: In the IMIP area, no major natural resources are present, which would be affected by the project. As such, the rehabilitation/construction work will not lead to unwarranted losses of precious resources [no significant impact].

(ii) Unwarranted accelerated use of resources for short-term gains: No Unwarranted accelerated use of resources for short-term gains are expected [no significant impact].

(iii) Adverse effects on the national energy and foreign exchange situation: By implementation of the project, a more efficient use of the water can be made, increasing productivity and the irrigated surface. The project will not affect the national energy situation [no significant impact].

(iv) Unwarranted hazards to endangered species. The project will not encroach into natural forests or wetlands and the environmental quality of air, soil and water will not be affected significantly. As such, no unwarranted hazards to endangered species are expected [no significant impact].

(v) Undesired population migration to urban sector. The rehabilitation/construction work of IMIP will enhance the socio-economic and living conditions in the rural area of the project area. Therefore, no undesired population migration to urban sector is expected. On the contrary, the project will contribute to stemming the flow of people from the rural areas to the towns [positive impact].

(vi) The project will increase the area rice which will result in some increases of methane emissions from the paddy fields. The project will support agricultural technologies such as SRI and alternative wetting and drying which are shown to reduce the levels of methane. The project will also support the diversification to non rice crops

7. Land Acquisition and Resettlement

106. Surveys of the project have found no resettlement will be required.

107. For the assessment of the significance of the (detrimental) impacts, no formal weighing procedure was used and only a distinction between no significant small significant

impacts, moderate significant impacts and major significant impacts was made. This assessment was based on expert judgment. The screening showed that most of the impacts related to the issues of the two checklists are not significant or of small significance. The most significant impacts and the proposed mitigating measures are described below and listed in Table 14 below.

Table 14 Overview of Environmental Impacts and Mitigation Measures

Issue / Impact	Mitigation Measures	Implementing Agent	Budget source	Supervision
Due to Project Implementation				
Damage to ecosystem during construction	Minimize damage to vegetation during	Contractor	Included in contract	IMO
Construction related impacts: noise, dust, vibration, pollution (air, soil, water) accidents (work, road) Social conflicts	Proper maintenance H&S regulations and enforcement Safe operating procedures/training operators; Maximize hiring of local staff Establish project communication center through the ICC to support communications with project stakeholders and complaints procedures	Contractor Contractor Contractor Contractor	Included in Contract ICC to be funded by Irrigation Service Charge revenue	IMO IMO IMO
Due to Oversight in Planning and Design				
Planning/design targets and impacts to monitored and reviewed.	Ensure planning/design assumptions and targets are met	IMO. Consultation with ICC	PMU	BWDB Safeguards and Monitoring cell
Due to Operational Deficiencies				
Pollution of ground water and surface water	Rational use of agrochemicals; training of farmers Monitoring water quality Modification cropping pattern	DAE (Min. Agriculture) PMU in association with DAE	Nob, supported by ADB See Monitoring Nob	PMU/SMC
Barrage Operation Impacts	Barrage operation procedures to be developed and agreed.	PMDC	PMDC budget	PMU/SMC
Overall Environmental Review Criteria				
Water allocations, cropping patterns,	Criteria to be defined and reviewed every 6 months	IMO	IMO contract through loan	PMU

stakeholder reports				

Notes: All activities to be monitored by PMU. PMU would engage a Safeguards Monitoring Consultant to undertake these tasks

V. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

A. Public Consultation and Disclosure

108. The environmental and project planning teams have carried out extensive consultations on the technical, socio-economic aspects and environmental aspects. The public consultation was carried out from December 2012 to June 2013 as part of the field activities. Public Consultation was done using approaches including,:

(i) Focus Group Discussions (FGDs) and Semi Structured Interviews(SSIs), Key interviews were held among the beneficiaries, farmers and project areas people in the six upazilas of Parshuram, Chhagalnaiya, Feni Sadar, Fulgazi, Sonagazi and Mirerswari.
(ii) Formal/ informal discussions with Government officials and other stakeholders; consultations was held in the field as well as Upazila and Project level workshops during the period December 2012 to June 2013. Final workshops and consultations are planned for July 2013.
(iii) Meetings were organized with various stakeholders as well as with the Feni District Department of Public Health Engineering (DPHE) on water quality data and information of shallow and ground water table of the project areas in those Upazilas within the framework of the feasibility study.
(iv) Visit by 40 stakeholders in two visits (farmers, WUA representatives and Government officials) and to the Barind Multipurpose Management Development Authority (BMDA) in Rajshahi Western Bangladesh to see firsthand similar approaches to those proposed for Muhuri Irrigation Project.

B. Comments and Feedback

109. The following comments on the environmental assessment were obtained from the consulted stakeholders:

(i) Rehabilitation/improvement/reconstruction of the project is supported, because it will create good conditions for economic development and improvement of the environment,
(ii) Rehabilitation/improvement of the project will not damage terrestrial and aquatic resource in the project influence area,
(iii) Rehabilitation/improvement/reconstruction of the project will retain more water during dry seasons in the rivers and khals and irrigation facilities will be increased,
(iv) Rehabilitation/improvement/reconstruction of the project will protect salinity intrusion in the project areas at the downstream, which will check crop damage in those areas, will increase crop cultivation and cropping intensity,
(v) Plantation and social forestation will be increased, which will increase dens of wild lives, exotic species(both flora and fauna) in the project areas,

(vi) The predicted potential environmental impacts and measures for impact mitigation suggested and explained by the Project Environmentalist were clearly understood.

110. **Visit to Example Project Barind**: In addition feedback based on stakeholder response to the visit to Barind where a similar system of meter card system has been established was obtained. Ten stakeholders from Muhuri (mostly farmers) visited BMDA schemes in January 2013 and another 30 farmers visited in May 2013. The general feedback is summarised below:

- Irrigation service to farmers was good, for example:
  - (i) Water is available whenever required by an individual farmer (i.e. reliable & flexible supply)
  - (ii) Low water charges (about 1/3 of Muhuri)
  - (iii) Financial transactions are transparent and secure with 100% payment for water according to the volume used
- Construction and O&M
  - (i) High quality and quick construction enabled by adoption of buried uPVC pipelines
  - (ii) No land take or obstruction to farm vehicle movements
  - (iii) 50 year design life for uPVC pipeline and low maintenance (design life of pumps and meters is 10-20 years)
- Results
  - (i) A variety of crops are cultivated in Rabi
  - (ii) Improved water use efficiency (and energy efficiency) so that the cropped area may increase
  - (iii) Increased productivity with near triple cropping
  - (iv) Sustainable /self-financing.

111. The environmental assessment process under the ADB's Safeguards Policy Statement requires the disclosure of the IEE in an accessible place and language to the public during the completion of the IEE. The BWDB will provide a Bengali version of a summary IEE in public places by providing relevant environmental information, including information from the documents as above in a timely manner, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. For illiterate people other suitable communication methods will be used. The BWDB will also organize meeting/ seminar in the locality to inform people effectively including providing copies of the IEE for display at the district and Upazila level during the same period when the IEE is disclosed on the ADB website.

VI. GRIEVANCE REDRESS MECHANISM

112. A grievance redress mechanism will be established through the Implementation Coordination Committee (ICC). The ICC will be under the leadership of the BWDB Zonal Chief Engineer. Members of the ICC will include representatives from the offices of the Deputy Commissioner, the Water Users Federation, Water User Associations, the Rural Electrification Board, Department of Agriculture Extension, and law enforcement. The Irrigation Management Operator for each sub project will also be the member secretary of the ICC. The ICC will deal with field implementation issues that arise related to conflicts, safeguards, security, and more generally concerns about the performance of the implementing parties and would meet four times per year at a location close to each sub project. The PMU with the support of the PMDC will be responsible for the establishment of the ICCs which will need to establish within six months of the loan agreement.

113. The IMO will be responsible for customer relations including grievances. The APs will register their grievances to the appointed person at the IMO Upazila offices office, who will document the complaint in the "grievance register book". The IMO will be responsible for responding the grievance either directly by resolving the matter, determine the corrective action or take up the grievance with the appropriate authority. A response will be provided to affected party within 7 days. The IMO will use a register to book to list; (i) the date of grievance registered, (ii) name / address of complainant, (iii) the nature of grievance, and (iv) the response. In case the IMO is unable to resolve the issue in 7 days, the matter will be forwarded to the office of the WUA. The corrective action will be carried out as agreed and documented in the grievance register book. The outcome will also form part of the progress reports to the ICC.

114. Where the AP considers the grievance not appropriately resolved than the AP can take the grievance to the WUA who in turn will submit to the ICC who will discuss the grievance with the appropriate committee. If a serious grievance is lodged outside the control of the IMO or the WUA a special ICC meeting can be called. Since the ICC meeting will have to be convened at short notice, at a minimum the IMO and a representative of the WUA, and a community representative should be present. If need be other members will be consulted to help respond within the given time frame. The ICC will prepare a formal, written assessment that describes the complaint and confirms whether the grievance is genuine. A response on the matter will be provided to the APs within 7 days by the ICC in consultation with necessary parties.

115. During the entire process, the alternative to appeal at court will remain open if the complainant wishes. The details and information on use of this grievance redress mechanism will be communicated to the local communities and beneficiaries by the project staff working in the subproject area.

VII. ENVIRONMENT MANAGEMENT PLAN

A. Institutional Arrangements

116. The institutional set-up with respect to project implementation and environmental management is defined in the main report. The organisation is summarized in Figure 5 and below. The environmental responsibilities are shown in Figure 6.

Figure 5 Project Implementation Arrangements

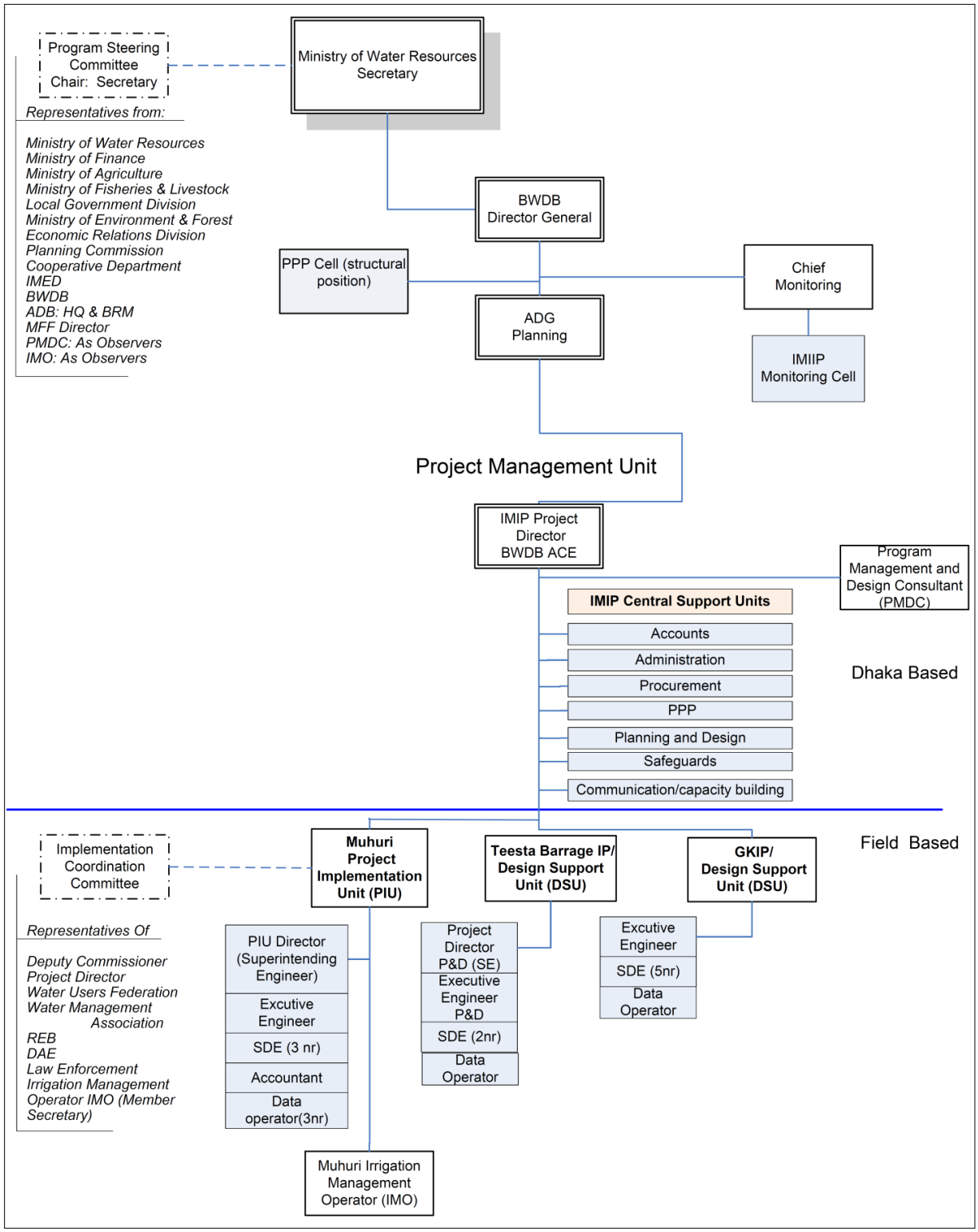
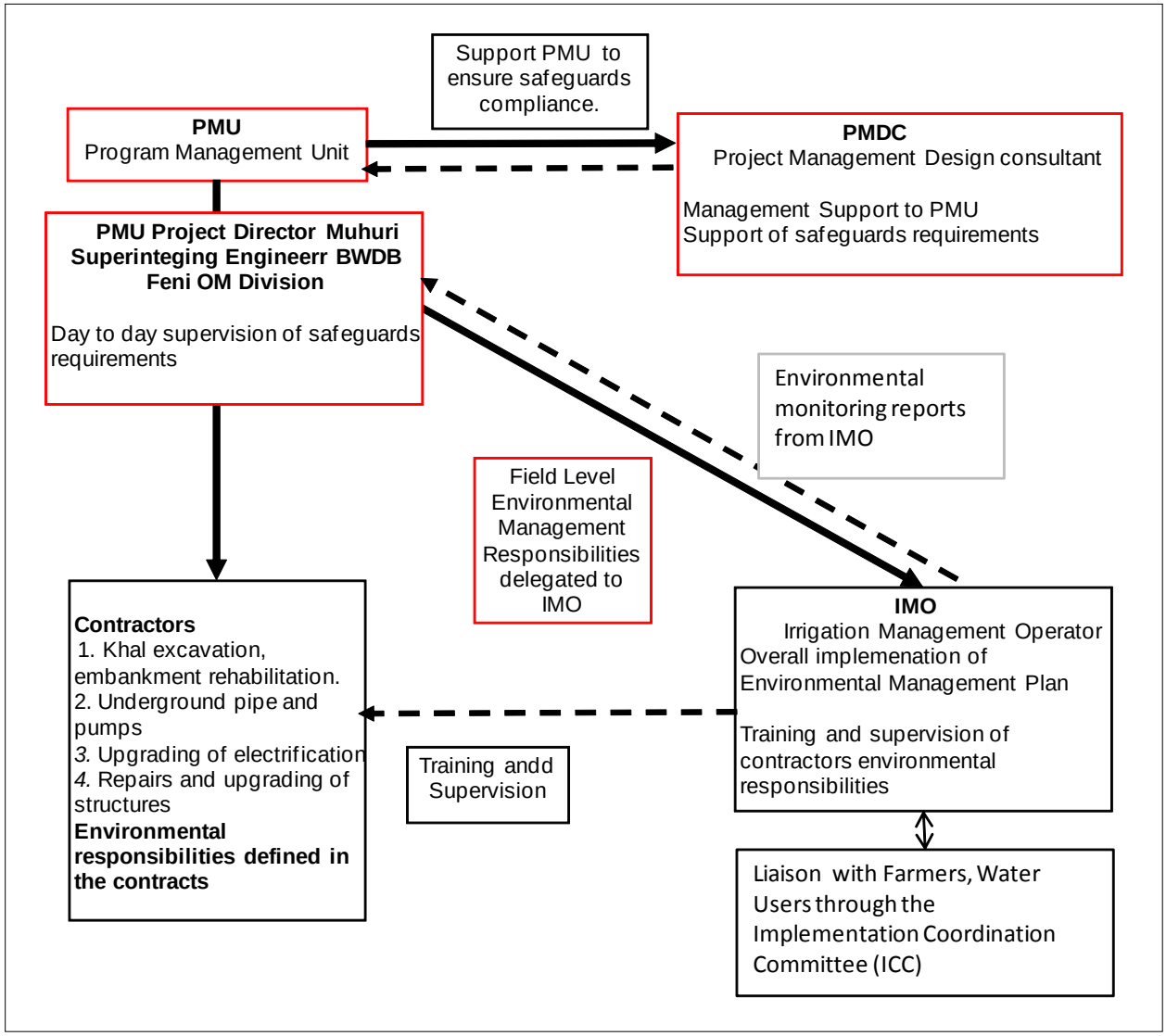


Figure 6 Environmental Responsibilities



1. Executing Agency

117. The Executing Agency for the Project will be the Bangladesh Water Development Board. A Project Director will be appointed with at least the rank of additional chief engineer. The Project Director will be responsible for the overall management of the project and will manage the Project Management Unit and authorise payments. He will report directly to BWDB additional Director General Planning.

2. Program Management Unit (PMU)

118. The Project Director will be supported by the IMIP support services based on seven support units; accounts, administration, procurement, PPP, Planning and Design, Safeguards and Communications and Strategy Building. The core of the project management will be managed by the Dhaka central office however supported by frequent field visits to engage with the field staff as well as stakeholders. All procurement, payments as well as planning and design will be managed by the support units based in Dhaka.

119. A Project implementation unit (PIU) will be established in MIP. A PIU Director with the rank of Superintending Engineer will appointed. He will be in charge of supervising MIP modernization in the field including the activities currently managed by the GoB as well as the investments and OM activities of the project. The PIU Director will be based in the field but will make frequent visits to the PMU in Dhaka. The PIU would incorporate the staff of the superintending engineer's office in Muhuri. Eight staff would be formally assigned to the PIU (executive engineer, SDE (3nr) Accountant and (data operator (3nr)).

120. The PIU Directors in the Program Management Unit (PMU) will assume primary responsibility for the environmental monitoring as well as implementation of EMPs for the MIP; the PIU director will report to the Program Director. A safeguards unit will be established in the PMU and will be responsible for environment, resettlement, and any other social development obligations. The officers in the safeguard unit will be supported by the PMDC consultants. The safeguards unit will be staffed by the safeguards officers; (i) an environment officer, (ii) a resettlement officer and (iii) a social safeguards/gender officer.

121. The duties of the safeguards unit will include: (i) oversight of construction contractors for monitoring and implementing the environmental management plan; (ii) preparing and implementing environmental good practices; (iii) liaising with the environmental agencies to obtain necessary permits/approvals and seeking their help to solve the environment-related issues of project implementation; (iv) providing awareness training on environmental and social issues related to irrigation rehabilitation projects under the IMIP. (v) preparation of environmental monitoring reports every 6 months for EIAs and once a year for IEEs (as required by ADB). Submission of reports as required by the DOE to meet GOB requirement requirements.

122. The PMU through the safeguards unit with support from the PMDC consultants will be responsible for the monitoring of the environmental management plan including:

(i) Obtain environmental clearance from ADB and DOE for environmental compliance before awarding any civil works contracts for that subproject.
(ii) Ensure mitigatory measures stated in the IEE are incorporated in the project design and EMP requirements are described in the bidding documents. EMP including any specific requirements of DOE shall be incorporated in the contract documents.
(iii) During implementation ensure that EMP is been implemented and recommend corrective measures for any unforeseen impacts
(iv) Ensure that any grievances from any stakeholders are adequately addressed Submit periodic monitoring reports to ADB and GOB.

123. ADB will monitor the implementation of mitigation measures through project review missions, and conduct environmental performance monitoring as necessary.The PMU will be supported by the PMDC and the Muhuri IMO (para 117 describes the role of the IMO). The PMDC will primarily support the development of the overall safeguards of the MFF program whereas the Muhuri IMO will be responsible for the collection of the field level data and monitoring of the execution of the Environmental Management Plan by the contractors, water quality operating procedures and the health and safety plan during sub-project implementation. The occurrence of accidents can be monitored by keeping records of number of times workers were hospitalized or had to go to a clinic for first aid in relation to accidents at the construction sites. Incidence of conflicts with local population can be assessed with a simple questionnaire. The survey should be carried out twice a year during construction.

3. Project Management and Design Consultants (PMDC)

124. The PMDC has a key role to support the overall project management of the Muhuri Irrigation Project. The PMDC will work closely with the Irrigation Management Operator (IMO) to develop efficient and sustainable management. The PMDC terms of reference includes supporting the PMU to effectively monitor and ensure the necessary safeguards including environmental issues. The PMDC's role would be primarily directed to the overall Project whereas the IMO's would focus on MIP only.

4. Irrigation Management Operator (IMO)

125. An Irrigation Management Operator (IMO) will be engaged to manage the Muhuri Irrigation Project and will be located and operate within or near the Muhuri project area. The role of the IMOs will evolve from managing the field design and construction supervision during the irrigation system modernization stage to managing, operating, and maintaining the system under longer-term lease arrangements during the system operation stage. For the system modernization stage, which is proposed to have a five year duration, the IMO would be contracted through a management contract by the PMU. During this period, the IMO will:

(i) Develop operation, maintenance, and management systems and procedures that will carry on following completion of physical work,
(ii) Establish a better understanding of system operating costs and revenue streams as input to the longer-term lease arrangements that follow-on the system modernization stage.
(iii) Liaising with BWDB and the newly established Implementation Coordination Committee (ICC)
(iv) Undertake participatory design of farmer distribution systems,
(v) Supervise the work of contractors engaged for system modernization
(vi) Ensure compliance with environmental requirements.
(vii) Conduct demonstrations and other agricultural support activities
(viii) Conduct pilots to investigate complementary cost recovery
(ix) Support the necessary environmental monitoring and ensure the effective implementation of the Environmental Monitoring Plan (EMP).

126. Environmental monitoring during construction and after project implementation (the operational phase) will be assigned to the IMO. The objective of environmental monitoring in the project area is to ensure further socio-economic development while maintaining acceptable environmental quality and sustenance of natural and ecological resources. Environmental monitoring mainly has to assure that the mitigation measures are implemented in a satisfactorily manner, and evaluated to confirm that they are achieving their original objectives. The monitoring program for the Muhuri sub-project would concentrate on; (i) various environmental impacts due to improvement/construction/rehabilitation works; (ii) pollution of surface water and groundwater, both during construction/improvement/rehabilitation as well as during the operation phase.

127. The IMO will provide a key role towards the environmental management plan including:

(i) The IMO would be responsible for the supervision of all the construction work and would act as the supervising engineer.
(ii) The IMO is required to collect and compile water data and environmental data

(iii) The IMO will establish and implement long term management operation and maintenance of the Muhuri Irrigation Project
(iv) The IMO will implement Agricultural Support Services and PIlot Cost Recovery Activities both of which will contribute to the environmental mitigation responses.

128. The high level management skills of the IMOs with both national and international staff will allow a development of national management skills which can be provide a key base resource in Bangladesh for irrigation management and the development of a framework for improved water resources and environmental management.

5. Responsibilities of the Contractor

129. The contractor(s) will implement mitigation measures during the rehabilitation/construction stage as defined in this EMP which will be included in the contract. The contractors will be responsible for minimizing nuisance to the population, minimize the risk of pollution, as well as of accidents. The contractors' effort in environmental management is to be supervised by the IMO, and BWDB and PMDC. The IMO as the supervisor is responsible to conduct quarterly monitoring of the implementation of mitigation measures by the contractor. The IMO will prepare and submit quarterly monitoring reports to the PMU who will consolidate the information and include in the annual environmental monitoring report to be submitted to ADB. The contractors will provide the IMO with monthly reports on the implementation of mitigation measures. The reports prepared by the contractors along with quarterly monitoring reports to be prepared by the IMO will be consolidated and submitted to PMU for review.

6. Implementation Coordination Committee

130. To facilitate implementation of the projects under the loan, an Implementation Coordination Committee (ICC) will be established for each sub project of the MFF. The ICC will be under the leadership of the BWDB Zonal Chief Engineer. Members of the ICC will include representatives from the offices of the Deputy Commissioner, the Water Users Federation, Water User Associations, the Rural Electrification Board, Department of Agriculture Extension, and law enforcement. The Irrigation Management Operator for each sub project will also be a member of the ICC. The ICC will deal with field implementation issues that arise related to conflicts, safeguards, security, and more generally concerns about the performance of the implementing parties and would meet four times per year at a location close to each sub project.

131. A communications office operated by the Implementation Coordination Committee (ICC) will be established to register complaints and incidents. A record of accidents (on the road and at the works) should be maintained. To monitor the effect of the (increased) use of agrochemicals like fertilizers and pesticides (and of the possible pollution due to works) on surface water and ground water, water samples are to be taken and analyzed in the field and laboratory monitoring plan/program will be required to monitor the environmental impacts and implementation of the mitigation plans. This work would be carried out by the IMO.

B. Environmental Monitoring

1. Responsibilities

132. The objective of the environmental monitoring in the project area would be to ensure that the project is implemented while maintaining acceptable environmental quality and sustenance of natural and ecological resources. Environmental monitoring mainly has to assure that the

mitigating measures are implemented in a satisfactorily manner and constructed and initiated on schedule, as well as evaluated to confirm that they are achieving their original objectives. To increase the cost effectiveness of the monitoring program, it should focus on the key parameters and criteria, and measurements of different parameters at the same site have to be carried out simultaneously.

133. The overall responsibility rests with the Project Management Unit (PMU) of the BWDB. Engagement of with the local institutions and stakeholders will be an essential part of the monitoring activities. As described in para 119 the IMO will also be responsible for several monitoring tasks.

2. Environmental Monitoring Activities

134. It is proposed to restrict the environmental monitoring to the principal components of the project supported by viable and meaningful monitoring parameters. The monitoring will build on the baseline which will reflect the situation in 2014 prior to the project interventions. Routine monitoring will be implemented through the IMO who will compile secondary data from other agencies as well as some primary data collection. The IMO will prepare quarterly construction progress reports of the project will include a short section giving the present status of implementation of environmental safeguards, and report any environmental concerns, if they exist. The requirements for environmental monitoring are summarized in Table 15. The full monitoring requirements would be defined in the contract of the IMO.

Table 15 Environmental Monitoring Plan

Nr	Project Activities	Parameter	Actions and Monitoring Frequency	Responsible authority
1	Re-excavation of khals	Removal of trees and vegetation. Management of spoil material excavated from the khal. Sedimentation-surveys and water analysis suspended solids. Status of regeneration of natural vegetation and trees.	Baseline inventory of trees and vegetation over 5% sample area. (25km) including photographs. Detailed cross section surveys of khal to process payments to incorporate assessment of spoil management including photographs. Annual monitoring of sedimentation every year during construction and for 6 years after (total 10 years). To include one periodic re-excavation. Baseline and annual monitoring of social forestry activities. Assessment of survival rates of trees.	IMO

			Cross section surveys every three years to assess sedimentation rates. Rainfall and river flow records to assess design parameters	
2	Rehabilitation of Coastal Embankment	Monitoring of construction progress Monitoring of borrow areas	Periodic progress reports Periodic progress reports-photographs. Daily monitoring of sea levels from existing monitoring stations	IMO
3	New Pipe distribution, electrification	Farmer agreements Progress of installation Monitoring of water use	Farmers accept the proposed layouts and have prepared MoUs to accept proposals. Progress reports of installation Bi annual assessment of water pumped and revenue based on data from prepaid meters.	IMO
4	Operation of main and secondary regulators.	Monitoring of water level and releases from the Feni regulator	Daily water level data at regulator Data on gate opening Calibration of discharges	IMO in coordination with BWDB
5	Hydrology	Monitoring of discharge for Feni, Muhuri and Kalidash Pahalia rivers	Improving the quality of flow monitoring. Use of Horizontal Acoustic Flow Doppler Flow Meter (ADCP)	Hydrology unit BWDB Comilla.
6	Intensification of agriculture	Increased cropped areas Increased yields Increased farm	To be based on the Benchmarking Activities being proposed by the ADB TA More Food for Less Water including analysis of satellite imagery	IMO

		inputs Increased use of pesticides Increased mechanization Increased use of water saving technologies	Farmer interviews and secondary data. Follow on monitoring would be carried out by the IMO annually including water efficiency assessments and the take up of improved agricultural systems. Use of pesticides will be monitored as part of the agricultural take up monitoring as well as sampling and testing of the water in the drains and shallow groundwater	
7	Groundwater use	Groundwater use	Monitoring of number of tubewells and groundwater use. Monitoring of groundwater levels	IMO
	Excavation and disposal of silt from canals	Test samples of silt for heavy metals prior to determination of disposal options		
9	Other activities	Progress reports	Feedback on progress and issues	IMO

135. The cost of the environmental monitoring are summarised in

136. Table **16** below.

Table 16 Cost of Environmental Monitoring

Parameters	Cost (Tk)			Total (Tk)	Total $
	Year 1 Establish Baseline	During Year 2-4 During construction period (Tk/yr)	Year 5-10 Recurrent costs (Tk/yr)		
Routine Monitoring by Irrigation Management Operator	800,000.	400,000	400,000	4,400,000	55,000
Bi-annual verification by PMU and PMDC	400,000	400,000	200,000	2,800,000	35,000
Total	1,200,000	800,000	600,000	2,800,000	90,000

C. Environment Management Plan

137. A summary of the proposed interventions is given in Table 17 below. The proposed environmental management plan is shown in Table 18.

Table 17 Proposed Interventions at Muhuri Irrigation Project

Name	Muhuri Irrigation Project
Type	Coastal Flood Protection, Drainage Improvement, Command Area Development and Water Conservation
Upazilas	Parshuram, Chhagalnaiya, Feni Sadar, Miersharai, Sonagazi, Fulgazi
Gross Project Area/ Net Irrigated Area	40,000ha. Net Irrigated Area 17,000ha
Proposed Interventions	Rehabilitation of the coastal embankment together with associated structures to prevent saline intrusion and ingress of sea water during storms. Repairs to existing and provision of new water and flood control structures River bank protection in localised parts to protect communities Excavation of khals to provide full access to irrigation water for all irrigation water users and improve drainage to reduce flood damage. Provision of a piped distribution system to improve water efficiencies Upgrading of the electrical distribution or supply to support the electrification of all pumps to reduce. Provision of prepaid card meters to allow water allocations to be based on a volumetric basis and ensure full and transparent payment and accounting. Repair and provision of new office space Increased water use efficiencies Intensification of irrigated agriculture

Table 18 Environmental Management Plan

Nr	Action	Resource Impact	Mitigation Measures	Responsibility		Cost
				Implementation	Monitoring	
A	Impacts on Water Resources During Design					
	Khals have adequate capacity to meet long term drainage needs.	Extreme rainfall events including climate change may cause flooding and damage.	Technical design of the khal to base on 1:25year return period (increased from 1:10 year return period) to incorporate provision for	PPTA Design Consultant during 2013	BWDB Design cell	PPTA budget

Nr	Action	Resource Impact	Mitigation Measures	Responsibility		Cost
				Implementation	Monitoring	
			climate change. Over-excavation not recommended as will increase sedimentation rate.			
	Improved water efficiency will reduce the recharge to the groundwater.	The use of pipe distribution may reduce the groundwater recharge. Improved surface water management will however reduce demand from groundwater.	Develop appropriate plan for conjunctive groundwater use.	PMDC will conduct groundwater studies.	PMU and the IMO to monitor groundwater use and levels	PMDC and IMO contracts
B	Impact on Soil Resources During Design					
	Excavation of khal including removal of vegetation	Excavation of khal including removal of vegetation may increase instability of banks.	Khal side slopes to be kept a 1:1.5 to ensure stability Contract document to specify correct cutting procedures Social forestry to be established to help stabilise khal banks. If any trees to be cut replanting to be done at 1:3. Introduce temporary soil erosion measures	Contractor	IMO	Included in construction contract
	Placing of soil material from khal excavation	Soil material if not properly managed can slip back into khal or encroach onto farmers fields	Most spoil will be placed on the banks but uncontaminated spoil with the correct constituency can	Contractor	IMO	Included in construction contract

Nr	Action	Resource Impact	Mitigation Measures	Responsibility		Cost
				Implementation	Monitoring	
			be used for fill for housing or spread on the fields.			
	Soil borrow areas for rehabilitation of coastal embankment	Soil borrow areas for the coastal embankment can cause instability of embankment. Resulting areas of excavation will fill with water and can be breeding location for mosquitoes.	Soil to be sourced from the existing land adjoining the coastal embankment. Soil borrow areas to be set back not less than 8m from the toe of the embankment. Borrow areas to be from existing BWDB land along the coastal embankment. where appropriate to be used as fish ponds.	Contractor	IMO	Included in construction contract Social forestry from loan funds
C	Construction Impacts					
	Excavation , filling, grading and finishing of earthworks	The work will be a mix of manual labour and machinery. Dust fumes and noise in the vicinity of the works	Reduce ambient dust levels by spraying. Remove construction debris and dispose of in an approved location.	Contractor	IMO	Included in construction contract
	Construction activities near and inside community areas	Construction vehicles can disturb the local communities	Select machinery and vehicle transport routes away from communities. Consult with local communities	Contractor	IMO	Included in construction contract

Nr	Action	Resource Impact	Mitigation Measures	Responsibility		Cost
				Implementation	Monitoring	
			about working hours.			
	Operation of construction vehicles	Air and noise pollution	Adequate maintenance	Contractor	IMO	Included in construction contract
	Impacts on archaeological sites, graveyards or other community heritage artifacts.	Not envisaged but in the event of any chance findings	Ensure the construction companies have understanding. If archaeological remains are found work has to immediately stop until impact verified by Department of Archaeology.	Contractor	IMO	Included in construction contract
D	Impacts on Wetland Habitats					
	Drainage may remove wetland areas	There are a few low lying areas that are wetlands	Very low land will not be provided with drainage	PPTA Design consultant	BWDB design unit	PPTA budget
	Excavation and removal of vegetation from khal may affect fish breeding.	The vegetation along the khal provides a refuge for fish.	Secondary vegetation will quickly regenerate. Only essential vegetation and trees should be removed	Contractor	IMO	Budget provided in IMO contract
E	Operation Impacts					
	Soil degradation due to poor on-farm management,	Intensive agriculture may cause soil exhaustion and soil toxicity due to chemical usage and lack of knowledge among farmers	Appropriate soil management and soil testing systems and educate farmers on it. Repeated information sharing on good agriculture and soil management practices	IMO will provide agricultural support	PMU and third party monitoring organization	IMO budget

Nr	Action	Resource Impact	Mitigation Measures	Responsibility		Cost
				Implementation	Monitoring	
	Increased agrichemicals in surface and ground water systems, and reduced quality of return flows	Increased use of agrichemicals envisaged to meet target of intensification and increasing yields	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design	IMO will provide agricultural support	PMU and third party monitoring organization	IMO budget
F	Social Impacts					
	Workers / labour camps and facilities.	External labor can cause disruption and disturbance	Provide appropriate shelter and other facility for any labour brought from outside. Ensure no conflict with local population due to labour camp. Provide sanitation and waste management faculties	Contractor	IMO	Included in construction contract

VIII. INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING

138. The BWDB does not does not have internal capacity to handle environment related activities and the environmental activities will need to be outsourced. The PMU will require to have some in house expertise on environmental management and it is proposed a qualified officer is seconded to the PMU from another departments or an appropriately qualified person is recruited

139. Strengthening of the PMU and the MFF stakeholders in environmental management will be the responsibility of the PMDC who will also be responsible for the establishment and strengthening of the Safeguards Cell as well training for stakeholders in the projects being implemented. Environmental training and awareness for the Muhuri Project will be the responsibility of the IMO. The proposed training program is summarized in Table 19.

Table 19 Environmental Strengthening and Capacity Building for MIP

	Capacity Building Activity	Frequency	Responsibility and budget	Type of training	Who will be trained
1	Awareness on ADB environmental procedures, monitoring and EMP needs	Once project start	PMDC	Half day workshop led by environment specialist of the PMDC	All stakeholders involved in project design and implementation.
2	Programme awareness training	Annually	IMO	Half day workshop	Muhuri stakeholders
3	Identification of possible environmental issues and possible mitigation actions and monitoring requirements. Feedback on actual and potential environmental issues.	At project start and annually	IMO with support from PMDC specialists	1 day – including both field visits and group discussions	BWDB staff, IMO supervisors, contractors, Water User Associations, Department of Agriculture and representatives from the ICC and other key stakeholders.

IX. CONCLUSIONS AND RECOMMENDATIONS

140. The project, aims at improving the agricultural production in the IMIP area by means of rehabilitation of the irrigation infrastructure and related facilities. In summary, the project can be described as an irrigation and flood protection rehabilitation project aiming at improving agricultural production in the Muhuri Irrigation Project.

141. The main negative impacts of the project are summarized in table 18.

Table 20 Main Negative Impacts and Proposed Mitigation Measures

Negative impacts	Proposed mitigating measures
Hazards and environmental impacts related to construction activities including: Worker accidents Air, water and soil pollution Conflicts with local population Risk of road accidents Loss of valuable flora along khals	Adherence to laws and regulations Watering of unpaved access roads Covering of trucks to prevent dust emission Minimize activities during prayer time/rest hours Provide sanitary facilities to workers Design a waste collection system for construction wastes/ wastes from worker camps Recruit workers locally Strict enforcement traffic rules Minimize destruction of bank vegetation Schedule works not to disrupt irrigation water supplies

(i). Water quality of surface waters and groundwater due to increased agro-chemical use including fertilizers and pesticides	(ii). Agriculture extension to support timely and correct pesticide application Introduction of integrated pest management

142. The main positive impacts of the project are summarized in Table 21. The rice production in the area will increase considerably. However, overall agricultural production will increase and this may lead to a regional socio-economic uplift.

Table 21 Main Positive Impacts of the Project

Project activity	Related positive impacts
Improved supply of irrigation water to agricultural lands	• Increased paddy production • Improvement of socio-economic conditions of farmers • Socio-economic uplift of the region • Increase in number of permanent jobs in agriculture.
Construction activities	• Creation of temporary job opportunities

143. In general terms the positive impacts are expected to outweigh the negative impacts, on the condition that the project rehabilitation activities are carefully planned and that due attention is given to the social aspects and risks of project implementation. If carefully implemented and when due attention is paid to the proposed mitigating measures, the project will not have unacceptable impacts and a complete EIA is not thought to be necessary.