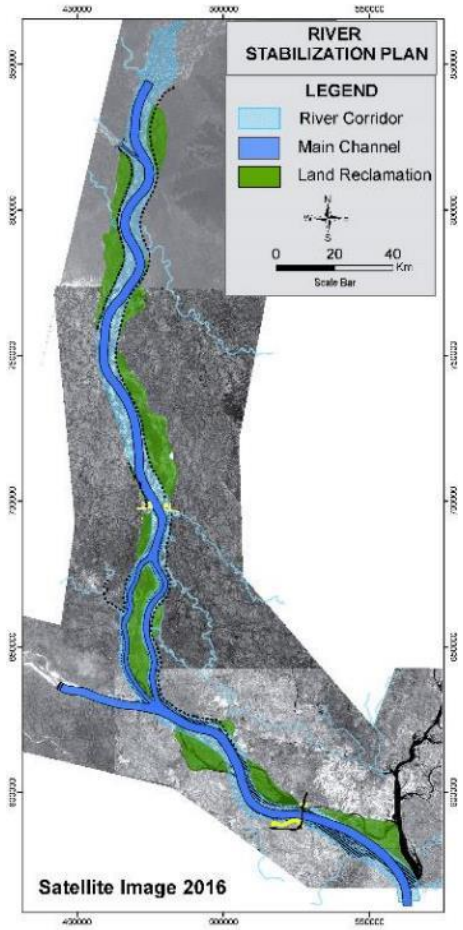
Government of the People's Republic of Bangladesh

Bangladesh Water Development Board

Asian Development Bank



Project Loan No 3138-BAN (SF) and Grant No 0396-BAN (EF)

Flood and Riverbank Erosion Risk Management Investment Program

FEASIBILITY REPORT FOR TRANCHE-2

August 2019

nhc northwest hydraulic consultants

MOTT MACDONALD

In association with
DELTARES
RPMC and CEGIS

FRERMIP

Flood and Riverbank Erosion Risk Management Investment Program

Consultant's Report

Flood and Riverbank Erosion Risk Management Investment Program

FEASIBILITY REPORT FOR TRANCHE-2

August 2019

Recommended for Approval.

(MOTAHER HOSSAIN)
Chief Engineer, Design
Bangladesh Water Development Board
Dhaka.

Prepared by

Institutional Strengthening and Project Management Consultant (ISPMC)

Joint Venture of Northwest Hydraulic Consultants Ltd. and Euroconsult Mott MacDonald Ltd. in association with Deltares, Resource Planning and Management Consultants and CEGIS

Approved.

(Md. Mahfuzur Rahman)
Director General
BWDB, Dhaka.

Flood and Riverbank Erosion Risk Management Investment Program
ADB Loan No. 3138-BAN (SF) and GRANT No. 0396-BAN (EF)

Institutional Strengthening and Project Management Consultant (ISPMC)

FEASIBILITY STUDY REPORT FOR TRANCHE-2
Main Report

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	Feb 2018	Bruce Walsh with contributions from ISPMC team)[1]	Knut Oberhagemann	Knut Oberhagemann	1st draft report
B	20 Mar 2018	Knut Oberhagemann			Update in line with discussions during the ADB Consultation Mission from 27 February to 5 March 2018
C	April 2019	Knut Oberhagemann	PMO, Design Office BWDB (7 May 2019)		Update in accordance with Technical Committee meeting, October 2018 and Consultation Mission, Nov 2018 as well as designs provided by the BWDB Design Circle
D	June 2019	Hiba Khan	PMO, Design Office BWDB (7 May 2019)	Knut Oberhagemann	Update following discussions with client
E	August 2019	Hiba Khan	Jesper Mathiesen	Knut Oberhagemann	Update following comments from BWDB Review Committee

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Flood and Riverbank Erosion Risk Management Investment Program
ADB Loan No. 3138-BAN (SF) and GRANT No. 0396-BAN (EF)

Institutional Strengthening and Project Management Consultant (ISPMC)

FEASIBILITY STUDY REPORT FOR TRANCHE-2

Main Report

Key Data

Name of Project:	**Flood and Riverbank Erosion Risk Management Investment Program (3 Tranches)**
Borrower, Executing Agency and Implementing Agency:	Government of Bangladesh (GoB) Bangladesh Water Development Board (BWDB) Department of Disaster Management (DDM)
Financing:	Asian Development Bank (US$ 251.1 million for 3 tranches). ADB Loan No. 3138-BAN (SF). Government of the Netherlands (US$ 13.7 for Tranche-1). Grant No 0396-BAN (EF). Government of Bangladesh (US$ 113.6 million for 3 tranches)
Consultant:	Joint Venture of Northwest Hydraulic Consultants Ltd. (Canada) and Euroconsult Mott MacDonald Ltd. (UK) in association with Deltares (The Netherlands), Resource Planning and Management Consultants (Bangladesh) and CEGIS (Bangladesh). Contract Signed: 8th September 2015
Contracting Authority:	PD, FRERMIP, BWDB, Dhaka
Start/ End Dates:	ADB Loan Agreement: 27 June 2014 (approved), 14 August 2014 (signed), 17 September 2014 (effective) Multi-tranche financing facility (9 years): June 2014 to June 2023 Dates for FRERMIP (updated): - Tranche-1: August 2014 to June 2020 (± 5.9 years) - Tranche-2: January 2020 to December 2023 (± 4.0 years) - Tranche-3: June 2021 to August 2024 (± 3.2 years)
Beneficiaries:	Local stakeholders directly and indirectly benefitting from river flood protection works and land reclamation and development
Subproject Sites/ Location/ Areas	Focus of works are along the Jamuna-Padma river corridor, from Bangabandhu (Jamuna) bridge to confluence with Meghna river at Chandpur; i.e. Reaches 3, 4 and 5. Master plan area comprises the three priority subprojects, JRB-1, JLB-2 and PLB-1 which extend over (part of) the following districts: Sirajganj, Tangail, Pabna and Manikganj.

	km²	ha
Total Area of all Sub-Projects	9,292.3	929,230
FRERMIP SPs (JRB1, JLB2,PLB1): Total Area	2,473.9	247,390
FRERMIP SPs: Agricultural Benefit Area	1,220.0	122,000
FRERMIP SPs: Population		10.6 million
FRERMIP SPs: Population Density		1,137 km²
FRERMIP SPs: No. of Households		2.03 million
FRERMIP SPs: Average HH Size		5.2
Master Plan Total Area	15,950.0	1,595,000
Master Plan Agricultural Benefit Area (flood risk mitigated)	5,000.0	500,000
Land Reclamation Area in River Corridor, Maximum	1,500.0	150,000
Land Reclamation Area in River Corridor, FRERMIP max.	660.0	66,000

EXECUTIVE SUMMARY

Background

THE ROLE OF RIVER STABILIZATION FOR MIDDLE INCOME STATUS

Bangladesh's main rivers will play an important future development role, constituting a major shift from earlier times when being considered as a primary cause of disaster. The country develops towards leaving the group of least developed nations and aspires to reach middle income status in the early 2030s as formulated in the Bangladesh Delta Plan, 2100, approved in September 2018 (GED; Bangladesh Planning Commission; GoB, 2018). Systematic river stabilization particularly of the Jamuna and Padma rivers will contribute three core elements for a more developed economy: (i) developing up to 1,500km² of recovered floodplain land in the heart of the country, supporting intensified agricultural production as well as peri-urban development, (ii) providing stable flood protection incorporating structures to reliably connect with wetlands and distributary rivers for environmental restoration, and (ii) facilitating transboundary dry-season navigation for more balanced multi-modal transport. The re-orientation towards larger development goals means that while the historic goals of self-sufficiency in food grains (rice) achieved through flood control and irrigation improvement remain valid, the water sector needs to take on additional roles in the field of stabilizing the main rivers and securing reliable dry season flow in dependent distributaries.

The backbone of more stable main rivers, particularly the Jamuna River, provides riverbank protection, which has reached a world-wide unique level of cost effectiveness and sustainability in Bangladesh. Based on a century of experience with river training work for bridge crossings and after systematic piloting a number of innovative solutions during the 1990s, the Bangladesh Water Development Board (BWDB) through the ADB supported JMREMP[1], developed revetments being (i) able to respond to unpredictable river changes through an adaptive or phased approach of construction to deepest erosion levels, while (ii) maintaining cost-effectiveness for the protection of largely agricultural lands with low economic returns. The initial investment cost for these revetments is around USD 3million in 2018 prices and remains unchanged since 15 years. The successful implementation of JMREMP, and the ability to protect nearly 30km of banklines, in places since 15 years, provided a strong rationale for continuation and expansion of the approach during the FRERMIP (2014 – 2023). In addition to riverbank protection and river stabilization, the FRERMIP provides for improving flood protection along stabilized riverbanks, a core element of disaster risk reduction and self-sufficiency in food.

FRERMIP AND TRANCHE-2 IN CONTEXT

The two ADB financed initiatives in the Lower Jamuna, the JMREMP (2002-2011) and the FRERMIP Tranche-1 (2014 – 2019) have provided first riverbank

[1] Jamuna-Meghna River Erosion Mitigation Project, ADB Loan BAN (SF) 1944, implemented from 2002 to 2011 with a pilot phase for geotextile bag revetments from 2004 until 2006.

stabilization measures to the some 60km long Lower Jamuna[2]. The FRERMIP Tranche-1 has also developed a "Strategic Framework for River Stabilization and Development: Jamuna-Padma and Dependent Areas" (NHC/EMM, 2016) to stabilize the main rivers for broad-based value capture including char land development[3], restoring dry-season distributary flows around Dhaka[4], and multimodal transport in a more navigable river combined with improved access to once inaccessible riverbanks and former char lands through roads over climate smart flood embankments[5]. This framework is in line with (i) Government's vision and incorporated into the Bangladesh Delta Plan, 2100 (GED; Bangladesh Planning Commission; GoB, 2018) as well as (ii) the Financing Framework Agreement of 2014 and justifiable through additional benefits streams.

The feasibility for the Tranche-2 project is prepared following a review of status and lessons learned from the first Tranche (NHC/EMM, February 2018), reflecting the latest river situation including changes after two high floods in 2016 and 2017 and, latest Government goals and BWDB recommendations (BWDB, Technical Committee, 2018). Within this context, the proposed FRERMIP Tranche-2 attempts to develop the Tranche-1 work systematically into the backbone of a stable Lower Jamuna river course. An additional benefit stream from developing potentially 6,000 hectares of char land contributes to the economic feasibility.

As of April 2019, the implementing agency Bangladesh Water Development Board (BWDB) has successfully implemented Tranche-1 to some 90% progress, with most of the construction activities near completion, and the Department of Disaster Management contributing non-structural flood risk management activities on community level- Knowledge-base development and institutional strengthening activities are also near completion.

Tranche-2: Balancing Principle Demands

The Framework Financing Agreement provides the flexibility to respond to the fast changing river environment and also allows changes pertaining to the overall country context. To this end, six fundamental requirements have to be balanced for the formulation of Tranche-2:

(i) The program follows the Framework Financing Agreement, having a focus on riverbank and flood protection and agrees with the Strategic Framework (NHC/EMM, Strategic Framework for River Stabilisation and Development: Jamuna-Padma and Dependent Areas, 2016).

[2] The Lower Jamuna extends from Bangabandhu (Jamuna) Bridge to Aricha at the confluence with the Ganges River. JMREMP provided 17km of riverbank protection at two locations of the right bank (PIRDP and Kaijuri), while FRERMIP Tranche-1 provided 9km of riverbank protection in two locations on the left bank (Chauhali and Zaffarganj).

[3] FRERMIP Tranche-1 protected some 1,800ha of attached char from erosion and incorporation into the floodplain. Tranche-2 will protect this land from flooding through a new flood protection embankment and is expected to initiate the recovery of some 6,000ha of lost floodplain land through piloting the closure of an eroding channel.

[4] Tranche-2 plans to provide the basis for a stable offtake of the Old Dhaleswari or Ghior Khal river downstream of the protective works built during Tranche-1 at Chauhali.

[5] Tranche-2 will provide for some 17km of new embankment over the recovered land at Harirampur with a modern cross section allowing the incorporation of road connectivity through the Roads and Highways Department or the Local Government.

	(ii) Program goals align with the Bangladesh Delta Plan, 2100, approved in September 2018. (iii) Each tranche and the overall program are economically viable. (iv) Tranche-2 can be implemented within the available timeframe. (v) The proposed work is technically feasible. (vi) The Technical Committee proposes a more risk sensitive approach through a higher level design of riverbank protection, which in ways continues the development process of innovative designs applied in JMREMP and FRERMIP Tranche-1.
	COMPONENT 1 – FLOOD AND RIVERBANK EROSION RISK MANAGEMENT **STRUCTURAL WORKS** Different from all projects implemented on the stable floodplain, work alongside eroding riverbanks or even within the river corridor of the very large, dynamic, and unpredictable rivers of South Asia requires the flexibility to change location and length of the works in line with the morphological developments, sometimes even the types of structure. Successful river stabilization is opportunity driven to capture favorable channel alignments and reduce investment cost. Time gaps between planning and implementation are required to adjust to a different river alignment and therefore the layout of effective protection works asks for adjustment immediately prior to construction. Furthermore, systematic river stabilization of well-defined reaches, once started, depends on a continuous development without time gaps that give the river a chance to develop in undesirable ways. Continuation avoids that earlier investment becomes redundant and needs to be supplanted through costly additional works. With continuous progress, there is a good chance of effectively integrating earlier investments and gradually reducing the unpredictability of the river. The "adaptive approach"[6] formed the basis for the FRERMIP, with the BWDB committing to maintain all implemented works as stated in Section 22 of the project Loan Agreement. To this end the BWDB has implemented adaptive works two times, at the PIRDP in 2006 and at Chauhali in 2018. However, within the context of more systematic river stabilization and particularly for channel locations not expected to change in the mid-term, the BWDB suggests to apply a higher level riverbank protection standard, reducing the uncertainties of future investments for adaptive riverbank protection (BWDB, Technical Committee, 2018). A higher design level is attempted through a composite design consisting of two layers of protection. Geobags form the base layer, later covered with hard materials (either rock or concrete blocks). Physical hydraulic model tests indicate some advantages, and therefore the BWDB has commenced proposing

[6] Adaptive approach refers to a phased construction process depending on the erosion of the river. This process depends on self-launching aprons providing temporary protection to deeper levels, subsequently strengthened ("adapted") to permanent protection. This approach was also followed at the world's largest river Bridge, the Padma Bridge, currently under construction at Mawa.

this design in most new DPPs. The additional fund requirement will be supplied through Government as per decision of the Technical Committee meeting. As the design has no history of long-term monitoring, the Tranche-2 provides the means for stringent monitoring through a number of different methods. Based on the additional knowledge gained from the first years of close monitoring Tranche-3 (a) may further adjust the designs and (b) formulate a risk-based design approach during the process of updating the "Guidelines for Riverbank Protection".

River stabilization and flood protection under Tranche-2, including the recovery of a substantial amounts of eroded floodplain, represent a continuation of the work implemented under Tranche-1 (2015 to 2019), with the focus on the Lower Jamuna bifurcation and the left branch at Chauhali. The work will continue at all three priority subprojects defined in the PPTA report (JRB-1, JLB-2 and PLB-1) The study team investigated optional protection for Chandpur Town (sub-project MLB-1), however this is dependent on available contingency funding.

Tranche-1 provided 17.8 km of river bank protection and 21.3 km of flood embankments. In Tranche-2, a further 15.5 km of river bank protection, plus 10.5 km precautionary protection, and 25.3 km of flood embankment are proposed, following the updated designs based on the Technical Committee Meeting[7]. Unless otherwise indicated, all data and discussions in this report are based on the designs recommended by the BWDB, which have been selected as the final option based on Client preference. The designs of the draft feasibility report of March 2018, , prepared by the ISPMC are not discussed in this report.

Work	Tranche-1: PPTA	Tranche-1: complete	Tranche -2: PPTA	Tranche-2: Planned	Tranche-3: PPTA	Tranche -3: Planned
Riverbank revetment	15 km	17.8 km	16 km	15.5 km +10.5 km precautionary	19 km	(8.8 km)
Embankment	23 km	21.3 km *1	43 km	25.3 km	23 km	(43.0 km)
Char recovery	-	1,800 ha	-	6,000 ha	-	-

**1. Implementation ongoing, March 2019*

In addition, flow redistribution works will extend the self-dredged Chauhali channel along a desired alignment downstream, while encouraging sedimentation in the 15km long eroding Solimabad channel, developing the char land in this area, and providing a stable offtake for the Old Dhaleswari. 10.5 km of precautionary riverbank protection is proposed to secure the riverbank for the intermediate period of closure.

While Tranche-2 focusses at river stabilization and flood protection, it also includes: (i) 40km strengthening/adaptation works to secure river protection

[7] The Technical Committee in October 2018 adjusted the location approved by the Technical Advisory Committee in September 2017 and recommended a new slope treatment. The BWDB Design Office provided the related designs in early 2019.

constructed under Tranche-1 and previous projects, (ii) 5km of emergency works, (iii) community-based flood risk management, and (iv) knowledge base development including advanced underwater and terrain surveys for comprehensive asset and O&M management. The concluding Tranche-3 will focus more on flood embankment construction.

River Stabilization and Dredging

Tranche-2 complies with Government's vision of combining the development of navigable channels with char development resulting in a number of activities involving dredging. Overall, some 28% of the construction cost and some 22% of the total cost involves dredging, primarily to: (i) speed up char land development, and (ii) construct flood embankments.

Non-Structural Works Component

Community based flood risk management activities will include: (i) engaging an NGO, (ii) Formation of 80 Community-based Disaster Management Units (CDMUs) comprising some 1,200 Community Volunteers (CVs), (iii) training of CDMU volunteers, (iv) agreement/ adoption of community level flood warning, (v) establishment of communications between the CDMUs and DDM staff, and (vi) institutionalization of CDMUs. It is anticipated that the CDMUs will share the same "office" facilities that are proposed for embankment WMOs, see below.

Flood Response Plans will be prepared for 13 Upazilas, based on the plan prepared for Shahjadpur under Tranche-1.

Community Capacity Enhancement for Participatory O&M will include: (i) formation and registration of 10 Embankment WMOs for O&M with BWDB providing annual maintenance funding, (ii) construction of 10 O&M sheds complete with facilities and equipment, and stockpiles, (iii) piloting bio-engineering solutions to stabilize embankment slopes, both from waves and rainfall (river side) and just rainfall (land side), including use of vetiver grasses, and (iv) training, support and monitoring. An NGO will be engaged for WMO establishment, registration, training and support. The O&M sheds will be constructed under one or more NCB civil works contracts. Ultimately, formation of embankment WMOs with a WMO "shed" for every 5 km of embankment is envisaged.

Livelihood support programs and courses will be identified for Affected Persons as well as for persons living along the river embankment or on the char lands, and will include vocational skills development and various livelihood trainings, for example: crop and fisheries, homestead small livestock and poultry rearing, handicrafts and tailoring, use of char lands, basic computer skills, establishment of fish sanctuaries, and so on. Participants for the courses will be carefully screened for interests while checking their suitability. Follow up monitoring and training will be provided, as well as start-up equipment and materials. To encourage women's participation care facilities for babies/ children, as well as segregated toilets, will be provided at training venues. In Tranche-2, about 2,000 affected persons shall attend on-site 1-day training, and about 800 persons shall

attend 2-5 day residential trainings. NGO services shall be procured to determine interest in trainings, screen participants, prepare training plans and budgets for approval, provide on-site trainings (in the O&M sheds) monitor the effectiveness of the trainings, and provide training reports including for the fisheries support works.

COMPONENT 2 – STRENGTHENED INSTITUTIONAL SYSTEMS FOR FLOOD AND EROSION RISK MANAGEMENT

INSTITUTIONAL CAPACITY

Training will comprise: (i) local training, primarily for BWDB but also for DDM, (ii) overseas training, and (iii) study tours. There will also be training to facilitate adoption and use of the various management information systems.

While the CD-River Management (CE RM) has been appointed, and staff positions sanctioned, his office is not yet fully operational. The combination of the PMO with the CE RM office could reduce the pressure on the understaffed BWDB. Priority for training will be given to staff from this office.

The website and file manager/ database successfully implemented during Tranche-1 will be further improved under Tranche-2 with a dynamic project map enabling the user to zoom into a specific site to access data from that site. The website database will also continue to be populated. A separate River Survey database containing more than 2,000 surveys since the mid-1990s is operational with a first BWDB engineer trained. It will be further expanded during Tranche-2.

The **Scheme Inventory and Mapping System (SIMS),** essentially an Asset Inventory, developed under WMIP will be further developed by addition of an integrated risk based O&M MIS module under Tranche-2 and then put into operation with the first some 60km of embankment assets added. The embankment survey will make use of latest drone technology.

To facilitate ADP management, it is planned to further assess the **Smart Project Monitoring and Management Information System (SPMMIS),** under Tranche-2, and then assist in its roll out and adoption by BWDB, subject to any required modification/ improvement after testing.

In addition to the Inception workshop, two national stakeholder (annual) workshops are proposed. Each workshop will be a 1-day event and be held at a major hotel in Dhaka. 50-80 persons would be expected to attend each of these workshops.

Senior BWDB / DDM/ GoB staff will be encouraged to contribute to and attend international workshops/ seminars organised by others which are related to larger rivers management.

The project will support preparation of the 5-year budgetary plan for riverbank protection O&M and emergency work for the main rivers, endorsed by BWDB

DATA AND KNOWLEDGE BASE

	During Tranche-2, the data and knowledge based will continue to be improved by a combination of: (i) studies, (ii) piloting, and (iii) surveys. **Studies**. While further technical knowledge is needed, there is sufficient information to proceed with some confidence with river stabilization works. Tranche-2 studies will be wider in scope and comprise: (i) Regional planning master plan refinement and dissemination, (ii) Main rivers management surveys and studies, (iii) Distributary surveys and studies, (iv) Land reclamation surveys and studies, (v) fishery surveys and studies, and (vi) safeguard studies. **Pilots** initiated under Tranche-1, concerning (i) grout-filled jute mattresses, and (ii) vegetative protection and char-land recovery including use of katkin/vetiver grasses will be refined and continued to be monitored into Tranche-2. **Surveys** will support studies, the improvement of the knowledge base, and to prepare designs for future works. Different types of state-of-the-art survey techniques (drone surveys, multi-beam echosounder surveys, advanced sediment measurement techniques) will be applied along the main rivers, as well as along distributaries. **COMPONENT 3 – PROJECT MANAGEMENT** The successful project management team of Tranche-1 will continue for Tranche-2: The Bangladesh Water Development Board (BWDB) will manage the Tranche-2 through its existing Project Management Office (PMO) which performed well in implementing the Tranche-1. However, the PMO needs increased staff strength, the more so as the volume of work is about four times the Tranche-1 work. The PMO will continue being supported by an experienced institutional strengthening and project management consultant fulfilling the role of specialist advisor during (i) implementation, particularly on project management, and construction and strengthening/adaptation aspects, (ii) preparation of Tranche-3, and (iii) specialist advice and guidance for knowledge-base development including a reliable asset management system.
Rationale	River bank erosion and unpredictable and uncontrolled flooding causes loss of land and crops destroying livelihoods of households living along the river and in the flood plain. The project through river bank stabilisation and flood protection will stop loss of land, and eventually contribute to reclamation and development of up to 150,000 ha of char-land in the Jamuna-Padma river corridor. Non-structural and institutional strengthening measures will meanwhile support affected persons (river bank and char-dwellers) to improve their livelihoods, as well as sustainable management and O&M of infrastructure. A stable river and protected flood plain will restore dry season flows to distributaries while controlling extreme flooding, and distributary dredging will increase capacity, addressing declining water tables and flows to the Dhaka metropolis. Connectivity will improve with roads along the flood embankments, as well as improved inland navigation. High value development in the flood plain and reclaimed char land will follow, for peri-urban residential, commercial and industrial use, as well as higher value agriculture.

Project Impact, Outcome and Outputs

The **Impact** (goal) of FRERMIP is for improved livelihoods in the project area, along the main rivers, and poverty alleviation.

The project **Outcome** is reduced vulnerability against flood and riverbank erosion risks in the subproject reaches and char-land reclamation. Targets are to achieve the following by 2023 in subproject areas: (i) 4,500 ha of char and/or main land protected from erosion and loss (43 ha from existing JMREMP work in 2013), (ii) 30,000 ha of main land protected from extreme (river) flooding, including agriculture land and land with assets (homesteads, roads, etc.), (iii) about 1 million persons directly or indirectly protected from extreme flooding (in JLB-1 and PLB-1), (iv) about 6,500 ha of char land recovered from the river for development, and (v) improved roads generating increased traffic and quicker/ easier transportation.

The project outcome will be achieved if the following mutually supporting project **Outputs** are achieved: (i) Output 1: Improved flood and riverbank erosion risk mitigation measures at priority reaches, comprising: (a) Structural Works, and (b) Non-Structural Components, and (ii) Output 2: Strengthened institutional systems for flood and riverbank erosion risk management, comprising (a) Institutional Capacity, and (b) Data and Knowledge base, and (iii) Output 3: Program management systems.

Cost Estimate

Total Tranche-2 project costs are shown below. The investment costs of the Project are expected to total US$ 361.3 million (around BDT 30 billion).

Detailed Categorization by Component	Tranche-1	Tranche-2
A Strengthening Institutional System for Flood and Riverbank Erosion Risk Management	**12.7**	**12.92**
A1 Institutional Capacity Strengthening for Sustainable River Management	1.3	2.43
A2 Knowledge-base Development	11.39	10.49
B Flood and Riverbank Erosion Risk Management Measures at Priority Reaches	**70.54**	**301.18**
B1 Infrastructure Improvement	67.69	295.77
B2 Community-based Flood Risk Management	1.58	1.05
B3 Participatory Regular O&M	0.3	0.36
B4 Livelihood Support for Project Affected People	0.96	3.96
C Project Management	**10.93**	**9.23**
Total Baseline Cost (Subtotal A+B+C)	**94.17**	**323.33**
Physical Contingencies	4.47	3.00
Price Contingencies	2.44	29.48
Total PROJECT COSTS	**101.08**	**355.81**
Interest During Implementation 2%	2.19	5.47
Total Costs to be Financed	**103.27**	**361.27**

Implementation Institutional Arrangements

The Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources (MOWR) is the Executing Agency. The Department of Disaster Management (DDM) under the Ministry of Disaster Management and Relief is the Implementing Agency for community based flood management activities.

	Goods and works contracts will be procured for supply of geo-bags and items of equipment/ vehicles, and for civil works including revetment, dredging, and flood protection works. Service contracts will pertain to project implementation support particularly the ISPMC and specialist NGOs / firms for the non-structural components of the project, for surveys, studies and pilots and for safeguards, resettlement and environmental work.
Implementation Schedule	The FRERMIP is being implemented over ten years[8], August 2014 to August 2024, in three tranches with around 158 implementation months (due to overlap with previous tranches): • Tranche-1: August 2014 to June 2020 (5.9 years) • Tranche-2: January 2020 to December 2023 (4 years) • Tranche-3: June 2021 to August 2024 (3.2 years)
Design Features	The main feature of FRERMIP is river stabilization through affordable riverbank protection. An effective River Management Office will conduct all planning, design and implementation of works within the river corridor, including regular monitoring and evaluation for annual implementation designs and strengthening/adaptation designs. Effective measures for implementation and maintenance of flood embankments, for which embankment WMOs and an asset management system with O&M module will play a central role, will continue being the responsibility of the zonal Chief Engineers. Logical implementation of the river stabilisation plan is important, for example river reaches should be sufficiently stabilized before works to control flows and sediment entry to off-taking distributaries.
Local Stakeholder Involvement	Local stakeholders firstly comprise local communities along the river banks and in char-lands, and secondly communities in the flood plain. These will be involved: (i) by working with zonal Chief Engineers, BWDB for participatory regular O&M and livelihood support, (ii) by working with DDM for flood warnings and management, (iii) through resettlement and land acquisition consultations and activities, and (iv) through construction works.
3rd Party and Consultancy Services	Third party support services of different durations will be procured from NGOs/ firms for the: (i) non-structural components of the project, (ii) for strengthened institutional systems, particularly for MIS establishment, (iii) knowledge-base development surveys, studies and pilots, and for (iv) safeguards, resettlement and environment. Most of these service contracts will be procured during the processing of Tranche-2. Consultancy services will be engaged for 42 months to support the PMO-BWDB, and PMU-DDM to implement Tranche-2 including: (i) support and advice during

[8] Agreed until 2023, recommended extension to 2024 to complete remaining works

	implementation of river stabilization and flood protection works, (ii) achieving non-structural project components including regional and community flood risk management, community involvement in regular O&M, and improved livelihoods for affected persons, (iii) strengthened BWDB institutional capacity for flood and riverbank erosion risk management through training, further development and adoption of MISs, and planning for O&M, (iv) improved data and knowledge base through studies, pilots and surveys, (v) efficient and effective project management, and (vi) preparation of Tranche-3. These consultancy tasks may be broadly categorised as being: (i) concerned with project implementation, or (ii) with improving the knowledge base. Therefore, as with Tranche-1, the ISPMC will comprise two teams: (i) Project Management and Feasibility Team, and (ii) Knowledge Team. The Team Leader of the project management team will be overall leader for the ISPMC.
Project Monitoring and Reporting	**Project performance monitoring**. The project MIS is based on the program's design and monitoring framework. During Tranche-2, the project database will be further improved with a dynamic project map enabling the user to zoom into a specific site to access data from that site. **Compliance monitoring**. The status of compliance with assurances, conditions and loan covenants—policy, legal, institutional, financial, economic, environmental, social and others— will be reviewed at each ADB review mission and reported in the quarterly progress report. **Safeguards monitoring.** Monitoring and reporting for social safeguards are described in the resettlement framework for the planning of works, and the concerned resettlement plans provide the arrangement for implementation monitoring. **Gender and social dimensions monitoring**. The GAP will be implemented and monitored by BWDB. The status of the implementation of the GAP will be reported in the quarterly progress report. Reporting will include: (i) quarterly progress reports, (ii) consolidated annual reports, and (iii) a project completion report. The DDM will report its monthly progress to PMO, with the PMO, BWDB reporting consolidated progress.
Safeguards, Gender and Social Dimensions	Involuntary resettlement and compensation in Tranche-2 will continue to be in accordance with the Resettlement Framework for the programme, (ADB-GoB, January 2018). The services of 3rd party firms/ NGOs will be procured to prepare Resettlement Plans, one for each site of works, and assist the PMO-BWDB and District Commissioner offices in making entitlement payments to effected persons. In total some 196ha of land will be required, mostly for flood embankment construction (some 170ha), affecting some 890 households. A large portion (about 35 ha) of this is on recovered char land at Harirampur. The (updated) Environmental Assessment Review Framework (EARF), May 2014, sets forth safeguards procedures to be followed in subsequent MFF tranches, as well as safeguards-related criteria to be considered in the selection of subprojects.

<table>
<tr><td></td><td>The Tranche-2 project is categorized A for environment, as has been the Tranche-1 project, and an Environmental Impact Assessment report (EIA) has been prepared for the four Tranche -2 sub-reaches, the three covered in the Tranche-1 EIA report (JRB-1, JLB-2 and PLB-1) as well as the provisional works at Chandpur (MLB-2). In total some USD 5million are allocated for environmental mitigation measures, including fish passes and restoration of wetlands/beels.

The Gender Action Plan for Tranche-2 includes targets for: (i) women's involvement in construction works, (ii) women's representation (minimum 30%) on committees for CbFRM, and receiving training, (iii) women's involvement in embankment WMOs for regulator O&M, including representation on the Executive Committee, and in doing maintenance work through formation of Labour Construction Societies (LCS) where there should be 30% of women, (iv) receiving livelihood improvement support for project affected people, and (v) women's participation of workshops and training as part of institutional strengthening.</td></tr>
<tr><td>Project Benefits and Economic Viability</td><td>Quantified benefits include: (i) reduction of land loss to bank erosion, (ii) reduced flood damage to crops and infrastructure, (iii) increased agriculture production due to reduced extent/ duration of flooding, (iv) char land reclamation and becoming available for development, and (v) improved road linkages. Non-quantified benefits include a reduction in loss of life and distress caused by flooding and loss of land to river erosion. Also not quantified are likely future benefits that arise from: (i) navigation improvements, (ii) improved water supply to Dhaka; (iii) increased surface flows addressing groundwater decline.

Despite the steep increase in land acquisition cost, reaching about 40% of the total cost associated with flood embankment construction, flood protection continues contributing a major benefit stream to the economic feasibility. The other two major benefit streams result from riverbank protection and char land development, newly introduced into Tranche-2.

<table>
<tr><th>Benefit Stream</th><th>JRB-1</th><th>JLB-2</th><th>PLB-1</th></tr>
<tr><td>Riverbank protection</td><td>8%</td><td>73%</td><td>24%</td></tr>
<tr><td>Flood mitigation</td><td>83%</td><td>0%</td><td>37%</td></tr>
<tr><td>Reduced damage</td><td>77%</td><td>0%</td><td>32%</td></tr>
<tr><td>Incremental agriculture</td><td>6%</td><td>0%</td><td>5%</td></tr>
<tr><td>Char land development</td><td>0%</td><td>27%</td><td>29%</td></tr>
<tr><td>Agriculture & Fisheries</td><td>0%</td><td>15%</td><td>8%</td></tr>
<tr><td>Settlements</td><td>0%</td><td>12%</td><td>21%</td></tr>
<tr><td>Road Transport</td><td>9%</td><td>0%</td><td>10%</td></tr>
<tr><td>Navigation</td><td>0%</td><td>0%</td><td>0%</td></tr>
<tr><td>Total</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

The Program in its totality, each tranche individually, and combination of tranches are to be economically viable. The results of the economic analysis for Tranche-1, 2 and 3 are presented in the following table and indicate that the</td></tr>
</table>

economic internal rates of return (EIRR) are economically viable with 11.6% after Tranche 2 and 14.9% after completion of all three tranches[9].

Investment Tranche	Total
Tranche-1	14.7%
Tranche-1 and Tranche-2	11.6%
Tranche-1 to 3	14.9%

Project Financing

The tentative financing arrangements is suggested in the following table. The financing from the Asian Development Bank and Government of the Netherlands was agreed at the start of the project.

Source of Financing	Amount	Percent
Asian Development Bank	**135**	**37**
Government of Bangladesh	223.3	62
Government of the Netherlands	3	1
Total	361.3	100

Assumptions and Risks

This feasibility study is based on the following core assumptions and risks:

Assumptions:

(i) The BWDB recognized the substantial contribution of Tranche-2 to stabilizing 60km of the Lower Jamuna River to develop some 6,000 ha of char land and provide for reliable dry-season navigation to Sirajganj.

(ii) The Tranche-2 bidding commences in summer 2019 to have suppliers and contractors for first construction mobilized by December 2019.

(iii) All work contracts will be updated through implementation designs reflecting the river situation after the 2019 flood season.

(iv) The DPP allows flexibility in work location, type of works, and length of works to respond to unpredictable river changes. The PD is empowered to implement the necessary changes without time consuming administrative process.

(v) The FFA gets extended by one year to 2024 and Tranche-3 processing starts in 2020.

(vi) The land acquisition process starts in summer 2019.

Risks:

(i) The PMO is not strengthened to implement a yet unprecedented project size of some US$ 100 million (or BDT 800 Crore) per year.

(ii) Lack of flexibility in DPP and bidding documents endangers flexible and fast implementation and therefore Government's goal of river stabilization.

[9] The provisional investment at Chandpur (MLB-2) is economically viable on its own, as explained in the March 2018 version of this report.

	(iii) Delays in procurement and work start could delay the Tranche-2 by one year, not only requiring major redesigns in line with river changes but also endangering the completion of the whole Program. (iv) Extensive increase in land acquisition cost, beyond the influence of the BWDB delays the process and requires DPP revisions

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ACRONYMS

ADB	Asian Development Bank
ADM	Adaptive Delta Management (defined in BDP 2100)
ADCP	Acoustic Doppler Current Profiler
BDP	Bangladesh Delta Plan 2100
BDT	Bangladesh Taka
BIWTA	Bangladesh Inland Water Transport Authority
BRE	Brahmaputra Right Embankment
BUET	Bangladesh University for Engineering and Technology
BWDB	Bangladesh Water Development Board
CbFRM	Community-based Flood Risk Management
CDMP	Comprehensive Disaster Management Program
CDP	Capacity Development Plan
CDMU	Community Disaster Management Unit
CEGIS	Center for Environmental and Geographic Information Services
CLP	Chars Livelihood Programme
CQS	Consultant Qualification Selection
DDM	Department of Disaster Management
DEM	Digital Elevation Model
DGPS	Differential Global Positioning System
DMB	Disaster Management Bureau
DPP	Development Project Proforma
DMC	Disaster Management Committee
DMIC	Disaster Management Information Center
DoE	Department of Environment
DoF	Department of Fisheries
DRR	Department of Relief and Rehabilitation
EA	Environmental Assessment
ECNEC	Executive Committee of National Economic Council
EGIS	Environmental and Geographic Information System
EIA	Environmental Impact Assessment
EMM	Euroconsult Mott MacDonald
EMP	Environmental Management/Monitoring Plan
F0 – F5	Land classification categories as per depth of flooding
FAP	Flood Action Plan
FCD	Flood control and drainage
FCDI	Flood control, drainage, and irrigation
FFWC	Flood Forecasting and Warning Centre
FRERMIP	Flood and Riverbank Erosion Risk Management Investment Project (ADB)
GAP	Gender Action Plan
GIS	Geographical Information System
GoB	Government of Bangladesh
HFL	High Flood Level
IEE/EIA	Initial Environmental Examination / Environmental Impact Assessment
IHE	IHE Delft Institute for Water Education
ILRP	Income Livelihood Restoration Program
INGO	Implementation Non-Governmental Organization
IR	Involuntary Resettlement
ISPMC	Institutional Strengthening and Project Management Consultant
IWM	Institute of Water Modelling
IWRM	Integrated Water Resources Management

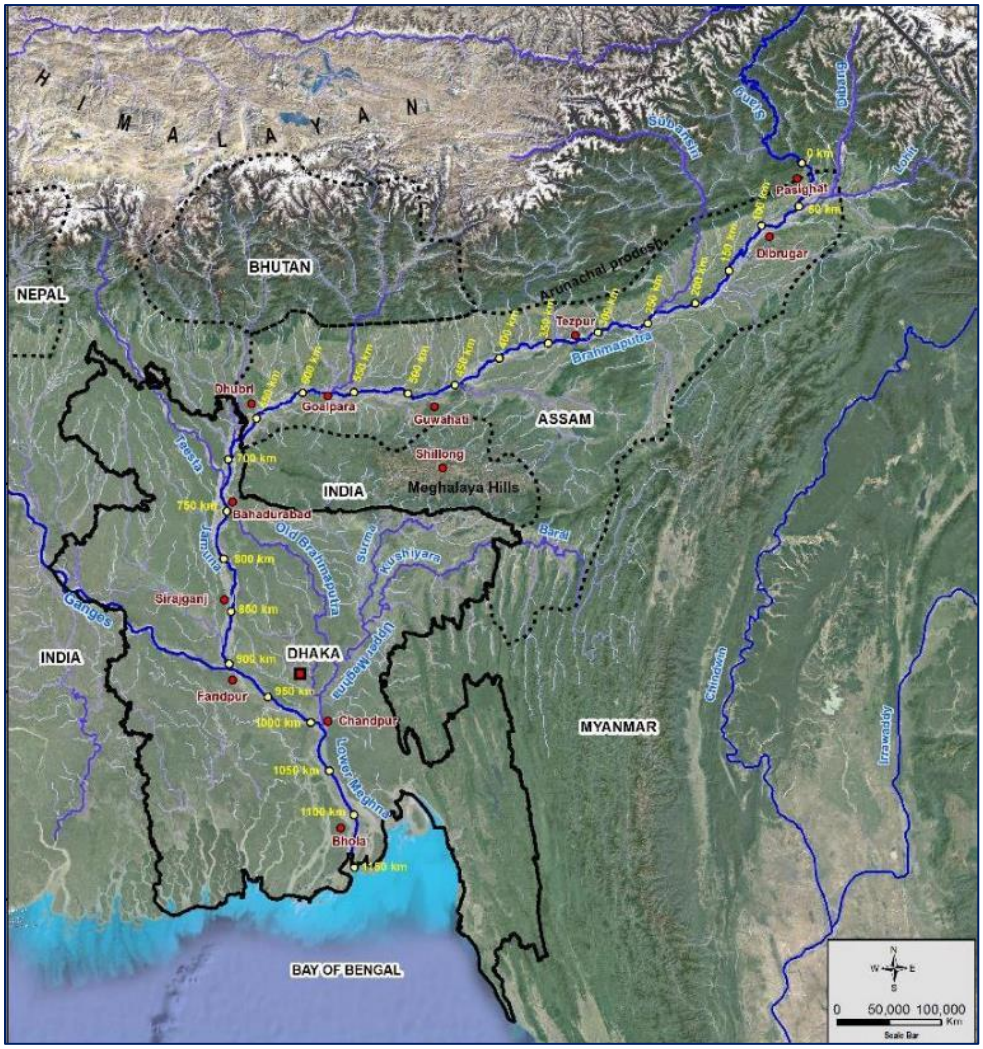
JBIC/JICA	Japan Bank for International Cooperation / Japan International Cooperation Agency
JLB	Jamuna Left Bank
JRB	Jamuna Right Bank
JMREMP	Jamuna-Meghna River Erosion Mitigation Project, 2002 to 2011 (World Bank)
LCS	Labour Construction Society
LGED	Local Government Engineering Department
LiDAR	Light Detection and Ranging
M&E	Monitoring and Evaluation
MCA	Multi-criteria Assessment
MDG	Millennium Development Goals
MDIP	Meghna Dhonagoda Irrigation Project
MFF	Multi-tranche Financing Facility
MIS	Management Information System
MoLGRDC	Ministry of Local Government, Rural Development and Cooperatives
MoWR	Ministry of Water Resources
MRP	Main Rivers Flood and Bank Erosion Risk Management Program
NCB	National Competitive Bidding
NGO	Non-Governmental Organization
NHC	Northwest Hydraulic Consultants Ltd.
NPDM	National Plan for Disaster Management
NWMP	National Water Resources Management Plan
NWP	National Water Policy
NWRD	National Water Resources Database
NWRC	National Water Resources Council
O&M	Operations and Maintenance
PIRDP	Pabna Irrigation and Rural Development Project
PMO	Project Management Organization (BWDB)
PMU	Project Management Unit (DDM)
PPTA	Program Preparatory Technical Assistance
PWD	Public Works Datum
QC/QA	Quality Control / Quality Assurance
QBS	Quality Based Selection
QCBS	Quality and Cost Based Selection
RAP	Resettlement Action Plan
RBIP	River Bank Improvement Project/ Program (World Bank)
RHD	Roads and Highways Department
RPMC	Resource Planning and Management Consultants (Pvt) Ltd.
RRI	River Research Institute, Faridpur
RSP	River Stabilization Plan
RTIP	River Transport Improvement Project
SDG	Sustainable Development Goals
SESA	Strategic Environmental and Social Assessment
SIA	Social Impact Assessment
SSWRDP	Small Scale Water Resources Development Project
ToR	Terms of Reference
USD	United States Dollar
WARPO	Water Resources Planning Organization
WB	World Bank
wl	Water level
WMF	Water Management Federation
WMG	Water Management Groups

WMO Water Management Organizations

Glossary

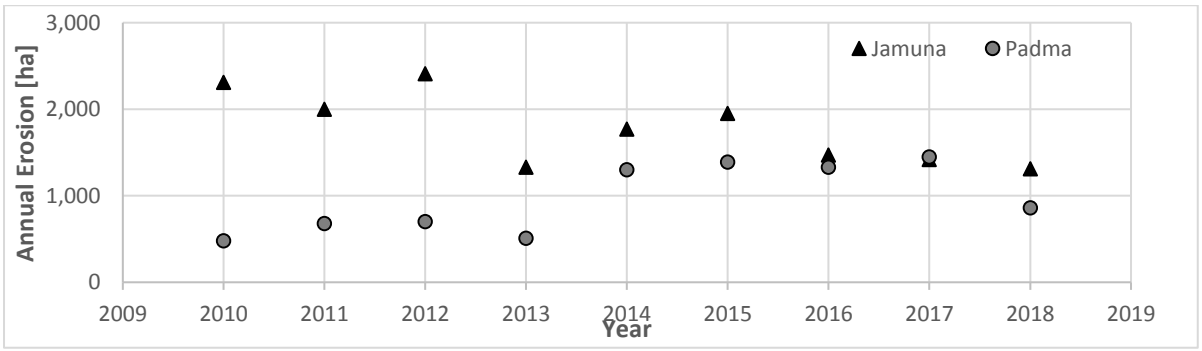
Adaptive management: "*Adaptive management enables participants to set goals, undertake actions, monitor effects of those actions on outcomes, and, most importantly, make adjustments as needed*" (National Research Council 2013).
"*The goals, associated strategies, policies, institutions and investments are moving targets and adaptive in nature. They are adaptive to changing natural events in order to respond appropriately and stay on the course to the path of the long term vision*" (BDP, 2100, 2018)

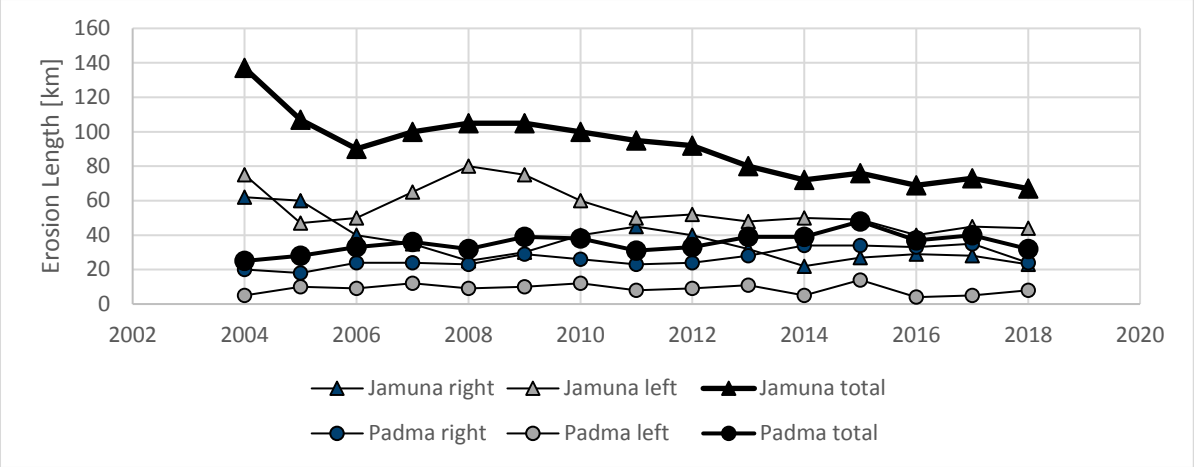
Brahmaputra System The river system influenced by the braided Brahamputra, starting from Pasighat in Arunachal Pradesh, India. In Assam, India the main course is referred to as Brahmaputra, while In Bangladesh it changes its names: the reach from the Indian border to its confluence with the Ganges is referred to as Jamuna River, from there to the confluence with the Upper Meghna as Padma, and from then on to the Bay of Bengal as Lower Meghna. The Jamuna is further subdivided into an Upper Jamuna from the Indian border to Sariakandi (corresponding to Reach 1), the Central Jamuna from Sariakandi to the Bangabandhu (Jamuna) Bridge, and from there to the confluence with the Ganges as Lower Jamuna. Major tributaries in Bangladesh are Darla, Dudkumar, Teesta, and Hurashagar/Baral on the Jamuna Right Bank, the distributaries Old Brahmaputra and Dhaleswari (Pungli, Dhaleswari and Ghior Khal or Old Dhaleswari) on the Jamuna left bank, and the Arial Khan on the Padma right bank.



The braided Brahmaputra System

Erosion rate: The amount of land lost annually along the main rivers and segregated per riverbank. It is established through annual erosion prediction and confirmed after the flood through comparing annual bankline changes. Erosion is typically expressed as area, and can be translated into length of riverbank affected in order to establish the investment volume for riverbank protection. The rates for Jamuna and Padma for the last decade are shown below.





No regret: There are two definitions, one per Delta Plan and one by the BWDB:

(i) "*No regret actions are useful and cost-effective on the short term and under a range of future conditions and do not involve hard trade-offs with other policy objectives.*" (BDP 2100, 2018)

(ii) *"adaptation technology along with bank protection with only geo-bags may not be considered in mighty river like Jamuna & Padma river as no regret consideration"* (BWDB, Technical Committee, 2018); *Riverbank protection has to be permanent* (Director General, BWDB); *BWDB prefers a technology that is stable after construction and does not need year-to-year interventions* (Chief Engineer Design). (Aide Memoire Consultation Mission 20 to 27 November, 10 December 2018 page 7, para 21, and page 5 para 15).
On a different level, higher initial investment cost per kilometer consequently reduces the potentially immediately protected length of eroding riverbank proportionately to the cost ratio.

Planform the channel pattern of a river, single (straight or meandering = sinuous), or multi-channel (anabranched = two channels separated by large islands, or braided multiple channels separated by unstable islands or sand bars). Planform shifting between different types are referred to as wandering. The planform is typically derived from low flow satellite imagery.

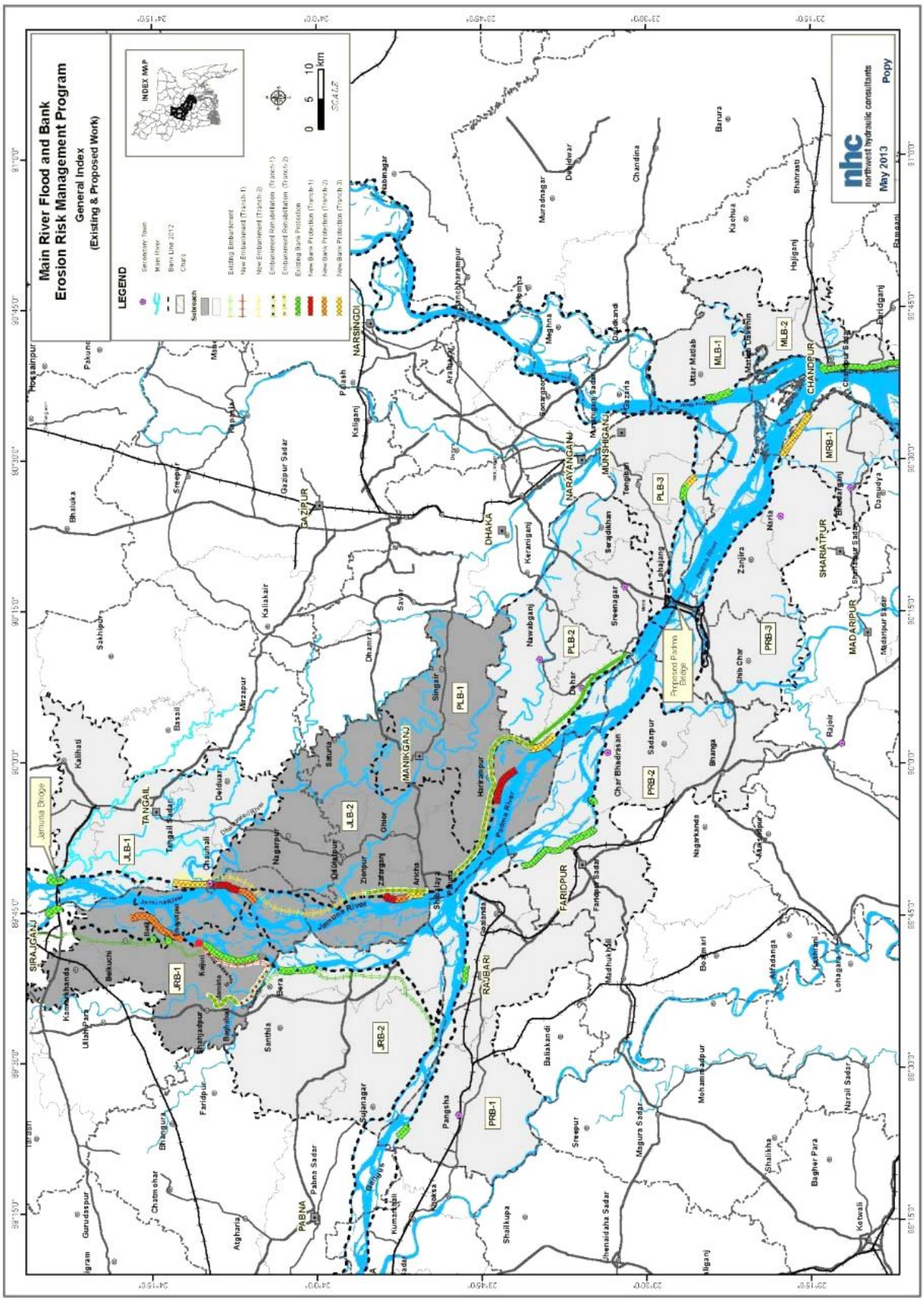


Figure 1-1 Subprojects of FRERMIP Program Area (PPTA 2013)

1 INTRODUCTION

1.1 Background

Bangladesh faces large challenges in providing stable living conditions and development opportunities on the world's largest deltaic environment with one of the highest disaster incidences in the world[10]. The largest disaster incidence in terms of area affected relates to flooding and riverbank erosion particularly along the Brahmaputra – Ganges course[11]. In total 39 districts, covering one quarter of the country are affected (BDP 2100, 2018a). Annual average flooding affects some 20% of the country while extreme floods (like 1998) can inundate up to two thirds of Bangladesh. Satellite image based riverbank erosion analysis since 1973 indicates that up to over 5,000 hectares of floodplain land have been lost annually, affecting an estimated over 55,000 people[12]. A main contributor to this dramatic floodplain erosion was the Great Assam earthquake in 1950, the sediment wave of which has reached Bangladesh in the 1970s with the effect of widening the river corridor by 50% or some 4km. Over the last two decades during the beginning of the 21st century, erosion rates have declined to some 2,000ha per year annually. Two main factors contribute to this decline: (i) the sediment wave has largely passed the country, and (ii) increasing investment into riverbank protection has reduced the vulnerable length of banklines.

The root cause for the unstable environment and major impediment for development is the lack of a stable boundary between river and floodplain, or water and land. The high population density of more than a thousand persons per square kilometer restricts the scope for moving people away from disaster prone areas and consequently depends on the protection of large parts of the floodplain against riverbank erosion. While embankment lines play a major role in avoiding annual flooding, larger scale stability and development are only possible when the river course, particularly of Jamuna and Padma are stabilized. This would not only allow the construction of modern flood embankments, free from erosion risk, but also recover floodplain lost since the 1970s, support dry season navigation in a more stable channel environment, provide stable distributary offtakes for all-year round flow, enhance the environment through well-defined habitats, restore interconnectivity of beels and wetlands with the main rivers through defined openings in the embankment lines, and finally support peri-urban development moving Bangladesh from predominantly agrarian to modern manufacturing and service sector characteristic.

1.2 FRERMIP Location and Subprojects

In 2012/13, the feasibility study (NHC., 2013) selected three priority sites along both banks of the lower Jamuna and upper Padma Rivers in central Bangladesh, specifically JRB1, JLB2 and PLB1 (Figure 1-1), and proposed systematic development at these three sites over three successive tranches (projects) resulting in gradually increasing river stability and flood protection contributing to flood risk reduction and economic development in subproject areas. Consequently, Tranche-2 (and later Tranche-3) will build on the initial developments achieved under Tranche-1. In this way, FRERMIP will contribute to and/ or enable realisation of a more stable river reach, particularly the Lower Jamuna.

[10] Bangladesh is ranked the 6th most vulnerable county in the world in terms of risk from natural disaster (BDP 2100, 2018a)

[11] consisting of Jamuna and Ganges until Goalando, then Padma until Chandpur, and followed by the Lower Meghna estuary

[12] River Study Technical Note 2: Holistic River Morphology Analysis for the Brahmaputra River System

The three priority site areas of FRERMIP are shown on Figure 1-1, and the associated Upazilas and districts are listed in Table 1-1. The three subprojects extend over a total area of about 2,476 km^2, or 247,600 ha mostly in Sirajganj and Manikganj districts, as well as the southwest portion of Tangail. The total area for all 13 subprojects identified along the Jamuna, Padma and Meghna rivers is 9,292.2 km^2, or 929,220 ha (Table 1-2).

Of the total gross area of 247,600 ha, about 128,400 ha can be used agriculturally. Out of this area 93,200 ha are flooded cultivable area without project as opposed to 52,000 ha with project. Without project, F0 and F1 land covers approximately 40,000 ha. After the program interventions are built an additional approximately 56,000 ha will be F0 and F1 land, (NHC., 2013).

Table 1-1 FRERMIP Upazila and Districts

River Reach	BWDB Zone	Sub-project	District	Upazila
3	North West	JRB-1	Sirajganj	Belkuchi
				Kamarkhandi
				Shahjadpur
3	North Central	JLB-2	Manikganj	Daulatpur
				Ghior
				Saturia
				Shibalaya
			Sirajganj	Chauhali
			Tangail	Nagarpur
4	North Central	PLB-1	Manikganj	Harirampur
				ManikganjSadar
				Singair

Table 1-2 Data for Priority Subprojects

Parameters	JRB-1	JLB-2	PLB-1	Total
Population, million	1.5	1.1	0.74	**3.34**
Bankline length, km	37.0	56.0	25.0	**118.0**
Gross Project Area, ha	58,209	121,200	68,200	**247,609**
Adjusted Project Area protected by Embankment, ha	41,067	82,927	52,070	**176,064**
Settlement Areas, ha	8,855	18,491	14,345	**41,691**
Ponds, streams, other non-agricultural land	2,213	2,696	1,082	**5,991**
Net Cultivable Area (NCA)	30,000	61,740	36,643	**128,383**
Total flooded cultivable area without project, ha	22,581	47,844	22,788	**93,213**
Total flooded cultivable area with project, ha	17,568	21,078	13,356	**52,002**
F0 and F1 land w/o project, ha	8,299	17,095	14,563	**39,957**
F0 and F1 land with project, ha	15,958	51,619	28,954	**96,531**

Source: PPTA Final Report, 2013

1.3 FRERMIP Tranche-2 Feasibility Report Preparation

The preparation of Tranche-2 started in 2016 and has undergone several changes:

(i) **Preparatory Activities in 2016:** The Aide Memoire of the Project Review Mission (30 August to 4 September) initiated the process of scoping Tranche-2, however this was affected by the need to reduce the overall loan amount for Tranche-1 and to defer

activities into Trache-2 due to an unfavorable exchange rate development. After presenting the outline of the Tranche-2 works at the national stakeholder workshop on 7 December 2016, the ISPMC submitted the "Site Selection and Initial Economic Assessment Report" (NHC/EMM, May 2017) in May 2017. In parallel the substantial reduction in loan amount, from US$ 65 million equivalent to some US$ 58 million equivalent, was processed, with the related first revised DPP approved on 15 June-2017. This provided substantial clarity about the Tranche-1 activities to be deferred to Tranche-2. The site selection report was discussed during a meeting headed by the Director General, BWDB during the ADB Consultation Mission at the end of July 2017 (Aide Memoire of Consultation Mission from 23 to 30 July 2017).

(ii) **Preparation of draft Feasibility Study 2017/18:** The third technical advisory recommended the site selection for approval on 17 September 2017. Subsequently, during the "National Stakeholder Workshop on the River Stabilization Plan for the Jamuna and Padma Rivers" on 29 November 2017, the Tranche-2 works was presented in the context of the larger river stabilization plan (Figure 1-2). The proposed approach with few small modifications was recorded in the Aide Memoire of the ADB mission at the end of the year[13]. The remaining uncertainty pertaining to the scope of work could be removed after awarding the last major civil works contracts for embankment construction in January 2018. As a result of the fixed DPP budget 1.7km of embankment construction had to be transferred to Tranche-2 and incorporated into the feasibility study. The ISPMC submitted the draft feasibility report on 22 March 2018. During the next months the feasibility designs were discussed with the BWDB design office and modified towards final design level. As Tranche-1 had to be extended by one year to complete the embankment construction, it was planned to overlap Tranche-1 and Tranche-2 during the construction season 2019/20.

(iii) **Revision of Feasibility Study 2018/19:** The Government approved the Bangladesh Delta Plan 2100 on 4 September 2018, which allows the alignment of the Tranche-2 works with the latest strategy towards adaptive delta management. The Technical Committee meeting reviewed the feasibility study on 8 October 2018 and suggested a number of changes, particularly restricting the work to protecting the floodplains as opposed to broader river channelization also on charland (NHC/EMM, draft Feasibility Report for Tanche-2, 2018a), and proposing a heavier riverbank protection design. Subsequently the changes were discussed during an ADB consultation mission (20 to 27 November 2018) with the decision that the BWDB would prepare all designs and provide a background document explaining a new concept of riverbank protection. The design office provided the background document on 11 December 2018 and the designs for three infrastructure package on 15 January 2019 and the fourth provided on 14th March 2019. In parallel to the design work, the ISPMC updated the draft feasibility study for a bankable loan in February 2019, which was subsequently revised in April 2019 to be fully compliant with the BWDB designs.

The feasibility report is prepared following a review of status and lessons learned from the first Tranche (NHC/EMM, February 2018), and with due cognizance of the BWDB recommendations (Technical Committee – Appendix B), recommendations of the river stabilization plan (NHC/EMM,

[13] Aide Memoire of Consultation Mission (26 November – 1 December 2017)

Strategic Framework for River Stabilization and Development: Jamuna-Padma and Dependent Areas, May 2017), the latest actual river situation and predictions, and the vision presented by the river management master plan (NHC/EMM, Februrary 2018).

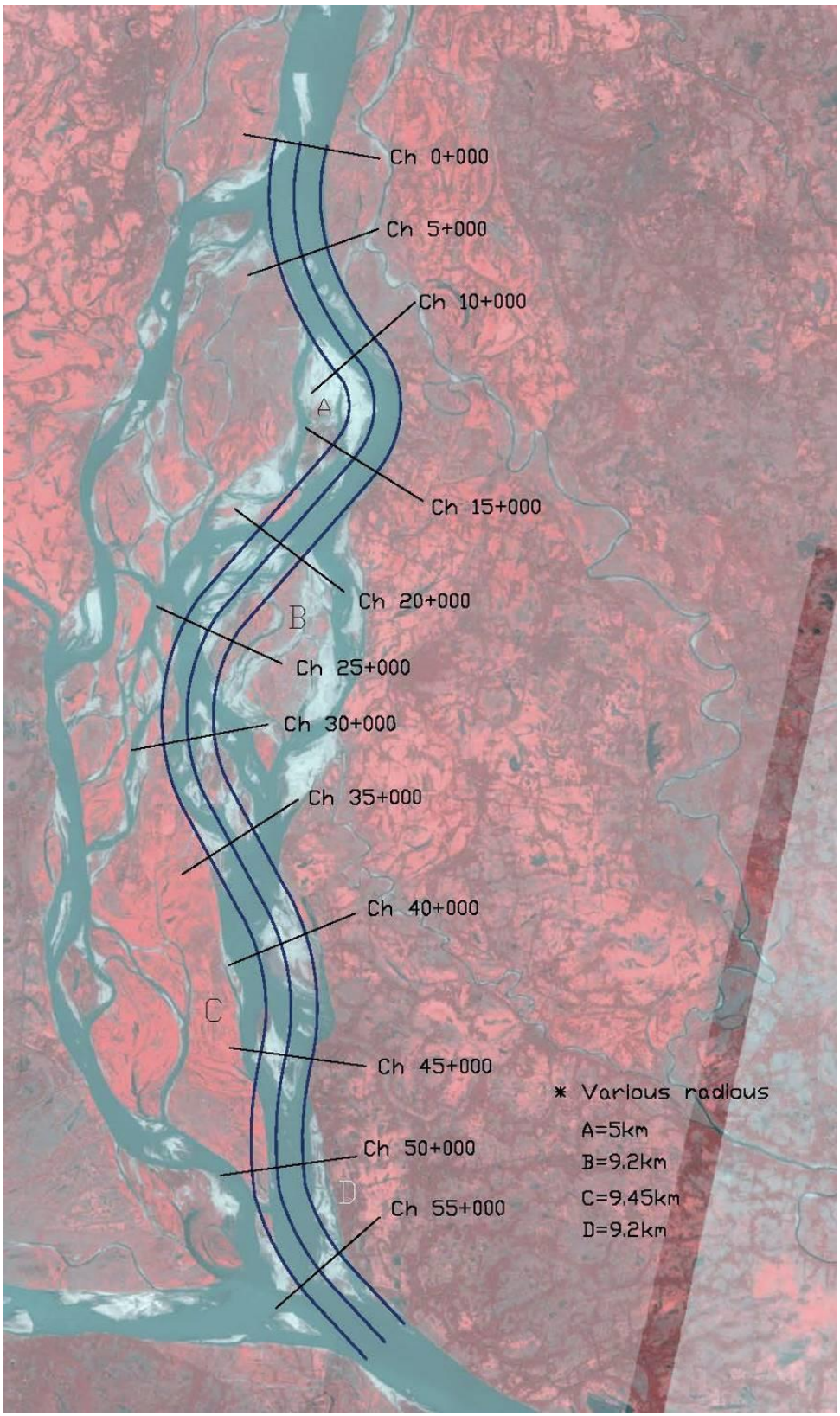


Figure 1-2 Stabilized left branch of the Lower Jamuna River

1.4 Report Structure

Following this Introductory Chapter, Chapter 2 provides background on Tranche-1 developments, the context of river stabilization and modern climate smart flood embankments, morphological developments at the sites, and finally provides structural and non-structural lessons learned.

Chapter 3 provides key criteria and considerations for Tranche-2 formulation and the general considerations for selection of the Tranche-2 works. This includes updates for the Design and Monitoring Framework (DMF) (Appendix A), governing criteria justifying the proposed works, dominated by the agreed Multi-tranche Financing Facility and Government's wider focus on developing the main rivers. Structural and institutional aspects are discussed in relevant subchapters.

Chapter 4 presents the proposed Tranche-2 project[14]. Due to the studies and lessons learnt from Tranche-1, there has been some shift from the original (PPTA) program design, to include for benefits expected to accrue from char-land recovery and development, as well as from increased agricultural production and protection of assets along the river bank. The three project components are discussed in details in separate subchapters.

Chapter 5 provides background on social and environmental safeguards, including resettlement, environmental impact assessment, gender action plan (Appendix E) and summary poverty reduction and social strategy (Appendix F).

Chapter 6 describes Tranche-2 implementation, including institutional arrangements, procurement plan, implementation schedule, and monitoring and stakeholder communications.

Chapter 7 contains the project cost as per provided BWDB designs and the cost for Tranche-3 following the Client's recommendations (see Appendix B). The only substantial change from the March 2018 feasibility report relates to the riverbank protection work. The costs are presented as per ADB components and the categories of the Detailed Project Proforma (DPP).

In Chapter 8 economic benefits are described and economic viability established.

Chapter 9 contains the references.

This main report is accompanied by six Attachments and five annexes:

Annex 1	Background Information
Annex 2	Involuntary Resettlement
Annex 3	Environmental Safeguards and Climate Change
Annex 4	Cost and Economic Assessment, and Implementation Aspects
Annex 5	Design Reports

[14] Supporting Appendices B – E provide background on a number of issues

2 FRERMIP-TRANCHE-1 DEVELOPMENTS, CONTEXT, AND LESSONS LEARNED

2.1 Tranche-1 Progress

The FRERMIP Tranche-1 Loan was signed in August 2014 for an implementation period of five years (until June 2019) and extended on 15 November 2018 by one more year. It is the first of three tranches of a Multi-tranche Financing Facility, with the Framework Financing Agreement approved together with the Tranche-1 loan. The total program duration was scheduled for 9 years (from mid-2014 until mid-2023). Out of the total planned expenditure of US$ 373.7 million, ADB agreed to finance US$ 255 million and the Netherlands US$ 15.3[15]. While the revised Tranche-1 budget increased by US$ 5 to US$ 108 million, the ADB contribution reduced to US$ 58 million from US$ 65million due to the depreciation of the Special Drawing Right (SDR) against the US Dollar. The Netherlands' grant contribution of US$ 15.3 million remains unchanged and Government increased its contribution from US$ 23 million to US$ 35 million (from 22% to 31% of the total Tranche-1 cost). On individual cost items, the largest change relates to the resettlement cost with an increase from the original estimate of US$ 11 million to US$ 26 million, or 11% to 24% of the Tranche-1 budget.

The Tranche-1 physical implementation is satisfactory. As of 25 February 2018[16], overall project progress is 70% against the elapsed time of 72%. The cumulative contract awards for the ADB loan and the Netherlands grant stands at 70% and 65%, respectively.[17] As of June 2019, more than 4.5 years of the total MFF have passed with an overall progress of 88% against the elapsed time of 79% (for the revised closure of implementation activities in June 2020). Tranche-1 has been under implementation for 50% of the total MFF period, or when accounting for the one year start-up delay, 38% in terms of actual implementation time. Total project expenditure as of December 2018 reached around US$ 75 million (or 23% of the total planed MFF).

Amongst others, FRERMIP Tranche-1 added some 18km of riverbank protection and 21km of embankments in the Lower Jamuna and Upper Padma Rivers. Together, FRERMIP is substantially contributing to the stabilization of the Lower Jamuna River, with riverbank protection providing the backbone for a more stable and navigable river to Sirajganj.

2.2 River Stabilization and Development along the Jamuna-Padma Rivers

The Flood and Riverbank Erosion Risk Management Investment Program – Project-1 includes the preparation of a long-term river channel stabilization plan and preliminary river management master plan covering Jamuna and Padma river including the North-central Zone influenced by the main distributaries of the Old Brahmaputra and the Dhaleswari System[18] (NHC/EMM, Inception Report,

[15] The Netherland's government has indicated additional potential financing in the order of US$ 5 million for Tranche-2 (Aide Memoire of Consultation Mission 27 November 2018).

[16] The mid-term review mission was held at this time.

[17] Aide Memoire of Midterm Review Mission (5-26 February 2018)

[18] The consulting team Tranche-1 has prepared the "Strategic Framework for River Stabilization and Development: Jamuna-Padma and Dependent Areas" in November 2016. Subsequently, the framework was presented and discussed in the National Stakeholder workshop in December 2016, and accepted by BWDB during two meetings: (a) in a meeting chaired by the Director General in July 2017 during the ADB Consultation Mission in July 2017 and in the Technical Advisory Committee Meeting chaired by the Chief Planning on 17 September 2017. Both meetings were attended by the development partners. The draft river stabilization plan was presented and discussed at the end of November 2017 in a

2016a). The Study Area is shown in **Figure 2-1**. The Terms of Reference refer of the river stabilization and preliminary river management master plan, which includes a strong regional component for the areas fed by distributaries and are commensurate with two of the six hotspot strategies of the Bangladesh Delta Plan 2100, namely River Systems and Estuary Strategy, and Sustainable Land Use and Spatial Planning.

The Strategic Framework (NHC/EMM, May 2017) focusses on the following five Development Objectives: (i) Reduced Flood and Erosion Risk, (ii) Reclaimed Lost Floodplain, (iii) Development Value Capture in the Study Area resulting from the Stabilized River Environment expressed in terms of poverty reduction, intensified agriculture, peri-urban industrial development, etc., (iv) Restored Navigation, and (v) Restored Riverine Ecology. It emphasizes the need for adaptation and flexibility and emphasizes "hard" interventions in the short-run (to 2030) and socio-economic value capture in the medium run (to 2040 and beyond). The Strategic Framework consists of seven Strategic Thrusts also referenced in the Delta Plan under Strategy RE2 (GED; Bangladesh Planning Commission; GoB, 2018):

(i) ***Stabilizing the River Corridor:*** The first intervention along the Main Jamuna – Padma River Course is to control river bank erosion; it is river bank erosion that makes the river unstable. Stabilizing the river corridor is central to all of the following aspects.

(ii) ***Land Reclamation:*** Land reclamation through erosion protection, primarily based on geobag revetments at critical bends, plus flood embankments, will result in up to 150,000 hectares of land being reclaimed, enough land to settle some 1.8 million people.

(iii) ***Flood Risk Reduction:*** Flood risk reduction through construction of flood embankments will protect livelihoods, provide embankments for improved road accessibility, incentives for more intensive agriculture, and enable high-value urbanization.

(iv) ***Distributaries Restoration:*** Distributaries will be stabilized by carefully designed flow-guiding bank protection structures in the main river, construction of off-take structures to enable increased dry season inflow and controlled flood inflow; thereby improving reliability of water quantity and quality year-round in the Study Area, including the Greater Dhaka Region.

(v) ***Enabling Commercial Navigation:*** Navigation would be restored on the Study Area rivers by establishing and maintaining safe navigation channels during low flow periods, without restricting the cross section of the River during flood discharges, utilizing measures like low spurs and dredging.

National Stakeholder Consultation workshop and was accepted by the audience. Safeguard aspects are summarized in a specific document, in lieu of a policy framework: Strategic Environmental and Social Assessment (SESA), reviewed by the Netherlands Commission for Environmental Assessment. A first review took place in mid-2017 with the second review ongoing in early 2019. The regional plan, focussing on spatial planning and water resources of the North-central region was submitted in September 2018.

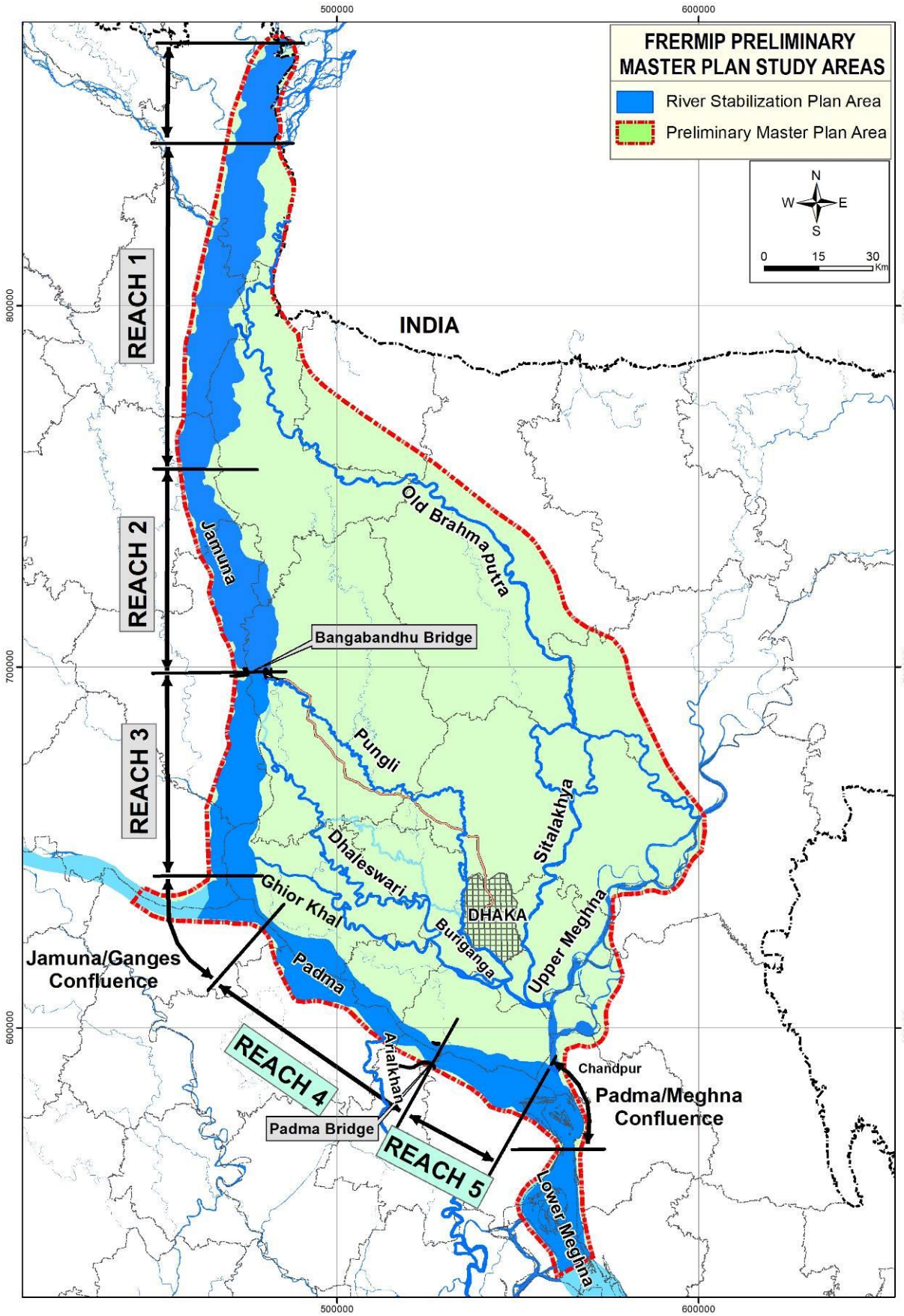


Figure 2-1 River Stabilization Plan and River Management (Regional) Master Plan Areas

(vi) ***Increased Land-Based Productivity:*** The prime benefit of the strategy will be to enable high value economic activity, and commensurate improvements in human well-being on reclaimed land, through intensified agriculture, and very importantly by enabling an industrially driven peri-urban area to be developed south of Dhaka employing up to a million workers in manufacturing, propelling Bangladesh to middle income status. Also, increased agricultural productivity within the 1.3 million ha Master Plan Area, over about 500,000 ha, due to increased water supply and managed flooding, benefitting about six million households. Figure 2-2 provides an overview over the proposed planning structure.

(vii) ***Environmental Enhancement:*** Environmental Protection Zones will be designated along the river courses enabling environmental enhancement, and providing flora and fauna habitat.

Expected Impact is a dramatic improvement of the socio-economic and environmental situation. Benefits will accrue from: (i) development of new, stabilized land within the river corridor for industry, settlement and agriculture, including peri-urban development, (ii) Enhancement of agricultural productivity on flood-free land partly raised from the river, and (iii) restored navigation supporting mass scale container barge, feeder vessels, and tourist cruise boat traffic. Other benefits include (i) enhanced riverine ecology, and (ii) restored water quality of rivers around Dhaka.

2.3 River Stabilization Plan and Tranche-2

River Stabilization of Jamuna and Padma – the Backbone of Development

The River Stabilization Plan draws on conjunctive use of three major implementation technologies:

(i) **Riverbank protection** to establish a fixed boundary between river and floodplain through alternating long-guiding revetment following the internationally proven approach of “bend control” and therefore encouraging a meandering river course. The revetments encourage a more stable channel pattern, and support dry season navigation.

(ii) **Multi-purpose Dredging** for establishing preferred channel alignments and overloading undesired channels for closure, construction of riverbank protection works and flood embankments. Importantly, dredging can only address the limited sand load of the river, transported during the flood season as bed material load and typically deposited as shoals and chars. This sand load constitutes only around one quarter of the overall sediment load and is insufficient to build up all 1,500 km² of land to floodplain level within a reasonable (multiple decades) time scale.

(iii) **Building with Nature** by harvesting sediment during the flood season to build up low lying land to floodplain level. This technology builds on the indigenous techniques of reed plantations, developed into standardized bio-engineering tools, started through pilot applications during Tranche-1. The approach targets the larger portion of the transported suspended sediment, constituting the fertile top layer of the Bangladesh delta.

Stabilization works according to the principle of guided meandering will not transform the braided Brahmaputra-Jamuna River into a fully meandering river, but reduce the braiding intensity and thereby contribute to increased sinuosity and improved navigability. The stabilized river will

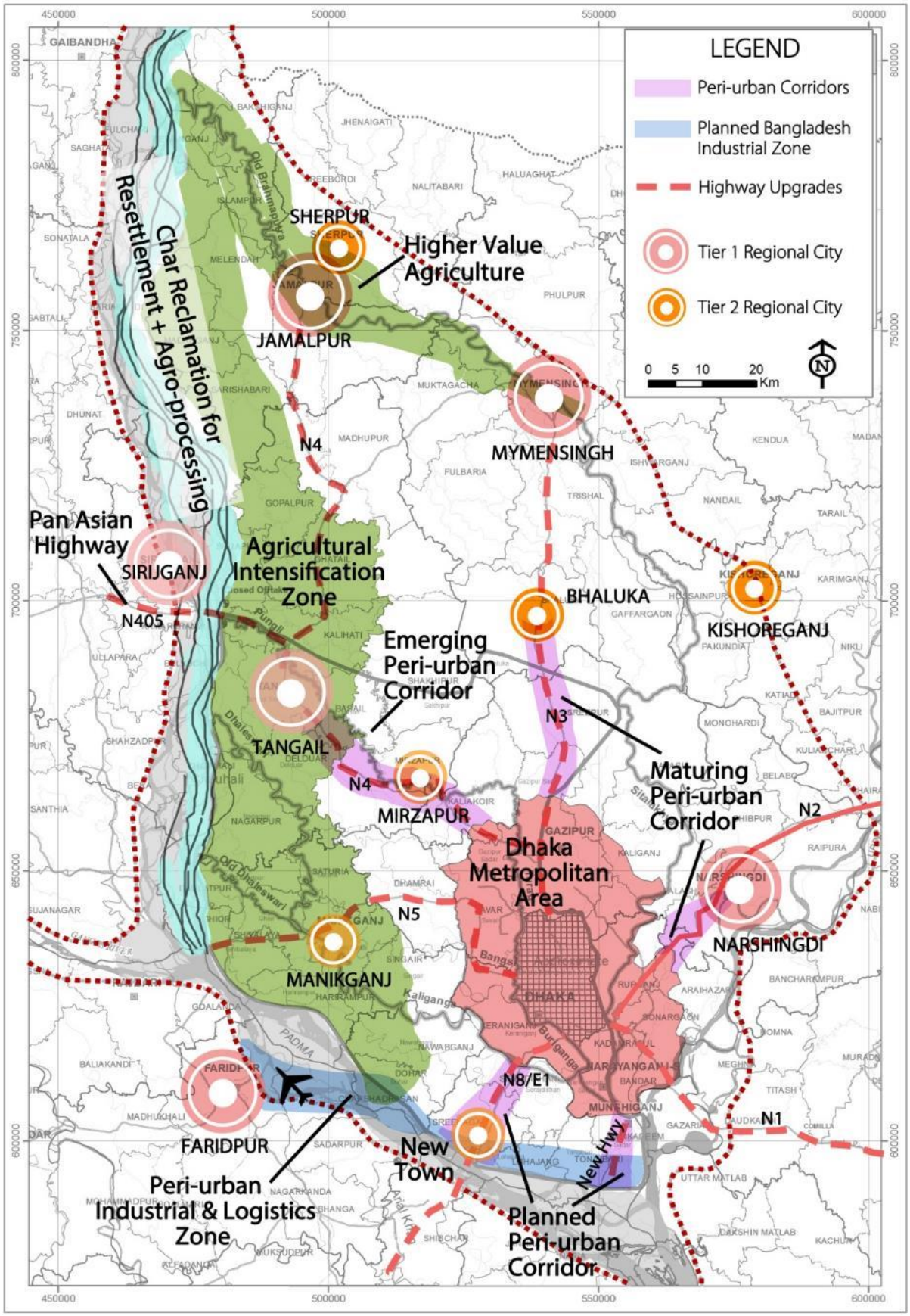


Figure 2-2 Proposed regional planning structure for the North-central region

maintain a dynamic character that can be steered by strategic dredging and dumping. Careful design of structures for guided meandering will reduce the costs of this dredging and dumping by triggering erosion and deposition processes in targeted reaches, also referred to as "self-dredging". In other words, the stabilized river could have long periods with a dominant sinuous channel, favourable for navigation, alternated with episodes of turn-over in which the river would re-assume a more braided character. Considering all periods together, channel sinuosity would increase as an important overall effect that is beneficial.

Inevitably the river stabilization plan retains uncertainties on different levels. With respect to baseline data and knowledge, the plan recognizes the overall sediment deficit, impacting on the amount of land that can be recovered from the river and built up to floodplain level. There is great uncertainty about the actual sediment load, as no reliable data has been collected since the mid-1990s. Uncertainties also relate to the knowledge base and inherent unpredictability of the river system. Therefore, every implementation step will be based on the best estimate according to current knowledge, leaving room for later adjustments and favouring the steps that cause no regrets under a variety of scenarios. Continuous monitoring and updates of predictions will be key ingredients for improvements, via 'learning by doing'. Monitoring and predictions will also be crucial for seizing the opportunities for stabilizing favourable situations created by the river itself during the implementation of the RSP.

In line with the "no-regret" criterion as defined in the Delta Plan 2100, investment into riverbank protection requires careful consideration about the level of investment. The Delta Plan 2100 is strongly based on avoiding expensive "lock-in" situation where high-cost infrastructure not only reduces the flexibility during later plan periods, but also requires continuous high investments for strengthening/adaptation and maintenance. With respect to the designs of riverbank protection, a more phased approach provides more flexibility. This approach introduces the element of risk, however acknowledging that a fully quantified assessment of risk is not possible due to the lack of a broad database on all performance criteria (subsoil, water, and structure). This notwithstanding, FRERMIP proposes a risk management approach which comprises three levels of safety, distinguishing between the common soil conditions of the riverbanks (Table 2-1).

Table 2-1 Probabilistic design approach (also referred to as risk-based design) for riverbank protection

Design level	**Consolidated riverbanks (typically stable at slopes 1V:2H)**	**Unconsolidated riverbanks (typically stable at slopes flatter than 1V:3.5H)**
Emergency works	Mass dumping along the riverbank Implemented under ***JMREMP*** from 2001 to 2006	***Not possible*** as aprons do not launch under these soil conditions
Standard Protection	Multilayer slope coverage with underwater toe protection to design scour level on natural slopes	Same on flat dredged slopes[19] with slope angle and dredging depth determined by soil composition

[19] In the draft feasibility report, March 2018, the ISPMC proposed for weaker soils dredging to around 10 to 15m below low water levels to flat slopes of 1V:6H in order to substantially increase the safety factor. In some cases, particularly for Chauhali the flattering of the slope above water level was proposed. The BWDB applied dredging earlier at Kalitola, Mathurapara, Sariakandi, and Sirajganj during the second half of the 1990s, while the river training for all major bridge constructions in the Ganges, Jamuna , Padma and Meghna rivers built since the second half of the 1990s is built on flat dredged slopes.

	Implemented under ***JMREMP and FRERMIP Tranche-1***	
Highest level Protection	Same as above with wider apron resilient to static flow slides. Approved by the BWDB design office for the ***RBIP*** in 2015	Same on dredged slopes, Under implementation for the ***Padma Bridge*** river training (Part of the feasibility study of March 2018)

Flood Protection Embankments for Defined Structural Flood Risk Management

Flood embankments will continue playing a fundamental role for the protection of agriculture alongside the main rivers. Increasing flood season crop intensity depends on reliable water levels, not influenced by the vagaries of the monsoon flows of the main rivers. The ever growing rural road network only affects flood patterns to a certain return period as these roads can be overtopped and breach during high floods. In addition, the road network leads to delayed drainage. Consequently, systematic flood protection and drainage improvement alongside the main rivers remains a main priority for flood risk reduction. In line with this, the Strategic Framework suggests to close embankment gaps and strengthen existing embankments. Importantly, more than half of the new embankment lines are proposed to be built on recovered char land, starting with FRERMIP.

The demand for higher embankment design standards will rise with increasing assets due to industrialization but also development of high value agriculture. The flood risk is defined as product of probability of exceedance (return period) and assets at risk of damage. Until recently design standards were based on a 30-year economic life and propose a 100-year return period. The accepted aggregate probability of failure during this period is 26% (Table 2-2). For comparison the Padma Bridge design adopted a 500-year flood for an economic life of 100 years, which results in an aggregate probability of failure of 18% (NHC., 2013). Given the rapid development of assets on the floodplain, doubling the assets would require to adopt an around 200-year flood level to arrive at the same aggregate probability of failure as before. Despite the high freeboard of 1.5m currently adopted, this consideration is very relevant as flood levels in a narrowed river corridor will increase more and consequently higher flood embankments will be required in future.

Table 2-2 Aggregate probability of exceedance for different return periods and economic life times

Return period (years)	probability of exceedance in … years lifetime					
	1	10	20	30	50	100
10,000	0.0%	0.1%	0.2%	0.3%	0.5%	1.0%
1,000	0.1%	1.0%	2.0%	3.0%	4.9%	9.5%
500	0.2%	2.0%	3.9%	5.8%	9.5%	**18.1%**
200	0.5%	4.9%	9.5%	**14.0%**	22.2%	39.4%
100	1.0%	9.6%	18.2%	**26.0%**	39.5%	63.4%
50	2.0%	18.3%	33.2%	45.5%	63.6%	86.7%
25	4.0%	33.5%	55.8%	70.6%	87.0%	98.3%
10	10.0%	65.1%	87.8%	95.8%	99.5%	100.0%
5	20.0%	89.3%	98.8%	99.9%	100.0%	100.0%
2	50.0%	99.9%	100.0%	100.0%	100.0%	100.0%
1	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

probability of exceedance higher than 50%

In line with future higher safety requirements and given uncertainties with future flood level increases associated with climate change effects and a narrowed corridor, today's embankments

need to be designed for the future. This includes having sufficient width for future widening to address uncertain water levels in two or three decades from now, while minimizing today's investment. Consequently, Tranche-2 proposes a "climate smart" embankment design. The cost effective adaptable design, in line with international standards, consists of different embankment elements: (i) a flood protection element to cope with design water levels, yet flexible for future adjustments, (ii) a central part, wide enough to address seepage, and (iii) a country side slope for drainage arrangements and as compensation for lost tree plantations. This design was accepted for the first time by the BWDB during the PPTA on 7 February 2012[20].

While the embankments have a number of positive impacts on society, negative impacts on the environment need to be mitigated and, in case of existing embankment lines, the present conditions will be enhanced. The new embankment lines will not only provide flood protection to up to 150,000 ha of recovered char land, but also easy access. For example Tranche-3 will connect Shibalaya (Aricha) at the end of National Highway N5 with Chauhali over some 6,000 ha of recovered char land of the Omarpur and Solimabad upazillas. In future this connection will extend to Tangail. LGED or RHD will build the road connections over the embankment depending on the importance of the road. Negative impacts on natural flood patterns will be compensated in two ways: (i) old and new embankments will be systematically equipped with regulators cum fish passes to reduce the separating effect, and (ii) distributary offtakes will be opened for all-year round flows.

Distributaries Restoration and Offtake Structures

Five important offtakes are present in the Brahmaputra river system; notably the Old Brahmaputra in Reach 1, the three Dhaleswari offtakes in Reach 3 branching off from the Jamuna River, and the Arial Khan branching of from Reach 4 in the Padma River. The four offtakes from the Jamuna system suffer from excessive sedimentation and loss of inflow, whereas the Arial Khan on the average is reasonably stable and functioning. Stabilization and narrowing of the Jamuna and Padma Rivers creates improved conditions for these offtakes, as the river and approach conditions to the offtakes is fixed. The following measures are included in the river stabilisation plan to improve the functioning of the offtakes and will be implemented during Tranche-2 and 3 for the Old Dhaleswari River:

(i) Shift of the offtake to a location at the end of an outer bend.
(ii) Adopt a gentle offtake angle to prevent too much sediment from entering the offtake. If needed additional works will stabilize the offtake geometry.
(iii) A flood barrier will be constructed in all offtake channels to limit the inflow during extreme flood conditions.

Importantly, the restoration of distributaries is proposed only after offtake stabilization, as the then known amounts of water and sediment allow sustainable management. Distributary restoration consists of restoring dry season flow through capital and maintenance dredging and protecting critical meander bends against riverbank erosion that is expected after more flow is introduced.

Implementation Period and Phasing of Works

The River Stabilization Plan works are to be implemented over 25 years, from 2015 to 2040, while FRERMIP is planned to close in 2024. In line with the Delta Plan 2100, two time periods have been identified, Short Term (to 2030) and Medium Term (2030 – 2040). The Short Term covers three Bangladesh national Five Year Plan periods, the plan for each period would provide guidelines for investment in the five-year period in question. Much hard engineering between Bangabandhu

[20] Aide Memoire of the TA Review Mission 11 February 2013

(Jamuna) Bridge and Chandpur could be completed by 2030, thus the Medium Term strategy focuses on: (i) Adaptation and Maintenance in regard to river stabilization, and (ii) Implementing measures to maximize the economic e.g., industrially driven navigation and peri-urbanization, human (e.g. employment), and environmental benefits from the stabilized system and the considerable reclaimed land area.

Institutional Framework for Unprecedented River Management of Jamuna and Padma Rivers

The predictability of the river morphology more than a few years ahead is low. Natural changes in river morphology as well as changes due to already implemented interventions may be different from what could be anticipated beforehand. Therefore, plans and designs have to be reviewed frequently and re-evaluated, responding to close monitoring and using prediction methods to forecast what the river is "about to do". Each intervention will influence river characteristics that must be assessed and analyzed before further works can be planned.

This approach is a challenge to any river management organization and institutional adjustments are required as follows:

(i) The operationalization of the Office of the Chief Engineer River Management (CE-RM). This is included in the "needs based" organizational set-up of BWDB. Main tasks of the CE-RM are to (a) Regularly adjust the long-term master plan framework, (b) Develop medium-term investment plans, and (c) Act as a repository for accumulated knowledge relevant for planning of main river management.

(ii) Assign the responsibility for all design work for the main rivers to a designated and specialized unit under BWDB's CE Design. This will allow for the development of specialized skills and knowledge and promote innovation.

(iii) Continuous monitoring of river characteristics. Continuous monitoring of river flows, riverbank erosion and scour depth is required to plan for subsequent river training works. This monitoring feeds information into the planning and design units mentioned above. A core function especially during the initial 15-year implementation phase, will lie with the Chief Engineer River Management, further supported by an expanded erosion prediction system which is annually updated.

(iv) Survey and monitoring of already implemented structural works. Detailed surveys of the structures to check the designs and check for damages. Measurements of flow velocities, wave heights, and surveys of adjacent river bed provides information about the exposure of the structure. The systematically stored data feeds into future designs for which improved design guidelines may be developed, but also into the planning of structural maintenance.

(v) The Planning Commission may be asked to promote framework DPPs with block allocations for River Management Projects to allow adaptive construction of river management infrastructure. The present rigidity of fund allocation through project DPPs is inconsistent with the dynamics of the main rivers.

(vi) The Ministries of Agriculture and Water Resources are asked to establish platforms for dialogue with key stakeholders for main river management at different levels: (i) The operational level (other GoB departments/units, NGOs, knowledge institutions, and subject matter experts) as well as at (ii) The higher policy level (Ministries).

2.4 Morphological Developments and Protection Strategy for Tranche-2

Morphology

While the conditions at the individual sites at Chauhali, Zaffarganj and Harirampur sites do not require further large-scale physical interventions during Tranche-2, larger river changes at the bifurcation of the Lower Jamuna need a response for the following reasons:

(i) The protection of the Chauhali bend is along a very curved, and therefore much less favourable, channel alignment as found during the PPTA in 2012. Figure 2-3, location 1 shows the dramatic bankline changes at Chauhali over the last ten years. The stronger curvature of the main channels, protected against erosion in 2016, is associated with a higher risk of cut-off formation and larger downstream river changes. In addition, the two extreme floods in 2016 and 17 have changed the channel behaviour from a predicted average. This increases the implementation risk of a river stabilization plan as additional work on the central char will be required and existing work could become redundant.

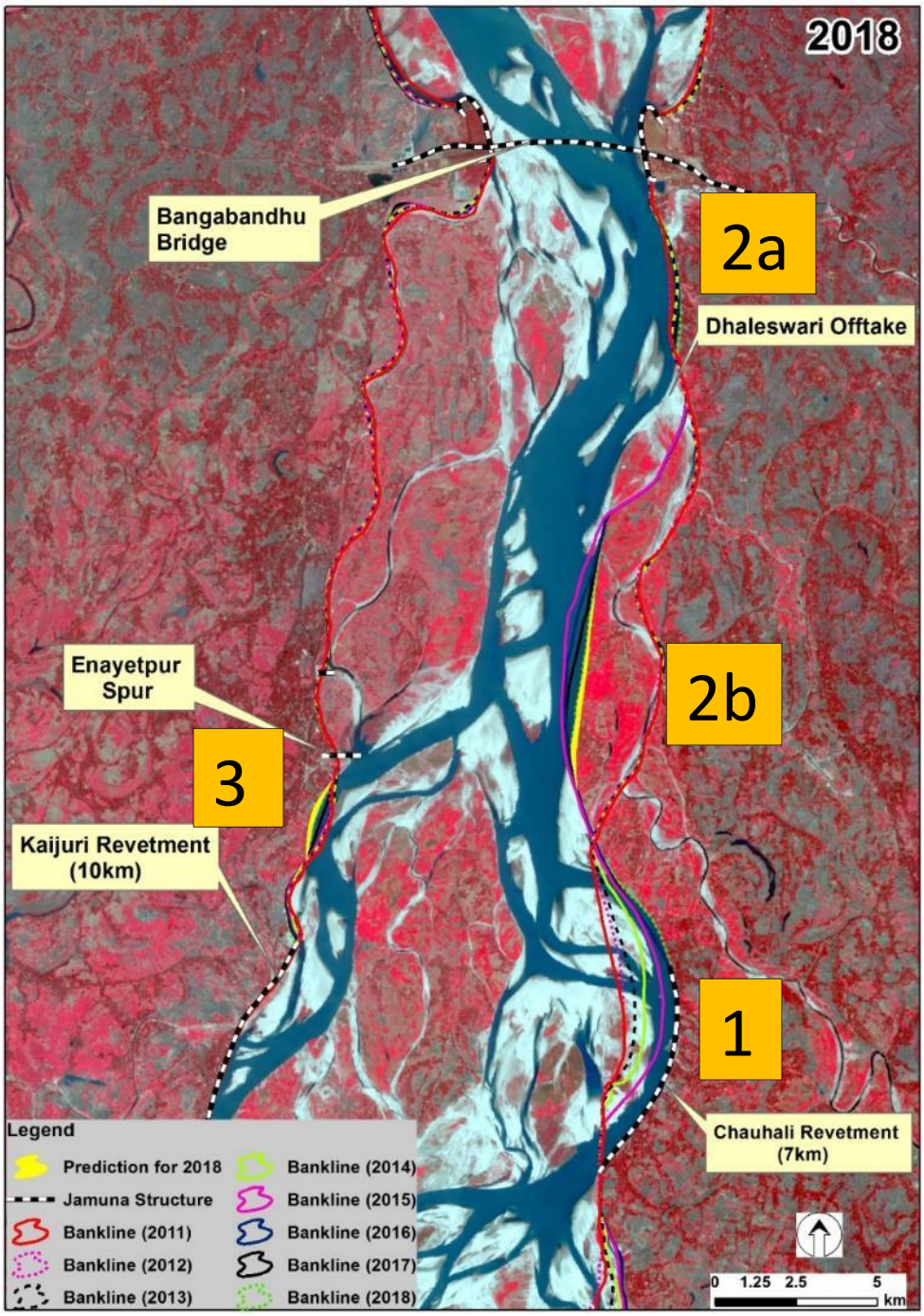


Figure 2-3 Changes in the Lower Jamuna over the last decade with numbers referred to in the document

(ii) The after effects of the capital pilot dredging in the area of the Bangabandhu (Jamuna) Bridge have destabilized the river downstream. While the capital pilot dredging achieved the purpose of protecting against outflanking of the Western Guide Bund, the pilot channel dredged through the stable mid-channel char under the bridge has triggered an unpredictable and major river change and disturbed the stable flow pattern in the downstream, some 15km long straight channel. As a consequence the channel develops a curved alignment with erosion at the Tangail bank immediately downstream of the bridge (Figure 2-3, location 2a), and a general widening tendency further downstream with massive riverbank erosion alongside the left bank (Figure 2-3, location 2b). Further

details can be found in Annexe 1.3. Related impacts are major changes of the offtake of Pungli and Dhaleswari Rivers and the overall stability of the bifurcation.

(iii) Right bank erosion between Enayetpur and Kaijuri (Figure 2-3 location 3), associated with changes in the bifurcation angle will be addressed by the BWDB through a separate DPP from the end of 2019.

Protection Strategy

FRERMIP from its start in 2012 postulated the stabilization of the Lower Jamuna including encouraging a more fixed meandering left (Chauhali) channel, embankment restoration/ construction, and the recovery of lost floodplain land downstream of Chauhali (Figure 2-4). The draft feasibility report (March 2018) reflected this strategy. At the end of 2018, the BWDB proposed modification to the concept (BWDB, Technical Committee, 2018), restricting the work initially to the floodplains before stabilizing also the chars (Figure 2-5).

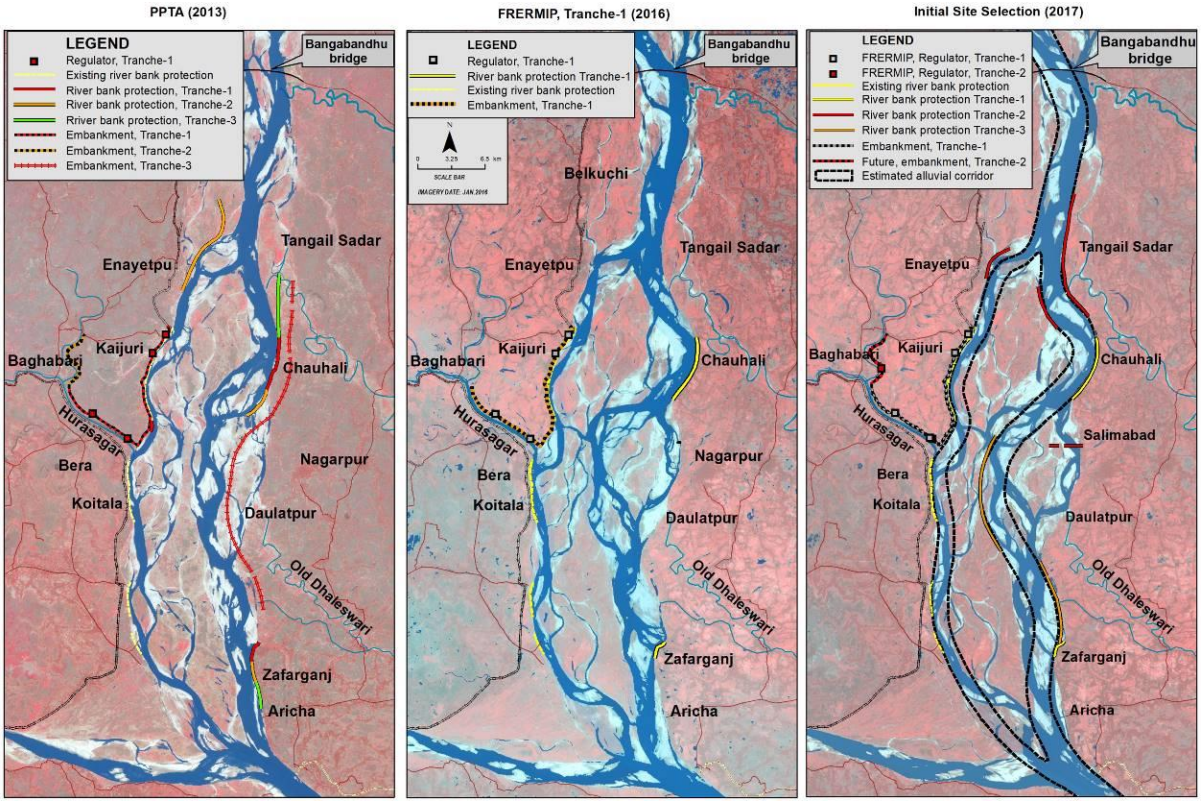


Figure 2-4 Stabilization Strategy for the Lower Jamuna from 2012 to 2017

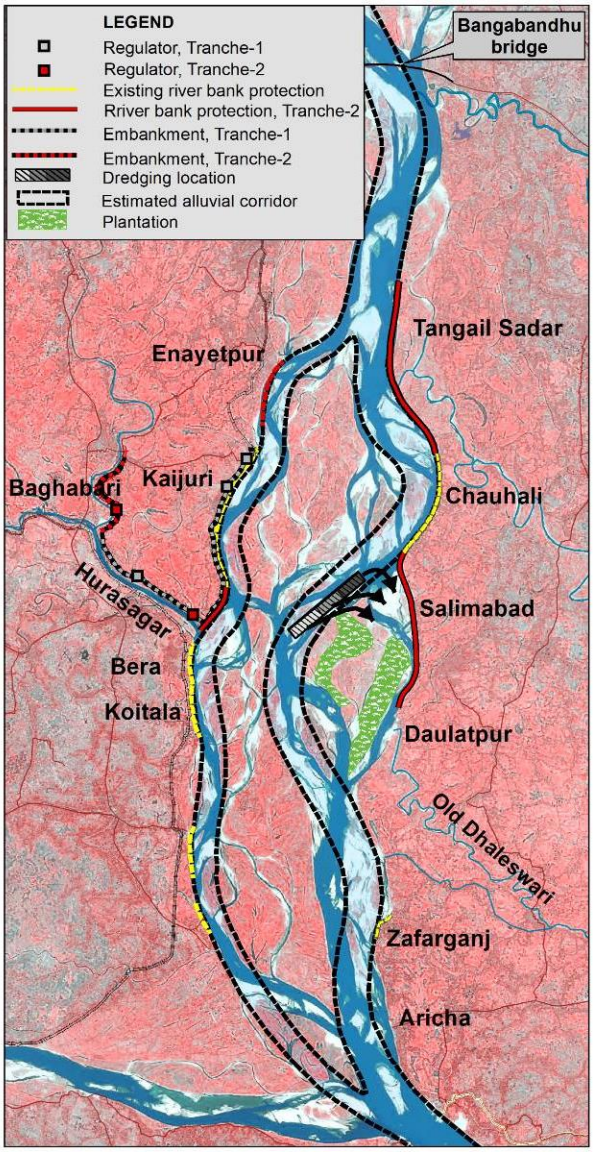


Figure 2-5 Tranche-2 investment proposal

2.5 FRERMIP Tranche-1 - Summary and Implications for Tranche-2

Project Area update

Work of the study team as well as the main team has provided additional background information used for the preparation of this updated feasibility study.

Infrastructure (Component A1)

Under Tranche-1, construction of 17.8 km of primary (new) river bank protection was completed at three sites, Chauhali, Zafarganj and Harirampur, and contracts for 21.3 km of flood protection embankment at Kaijuri have been awarded in early 2018 for completion by June 2019. FRERMIP has set new benchmarks in terms of construction speed, after contract award: while 16km of riverbank protection were built in one season (2016), the 21km of embankment work will be completed during the 2019 season due to the use of an innovative, in-situ construction technology never used by the BWDB before. Importantly, after initial adaptation works for a short area at Koitala in 2006, FRERMIP built systematic adaptation works at Chauhali over a length of 3.8km prior to the 2018 flood. As opposed to the previous years without adaptation works, the adapted areas showed no damages during the 2018 flood season.

DESIGN ISSUES AND RECOMMENDATIONS

The above water protection with concrete blocks is expensive, slow to build, and more susceptible to damages. At Chauhali major slope instability occurred at the upper slope after replacing temporary, single layer geobag protection with some 25 tons of concrete blocks, the equivalent weight of two loaded trucks, per meter. To improve the above water protection, Tranche-1 has developed and is pilot testing an alternative making use of local jute mattresses filled with grout and directly placed on the slope (Figure 2-6). This alternative, once successfully pilot tested, could reduce the cost for the above water protection, increases the construction speed to one season, and reduces the weight on the slope by some 50%, as such avoiding geotechnical instability problems. The more effective installation would also better support the use of flatter slopes above low water particularly to address weaker soils.

Figure 2-6 Installation of grout-filled jute mattress (Harirampur Feb 2019)

As with all riverbank protection, securing riverbanks against erosion requires regular post construction surveys, determining the river response to the work and the need for adaptive protection, particularly strengthening of the launched apron. Tranche-1 has demonstrated this particularly at Chauhali, where the apron launched beyond the specified performance due to delays in the implementation of strengthening/adaptation works. Typically some 5 to 8m vertical scouring can be allowed prior to adaptation works. At Chauhali angular flow attack during two high flood seasons resulted in up to 22m of vertical scouring and reaching design scour depth over a length of around 1km. Despite failures in the upper wave protection slope above low water level, the resulting underwater launched slope length was up to 49m and protected well across the majority of its length through launched individual bags. This notwithstanding, local imperfection of launching due to buried debris from eroded homesteads (concrete pillars, bamboo clumps etc.) might be the

trigger of some localized deeper slope failures. However, the wide aprons initially placed provided sufficient material to cover the slopes also after localized failure. All launched slope had a consistent angle of 1V:2H, which is geotechnically stable in consolidated sandy soils. Adaptation works took place in early 2018, with much reduced allocations. In the adapted areas no further slope damages were reported during the 2018 flood season.

Tranche-1 has commenced major embankment construction after decades of limiting construction to emergency closure of breaches along the main rivers. Following experience with two failed bids being some two third and one third over engineer's estimate, FRERMIP introduced a modern work design and construction methodology for embankment fill dependant on directly placed and compacted dredged sand-fill for the embankment core (Figure 2-7). This modern design not only increases construction speed, allowing the embankment to be built in one dry season, but also reduces the cost as well as the social and environmental impact, by not mining valuable topsoil used for farming.

Figure 2-7 Embankment construction at JRB-1 with compacted dredged sand (Kaijuri, Feb 2019)

Community-based Flood Risk Management (Component A2 and A3)

Despite initial implementation delays, the Community-based Flood Risk Management component, implemented through the Department of Disaster Management (DDM) has been successful in forming Community Disaster Management Units linked to higher tier Union and Upazila Disaster Management Committees. The formed committees do not only address disaster management aspects but also operation and maintenance of flood risk mitigation infrastructure, for example embankments. Tranche-1 has demonstrated that an integrated approach addressing the flood risk and operation and maintenance is successful and consequently can be continued and expanded during Trache-2.

Safeguards - Livelihood Support for Affected People (Component A3)

The implementing resettlement NGO has led the process of resettlement compensation of affected people. With the exception of few outstanding issues, resettlement activities have come to an end. Affected persons have mostly opted for self-relocation and therefore the PMO has decided not to provide resettlement villages. In general, resettlement and compensation to affected persons was comparatively late for Tranche-1 sites and somewhat compromised by abandoning the proven

JMREMP approach of first stabilizing the existing riverbank under water and temporarily above water, followed by land acquisition and resettlement and finally the replacement of the temporary with permanent protection above water (Ragsdale, 2008). In addition, late resettlement particularly impacted on the start of the embankment construction.

BWDB Institutional Capacity (Component B1)

Tranche-1 made good progress in capacity enhancement of BWDB staff through more than ten national and international training courses, one conference attendance, and four overseas study tours related to river management aspects, financed from the DPP and ISPMC allocations. Importantly, much training was provided to lower level BWDB engineers through BUET and members of the ISPMC team on sustainable riverbank protection. In addition, the ISPMC provided environmental training to BWDB and contractors, but also gender training to women in BWDB. Activities related to sustainable O&M systems were postponed to Tranche-2.

The BWDB has created, as envisaged under the MFF, the office of the Chief Engineer River Management (CE RM), and the position was filled on 22 November 2017 for the first time. This office is expected to be the focal point for coordination, communication and monitoring the progress of stabilizing the Jamuna and Padma rivers. The ISPMC has supported the process by drafting an outline of the functions of the office.

Data and Knowledge Based Development (Component B2)

The ISPMC has worked on a river stabilization study as outlined in Section 2.2 and 2.3 with some of the outcomes currently under review by the Dutch Government and reflected in the design of Tranche-2. Pilot activities related to riverbank protection are reflected in Section 0, those pertaining to river training, particularly the plantation of reeds for suspended sediment harvesting for vertical char-built-up, were planned during the flood season 2019.

The flood and river survey database was developed including providing specialist training to the BWDB. The databased combines nearly 2,300 individual bathymetric surveys mostly of the Jamuna River surveyed since the mid-1990s. In addition, discharge and multi-beam survey data are included and available for analysis. The data base allows users to retrieve and analyze survey data for cross and long sections, point elevations and area volumes. This data base provides the largest consistent set of survey information available for the Brahmaputra System.

The combination of the updated erosion prediction model, updated by CEGIS, and numerical modelling of the whole Lower Jamuna based on flood season surveys allowed broadening of the understanding of the morphological process in the complicated bifurcated river reach and provided annually updated forecasts of major morphological developments. While the CEGIS erosion prediction contract ended in 2018, the ISPMC also conducted numerical modelling for morphological assessment, which is planned to be extended to the 2019 flood season.

Dissemination of FRERMIP operation information took place in two ways: (i) more broadly, a project website informs about key features since November 2017, and (ii) more specifically technical developments were presented at conferences in 2016, 2017 and 2018. Both activities contribute to a broader communication strategy and therefore are recommended to be continued.

3 TRANCHE-2 FORMULATION – CRITERIA AND CONSIDERATIONS

3.1 The Bangladesh Delta Plan, 2100

With the approval of the Delta Plan on 4 September 2018, the government has presented a clear vision, mission, goals and strategies of how to develop Bangladesh to Upper Middle Income Status by 2030 and a prosperous nation by 2041. The Delta Plan acknowledges the fragile deltaic environment shaped by large rivers originating outside of the country, influenced by powerful upstream riparian neighbors, and the generally unpredictable nature further destabilized by climate change. A cornerstone to future development is 'Adaptive Delta Management' (ADM), allowing necessary investments for the development of the country to be done in a flexible manner that remains open to adapt to a changed natural and socio-economic environment in future. The BDP, 2100 states: "By focussing on the short and the long term, the BDP 2100 aims to overcome the well-known pitfall that 'the solutions of today become the problems of tomorrow'." Therefore, ADM is the method of choice for a 'robust' or 'no-regret' approach. 'No regret' is defined as applying measures useful and cost-effective on the short term and under a range of future conditions that do not involve hard trade-offs with other policy objectives. The Plan also recognizes under one of the two end visions – in this case 'Optimized Water Control' - that "long term development for countries with complex and highly variable water and climate regimes, such as Bangladesh, comes through controlling their water systems. Control entails enhancing productive potential on the one hand and ensuring protection against destructive impacts on the other." (BDP 2100, 2018b).

The Framework Financing Agreement for FRERMIP, even though it was signed in May 2014, aligns very well with key goals and the adaptive strategies of the Delta Plan 2100. The Plan's two specific goals, one national and one hotspot specific are directly relevant for FRERMIP and, with respect to the investment component, particularly mentions the FREMRIP approach to erosion control and river stabilization. With respect to the institutional component, the plan specifically recognizes that "the main problem is the weak capacity of all water and water related institutions … an absence of key stakeholder (beneficiaries) in water decision making … inadequate institutional coordination" (BDP 2100, 2018b). Both are comprehensively addressed by the two main FRERMIP components "flood and riverbank erosion risk mitigation measures at priority reaches" and "strengthening institutional system for flood and riverbank erosion risk management". Table 3-1 demonstrates how closely the Delta Plan and FRERMP align.

Table 3-1 Comparison of FRERMIP Components and the Delta Plan

FRERMIP		**Delta Plan**
Component 1: Flood and Riverbank Erosion Risk Management Functioning at Priority Reaches		
1	Infrastructure Improvement	Strategy FR1 Protecting economic strongholds and critical infrastructure
1-1	Construction of riverbank protection structures	Sub-strategy FR2.5 River management, excavation and smart dredging Sub-strategy RE1.4 secure discharge and storage capacity by allowing space for the river ('no regret') Sub-strategy RE2.1 River stabilization and channelization with use of combined river training works and river bank protection

FRERMIP		Delta Plan
1-2	Construction of embankments	Sub-strategy RE2.2 Controlled and accelerated stabilization of newly formed (char) lands and land reclamation Sub-strategy FR 1.1 Develop and improve embankments, barriers and water control structures Sub-strategy FR 2.1 Drainage improvement Sub-strategy FR 2.2 Restoration, redesign and modification of embankments and structures Sub-strategy RE 1.1 Reduce flood risk (preferred short-term strategy)
1-3	Emergency and strengthening/ Adaptation works	
2	Community based flood risk management	Sub-strategy FR 1.4 Extension of the flood warning lead time Sub-strategy FR3.1 Extension of early waring services into the communities
2.1	Formulating CDM units	
2.2	Capacity development for CDM units	
3	Community-based enhancement for participatory O&M	
3	Livelihood support for affected people	
3.1	Construction of resettlement areas	
3.2	Support of project affected people	
Component 2: Strengthened Institutional System for Flood and Riverbank Erosion Risk Management		
1	Institutional capacity strengthening	The BDP 2100 acknowledges institutional weaknesses.
1.1	Capacity enhancement of BWDB	
1.2	Support office of CE River Management	
1.3	Develop sustainable O&M system	Sub-strategy FR2.4 Improve operation & maintenance
2	Data and knowledge base development	"The adaptive nature of delta management puts knowledge at a premium. BDP2100 should be continuously science and knowledge driven."
2.1	Studies for long-term river management	
2.2	land recovery/river training piloting	Sub-strategy RE2.2 Controlled and accelerated stabilization of newly formed (char) lands and land reclamation
2.3	flood and river survey database	Sub-strategy FR 1.3 Adopt spatial planning and flood hazard zoning
2.4	improving knowledge base	
2.5	information dissemination	

3.2 Updated Context for the Design and Monitoring Framework

This study has reviewed impacts, outcomes and outputs and updated the Design and Monitoring Framework for the program as well as prepared one for Tranche-2. The Design and Monitoring Framework as per Facilities Administration Memorandum (ADB, 2014a) is summarised in Appendix A for the original performance targets, and with revised targets and comments. In addition, a draft DMF for Tranche-2 is provided. The Appendix A provides details of the underlying data.

The impacts as stated in the Design and Monitoring Framework (DMF) of the Financing Framework Agreement (FFA) and agreed between Government and ADB, remain valid. Assumptions and risk may consider additional Government priorities and past flood developments. More recently Government has shifted towards consideration of a more comprehensive role for the major rivers in Bangladesh's development as a middle income country, instead of a narrow focus on flood protection. In order to complete the work as planned, it is recommended to extend the program by one year to August 2024.

Refined flood modelling results[21] justify the revision of the original DMF outcomes. While the flood modelling arrives at similar results as the PPTA study, the DMF used different numbers, which justify correction: we recommend reducing the outputs from 122,000 ha of land protected from flooding by 2023, to 75,000ha of land protected from flooding by 2024. The number of people benefitted is some 950,000 people directly, with a larger number being indirectly benefitted. The assumption could be that one third of the total subproject population could be benefitted indirectly[22] and consequently the total would amount to 2million. While the flooded area appeared to be overstated in the original DMF, the area protected against erosion appears to be understated. Overall, it is recommended to increase the present number of erosion protected land from 460ha (with a baseline of 43ha in 2013) to 4,600ha.

The Tranche-2 Project Outcome may be expanded to "*Reduced vulnerability against flood and riverbank erosion risks in the subproject reaches and char land recovery",* i.e. to include for char land recovery benefits. Tranche-2 outcome targets are: (i) 4,500 ha of char and/or main land protected from erosion and loss, (ii) about 30,000 ha[23] of main land in JRB-1 and PLB-1 protected from extreme (river) flooding (some 10,000 ha flood free and additional 20,000 ha with reduced inundation depth caused by embankment breaches or flooding from the river), including agriculture land and land with assets (homesteads, roads, etc.), benefiting about 1 million persons, half indirectly, (iii) 6,000 ha of char land recovered from the river for development[24], and (iv) improved road transport generating increased traffic and quicker/ easier transportation.

Outputs have been updated in line with the proposed work, following the most recent morphological developments particularly after the two high floods of 2016 and 2017, and including the recommendations of the BWDB technical committee (BWDB, 2018). The scope of works, and design of some program components, such as the livelihood support programme and for participation of communities in regular O&M, are modified and firmed up. Data and knowledge base development activities under Tranche-2 continue to be important, but in additional technical knowledge for river training and stabilisation the focus shifts to include land reclamation and development, as well as distributary flows.

Updated outputs for Tranche-2 including performance targets and Indicators with baselines are provided in Table 3-2.

[21] Around 200 different flood scenarios with a refined digital elevation model, conducted for the Climate Risk Variability Assessment, provide a much more refined picture than the original PPTA study, even though the relevant scenario shows similar results (see Annexe 3).

[22] This would allow maintaining the original number of 2 Million people, as the total population borders 3 Million.

[23] 25,000 ha at JRB-1 and 4,740 ha at PLB-1

[24] Under Tranche-2, about 7,000 ha of char lands will be recovered and become available for development, comprising: (i) about 2,000 ha in Harirampur (PLB-1), and (ii) 5,000 in Chauhali char (JLB-2).

Table 3-2 Tranche-2 Output Performance Targets

Outputs	Performance Targets and Indicators with Baselines
1. Improved flood and riverbank erosion risk mitigation measures at priority reaches 1.1 Structural Works	**By June 2023:**
	33.3 km (17.8 from Tr-1 and 15.5 from Tr-2) of riverbank protection revetment constructed applying appropriate technology and methodology. Additional 10.5 km of precautionary protection at Solimabad. Flow redistribution works chokes 15km of the Solimabad channel for navigation channel and char land development (baseline = 0 km)
	46.6 km (21.3 Tr-1 and 25.3 Tr-2) of flood embankment constructed (baseline= 0 km)
	13 regulators/ fish passes constructed (baseline=0)
1.2 Non-Structural Works	100 community-based Disaster Management Units operate disaster-resilience action plan against flood and erosion disasters with minimum 50% of units led by women (baseline=0)
	10 embankment - WMOs/ community organisations set up and active in participating regular O&M works
	2,000 affected persons attend on-site 1-day trainings, and about 800 persons attend 2-5 day residential trainings to support livelihood enhancement activities, with half of these being women. (baseline=0)
2. Strengthened institutional systems for flood and riverbank erosion risk management 2.1 Institutional Capacity	Office of the CE-River Management established, staff trained and office operational for FRERMIP subprojects Information and management systems including: (i) Project Website and Database with sex-disaggregated data as appropriate in use, (ii) Asset web-based database developed and piloted, (iii) ADB/ Smart Project Monitoring and Management Information System (SPMMIS) database refined and piloted. 5-year budgetary plan for riverbank protection O&M and emergency work for the main rivers endorsed by BWDB
2.2 Data and Knowledge base	Studies and pilots add significant to quality of planning and design guidelines, and include for (i) river training, (ii) land reclamation/ development, and (iii) planning of future (Tranche-3) interests
	Flood and river surveys carried out each year with data entered into web-based database
3. Program management systems operational	Tranche-2 outputs completed on time within budget.

3.3 Regulatory Framework for Tranche-2

Framework Financing Agreement

The selection of Tranche-2 activities is defined in the Facility Administration Manual (ADB, 2014a) and the Framework Financing Agreement (ADB, 2014d). The MFF focusses on three selected priority subprojects and suggested systematic development over three successive programme tranches to achieve river stability as a precondition for successful flood risk management arrangements (structural and non-structural), economic development and poverty reduction, as well as institution

building of the executing agency. The Report and Recommendations of the President (ADB, June 2014) states:

"ADB will support the investment program through the MFF modality, which allows (i) flexible phased interventions that are technically appropriate to cope with the dynamic river morphology in Bangladesh; (ii) strategic and systematic interventions that can facilitate longer-term flood and erosion protection management planning; and (iii) longer, more effective , and strategic support for enhancing central-level institutional capacity." (Para 7)

"Subsequent tranches will extend the protection structures and associated non-structural measures to adjacent stretches, and the design will be adjusted to the latest riverbank erosion conditions." (Para 8)

The government and ADB confirmed the arrangements in the Aide Memoire of the Review Mission 9 – 11 November and 4 – 8 December 2016) (para 19):

"The overall approach and draft site selection of Project 2 was presented and agreed at the workshop on 7 December 2016. The priority will be given to the remaining critically eroded sites and continuation of ongoing Project 1 works to ensure the sustainability of the currently constructed riverbank protection structures."

Bangladesh develops towards leaving the group of least developed nations and aspires to reach middle income status over the next decade. Consequently, its development focus shifts, with major rivers playing an important future role. Self-sufficiency in food grains (rice), represented by the traditional focus on flood control, drainage, and irrigation, reduces in importance towards a focus on high-value agricultural products. While the formulated goals of flood disaster risk management and irrigation improvement remain valid, the water sector needs to take on additional roles in the field of stabilizing the main rivers and securing reliable dry season flow in dependent distributaries. Both are justifiable through distinctive benefit streams.

Reflections on project benefits justify minor realignment of the design for FRERMIP, taking into account the strategic framework and thrusts, particularly char land recovery and increased land based productivity not just from agriculture but also accruing from residential and commercial developments. These strategic thrusts represent some departure from the original (PPTA) programme design where the focus was on flood protection of agricultural areas and poverty reduction. The Tranche-2 design reflects this change and prepares for further development during Tranche-3 through different knowledge base components, further improving the understanding of river processes, planning new, yet untested work like distributary offtakes, and contributing to an increased understanding of the performance of innovative stabilization works.

Government Guidance

Decision 9.2 (kha) of the ECNEC, dated 2nd June 2016, states: "*Embankment Construction and River Protection Projects will essentially have provision for Capital Dredging and 50-60% fund allocation of the estimated expenditure will be allotted to Capital Dredging*." Adoption of this directive without due consideration of dredging priorities may result in wasteful dredging in the main rivers. Dredging activities have to be planned carefully and in a coordinated manner for a number of reasons:

(i) To avoid destabilization of the downstream river course. Experience form the capital pilot dredging at the Bangabandhu (Jamuna) Bridge shows that a pilot channel has the potential to destabilize the downstream river course over a distance of some 20 kilometers over decades.

(ii) Man-made dredging is limited to the dry season when the flow conditions allow the operation of dredgers and the sand of the bed material load does not move. Their dredging capacity is orders of magnitude lower than the sediment carrying capacity of the Brahmaputra River, and consequently natural river forces will dominate channel formation during the flood season.

(iii) Dredged pilot channels have the potential to turn into very wide shallow channels, causing unwanted riverbank erosion unless accompanied by riverbank protection works planned in advance.

(iv) The construction of riverbank protection activates self-dredging of the river in response to the protective works. The self-dredging ability can well exceeds machine dredging capacities.

The long-guiding revetment works built at Chauhali under Tranche-1 have protected seven kilometers of riverbank against erosion and stabilized the course of the eastern branch of the Lower Jamuna. The stabilization is also confirmed by substantial self-dredging of the river and formation of a stable deep channel alongside the bank, suitable for navigation. The 7 km long revetment works has developed a 7 km long deep channel extending 2 km beyond the downstream extent of the revetment. The river has self-dredged more than 8.3 million cubic meters of riverbed material (5.4 million during the first year of implementation in 2016 and 2.9 million during the second year in 2017), to a river depth of around 20m during the dry season. The equivalent monetary value of self-dredging amounts to US$ 25 million compared with the investment cost for the revetment of US$ 19 million including strengthening/adaptation works, land acquisition, and resettlement.

Dredging in the context of the strategic framework (ISPMC, 2016) is usually required for the following works: (i) for riverbank protection particularly on weaker soils to establish stable slopes and deeper apron setting levels, (ii) as fill for reclaimed/ protected char lands, particularly in closed channels, (iii) sourcing materials for flood embankments and to fill geo-bags, (iv) to dredge out (annually) low-flow channels, particularly between protected river bank bends for navigation, (v) to ensure low season flows to off-taking distributaries, and (vi) to increase capacity and flows along the distributaries for improved water supply as well as inland navigation.

BWDB's Approach towards River Stabilization and FRERMIP Tranche-2

The BWDB, specifically the Director General, and the ADB mission leader have asked the ISPMC during the first half of 2016 to concentrate on riverbank protection to minimize erosion losses, which is achieved by systematic stabilization of river banks combining the benefits of individual riverbank protection works. The Aide Memoire of the Review Mission (30 August – 4 September 2016) states:

"BWDB requested and the mission agreed that the priority should be given to critically eroding sites and continuation of ongoing Project-1 works to ensure the sustainability of the current constructed structures." (para 19)

This approach is in line with the Strategic Framework (NHC/EMM, 2016) for stabilization of the river corridor, see Section 2.1.

In October 2018, the BWDB reconsidered the site selection (NHC/EMM, May 2017) based on morphological development, approved by the Technical Advisory Committee in September 2017 (BWDB, 2017) and detailed in March 2018 (NHC/EMM, 2018a). During the Technical Committee meeting (BWDB, 2018), the BWDB took the strategic decision to limit Tranche-2 to riverbank

protection along floodplain land proposing a higher level design standard for riverbank protection based on observations from physical hydraulic model studies (RRI, 2016). The experience with the upper slope instability at Chauhali was specifically mentioned as reason for the design change of the underwater slope[25].

With respect to the cover layer of the new design, the Director General suggested the alternatives of concrete blocks or rock, which the committee adopted:

"Riverbank protection works may be implemented considering dumping volume of approximately 75 cum/m (50% CC Blocks/Hard rock and 50% geobags) at apron and 3.25 cum/m at berm (1 cum/m geo-bags & 2.25 cum/m CC blocks)."

Subsequently the Chief Engineer and Superintending Engineer Design II, attending the October meeting, provided the ADB with further substantiation on the need for a higher design standard on 11 December 2018 titled : "Observation on the Design for "Construction of River Bank Protection work at the U/S of Chouhali" proposed by ISPMC under FRERMIP". The document states, amongst others:

(i) The lack of drawings for adaptive works, problems in planning the work ahead of time, the uncertain river environment[26], and fund allocation (also refer to Section 0 and 0 of this report).

(ii) That a higher design standard can be achieved through a double layer underwater protection: *"For a sustainability, BWDB follows "No-regret" approach as it was included in Delta Plan 2100. For better safety, in all other BWDB project, Combination of Geobag (50%) & CC Block (50%) are used for under water protection"*. As proof of better performance of a combination of concrete cubes and geobags, the document provides photographs from a physical hydraulic model study at 1:30 scale, conducted at the RRI in Faridpur in 2016.[27]

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[25] *"Director General BWDB, Dhaka opposed to apply adaptation technology in case of river bank protection works. He state in the meeting that, from past experience it has observed that capital cost is less in respect to maintenance cost and so many times in many places damages occurred in Chauhali during the flooding period of 2017 along with 3 times damages this year. For this reason, adaptation technology along with bank protection with only geo-bags may not be considered in mighty river like Jamuna & Padma river as no regret consideration. In this context, Mr. Mohammad Harun-Ur-Rashid, Superintending Engineer, Design CirclD-II, BWDB Dhaka stated in the meeting that, total cost in favour of adaptive management not reduces than the permanent bank protection cost as usual practice of BWDB … Mr. Motahar Hossain, Chief Engineer, Design, BWDB Dhaka stated in the meeting that bank protection work with only geo-bags will not applicable further. He also explained that from past experience CC blocks with geo-bags is more effective than only geo-bags as a dumping materials."*

The memo: "Review of bank protection design and bank failures in Chauhali for Chauhali Committee", dated 31 July 2018 identified geotechnical failure of the upper slope after placing a surcharge of 25tons of concrete blocks as the main failure cause for observed failures at Chauhali. The latest failure in February 2019, also relates to this cause – see memo ISPMC-FRERMIP-596, dated 13 March 2019

[26] The Chief Engineer explained during the ADB mission from 20 to 27 November (Aide Memoire para 15 (iii): *"BWDB prefers a technology that is stable after construction and does not need year-to-year interventions. In order to arrive at permanent work, BWDB has conducted a physical hydraulic model study which indicates that a design change, mixing geobags with concrete blocks, would perform better in bank protection works in their opinion. Also, he mentioned that lots of 'angry words' were received from the public and the media when some above surface elements of the riverbank protection works slipped during a flood season. "*

[27] Additional high resolution (multi-beam) underwater surveys on the launching of geobag aprons are available from FRERMIP Tranche-1 (particularly November 2017 at Chauhali and Kaijuri) and Padma Bridge, where the adaptive

3.4 Infrastructure Design

This report follows the designs provided by the BWDB design office in January and February 2019 in line with recommendations from the Technical Committee (BWDB, 2018). Its full implementation will result in a project size of USD 361 million[28].

In line with the agreed MFF concept, the decisions of the Technical Committee on 8 October 2017 (BWDB, 2018), and reflecting recent river changes, the key investment activities of Tranche-2 are (Table 3-3):

(i) Expanding riverbank protection towards larger reach stabilization, focussing on the Lower Jamuna (sub-projects JRB-1 and JLB-2);

(ii) Expanding flood protection works (sub-project JRB-1 and PLB-1)

(iii) Recovering lost flood plain land and stabilizing a larger reach through a combination of innovative, nature-based solutions[29] involving dredging and sediment harvesting through "building with nature" technologies.

The second Technical Committee recommendation to continue the design development process is consistent with the FRERMIP philosophy.

Table 3-3 Summary of investment activities for Tranche-2

Major Work Items	
Embankments	Shajadpur embankment: Approximately 7.9km of embankment along Hurasagar River with 2 regulators (1 to be constructed on Tranche-1 Koijuri embankment as per original PPTA design) Harirampur - Doha embankment: Around 17.4 km of reconstructed Dhaka Southwest embankment with 7 regulators and a bridge at Kartikpur to allow re-opening of previous river closure in early 1970s
Riverbank Protection	Provision of approximately 3.5 km of bank protection at Benotia consisting of 37.5 m^3/m of concrete block protection above 37.5 m^3/m of geobag protection (figures include berm) Provision of approximately 12 km of riverbank protection upstream of the existing Chauhali bank protection consisting of 37.5 m3/m of concrete block protection above 37.5 m^3/m of geobag protection (figures include berm)
River Stabilization	Dumping of sediment downstream of Chauhali following intelligent dredging

approach with geobag aprons has been followed since 2015 (for protection of the construction yard as well as the main bridge).

[28] Deferring some of the investment into Tranche-3 would improve the economic feasibility and is in line with the recommendation of the Technical Committee: "*GoB contribution may be higher or scope of work may be reduced and remaining work may be implemented under Tranche-3 in case of higher DPP cost of Tranche-2 than planned in the PPTA.*"

[29] The Prime Minister mentioned in her speech for the World Water Day on 22 March 2018: *"There are no alternative to nature-based solutions for facing the mounting challenges of water resources management. … We should introduce innovative nature-based solutions for water resources developments and management in addition to the conventional solutions"*

" … Plantation of Doincha along with vetiver grass on the char Solimabad for sedimentation and land development may be adopted." ."[30] (BWDB, Technical Committee, 2018)

Visual inspection indicates that the area coverage of a mix of geobags and concrete blocks is more complete. (RRI, 2016).[31]

Major design development works, conducted during Tranche-2, will pertain to the creation of a stable offtake of the Old Dhaleswari River, as the first stabilized offtake in the Brahmaputra System. This work will consist of innovative dredging, as well as physical and numerical modelling. Dredging will have major focus as key technology to close undesirable channels with a phased pilot approach: during the first year the targeted dredging quantities will be excavated from the desired channel and pumped into the undesired channel (Solimabad channel downstream of Chauhali) in order to establish maximum daily, weekly, and monthly dredging capacities. During the next season the same excavation of the desired channel will be applied but this time for closing the undesired channel to a specific level, allowing the rising discharge of the incoming monsoon to excavate the desired channel further. Only at high water levels the dredged material will be overtopped and breach, allowing the dredged material to be transported downstream. The reduction of channel size will be further supported by systematic reed plantations to increase the char level and reduce the inflowing discharge. Overall this approach attempts to divert the risk of the deep Chauhali channel moving into the Solimabad channel, by reducing the channel size to the size of the Old Dhaleswari, protecting 15km of vulnerable riverbank against erosion and supporting the recovery of several thousand hectares of land from the river.

This approach depends on the morphological development, with the inherent risk that the undesired channel starts opening up and cannot be closed with limited dredging capacity. Recent developments of the Solimabad channel show wide fluctuations of areas and volumes below low water level, with times of channel reduction and opening (Figure 3-1). The channel in 2018 is much deeper than during earlier years.

As per recommendation of the second Technical Committee, Tranche-2 will contain increased provisions for strengthening/adaptation and emergency works, as a lesson learned from Tranche-1

[30] Government and Deltares have signed a MoU on 13 February 2019: *"Deltares will be supporting the Ministry and their sub-ordinate institutes through capacity building, training and advice. Bangladesh faces a challenging future given the impact of climate change and Deltares will particularly support their ability to perform applied research. Particularly through piloting innovative technology and approaches with our Bangladeshi partners. The visit on Wednesday 13 February included a tour of Deltares physical modelling facilities and ID-Lab. The delegation also visited various innovations throughout the Netherlands, such as the Sand Motor, new promenade at Scheveningen and the new composite ship-lock gates at Tilburg."* (https://www.deltares.nl/en/news/deltares-strengthens-ties-government-bangladesh/)

[31] Several aspects of the design could be investigated: (i) the comparative use of rock or concrete blocks as suggested by the DG BWDB during the second Technical Committee meeting, (ii) recent research (Thompson, Oberhagemann, She, & Haque, 2018) indicates large performance differences between very small model bags and real ones, (iii) field measurements of the launched slopes which can vary due to scale effects in physical models, (iv) implications of the launching to design scour depth in one step on the geotechnical stability of the slope (v) and (vi) clarity on the design approach which calculates the thickness of coverage based on theoretical geometry.

Additional controlled piloting and analysis during Tranche-2 would further strengthen the updated Guideline for Riverbank Protection, which then can be based on some 20 years of experience with different types of riverbank protection applied in the large rivers of Bangladesh.

implementation[32]. The recent experience from FRERMIP demonstrates that delays in the strengthening/adaptation of the Chauhali apron meant that it launched more than 5m more than the design launching before adaptation works were carried out. Despite a number of failures of the upper slope, the protection withstood two high flood seasons in 2016 and 2017 to maintain the original bankline. At Kaijuri (constructed from 2009 - 11) the aprons has launched by approximately 15m vertically. About one decade after construction and without any strengthening/adaptation works, local slope failures now occur at an increasing rate. Because of the overall constraint in the BWDB O&M budget (refer to Section 0) and the reduced fund availability under Tranche-1, the required strengthening/adaptation works could not be undertaken when required and consequently 40km of strengthening/adaptation works have been incorporated into the Tranche-2 design, in addition to 5km of emergency works.

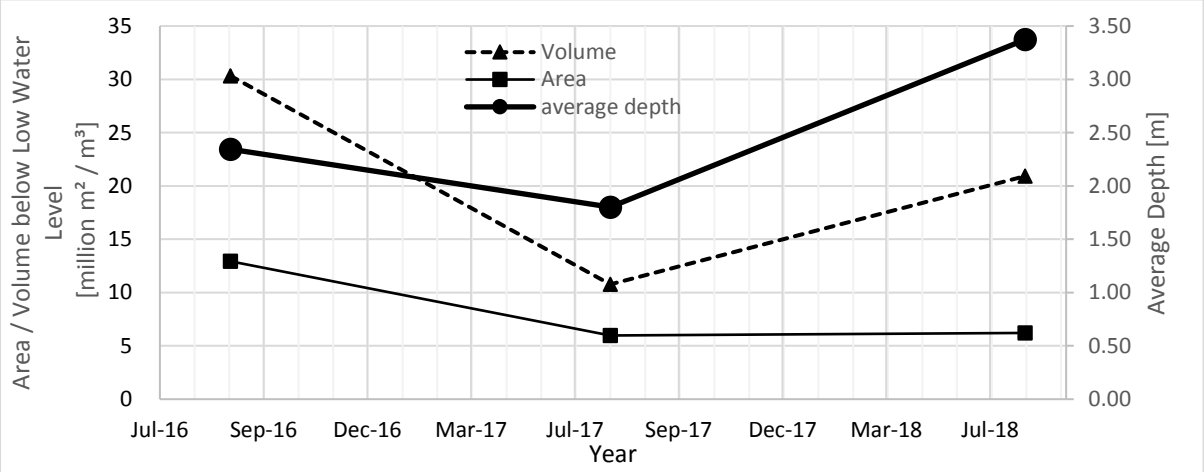


Figure 3-1 Development of Solimabad channel from 2016 to 18

Mitigation of Risks

River stabilization works built into the river are always relatively high risk. The more so as a river of the complexity and magnitude of the Jamuna has never been stabilized before. Consequently, a number of risk reduction mechanisms are part of the tranche 2 design[33]:

(i) Limiting riverbank protection to the existing more consolidated floodplains.
(ii) Introducing a heavier design with concrete blocks that was tested in an RRI 1:30 scale physical model in 2016.
(iii) Assuring a high flexibility in both location and work length in the Government Development Project Pro-forma as opposed to the common fixed definition of work locations that cannot be predicted precisely.
(iv) Extending capacity development activities particularly related to geotechnical engineering especially to the design office,.

[32] The second Technical Committee recommends: "Provision of sufficient maintenance budget for completed works of JMREMP & FRERMIP Tranch-1 project as strengthening/emergency works in the DPP of Tranche-2". In line with the Framework Financing Agreement, the BWDB will provide the funds for maintenance, while the funds allocated under Tranche-2 pertain to 40km of adaptation works (strengthening of launched underwater slopes) and 5km of emergency works financed from loan proceeds. The adaptation works constitutes a continuous under-water construction process towards design depth.

[33] The Delta Plan 2100 is built on the principle of Adaptive Delta Management consisting of a strategic vision of the future, short term action, and a framework to guide future actions. An underlying paradigm is *"that given ignorance about the possible side effects of technologies under development, one should strive for correctability of decisions, extensive monitoring of effects, and flexibility"* (Collingridge, 1980) quoted in (Haasnoot, Kwakkel, Walker, & ter Maat, 2013).

(v) Providing contingencies in the form of additional work items, that can be flexibly applied.

(vi) Adding provisions for emergency and strengthening/adaptation works, independent of the construction contracts, and on long-term bases (on-call contracts).

3.5 Institutional Setting

The Water Sector

Bangladesh has created an institutional framework for water management that extends from the highest levels of government to the grassroots. It comprises policy level organisations (MoWR, NWRC, WARPO and the Joint River Commission), implementing organisations (mainly BWDB and LGED), research organisations (BUET, CEGIS, IWM and RRI), as well as a system of grass root organisations of water users (WMO, WMG and WMF). Numerous consultancy firms and contractors work in water management. Of particular relevance are long-term relationships with Dutch partners (IHE, DELTARES), providing opportunities for sharing world-wide experience[34].

A limited number of International Development Agency partners have supported major interventions in the water sector in Bangladesh over the last decades: in particular, the Asian Development Bank (ADB), the World Bank (WB), the Japan International Cooperation Agency (JICA) and the Kingdom of the Netherlands (KNE). Other development partners contributed smaller amounts or for shorter periods.

Over the years the institutional structure for water resources management has adjusted to different requirements. Functions previously with BWDB are now assigned to different specialised organisations: (i) Macro Planning to WARPO (National Water Management Plan, 2004) and the Planning Commission ("Delta Plan", 2016), (ii) Research and Knowledge Management to CEGIS, IWM and RRI, and (iii) much of the study and planning to private consultants. This has contributed to the build-up of specialised knowledge, but has also complicated coordination and cooperation between the different organisations.

BWDB Budget Allocations

The BWDB budget has greatly increased since two years and exceeded the historic peak of BDT 4,000 Crore (in 2018 prices) of 1998/99 by 2016/17 (Figure 3-2). While donor funds contributed some two-thirds until the end of the 1990, their percentage stabilized at around 20% during the 21st century (Figure 3-3). With the sharp increase in available budget, the waterboard also observed a sharp increase in O&M demand as shown in Figure 3-2.

[34] Also refer to earlier mentioned MoUs between Government and Dutch partner organizations.

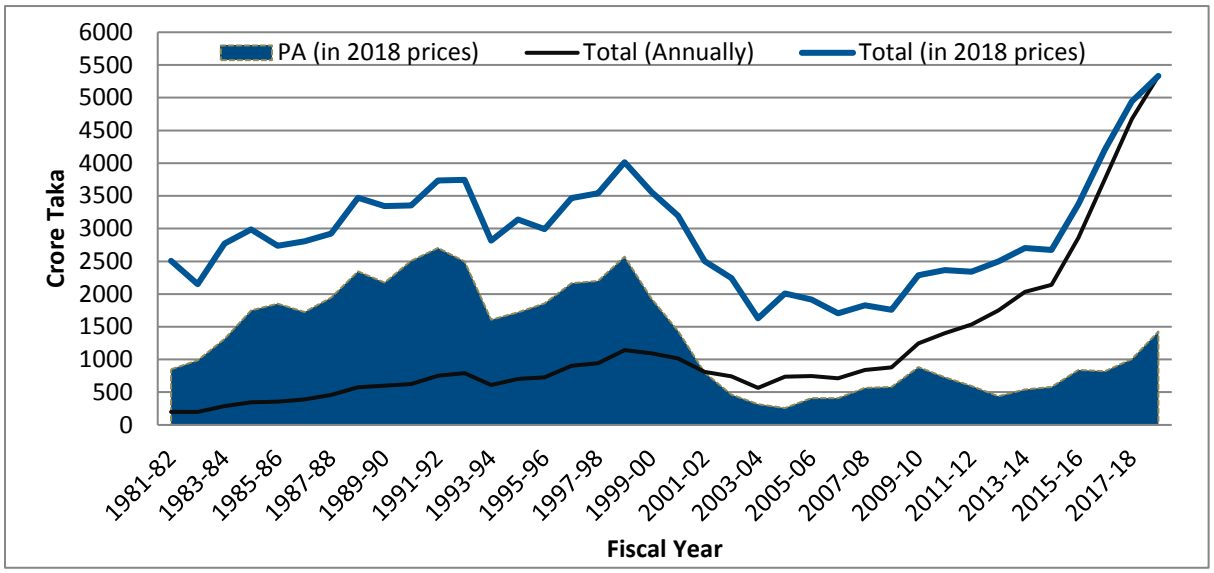


Figure 3-2 Annual BWDB budget in actual and 2018 prices, PA relates to donor contributions

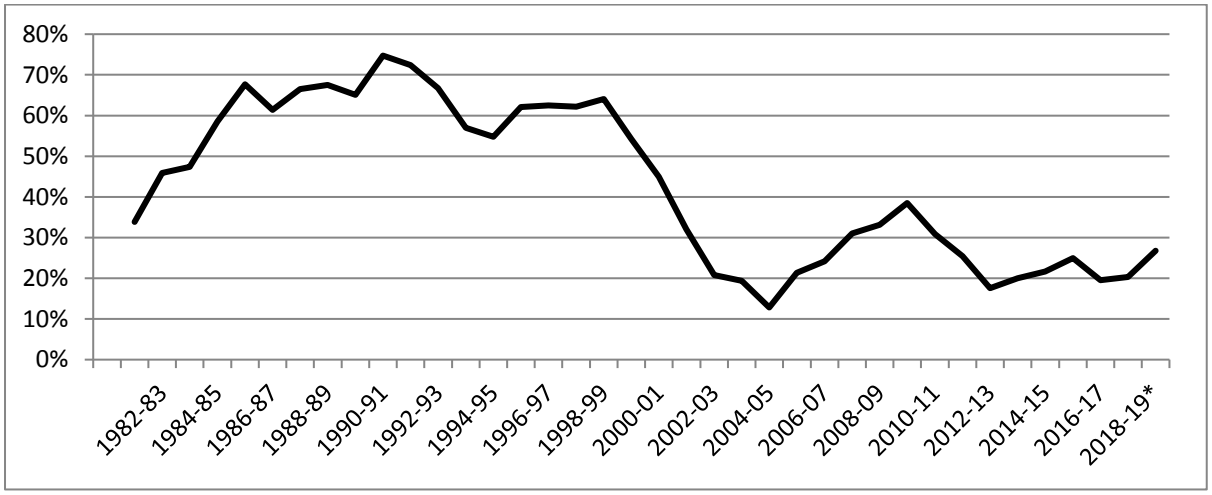


Figure 3-3 Percentage donor contribution to the BWDB (2018 prices)

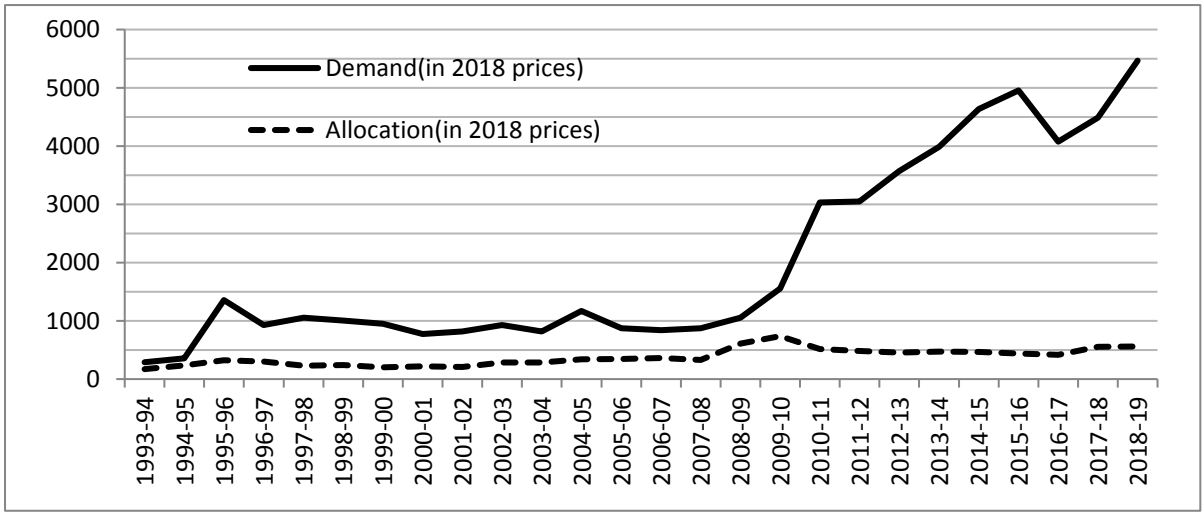


Figure 3-4 O&M demand and budget allocation (in 2018 prices)

FRERMIP Arrangements and a Way to Address Increased Demand for O&M

The FRERMIP program is focussed on main rivers management and with the exception of the relatively small community based flood management component which falls under the DDM, is managed by the BWDB. A Project Management Organisation (PMO) has been set up to execute the project with assistance from an the ISPMC. Construction at the various works sites is supervised by BWDB O&M Division staff where the Superintending Engineer has delegated powers of "the Engineer/ Project Manager" as per FIDIC/ ADB Minor Works contract conditions. Major work was supervised on a day-to-day basis by the Task Force or the regional BWDB staff for Quality Control. The BWDB has taken over the full design responsibility for Tranche-2 works[35]. This notwithstanding, the ISPMC typically provided initial design solutions, and discussed intensively the designs prepared by the BWDB, particularly for including in general international best practice and specifically geotechnical design aspects.

A pragmatic way out of the O&M nexus is the preparation of on-call contracts using investment funds for systematic strengthening/adaptation and maintenance work along river reaches or BWDB zones over a period of multiple years. The core principle is a framework DPPs with block allocations of funds. This approach would not only provide flexibility but is also sensitive to the planning commission requirements for approving new projects and the fact that work pertaining to large and medium rivers in Bangladesh has a high level of uncertainty and unpredictability. This means that it can neither be fully designed in terms of length and cross section as the future river is unknown as well as requires flexibility during implementation to adjust the underwater works to the actual river conditions.

[35] Aide Memoire of Consultation Mission (20 – 27 November 2018), para 18 (iv) *"The Chief Engineer Design confirmed that the Design Office would take full responsibility for the designs."*

4 PROPOSED TRANCHE-2 PROJECT

4.1 Component 1: Infrastructure Improvement

General Approach

Tranche-2 river stabilization depends on three technologies, in line with Government priorities[36]:

(i) Providing a reliable **boundary between floodplain and river**, or land and water through long-guiding revetments acting as "bend control" to encourage a more meandering and stable channel pattern. These revetments have a demonstrated self-dredging ability and result in a more predictable channel pattern even when only built along parts of the riverbank. This technology is classified as structural measure.

(ii) **Multi-purpose dredging** supports a more stable river environment, through navigation dredging during the dry season, supporting the construction of riverbank protection, and providing the source material for revetment and embankment construction[37], and the raising of land above high flood levels. Dredging is limited to the sand fraction of the transported sediment (bed material load) which only constitutes around one quarter of the total sediment load.

(iii) Sediment harvesting extends river stabilization into the flood season by capturing the dominant part of the sediment transport, the suspended sediment. This deposited finer sediment provides Bangladesh's fertile top soil allowing multiple cropping. The suspended sediment can best be attracted through the indigenous technique of reed plantations. Applied systematically, it turns into a bio-engineering technique in "**Building with Nature**".

The combination of above three technologies provides significant advantages as it allows an integrated, phased approach and reduces cost due to actively encouraging natural forces to participate in the stabilization effort. Figure 4-1 provides an overview of the application particularly in line with the sediment transport, which is relevant for two of the technologies. Consistent with FRERMIP Tranche-1, riverbank protection will provide the backbone for stabilizing the Lower Jamuna channel while continuing the development process of long-term sustainable solutions. River stabilization techniques particularly dredging and "building with nature" will be developed and applied for recovering some 6,000 ha of land downstream of Chauhali, Sirajganj District.

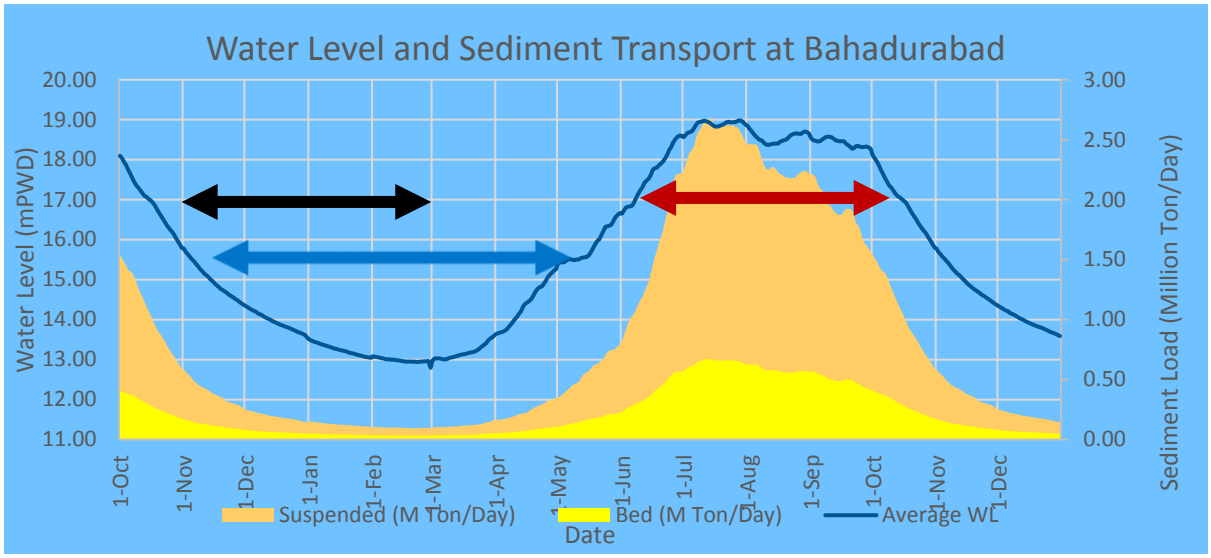
[36] The Prime Minister in her speech for the World Water Day on 22 March 2018, highlighted:

"There is no fixed boundary between river and floodplain. Defining the river course, boundary between land and river, plan form and buffer zones are essential for the management of the major rivers."

"The government since taking over has given special emphasis on the restoration and development of natural wetlands, revival of the river and navigation through dredging … maintaining the connectivity between the river and the floodplain, creating buffer zone along the riverbank for the protection of the environment and ecosystem."

"There are no alternative to nature-based solutions for facing the mounting challenges of water resources management. … We should introduce innovative nature-based solutions for water resources developments and management in addition to the conventional solutions."

[37] The use of compacted dredged sand for 21km of embankment construction at Shahjadpur, Sirajganj Division allowed substantial completion of the embankment in one season at significantly lower cost.



DREDGING **RIVERBANK PROTECTION** **BUILDING WITH NATURE**

Figure 4-1 The three basic technologies for river stabilization and their use during the year

Tranche-2 will build more than 25km of flood embankments in two locations: the work started under Tranche-1 will be completed at Shahjadpur and a new, some 17.4km long embankment will connect Harirampur with Dohar protecting more than 1,500 ha of recovered floodplain land. Embankment construction will use compacted sand, dredged from the river and provide for a number of regulators with fish passes, to connect floodplain water-bodies with the main rivers.

Tranche-2 Civil Works

Following the design decisions of the Technical Committee and confirmed during subsequent discussions between Project Director and Director General Tranche-2 attempts to fully implement the new riverbank protection design as supplied by the BWDB Design Office in February/March 2019[38]. Optional underwater protection at Chandpur will be further deferred for cost reasons. Table 4-1 provides the details of the Tranche-2 works, updating principles agreed in four Aide Memoires between July 2017 and November 2018[39].

[38] While Tranche-1 deferred the implementation of parts of the riverbank protection design provided for Harirampur and the Technical Committee recommendation (point VI): *"GoB contribution may be higher or scope of work may be reduced and remaining work may be implemented under Tranche-3 in case of higher DPP cost of Tranche-2 as planned in the PPTA"* the Director General confirmed his preference for full implementation of all riverbank protection during Tranche-2 as designed in March 2019.

[39] Aide Memoire of (i) Consultation Mission (23 – 30 July 2017); (ii) Consultation Mission (26 November – 1 December 2017); (iii) Consultation Mission (27 February – 5 March 2018); (iv) Consultation Mission (20 – 27 November 2018)

Table 4-1 Summary Tranche-2 civil works

Work Item	Work details	Remark
JRB-1 – priority sub-project		
Kaijuri embankment	Approximately 7.9km of embankment along Hurasagar	The embankment will be completed as per PPTA to achieve the full benefits of this sub-project. Construction of the road has been abandoned in favor of additional river stabilization work
Fish passes	2 Nos., to the Hurashagar and Jamuna River	Expanding the PPTA report. One will be built in the existing embankment where the current regulator size was reduced
Riverbank protection	Provision of some 3.5 km of riverbank protection at Benotia	No riverbank protection is planned along the char
JLB-2 – priority sub-project		
Dredging	Channel choking with sediment downstream of Chauhali	Adjusted PPTA approach to account for changed river situation and incorporate "building with nature" and to ensure sufficient dredging.
Riverbank protection	Provision of some 12 km of riverbank protection upstream of Chauhali and 10.5km of precautionary protection at Solimabad	No protection planned on the central char, but extension of existing river bank protection
PLB-1 – priority sub-project		
Embankment from Harirampur to Dohar	17.4 km reconstructed Dhaka Southwest embankment	Following the PPTA, the reconstructed embankment will provide reliable flood protection from Padma flooding in future. A bridge is proposed to open up a khal, closed during the 1970s upstream of the embankment at Kartikpur
Fish passes	7 regulator / fish passes to connect Ichamoty River and local khals and for drainage	Expanding PPTA report and based on future plans to reopen closed sections of Ichamoty River
Strengthening/Adaptation and emergency		
Strengthening/Adaptation works	40km	Extended from the PPTA incorporating previously built sites
Emergency works	5km	To cover unforeseen developments

Table 4-2 Revised Scope of Primary (new) Works by Tranche

Work	Tranche-1: PPTA	Tranche-1: implemented	Tranche-2: PPTA	Tranche-2: Planned	Tranche-3: PPTA	Tranche-3: Planned
Riverbank revetment	15 km	17.8 km	16 km	15.5 km (+10.5 km precautionary)	19 km	9.0 km
Embankment	23 km	21.3 km *1	43 km	25.3 km	23 km	40.0 km

**1. Construction ongoing, April 2019*

Remaining Tranche-3 Works

Tranche-3 will complete the ongoing activities and therefore, will focus more on flood embankment construction along the Jamuna left bank. Together with flood protection the offtake of the Old Dhaleswari will be stabilized potentially including work upstream and downstream of Chauhali on the central char. The associated land acquisition will focus on the embankment works, with a substantial part expected over recovered floodplain land, similar to the Harirampur embankment proposed for Tranche-2. The embankment includes the fully developed offtake layout and flood barrier for the Old Dhaleswari, including providing a channel along the recovered land to the offtake at the present bankline.

Assessment of Dredging

Dredging within the context of river stabilization may include dredging for:

(i) Underwater slope preparation for riverbank protection works, particularly on unconsolidated loose char soils,
(ii) River training purposes including forming pilot or cut-off channels and choking (overloading with sediment) unwanted channels
(iii) Embankment construction (sand core),
(iv) Low-flow navigation channels,
(v) Speeding up land reclamation of char-lands by filling with dredged material, and
(vi) Speeding up offtake and distributary re-development by increasing capacity and flows along the distributaries for improved water supply as well as inland navigation.

Table 4-3 compares different measures and Table 4-4 demonstrates that Tranche-2 will use five of six possible dredging measures.

Table 4-3 Comparative Assessment of Different Types of Dredging

Purpose	Dredging proportion	Technical feasibility and appropriateness of measure for Tranche-2	Likely economic benefit	Risks/ Uncertainty
For revetment construction particularly on weaker soils to establish stable slopes and deeper apron setting levels	Depending on soil conditions and related apron setting level	Feasible measure and suitable to establish more stable underwater slopes prior to dumping geo-bags. This reduces need for strengthening/adaptation work. Implementation during dry season is demanding as higher dredging requirement is required	• Reduced risk of failure • Reduced maintenance and strengthening/ adaptation works requirements	• Low – this measure reduced risk • Deep water/ high capacity dredging required

Purpose	Dredging proportion	Technical feasibility and appropriateness of measure for Tranche-2	Likely economic benefit	Risks/ Uncertainty
River training measures including (i) pilot channels for leading/ training flow, (ii) sand plug / choking channel ("*building with nature*")	90%	Measure likely suitable for river stabilisation and training, but needs study and piloting for effectiveness. This is planned for Solimabad – downstream of Chauhali (JLB-2)	• Effective stabilisation measure • Dredged material will beused for channel closure	Measure is a pilot and results will be compared against model work and lessons will lead to future refinement/ improvement
Dredging sand for embankment construction	> 60% of construction cost, and depending on volume of wave protection and regulators	Standard measure for modern embankments which minimize the use of fertile, intensively agriculturally used topsoil.	• Reduced environmental impact • Improved bearing capacity for road construction • Contribution to channel stabilization	Low, as technically sound measure also implemented under Tranche 1
Dredging low-flow channels, particularly between protected river bank bends for navigation	100%	Navigation dredging to flow river stabilisation, and likelihood of larger ships needing navigable river in FRERMIP area	• Low at this time due to limited dry season navigation	• Dredging at this time likely to be less economically feasible • Taken up by BIWTA
Speeding up land reclamation of char lands by filling with dredged material	100%	Technically feasibility but depending on (i) social acceptability/ land holding/ resettlement aspects, and feasibility of removing large quantities of sediment from the river with degradation	• Depends on land use after reclamation – not so beneficial for agriculture • suited to land allocated for commercial developments	• River destabilisation due to over dredging locally. • Lack of demand from developers for commercial real estate
Speeding up offtake and distributary re-development by increasing capacity and flows along the	100%	Flood management structure required at head of distributary before dredging initiated for dry season flows.	Likely to be high to: (i) address declining water tables and quality, (ii) increase availability of surface lean season flows for irrigation,	• Increased flows along distributary may lead to some bank instability leading, for

Purpose	Dredging proportion	Technical feasibility and appropriateness of measure for Tranche-2	Likely economic benefit	Risks/ Uncertainty
distributaries for improved water supply as well as inland navigation		Dredging along distributary to increase/ restore dry season flows should ideally follow on from flood management structure construction at head. Disposal of dredged material may be problematic	reducing dependence on tubewells, (iii) increased supply to Dhaka metropolis, (iv) improved navigation, (v) improved connectivity for fisheries, and (v) improved habitats	example, to failure of bridges/ other structures. • Disposal of dredged material • Studies required to firm up desired flows

Table 4-4 Dredging Measures per Tranche

Measure	Tranche-1	Tranche-2
Underwater slope preparation	-	For construction on chars
River training works	-	Channel closure piloting
Embankment construction	For 21.3km	25.3km
Low flow channel	-	Extension of Solimabad channel
Char land build up	-	Estimated up to 14 million m^3
Offtake and distributary restoration	-	-

4.2 Component 1: Non-structural Flood and Erosion Risk Mitigation under Tranche-2

Non-structural, flood and erosion risk mitigation measures include: (i) Community Based Flood Risk Management, (ii) Community Capacity Enhancement for Participatory O&M, and (iii) Livelihood Support. Work. Proposed modifications in the design of these components, as well as associated costs for Tranche-2, are provided below.

Subcomponent 1.2 Community-based and Regional Flood Risk Management

COMMUNITY-BASED FLOOD RISK MANAGEMENT

There is little change to the project design to establish community based flood risk management. Activities will include: (i) engage INGO, (ii) Formation of Community-based Disaster Management Units (CDMUs) comprising Community Volunteers (CVs) in most vulnerable (both physical and economical) wards of the unions, (iii) training of CDMU volunteers, (iv) agreement/ adoption of community level flood warning, such as marks at populated areas to indicate usual and extreme flood water levels, (v) establishment of communications between the CDMUs and DDM staff, and (vi) institutionalization of CDMUs through integration into the mainstream government disaster management framework. It is also anticipated that the DMUs may share the same “office” facilities that are proposed for embankment WMOs (see Sections 0 and 0 below).

Under Tranche-2, 80 CDMUs will be established, and 1,200 volunteers trained.

REGIONAL FLOOD RISK MANAGEMENT

Flood Response Plans will be prepared for each of the 13 Upazilas in collaboration with key Upazila level stakeholders, including staff from DDM, BWDB, Upazila office as well as the Union Parishad Chairmen and representatives from the ward level DMUs. The Plans will be based on the one prepared for Shahjadpur under Tranche-1.

COMPONENT DETAILS

Community-based and Regional Flood Risk Management activities will be implemented by an INGO working as directed by the PMU-DDM. Costs under this component include for the following:

(i) DDM equipment.
(ii) INGO staff costs and expenses (per diems, office equipment, transport, etc). A 30-month INGO contract is planned.
(iii) Capacity development and training costs for community based CDMUs.
(iv) Capacity development and meeting costs for dissemination of regional flood risk management plans at Upazila level. Workshops at the 13 Upazilas in the priority SPs areas are planned.

Subcomponent 1.3 Community Capacity Enhancement for Participatory O&M

The concept for communities along the river banks to take some responsibility for regular O&M of structures and embankments remains unchanged; however it is not considered realistic that this can be managed by reaching agreements for "reward in kind" from lease of embankments for social forestry. The following modifications are therefore proposed under this component:

(i) Form Embankment WMOs registered under the Participatory Water Management Rules (PWMR), 2014[40]. The community DMUs would therefore be separate organisations though members may be common to both, and they may share facilities.

(ii) BWDB to contract out regular maintenance works to the WMOs on an annual basis, following joint inspections. Work item rates and modality of procurement remain to be approved by competent authority. WMOs would open bank accounts to receive payments.

(iii) WMOs may sub-lease embankment land to community members to raise cash for WMO activities. Such leases are to be approved by BWDB.

(iv) O&M sheds for WMOs are to be provided on raised ground along the embankments. These sheds may be used as a venue for WMO meetings, for trainings, storage purpose, for communicating with DDM, BWDB and others (by cellular linked computer) and for livelihood support activities. Each shed will have water supply, separate toilets for men and women, and electric connection. It is expected land for the sheds will be government owned land or donated by the community.

[40] Alternatively they may be registered as a Cooperative under DOC

(v) Materials and equipment will be provided to each Embankment WMO, for O&M including paint/ shovels/ stockpiles such as geotextile bags.

Under Tranche-2, community regular O&M activities will be piloted and assessed. If successful, the pilot will be expanded and rolled out under Tranche-3. The pilot will comprise: (i) formation and registration of 10 Embankment WMOs for O&M, (ii) construction of 10 O&M sheds complete with facilities and equipment, and stockpiles, (iii) piloting bio-engineering solutions to stabilize embankment slopes, both from waves and rainfall (river and country side) and just rainfall (land side), including use of vetiver grasses, and (iii) training, support and monitoring.

An INGO will be engaged for the pilot, particularly for WMO establishment, registration, training and support including embankment stabilisation by bio-engineering. The 1O O&M sheds will be constructed under one or more NCB civil works contracts.

Ultimately, formation of embankment WMOs with a WMO "shed" for every 5 km of embankment is envisaged if the pilot is successful.

COMPONENT DETAILS

Costs under this component include for the following:

(i) Construction of O&M Sheds, BDT 1.8 million each
(ii) O&M shed equipment and stores, BDT 0.2 million each.
(iii) INGO staff costs and expenses (per diems, office equipment, transport, etc). A 30-month INGO contract is planned.
(iv) Capacity development and training costs for Embankment WMOs.

Subcomponent 1.4 Livelihood Support including Fish Sanctuaries

In Tranche-2 livelihood programs and courses will be identified for Affected Persons as well as for persons living along the river embankment or on the char lands, and will include for vocational skills development and various livelihood trainings, for example: crop and fisheries, homestead small livestock and poultry rearing, handicrafts and tailoring, use of char lands, basic computer skills, and so on. Participants for the courses will be carefully screened for interest and check suitability. Follow up monitoring and training will be provided, as well as start-up equipment and materials. To encourage women's participation care facilities for babies/ children, as well as segregated toilets, will be provided at training venues.

In Tranche-2, about 2,000 affected persons shall attend on-site 1-day training, and about 800 persons shall attend 2-5 day residential trainings.

Open water (capture) fisheries support may include for establishment of fish sanctuaries both in main rivers, distributaries/ flood plain, including excavation, planting and fencing/ boundary marking works to establish favourable breeding nurseries.

NGO services shall be procured to determine interest in trainings, screen participants, prepare training plans and budgets for approval, provide on-site trainings (in the O&M sheds) monitor the effectiveness of the trainings, and provide training reports. Also for the fisheries support works. Residential training shall be carried out by the agency appropriate for the course, for example: Rural Development Academy (RDA) in Borgra, the National Agriculture Training Academy (NATA), Department of Livestock Services (DLS), Bangladesh Fisheries Research Institute (BFRI), Mymensingh, and the Fisheries Training and Extension Centre (FTEC), Faridpur as well as a variety of private and

NGO agencies that run handicrafts and tailoring courses. The Embankment WMOs will be central to planning and implementation, particularly for fisheries support activities.

COMPONENT DETAILS

Costs under this component include for the following:

(i) NGO staff costs and expenses (per diems, office equipment, transport, etc). A 30-month contract is planned.
(ii) Support for establishment of fish sanctuaries.
(iii) On-site training in the O&M sheds/ other available, for about 2,000 persons delivered by the NGO.
(iv) Residential training courses; a total of about 40 courses are planned each for 20 persons (800 persons), with each course lasting 2-5 days.

4.3 Component 2: Strengthen the Institutional System for Flood and Riverbank Erosion Risk Management of the Jamuna and Padma Rivers Knowledge Base and Land Development

Subcomponent 2.1: BWDB Institutional Capacity Strengthening and Sustainable Asset Management

Under Tranche-2, proposed activities fall under the following major tasks: (i) Training, (ii) support for Office of CE-River Management, (iii) Further development and support for adoption of various MISs, and (iv) workshops.

TRAINING

Training will comprise: (i) local training, primarily for BWDB but also for DDM, (ii) overseas training, and (iii) study tours. There will also be training to facilitate adoption and use of the MISs – see below.

In-country training for BWDB will focus on design, construction and O&M of river bank and flood protection works, including safeguards, resettlement and environment impact mitigation. Technical courses will include: Technical training for main rivers, O&M major adaptive works, Environmental management, Land acquisition and social safeguards, GIS mapping, Procurement, Survey and data collection, Numerical modelling, DDM capacity development, O&M for WMOs. For regular O&M proposed to be done by embankment WMOs, training will cover formation, registration and working with WMOs. The focus for local training will comprise staff from the Office CE-River Management as well as Zone based staff.

For DDM, training will include the early warning system, the Flood Forecasting Response Plan developed under Tranche-1, and working with the DMU and community volunteers. Higher level staff will have the opportunity for a study tour to get acquainted with disaster management in other neighboring countries, particularly India.

Following Tranche-1, the content of the technical courses will follow the successfully completed training, particularly at BUET. Each course will be for about 10 persons, and duration shall be from 1-5 days.

Tranche-2 will include eleven study tours mostly to large rivers and locations with important developments in river and flood management (four in Asia – one for DDM, two each North America, Europe, South America/Africa, one New Zealand) with ten persons in each tour group.

Participation in international conferences or seminars for a total of 5 persons is planned.

Two M.Sc. courses shall be through the IHE Delft[41].

SUPPORTING OFFICE OF THE CE-RIVER MANAGEMENT

While the Chief Engineer-River Management (CE RM) has been appointed, and staff positions sanctioned, his office is not yet fully operational. Under, Tranche-2, it is suggested that the FRERMIP Project Management Office (PMO) and the office of the CE-RM work closely together.

MANAGEMENT INFORMATION SYSTEMS

The project website and project management database, established under Tranche-1, will be continued during Tranche-2. Both will be further improved under Tranche-2 with a dynamic project map enabling the user to zoom into a specific site to access data from that site. The website database will also continue to be populated. Note: data from river surveys are currently entered into a separate River Survey database (see Section 0 below).

The Scheme Inventory and Mapping System (SIMS), essentially an Asset Inventory, developed under WMIP will be further developed by addition of an integrated risk based O&M MIS module under Tranche-2.

Under Tranche-2, to facilitate Annual Development Plan (ADP) management, it is planned to further assess and improve the Smart Project Monitoring and Management Information System (SPMMIS) recently developed by CEGIS. After any required modification/ improvement and testing, support would be given to facilitate the roll out and adoption by BWDB of the updated system.

Under Tranche-2 one or more third parties will be engaged for the implementation of both the Risk-based O&M Module and the ADP Management MIS. These third parties would provide the following services: (i) MIS systems development/ refinement/ improvement, (ii) for data entry, (iii) for training of BWDB staff, (iv) for workshops, and (v) for MIS system operation and trouble-shooting for at least 12 months. This work will be done under the overall guidance and direction of the ISPM consultants.

WORKSHOPS

In addition to the Inception workshop, two national stakeholder (annual) workshops are proposed. Each workshop will be a 1-day event and be held at a major hotel in Dhaka. 50-80 persons would be expected to attend each of these workshops.

Senior BWDB / DDM/ GoB staff will be encouraged to attend and participate in international workshops/ seminars organised by others which are related to larger rivers management.

COMPONENT DETAILS

Costs under this component include for the following:

(i) Local training courses for BWDB and DDM, several courses, with each course for 10 persons and lasting from 1 to 5 days.
(ii) Two M.Sc. courses for BWDB engineers in IHE Delft, The Netherlands.
(iii) Study Tours, 11 (10 BWDB, 1 DDM) for 10 persons

[41] The Ministry of Water Resources (MoWR) Government of the People's Republic of Bangladesh and IHE Delft signed a Memorandum of Understanding (MoU) on 13 February 2019. The MoU will enable capacity development of future young water professionals from Bangladesh through tailor-made short courses, MSc and PhD programmes, including training courses on basin-wide water resources management.

(iv) For the MISs the services of one or more third parties will be procured for the total duration of the MIS services of 36 months:
   - MIS systems development/ refinement/ improvement,
   - for data entry,
   - for training of BWDB staff,
   - for workshops, and
   - for MIS system operation and trouble-shooting for at least 12 months.

(v) Costs for three 1-day workshops for 50-80 persons held at a major hotel in Dhaka.

(vi) A provisional sum is included for senior BWDB/ DDM/ GoB staff to attend international workshops or seminars.

Subcomponent 2.1 Data and Knowledge Base

During Tranche-2, the data and knowledge based will continue to be improved by a combination of: (i) studies, (ii) piloting, and (iii) surveys. An important element is the extension the BUET involvement from training delivery to research teams, assisting in development and later expansion and maintenance of the knowledge base.

Technical studies conducted under Tranche-1 resulted in about 35 technical reports/ notes. These focussed on studies to improve knowledge base for river training and river bank protection. In addition, key reports were prepared including the Strategic Framework for Development: Jamuna-Padma and Dependent Areas, a river stabilisation plan, a preliminary master or regional plan, and a strategic environment and social assessment, see Section2.2.

It is recognised that while further technical knowledge is still needed, it is now sufficient to proceed with some confidence with river stabilization in the Lower Jamuna River.

Major benefits will accrue from: (i) stabilisation of the river corridor and reclamation and subsequent development of up to 150,000 ha of land in the river corridor, (ii) improved inland waterways for navigation and water supply, and (iii) from agricultural and non-agricultural (e.g. higher value asset and peri-urban) benefits within the 1.6 million ha master plan area.

The river stabilization plan much depends on the understanding of the present **annual sediment load** particularly of the Brahmaputra River. While some historic data are available, no systematic measurements exist since the mid-1990s, when the River Survey Project (FAP 24) ended. This constitutes a serious shortfall in knowledge as not only the development of land, but also all dredging plans depend on a precise understanding of the annual sediment transport. Of particular interest is the yet undetermined bed load mostly consisting of dredgeable sand, with estimates ranging from 10 to 40% of the total sediment load. This sand is of major importance to the development of Bangladesh as it is used for all infrastructure raised above floodplain level including building construction. Major efforts are required to establish sediment rating curves, determine the changes of sediment load to the past, and particularly establish the bed load in a reliable way.

Agricultural benefits will result from main rivers flood protection which will reduce extensive flooding from extreme flood events in the river, and from increased surface supply once off-taking distributaries offtakes are stabilised, controlling sediment and water flow, and the distributaries dredged to increase capacity. The increased water supply will: (i) enable an increase in dry (Rabi) season irrigation with pumping from the distributaries, and (ii) result in an increased recharge to groundwater, reversing a declining water table trend, particularly towards the Dhaka metropolis, so

that farmer operated STWs do not run dry[42]. To maximise agricultural benefits additional investments in FCDI infrastructure will be required.

Urban and commercial **developments on reclaimed as well as protected land** will yield very high returns, but require significant investments by developers. Government is expected to control and support this, partly though Special Economic Zones developed by the Bangladesh Economic Zones Authority under PPPs with private sector, and partly through peri-urban developments, with the Dhaka Metropolitan area expected to develop towards the southwest, towards Mawa, see Figure 2-2. Consideration of priorities for use of scarce (dry season) surface water should influence planning and investment decisions.

The development of Bangladesh much depends on the performance of flood protection infrastructure protecting future high investments on the vulnerable flood plains constituting most of Bangladesh. In order to help maintain the significant new infrastructure being constructed by the BWDB, an asset management system as per those used internationally will raise the awareness of and the insight into the actual annual maintenance requirements to allow for investment to be prioritised based on need and aided by the use of the technology. For example by conducting annual drone flights along existing embankment lines and estimating the difference between designed cross section and actual one, this system can helps to identify particular weak spots to be repaired on priority basis.

While the original program expected to update the design guideline during Tranche-2, extended experience with pilot works and the new concept of double layer protection, suggest that it would be beneficial to move this activity towards the end of Tranche-3. At that time sufficient experience will be available, and through intense involvement of BUET during Tranche-2 a team of well acquainted and reputed researchers will be able to guide the update of the 2010 BRTS guideline for riverbank protection.

Above outlined broader longer-term developments influence the scope for studies and piloting under Tranche-2 and on into Tranche-3, as described below.

STUDIES PROPOSED FOR TRANCHE-2

Technical studies proposed under Tranche-2 will include for the following categories of study:

(i) **Main rivers monitoring and evaluation studies** to further knowledge and design of river stabilization works, and also impact of flow redistribution and charland recovery. Key components include:

- Continuation of erosion prediction through CEGIS for the main rivers in Bangladesh
- Sediment surveys consisting of (survey team with dedicated survey vessel, sedimentologist, and BUET research team)[43]:
  - Discharge measurements (from June to October weekly to daily) at selected cross sections.
  - Systematic sediment surveys in the lower Jamuna and at the Ganges confluence
- Diving investigations of newly constructed and existing works (diving team, river engineer, team leader-diver)

[42] Farmers draw water from STWs using LLPs which can abstract water up to about 7.5 m below ground level.

[43] Service providers are named in brackets

- Channel and scour prediction through continuation of the established Delft 3-D numerical model (river modellers, BUET research team)
- Determination of flow forces on underwater works through CFD modelling as input for design guideline (CFD modeller)
- Review of geotechnical slope stability of launching underwater slopes (geotechnical company, geotechnical specialist, BUET research team)

(ii) **Distributary studies** related to distributaries/river offtakes in the study area, particularly the Old Brahmaputra, Dhaleswari and Arial Khan. The BWDB carried out studies and pilot dredging for the Pungli, the northernmost of the three Dhaleswari offtakes[44]. Tranche-2 will focus on the Old Dhaleswari or Ghior Khal, the southernmost offtake, located downstream of the protective works at Chauhali. Consequently, the Old Dhaleswari – Kaliganga system will be studied in details through numerical (and physical) modelling of the offtake and advancing design of offtake structure and management works to control sediment and flows. Regular (annual) dredging requirement to keep the offtake clear would also be estimated. The study details would comprise:

- Rivers survey will include: (a) for benchmarks and long and cross sections survey over a length of about 120 km, (v) for monthly/ bi-monthly flow monitoring, and sediment sampling at a few (3-5) selected points along the river, through the year. (survey contractor, river engineer);
- Hybrid model study of the Old Dhaleswari Offtake comprising two and three-dimensional numerical modelling for different flow scenarios and physical modelling of the offtake and flood barrier geometry (physical modelling organization, numerical modellers, BUET research team);
- Design of flood barrier including foundation and structural design, hydraulic confirmation with CFD modelling (structural, geotechnical, river, and mechanical engineers).

(iii) **Fisheries studies** to support design and establishment of community managed fish sanctuaries (under livelihoods) and efficacy of fish passes/ other measures to improve production of capture fisheries (fisheries specialist)

(iv) **Safeguard studies** relating to resettlement and the environment. These will: (i) assess need and, if justified, identify a possible location for a resettlement village, and (ii) study environmental aspects, particularly focussing on effects of dredging and dumping of spoil for charland recovery (resettlement specialist, dredging specialist).

These studies will be carried out by 3rd parties (for example CEGIS, IWM, RRI-Faridpur) with strong contribution through the BUET and guided by the Knowledge Base Team[45]. As in Tranche-1, technical notes (reports) would be prepared as deliverables.

A study pertaining to agricultural intensification is proposed during Tranche-3 in conjunction with the planned left bank embankment from Aricha to the Dhaleswari River.

PILOTS FOR TRANCHE-2

[44] An IWM study in 2015 of the Dhaleswari offtake noted that the aim is to divert 245 m^3/s from the Jamuna River into the Dhaleswari/Pungli/Bangshi/Turag/Buriganga river system with 141 m^3/s to the Buriganga river to bring the dissolved oxygen levels up to 4mg/l from the current 1mg/l. The BWDB-GOB with Chinese assistance has studied the Pungli system and has carried out dredging over two years.

[45] As part of the ISPMC, replacing the study team from Tranche-1

Pilots initiated under Tranche-1, concerning grout-filled mattresses, vegetative protection using katkin/ vetiver grasses, and morpho-hydraulic design of an offtake for the Old Dhaleswari river are expected to continue into Tranche-2. Provision sums to extend/ refine/ monitor these pilots are included, most importantly the vegetative piloting related with land reclamation.

SURVEYS DURING TRANCHE-2

Surveys are required to support studies and improvement of the knowledge based, and to prepare designs for future works. Under Tranche-2 surveys along the main rivers, as well as along distributaries are proposed.

Main rivers surveys will be done by 3rd party contractors with the data entered into the web-based river survey database already in use in Tranche-1. Surveys will include: (i) Bathymetric single beam surveys for the Lower Jamuna and alongside all protective works, (ii) Bathymetric multi-beam echosounder surveys of a number of sites[46], (iii) Acoustic Doppler Current Profiles, ADCPs for discharges and flow velocity measurements over protective works, (iv) Float track surface flows along all main channels of the Lower Jamuna. The surveys will follow established principles from Tranche-1 and conducted through third party survey companies guided by the river engineer. The data will be integrated into the survey data base through BWDB staff trained during Tranche-1 with guidance through the MIS specialist.

These surveys will also serve the purpose to check and plan strengthening/adaptation works at subproject sites, assist with resettlement, but also as part of the general river monitoring work to improve the knowledge base. Most of the surveys will be carried out during the flood season when scour and sediment loads are greatest.

Topographic surveys for existing infrastructure alongside the Lower Jamuna, mostly applying drones, will be conducted through specialist companies, guided by the drone surveyor and integrated into the suite of MIS by the MIS specialist[47]. The survey will be used for populating an asset management system and activating the O&M module.

COMPONENT DETAILS

Costs under this component include for the following:

(i) Sums for 3rd party firms/ NGOs to assist the ISMPC- Knowledge Base Team for: (i) Regional planning master plan refinement and dissemination, (ii) Main rivers management surveys and studies, (iii) Distributary surveys and studies, (iv) Land reclamation surveys and studies, (v) fishery surveys and studies, and (vi) safeguard studies.
(ii) A provision sum for continuation and refinement of the pilots carried over from Tranche-1.

4.4 Component 3: Project Management

Implementing arrangements are described in Section 6.1. Project management will be by the BWDB – PMO for most project activities, except for community and regional flood risk management which is managed by the PMU-DDM. The PMO and PMU will be supported by the Institutional Strengthening and Project Management Consultant (ISPMC) in managing and implementing the project. Key management activities comprise the following:

[46] During the initial years, international experts will guide the activities and train BWDB staff in their applications. This follows the principle of the development and handing over of the river survey database during Tranche-1.

[47] Drone 3D topographic and imagery surveys have been used during Tranche-1

i. Planning of tasks/ activities and timely mobilisation and guidance for construction activities, stakeholders and 3rd party services.

ii. Procurement and management of various 3rd party services: (i) contractors to implement the works, (ii) 3rd party firms and NGOs for non-structural tasks including community flood management, regular O&M by local stakeholder WMOs, and livelihood training, (iii) NGOs for resettlement surveys, and (iv) 3rd party firms/ contractors for studies, pilots and surveys.

iii. Coordination with Partner Agencies, and most importantly (i) between BWDB and DDM for flood warning and community disaster action planning, and (ii) between BWDB and DC for resettlement and land acquisition.

iv. Management and use of MIS systems and databases.

v. Tranche-2 activity and progress monitoring and timely and quality reporting covering designs, construction works, non-structural project components, capacity development activities, data and knowledge base studies and surveys, and safeguards including resettlement and environmental impact.

vi. Preparation/ updating documents as required for processing of Tranche-3, including feasibility and safeguards.

vii. Contribution to knowledge through publication on experience with riverbank protection in Bangladesh.

viii. Capacity development of BWDB and DDM, and targeted institutional strengthening through involvement of the office of the CE RM.

5 SAFEGUARDS, GENDER AND SOCIAL DIMENSIONS

5.1 Resettlement

Involuntary resettlement and compensation in Tranche-2 will continue to be in accordance with the Resettlement Framework for the programme (ADB-GoB, January 2018). The resettlement framework has been updated (Annex 2) in order to reflect the updated work locations, as well as the new Land Acquisition Act, September 2017. In addition, to some 15.5 km of permanent riverbank protection and some 25.3km of embankments are planned to be constructed at two locations during Tranche-2 (Table 5-1). While resettlement plans for all riverbank protection works will be prepared after the underwater works is completed, land acquisition and resettlement for embankments will be prepared from the start of Tranche-2 including access channels to regulators and ramps for road crossings. The resettlement process commonly takes one to two years, and for this reason embankment construction is not expected before year 2. The land acquired for riverbank protection is limited to a strip of some 50m width above low water level, where the bank will eventually be sloped and the permanent wave protection be placed. Also as this process takes one to two years, the actual work will be conducted during Tranche-3, while temporary protection will provide stability for the intermediate period of one to two years. This approach further supports quick completion of the remaining investment during the limited period of Tranche-3 (from 2021 to 2024).

Table 5-1 Land Acquisition Requirements for Tranche-2 Sites

Site	Land Acquisition Requirement
JRB-1: Kaitola	• Kaijuri Flood Embankment: 39.6ha for some 7.9km rehabilitation along the Hurasagar River • River bank protection: 50m strip for 3.5 km as downstream extension of the Kaijuri revetment after stabilizing the riverbank
JLB-2: Chauhali	• River bank protection: 50m strip for 12 km on the left bank upstream of Chauhali after stabilizing the riverbank. • Riverbank protection: 7km Chauhali Tranche-1 work for flattening upper slope to 1V:4H, • Optional: 50m strip for 10.5km for Solimabad riverbank protection if closure of channel through dredging does not work. • Flow redistribution and charland development to floodplain level downstream of Chauhali through dredging and building with nature technologies, if required
PLB-1: Harirampur	• Flood Embankment from Harirampur to Dohar: 128ha for some 17.4 km of embankment • Riverbank protection: 5 km upper slope protection already acquired during Tranche-1
Strengthening/ Adaptation and Emergency	• 40 km of adaptation works for all previously implemented work under JMREMP/FRERMIP – under water without any land acquisition • 5km of emergency works – no land acquisition due to work on bank below bankline and under water

Typically an implementing NGO (INGO) prepares Resettlement Plans, and assist the PMO-BWDB and District Commissioner offices during implementation of land acquisition and resettlement in direct contact with affected persons. Experience with Tranche-1 indicates the need for an experienced INGO fielded early during the process. This is time critical, as the works is expected to start from the end of 2019. An alternative arrangement could consist of incorporating the INGO services as

provisional sum into the ISPMC contract, which could be extended into Tranche-2 and would avoid any delays in resettlement activities.

Resettlement requirements for the Tranche-2 sites are summarized in Table 5-2. The recent law requires land is compensated at three times its value, and consequently land acquisition costs are considerably higher than originally estimated at programme preparation. In addition to payments for land, resettlement grants will be made to squatters, and compensation paid for assets including structures, homes, trees and so on.

An External Monitor will be engaged to review and verify the proper and timely implementation of the resettlement plans. Also as lesson learned from Tranche-1 the monitor should be engaged during year 1 to accompany the full resettlement process and not only at the end of the implementation period.

The Resettlement Plans for Tranche-2 as well as due diligence documents for flow redistribution work and precautionary riverbank protection are attached in Annex-2[48].

Table 5-2 Summary estimated Land Acquisition and Resettlement Impact

Sub-project	Land/ House Holds	Tranche-1		Tranche-2		Total T1+T2	
		Land	HH	Land	HH	Land	HH
JRB-1 EMB	Land ha	97.9		39.6		137.5	
	HH Nos.		2322		366		2688
JRB-1 RBP	Land ha			12		12	
	HH Nos.				209		209
JLB-2 RBP	Land ha	13.81		7.5		21.31	
	HH Nos.		191		131		322
	Land ha	4.44				4.44	
	HH Nos.		116				116
PLB-1 RBP	Land ha	13.77				13.77	
	HH Nos.		81				81
PLB-1 EMB	Land ha			128		128	
	HH Nos.				180		180
Total (all sub reach)		**129.92**	**2710**	**187.1**	**886**	**317.02**	**3596**

5.2 Environment

The Environmental Assessment Review Framework (EARF), May 2014, sets forth safeguards procedures to be followed in subsequent MFF tranches, as well as safeguards-related criteria to be considered in the selection of subprojects. The updated EARF is attached in Annex 3.

Initial Environmental Examination

For Tranche-2, an Initial Environmental Examination (IEE) was prepared and provides a preliminary oversight of the relevant regulatory framework, describes in general terms the considered interventions (as far as they were knows at that time), and identifies expected impacts – both

[48] The resettlement plan for Option 1 was reviewed by ADB during the early days of 2018 and the ISPMC incorporated comments from this review in February 2018. The new resettlement plan considers the Client's preference as per decisions of the Technical Committee of the BWDB.

positive and negative – and possible mitigation measures. It also provided the Terms of Reference for a subsequent Environmental Impact Assessment (EIA). The IEE report is included in Annex 3.

Environmental Impact Assessment report

The Tranche-2 project is categorized A for environment, as has been the Tranche-1 project, and an Environmental Impact Assessment report (EIA) is therefore required to be posted on ADB's website 120 days prior to approval of the Project. The (draft) EIA for Tranche-2 for the original option, prepared by the ISPMC at the end of 2017 was reviewed by the ADB in early 2018 and updated in February 2018. The site description has been updated in early 2019 to reflect the updated BWDB design as per decision of the Technical Committee in October 2018 (BWDB, Technical Committee, 2018).

The Tranche-2 EIA report covers the three priority sub-projects covered in the Tranche-1 EIA report (JRB-1, JLB-2 and PLB-1) and in addition the Meghna Left Bank 2 (MLB-2), which is optional. Construction interventions for Tranche-2 are mostly similar to those of Tranche-1 and other sites in Bangladesh, and are conducted in the same or similar environments as the ones of Tranche-1. Therefore, the present EIA for the Tranche-2 works is an update of the EIA for Tranche-1. Pertinent points are summarised below.

Flood Embankment Interventions and Impacts – General

While proposed interventions will result in positive impacts, of reduced flood damage to crops, security of land from river erosion, and improved agricultural and investment conditions, changes in floodplain hydrology due to construction of embankments will result in several negative impacts, despite FREMRIP's approach to systematically provide fish passes in all new embankments, revive wetlands, and restore distributary flows throughout the year, with the exception of capping extreme flood peaks. Restoration of distributary flow and creation of fish passes as mitigation measures will facilitate fish migration which is now significantly impeded by the poor river-floodplain connectivity as found in a recent ISPMC study.

Despite the additional openings in the embankments, some floodplain aquatic (wetland) habitats will be degraded or extirpated due to reduced flooded area, depth, and duration; reduced hydrologic connectivity; and physiochemical / water quality changes. This in turn will adversely affect floodplain-dependent open-water fish species migration, population levels, and catch levels, as well as wetland biodiversity, services, and products more generally. These impacts can in turn adversely affect the nutrition, health, and economic status of poor people. The embankment can impede cross-drainage resulting in drainage congestion, adversely affecting agriculture within the protected area, and block the movement of migrating fish.

Riverbank Protection Interventions and Impacts – General

River changes associated with FRERMIP riverbank protection work have been and are being assessed through specific morphology studies, which conclude among others that river stabilization invites deeper channels and could result in recovery of up to 150,000 km^2 of char lands from the river belt.

The JMREMP, 2007 study found that there were more fish species and higher population numbers at protected banks, as opposed to unprotected banks. The size of the fish depends on the size of the voids in the protection, which means that large voids in concrete blocks tend to attract larger fish, specifically carnivores, but fewer numbers, while geo-bags, having more but smaller voids, attract smaller fish in larger numbers. CEGIS, 2011 identified overall positive impacts of geotextile bag revetments on water resources, fisheries, the algae community, the ecosystem and the socio-economy. A recent ISPMC study also revealed that bank lines with geotextile bag revetments

support growth of vegetation like reeds to create ecosystems beneficial for fish. Important findings are that there is no change in water quality, the terrestrial habitat is protected, and the socio-economic conditions are improved for the local population, including employment opportunities during construction, health and sanitation conditions, fishing opportunities, and especially the situation of women.

Localized stable and deeper channels are more attractive for the endangered dolphins as they provide preferred migration routes, while small fish are the main food for dolphins. The construction season lies outside of the migration season of the dolphins (during the rising and falling of flood waters) and does not overlap much with the surfacing time of the juvenile and neonate dolphins in the morning and afternoon-evening hours.

Environmental Management Plan

The Environmental Management Plan (EMP) sets for the mitigation and monitoring to be undertaken. Four mitigation packages address:

- **Construction-phase impacts**. Management will be through the inclusion of standard environmental safeguard clauses in construction contract bidding packages, Contractor's Environmental Management Plans (CEMPs) and BWDB construction supervision.
- **Impacts on critical habitats and trans-boundary/internationally migrating/threatened species:** The proposed mitigation measures are modelled after the Wetland Biodiversity Rehabilitation Project of GIZ /Department of Fisheries/BWDB, recently concluded in District of Pabna adjacent to the JRB-1 project area.
- **Impacts on open-water fish biodiversity and production**. Measures to mitigate these impacts include (i) open-water fisheries development-related measures like establishment of fish sanctuary and (ii) expansion of aquaculture, particularly in areas benefitting from Project-led reductions in flood and erosion risk.
- **Land acquisition and resettlement impacts**. Management measures will be documented in the Resettlement Action Plan for Tranche-2.

The EMP will be implemented by the PMO supported by the Institutional Strengthening and Project Management Consultant (ISPMC) team that includes environment specialists. Also a 3rd party NGO/ Firm will be contracted to expand the biodiversity database for the study area and outline the establishment of fisheries sanctuaries.

Mitigation measures include construction of fish passes to maintain connectivity between the river and the floodplain, khal (distributary) excavation for the same reason, and installing buoys with the dual purpose to indicate the navigation channel and prevent indiscriminate fishing practice with drift nets.

Design and Implementation Phase Public Consultation

Stakeholder consultation will continue during subproject implementation to provide information to stakeholders about the project and to receive their input and concerns. Meetings will include in particular households and persons affected by resettlement (AHs and APs) and other adverse environmental and social impacts. At these meetings, information about designs, impacts, and mitigation and monitoring measures, including specific resettlement entitlements, will be disclosed verbally and in Bangla-language information handouts.

Grievance Redress Mechanism

At each sub-project location, a local Grievance Redress Committee (GRC) has been set up during Tranche-1 and will continue to be in operation throughout FRERMIP implementation. While the Tranche-1 committees focussed on resettlement aspects, the role will be expanded to incorporate environmental issues during Tranche-2.

Reporting and Monitoring

Environmental monitoring reporting will continue during Tranche-2, and reports will be disclosed on ADB's website. Environmental monitoring reports will be prepared by the PMO under the direction of the nominated environmental officer with the help of the consulting team's environmental specialist.

5.3 Strategic Environmental and Social Assessment

A Strategic Environmental and Social Assessment (SESA) of the MFF was carried out by the ISPMC (NHC/EMM, Strategic Environmental and Social Assessment (SESA) of River Stabilisation, September 2018) and reviewed by the Netherlands' Commission for Environmental Assessment in mid-2017 and a second time in early 2019. The SESA differs from a usual EIA in that it focuses on regional development comprising several interventions over a long period of time rather than on a local site-specific intervention.

The potentially long-term impacts of proposed works as detailed in the River Stabilisation Plan, (NHC/EMM, November 2017), pertain to the river as well as the floodplain and include changes in river morphology and aquatic habitat caused by riverbank revetments; effects on water bodies and associated habitats caused by disruption of hydrological and ecological connectivity between main and internal rivers, *beels* and *khals*, and so on.

Mitigation measures include fish passes and inland waterways (distributary) excavation. To evaluate environmental sustainability, identification of indicators to monitor the following is proposed:

(i) For the river and floodplain: (a) Conservation of biological diversity, (b) Maintenance of a productive river and floodplain fisheries, (c) Maintenance of ecosystem's health and vitality, (d) Conservation and maintenance of wildlife populations, and (e) Legal, institutional and economic framework for conservation and sustainable management.

(ii) For the floodplain: (a) Maintenance of wetlands, (b) Maintenance and enhancement of long-term economic benefits to meet the needs of local communities

5.4 Social Dimension, Poverty and Gender

Riverbank erosion along the main rivers destroys land, assets and infrastructure, and as a consequence poses a threat to people's lives, assets and livelihoods. Uncertainty in the face of frequent floods and riverbank erosion prevents investment in infrastructure, higher value agriculture and small business. As such, poverty is higher in riverine districts. Investments in erosion prevention reduces migration to urban slums.

Gender Actions

The Gender Action Plan for Tranche-2, included as Appendix D, is very similar to that adopted for Tranche-1, and has clear targets and responsibilities. The plan includes targets for: (i) women's involvement in construction works, (ii) women's representation (minimum 30%) on committees for CbFRM, and receiving training, (iii) women's involvement in embankment WMOs for regulator O&M, including representation on the Executive Committee, and in doing maintenance work through

formation of Labour Construction Societies (LCS) where there should be 30% of women, (GoB B. G., 2014), (iv) receiving livelihood improvement support for project affected people, and (v) women's participation of workshops and training as part of institutional strengthening.

Labor, Health, and Social Protection

BWDB will ensure that civil works contracts under each project follow all applicable labor laws of the Government and that these further include provisions to the effect that contractors; (i) carry out HIV/AIDS awareness programs for labor and disseminate information at worksites on risks of sexually transmitted diseases and HIV/AIDS as part of health and safety measures for those employed during construction; (ii) do not use children as labor, and (iii) follow legally mandated provisions of labor (including equal pay for equal work), health, safety, sanitation, welfare and working conditions. The contracts shall also include clauses for termination in case of any breach of these provisions by contractors.

Social Assessment

Latest poverty data are based on recent surveys from the Bangladesh Bureau of Statistics (BBS). Additional information comes from the MDGs as well as information linked with SDG Goals and the 7th Five Year Plan, and the ADB's country partnership strategy (CPS) period (2016–2020), which will adopt a broad-based approach in order to respond flexibly to the needs and demand of the country. ADB assistance is strongly aligned with the government's Vision 2021 and its 7th Five-Year Plan, which lays out a roadmap for higher, sustainable and inclusive growth. Freeing the country from poverty and inequality remains a major though separate challenge. Currently, 12.9% of the population is in extreme poverty. Unless specific actions are taken, extreme poverty in parts of the country and inequality between regions will likely remain, even as the country's economy continues to grow. Effective implementation of the government's social protection strategy is needed to elevate people out of extreme poverty. Priorities include housing and basic services—including primary health care—for the poor, and disaster risk management to reduce vulnerability and build resilience to extreme weather conditions.

The Summary Poverty Reduction and Social Strategy has been updated for Tranche-2 and the draft revised SPRSS is attached in Appendix F.

6 IMPLEMENTATION

6.1 Implementation Arrangements

General

The implementing arrangements for Tranche-2, will remain broadly as established for Tranche-1, described in the FAM, (ADB, Facility Administration Manual. Multi-tranche Financial Facility - Flood and Riverbank Erosion Risk Management Investment Program, 2014a) and summarised in this report in Section 0. The PMO and two ISPMC offices became fully operational in September 2015, and two SMOs, at Tangail and Manikganj, in November 2015. The ISPMC project management team is located together with the PMO-BWDB in the Firoz Tower, 152/3/B Bir Uttam, Kazi Nuruzzaman Road (*Green Road Office*), Dhaka-1205. The ISPMC Study Team was located at House 47 (8th Floor) Road 27, Banani, Dhaka (*Banani Office*).

The successful project management team of Tranche-1 will continue for Tranche-2: The Bangladesh Water Development Board (BWDB) will manage the Tranche-2 through its existing Project Management Office (PMO) which performed well in implementing the Tranche-1. The PMO will continue managing the Tranche-1 remaining activities, and its work volume will more than double with the commencement of Tranche-2 implementation. The supervision of the remaining Tranche-1 activities including the just-commenced five embankment contracts of Tranche-1, plus works under the much larger Tranche-2, will necessitate substantial strengthening of the PMO staff complement at headquarters as well as field levels. The Tranche-1 Mid-term Review Mission already identified the need to fill the vacant professional staff positions in the project and subproject management offices[49]. Additional professional support, particularly during the start-up phase in 2019 and 2020 will be required to avoid delays of works of critical importance including procurement, and safeguards compliance. The situation could be further improved once the office of the Chief Engineer River Management becomes operational. For Tranche-2, to strengthen capability and role of the office of the Chief Engineer - River Management, and to derive synergies in term of staffing[50], it may be considered to integrate the PMO with the office of the CE RM.

Project implementation support will be provided by the ISPMC -Tranche-2 consultancy, with particular focus on construction supervision and preparation of Tranche-3. The ISPMC will include a sub-team with expertise to guide and manage the various service providers for studies and knowledge-base development, pilots, and surveys. Third party support services will be procured from NGOs/ firms for the non-structural components of the project, for surveys, studies and pilots and for safeguards, resettlement and environment.

Implementation Institutional Arrangements

The Bangladesh Water Development Board (BWDB) under the Ministry of Water Resources (MOWR) is the Executing Agency for implementation of FRERMIP. The Department of Disaster Management (DDM) under the Ministry of Disaster Management and Relief is the Implementing Agency for community based flood management activities.

[49] Refer to para 41 in the Aide Memoire of the Mid-term Review Mission 15 – 26 February 2018

[50] The BWDB is seriously understaffed with more than 8,500 approved positions but only little more than 6,000 placed. Temporary Project Management Office contribute to the staff shortage, which has to be drawn from the understaffed pool of regular posts.

The Project Management Office (PMO) is responsible for project implementation, procurement of goods and works and the monitoring of work progress while the BWDB design circle is in charge of design. The Employer (BWDB) designated the Superintending Engineer of the O&M Circle, Mymensingh as the Engineer for the construction supervision of the works packages. The majority of quality control was by the Task Force team of BWDB and the Diving Team recruited under the ISPMC contract, later supplanted by multi-beam echosounder surveys financed through the ISPMC budget. The ISPMC provided an advisory and support role to the BWDB with regards to their documentation of the construction supervision and quality control works. Institutional arrangements are given below, Figure 6-1.

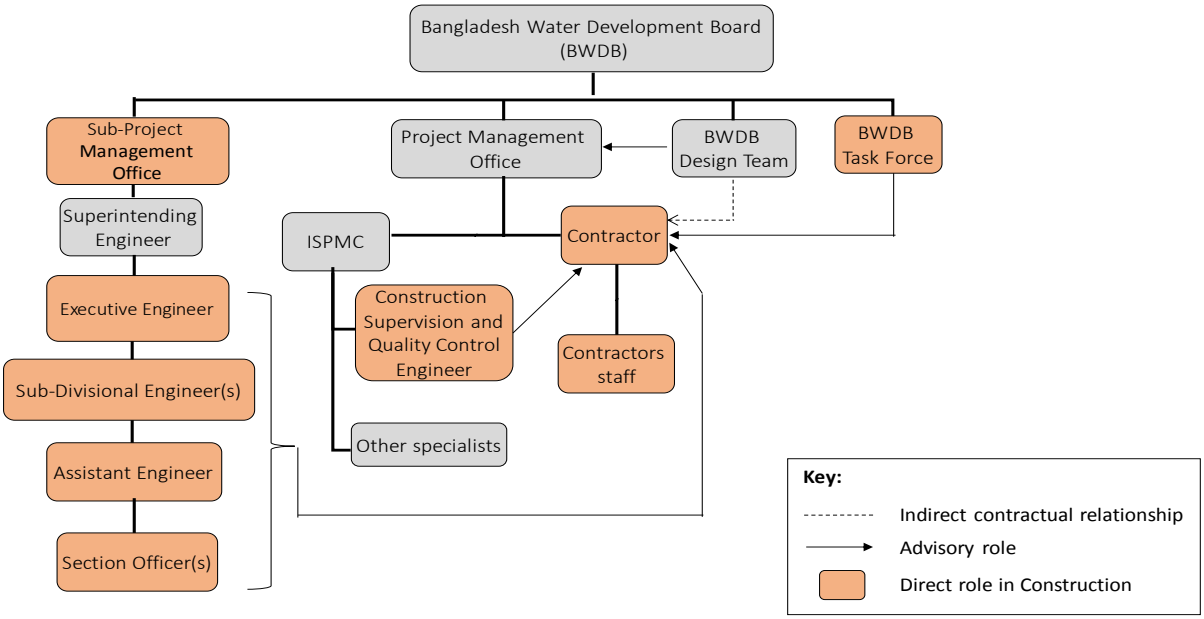


Figure 6-1 Institutional Arrangement for Works Implementation

PMO and SMO Office Costs

Office Operation

Staffing and operational costs for the PMO Office, and for four site management offices (SMO-JRB1, SMO-JLB1, and SMO-PLB1) which are located in the relevant O&M Division offices[51] are detailed in Supplementary Report 3. Costs include for: (i) staff salaries, (ii) office rent, (iii) transport/ vehicle running costs, and (iv) office operational costs including stationary.

In estimating costs, salaries for existing/ required BWDB staff within the offices (PMO and O&M Division Offices) are determined, and the proportion of the time that these staff will be working on the project estimated. These staff include: CE/ ACEs, Superintending Engineer, Executive Engineers, Sub-Divisional Engineer (Civil), Assistant Engineer, Accounts Officer, Accounts Assistant, Typist/ Computer Operator, Drivers, Guards and so on.

Equipment and Vehicles Costs for PMO and SMOs

New office equipment to replace that provided at the beginning of Tranche-1 is required for each SMO, while for the PMO particularly if relocating into the office of the CE-River Management new, additional equipment are required. Details are given in Annex 4 and summarised below.

[51] Tangail and Manikganj on the Jamuna-Padma Left bank, and Kaitola on the Right Bank, the Dhaka division for the embankment at Haririampur

Table 6-1 Equipment Requirement and Costs for PMO and SMO Offices

Item	Unit	No
Desktop PC	No	13
Laptop PC	No	8
A3 Printer / photocopy machine	No	5 / 6
Misc	LS	1

Survey equipment requirements are tabulated below.

Table 6-2 Survey Equipment and Cost

Item	Unit	No
Speed boats	No	3

Vehicle requirements are tabulated below.

Table 6-3 Vehicle Requirements and Costs for PMO and SMO Offices

Item	Unit	No
Pickup truck	No	8
Jeeps	No	4
Microbus	No	2

PMU-DDM Office Costs

Operating Costs

Staffing and operational costs for the PMU are detailed in Annex 4. Costs include for: (i) staff salaries, (ii) office rent, (iii) transport/ vehicle running costs, and (iv) office operational costs including stationary.

In estimating costs, salaries for existing/ required DDU staff within the office are determined, and the proportion of the time that these staff will be working on the project estimated. These staff include: Project Manager/ DS, Assistant Director, Accounts Officer, DEO, MLSS, drivers and guards.

Equipment and Vehicle Costs for PMU

New office equipment to replace that provided at the beginning of Tranche-1 is required. Details are given in Annex 4 and summarised below. Field equipment requirements and other costs associated with the community and regional flood risk management are described in Section 0.

Table 6-4 Office Equipment and Vehicle Requirements and Costs for PMU

Office equipment	Quantity
Desktop computer	3
Laptop	1
Air conditioner	2
Printer cum copier	1
Furniture (table, chair) set	4
Office operation	**Quantity**
Micro bus rent (2)	48

Allowance for POC and PEC members attending meetings	10
Stationaries and consumables	48
Per-diem during field trip	48
Entertainment	48
Telephone/fax internet	48
Filtered water	48
Fuel for vehicles	48
Maintenance	48

Institutional Strengthening and Project Management Consultancy Support

Consultancy services will be engaged for 48 months (January 2020 to December 2023) to support the PMO-BWDB, and PMU-DDU to implement Tranche-2 including: (i) implementation designs and construction of riverbank protection, strengthening/adaptation, and flood protection works, (ii) achieving non-structural project components including regional and community flood risk management, community involvement in regular O&M, and improved livelihoods for affected persons, (iii) strengthened BWDB institutional capacity for flood and riverbank erosion risk management through training, further development and adoption of MISs, and planning for O&M, (iv) improved data and knowledge base through studies, pilots and surveys, (v) efficient and effective project management.

To do this, the tasks of the required Institutional Strengthening and Project Management Consultancy Support (ISPMCS) services have been identified and are tabulated below, grouped under 6 main tasks. These tasks may be broadly categorised as being: (i) concerned with project implementation, (ii) preparing the Tranche-3 project, or (iii) with improving the knowledge base. Therefore, as with Tranche-1, the ISPMC will comprise three teams: (i) Project Management, Implementation and Feasibility Team, and (ii) Knowledge-base Team. The Team Leader of the implementing team will be overall leader for the ISPMC.

Table 6-5 ISPMCS Tasks

A. Project Management and Implementing Team	
T1: Implementation Management Support including Safeguards	T1-1: Planning of tasks/ activities and timely mobilisation and guidance for ISPMC team members, stakeholders and 3rd party services. T1-2 Procurement and management of various 3rd party services from civil works contractors, and from 3rd party firms and NGOs for non-structural components, resettlement, environment and social surveys, and for studies, pilots and surveys. T1-3: Coordination with Partner Agencies, and most importantly (i) between BWDB and DDM for flood warning and community disaster action planning, and (ii) between BWDB and DC for resettlement and land acquisition. T1-4: Management and use of MIS systems and databases. T1-4: Tranche-2 activity and progress monitoring and timely and quality reporting covering designs, construction works, non-structural project components, capacity development activities, data and knowledge base studies and surveys, and safeguards including resettlement and environmental impact. T1-5: Preparation/ updating documents as required for processing of Tranche-3, including feasibility and safeguards.

T2: Support for Structural Works Component	T2-1: Support surveys and implementation of resettlement including land acquisition for construction of works. T2-2: Assist PMO with detailed implementation designs for civil works for river bank protection and river training, flood protection and land reclamation, including new, strengthening/adaptation and repair works. T2-3: Data analysis for updated design guidelines. T2-4: Supporting BWDB for supervision of structural works and ensuring quality control. T2-5: Prepare reports documenting major construction activities, quality and lessons learned.
T3: Support for Non-Structural Works	T3-1: Support PMO-DDM implementing CbFRM and also regional flood risk management, by component design, procurement of 3rd party firm(s), stakeholder consultations, monitoring activities and reporting T3-2: Support participatory regular O&M by component design, procurement of 3rd party firm(s), stakeholder consultations leading to WMO formation, registration and strengthening, monitoring activities and reporting T3-3: Support livelihood support including component design, procurement of 3rd party firm(s), stakeholder consultations, monitoring activities and reporting
T4: Institutional Capacity Support	T4-1: Monitor progress of sector policy and institutional agenda T4-2: Plan, design, conduct or arrange capacity strengthening programs/ training events/ study tours T4-3: Use, improve and extend MISs: (i) Project Website and Database, (ii) Asset web-based database, and (iii) ADB/ Smart Project Monitoring and Management Information System database T4-4: Plan and arrange annual workshops for information sharing
B. Feasibility Team	
T5: Supporting Preparation of Tranche-3 Project	T5-1: Verify and update selection of work sites, technology and designs. T5-2: Technical and social field surveys and updated data collection. T5-3: Basic structural designs for works. T5-4: Updating/ amending designs of non-structural components/ activities. T5-5: Safeguard, gender and poverty assessments. T5-6 Tranche-3 Economic Feasibility. T5-7 Tranche-3 formulation (implementation schedule, procurement packaging, financing plan, etc). T5-8: Detailed design and preparation of procurement documents. T5-9: Support for preparation of project processing documents including DPP and PFR
C. Knowledge Team	
T6: Data and Knowledge Base Development	T6-1: Refine the long-term river stabilization and river management master plans prepared in Tranche-1, including for char land development, and present to BWDB and department/ agencies of other Ministries for wider adoption in project planning. T6-2: Undertake studies, directly or with 3rd parties, to add to quality of planning and design guidelines covering: (i) Offtake modelling and distributaries study, (ii) Fisheries studies, (iii) Main rivers monitoring survey, (iv) Safeguard studies. T6-3: Plan, supervise, monitor and assess developments and pilots, expected to be extension of pilots started in Tranch-1, i.e. concerning grout-filled mattresses, vegetative protection using katkin/ vetiver grasses for flood embankments, river bank slopes and for reclaimed land, and morpho-hydraulic design for distributary off take(s). T6-4: Support procurement and supervision of 3rd parties for flood and river surveys and also distributary surveys, and ensure entry of data into web-based (project) database.

Indicative ISPMC staffing and other requirements and costs are given in Annex 4, and summarised below.

Table 6-6 ISPMC Staffing Details

Item	Unit	Implementing Team and Feasibility Team	Knowledge base update	Total ISMC
International Consultants	Staff-month	162	78	240
National Consultants	Staff-month	510	160	670
Office operation and support services	Month	48	48	96

3rd Party Firm and NGO Services

Third party support services will be procured from NGOs/ firms for the: (i) non-structural components of the project, (ii) for strengthened institutional systems, particularly for MIS establishment and use within the office of the CE-WM, (iii) surveys, studies and pilots, and for (iv) safeguards, resettlement and environment. Amounts and a general description of proposed services contracts are tabulated below. Most of these service contracts will be procured early in Tranche-2.

Details of the services are given in the relevant sections of this report and costs in Annex 4.

Table 6-7 Summary of 3rd Party Services for Tranche-2

	Service Contract	Duration (months)	Description of Service
1	**Community based flood risk management**		
1.1	Regional & Community based Flood risk management	36	Awareness, formation and strengthening of community based DMUs and installation of DDM equipment
2	**Strengthened Institutional Systems – MISs**		
2.1	Scheme inventory and mapping system, SIMS (Asset Inventory with risk based O&M Module)	36	Services of one or more 3rd parties: (i) MIS systems development/ refinement/ improvement, (ii) for data entry, (iii) for training of BWDB staff, (iv) for workshops, and (v) for MIS system operation and trouble-shooting for at least 12 months. The total duration of the MISs services contract(s) would be 36 months
2.2	Smart project monitoring and management information system, SPMMIS	36	As outlined during Tranche-1
3	**Survey for Structural Works Design and Data and Knowledge Base Improvement**		
3.1	Regional planning master plan refinement and dissemination	12	Hire of local expert(s) to assist in plan refinement and dissemination through additional data collection and analysis.
3.2	Main river surveys and studies *(2 survey contracts envisaged)*	40	Surveys will include: (i) Bathymetric Single Beam underwater topographic river cross sections, (ii) Bathymetric Multi-Beam underwater 3D bank surveys, (iii) Float Track surface flows, and (iv) above water topographic/ feature/ imagery surveys using drones/ terrestrial instruments .
3.3	Discharge and sediment survey	42	Surveys will be conducted through a dedicated fully equipped survey vessel and include: (ii) Bathymetric Multi-Beam underwater 3D dune tracking, (iii) Acoustic Doppler Current Profiles, ADCPs for flow and sediment discharge, (vi) sediment sampling,
3.4	Distributary surveys	24	Surveys will include: (i) Establishment of benchmarks and long and cross sections survey at about 200 m intervals

	Service Contract	Duration (months)	Description of Service
	(1 survey contracts envisaged)		over a length of about 120 km, (ii) for monthly/ bi-monthly flow monitoring, and sediment sampling at a few (3-5) selected points along the rivers, through the year.
3.5	Land reclamation surveys & studies (1 contract)	24	Land reclamation study relating to about 7,000 ha of char-land reclamation and development, monitoring effectiveness of measures, including vegetative planting, local stakeholder awareness and information concerning land ownership and registration status
3.6	Drone survey (1 contract)	40	Survey of some 60km of right embankment over three years for inclusion into the asset management database
4	**Safeguards**		
4.1	Resettlement village study	12	Study and surveys for the possible establishment of a resettlement village in reclaimed char land
4.2	Environment/ biodiversity and social baseline and impact monitoring	30	Biodiversity and social baseline and monitoring of impact of works (including dredging) and FRERMIP programme activities
5	**Participatory regular O&M**		
5.1	NGO engaged to implement participatory O&M	30	Support for establishment and strengthening of Embankment WMOs, guidance for regular community O&M including pilots for vegetative protection of embankments
6	**NGO for Livelihood support and training**		
6.1	NGO engaged to implement Livelihood support and training	30	Identification of training requirements and interests, selection of participants, on-site training.
7	**Environmental management**		
7.1	NGO engaged to implement Environmental management plan		Services to include: (i) monitoring of compliance with EMP (as defined in EMP), (ii) Establishment of fish sanctuaries, (iii) Reporting, (iv) identification of issues and impacts of construction
8	**Resettlement INGO**		
8.1	Resettlement and land acquisition plan preparation & implementation (1-2 contracts)	36	Services to include: (i) survey of assets/ other, (ii) stakeholder awareness, (iii) identification of affected persons and issue of identification cards, (iv) monitoring of compensation and compliance, and (v) reporting.
9	**Offtake modelling and distributaries study**		
9.1	Model study for offtake of distributary		Focus most likely on offtake of Old Dhaleswari at Solimabad. Scope to include: (i) hydraulic model of offtake, (ii) feasibility design of offtake structure, (iii) modelling of sediment flows into distributary
9.2	Study on management of distributary		In combination with 9.1, study on effects of offtake arrangement on flows and stability of distributary
10	**Fisheries study**		
10.1	Fisheries study and survey	18	Monitoring and surveys to support design and establishment of community managed fish sanctuaries (under livelihoods) and efficacy of fish passes, and so on

6.2 Implementation Schedule

There are three tranches (projects) within the ten year multi-tranche financing facility, which started with loan signing on 14th August 2014 and ends in August 2024. The proposed Tranche periods are:

- Tranche-1: August 2014 to June 2020 (5.9 years)
- Tranche-2: January 2020 to December 2023 (4.0 years)
- Tranche-3: June 2021 to August 2024 (3.2 years)

Implementation of Tranche-2 will commence during the dry season 2019-20, which will provide some overlap with Tranche-1. Until then, Tranche-1 will implement emergency and strengthening/ adaptation works. Tranche-2 will continue for about 4.0 years, to December 2023. Tranche-3 will overlap minimum one year with Tranche-2, starting in June 2021[52].

The broad implementation schedule is shown below on Figure 6-2.

6.3 Procurement Plan and Contract Packaging

Procurement of Goods, Works and Consulting Services

Procurement of goods, works and consulting services will be in accordance with the Facility Administrative Manual for the Program, (ADB, Facility Administration Manual. Multi-tranche Financial Facility - Flood and Riverbank Erosion Risk Management Investment Program, 2014a), key points of which are summarized below.

Procurement of goods and works. International competitive bidding (ICB) will be followed for civil work contracts costing $15 million or more, to ensure competition. National competitive bidding (NCB) will be applied for civil works contracts costing less than $15 million. For procurement of goods and related services, ICB procedures will be used if the estimated cost is $2 million or more, and NCB if the estimated cost is less than $2 million. Shopping will be used for goods and works, if the estimated cost is less than $0.1 million.

Table 6-8 Procurement Methods and Thresholds

Method	Threshold
International Competitive Bidding (ICB) for Works[1]	$15,000,000 or more
International Competitive Bidding for Goods[1]	$2,000,000 or more
National Competitive Bidding (NCB) for Works[1]	Beneath that stated for ICB, Works
National Competitive Bidding for Goods[1]	Beneath that stated for ICB, Goods
Shopping for Works	$100,000 or less
Shopping for Goods	$100,000 or less

[1] Refer to Para. 3 of PAI 3.04 National Competitive Bidding

Consulting services. All consultants, NGOs, and other institutions will be recruited according to ADB's Guidelines on the Use of Consultants.

The Institutional Strengthening and Project Management Consultants (ISPMC) for Tranche-1 may be engaged for subsequent tranches through single source selection (SSS) modality, at the request of the executing agency/ government and subject to their performance during Tranche-1. This is to ensure continuity of the services throughout the MFF period.

National NGOs will be engaged for: (i implementation of land acquisition and resettlement plans, (ii) community-based flood risk management (CBFRM), (iii) participatory operation and maintenance support, (iv) livelihood supports, and (v) surveys and supporting studies. PMU of DDM will select and engage national NGOs for CBFRM. PMO of BWDB will select and engage other packages.

[52] Based on experience with the land acquisition process during Tranche-2 for embankment works an earlier start could be indicated.

NGO(s) and national consulting firm(s) will be engaged through QCBS, if no NGO is included in a shortlist, or QBS, if one or more NGOs are included in a shortlist, as per ADB's guidelines. Other rather small-size consulting/NGO services will be engaged through consultant qualification selection (CQS) modality or may be through QBS modality, as indicated in the procurement plan.

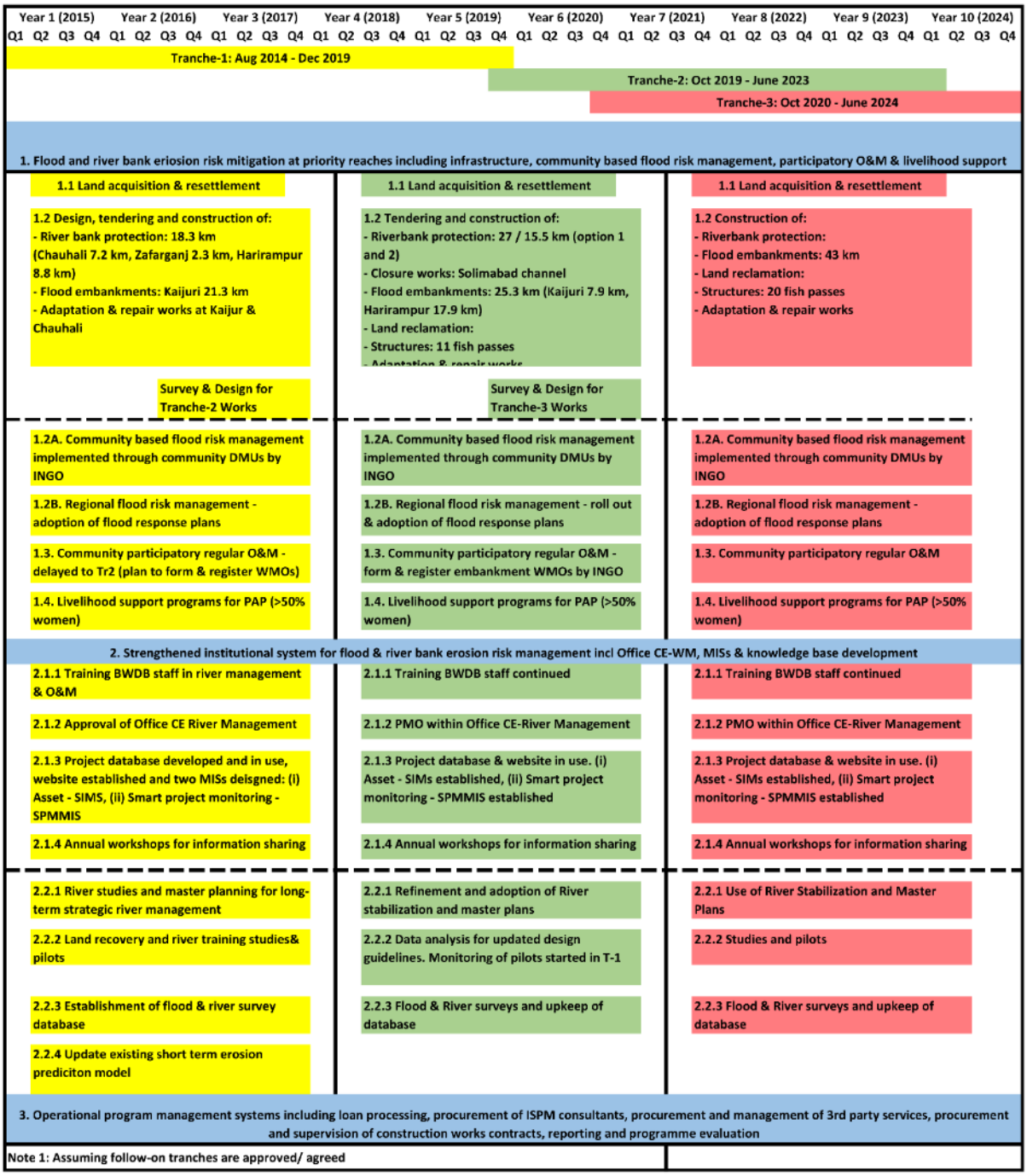


Figure 6-2 Program Implementation Schedule

Procurement Plan and Packages for Tranche-2

Planned procurement packages for Tranche-2 are provided in Annex 4.

6.4 Monitoring

Program monitoring shall be as described in the FAM, (ADB, Facility Administration Manual. Multi-tranche Financial Facility - Flood and Riverbank Erosion Risk Management Investment Program, 2014a) and summarised below for Tranche-2.

Project performance monitoring: The PMO supported by the ISPMC/ 3rd parties established a project MIS, based on the program's design and monitoring framework. The framework for Tranche-2 is given in Section 6.5. Financial and physical progress is being recorded in this MIS. During Tranche-2, the project database will be further improved with a dynamic project map enabling the user to zoom into a specific site to access data from that site.

Compliance monitoring: Status of compliance with assurances, conditions and loan covenants— policy, legal, institutional, financial, economic, environmental, social and others— will be reviewed at each ADB review mission. All non-compliance issues, if any, will be updated in quarterly progress reports together with remedial actions. PMO will include status of compliance in quarterly progress reports.

Safeguards monitoring: Monitoring and reporting for social safeguards are described in the resettlement framework for the planning of works, and the concerned resettlement plans provide the arrangement for implementation monitoring.

Gender and social dimensions monitoring: The GAP will be implemented and monitored by BWDB. The status of the implementation of the GAP will be reported in BWDB's quarterly progress report. The status will also be discussed at each ADB review mission.

6.5 Monitoring and Reporting Requirements

PMO/BWDB will provide ADB with (i) quarterly progress reports in a format consistent with ADB's project performance reporting system; (ii) consolidated annual reports including (a) progress achieved by output as measured through the indicator's performance targets, (b) key implementation issues and solutions; (c) updated procurement plan and (d) updated implementation plan for next 12 months; and (iii) a project completion report within 6 months of physical completion of the Project. To ensure projects continue to be both viable and sustainable, project accounts and the executing agency AFSs, together with the associated auditor's report, should be adequately reviewed.

DDM reports it's monthly progress to BWDB with support of the project management consultant. BWDB will report consolidated progress to ADB.

Details of requirements which allow for physical and financial progress to be monitored are given in the FAM, were broadly adhered to in Tranche-1 and will continue will little change in Tranche-2.

6.6 Stakeholder Communication Strategy

The primary audiences for the communication strategy are local communities along the project rivers, the general public (NGOs and development partners, key individual decision makers) and Government and authorities (local Upazila administration, institutions and ministries).

The stakeholder communication strategy is built into the design of the investment program, including the non-structural components, resettlement plans, environment monitoring plans and the gender action plan. Details are given in the FAM, (ADB, Facility Administration Manual. Multi-tranche Financial Facility - Flood and Riverbank Erosion Risk Management Investment Program, 2014a).

7 PROJECT COST

7.1 Introduction

Study Area and Main Work Items

The study area and interventions are described earlier, Chapters 1, 2 and 3; particularly Sections 3.4, 4.1, Figure 1-1, Figure 1-2 and Table 4-1. The main interventions are summarized in
Table 7-1.

Table 7-1 Main Interventions at Priority Sub-project under Tranche-1 and 2

Sub-project	River Bank Protection		Flood Embankment		River Stabilization	Charland Develop-ment (T-1&2)
	Recently constructed (T-1)	Proposed (T-2)	Under construction (T-1)	Proposed (T-2)		
JRB-1		3.5 km	21.3 km, 4 regulators	7.9 km 2 regulator/ fish passes	n/a	
JLB-2	9.0 km	12 km, 10.5 km (precautionary)			8km dredged channel	6,000 ha
PLB-1	8.8 km			17.4 km, 7 regulator/ fish passes		1,700 ha
Total	**17.8 km**	**23.5 km**	**21.3 km**	**25.3 km / 9 regulators/ fish passes**	**8km dredged channel**	**7,700 ha ha**

Work Program and Cost

Tranche-2 is scheduled for four construction seasons with the following work items:

(i) Riverbank protection

(ii) Upstream of Chauhali, at Benotia and at Solimabad: dry season 2019/20 and 2020/21. The location and type of works, depends on the 2019 flood.

(iii) Strengthening/Adaptation works is planned for three dry seasons from 2019/20 to 2020/21

(iv) Flow redistribution and char land development in one phase during dry season 2019/20 to 2022/23.

Embankment works is planned from 2019/20 to 2020/21, with the first year to complete the land acquisition and resettlement process.

The optional works at MLB-2 (Chandpur) can be implemented during one dry season, if financing will be available.

Table 7-2 provides an overview of the works and cost for both Tranche-1 and -2 for the BWDB design as per Client preference.

7.2 Programme and Tranche-2 Project Costs

Cost Structure

The cost structure is based on the following parameters:

(i) **Unit Rates:** the unit rates are expressed either for individual units, such as geotextile bags, or as kilometer cost, for example for earthwork of an embankment. Costs follow market rates at the time of preparing the estimates, and for civil works were checked against BWDB's schedule of rates. Cost could be established within reasonable confidence levels, based on past experience with the type of work proposed.

(ii) **Base Cost:** the unit rates for different cost items were increased by the percentage of taxes applicable in Bangladesh, for example deducted at source from contractors' bills. Broadly 5.5% value added tax (VAT) is applicable to work contracts and 15% to service contracts. In several cases taxes vary, e.g. depending on import duty.

(iii) **Physical Contingencies:** In order to reflect uncertainties physical contingencies were applied. Globally 5% physical contingencies were applied as (i) there is recent, practical implementation experience, reducing the uncertainties in terms of volumes of work, and (ii) most of the critical underwater works is expected to be implemented at the beginning of the loan, which reduces the uncertainties related to sudden, unexpected river changes. The exception is pilot works, which do not have any contingency, due to their experimental nature.

(iv) **Price Contingencies:** These are computed on foreign exchange costs at costs at 0% in year 1, 1.9% in year 2 and 1.8% thereafter, and on local currency cost at 0% in year 1, and 6.5% thereafter, including provisions for exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.

(v) **Total Cost:** These consist of the summary of base cost, physical contingencies, and price contingencies.

(vi) **Financing Charges:** These are computed by COSTAB, applying 2% interest on the loan amounts disbursed only during the period of implementation. The Financing charges are computed for each tranche individually.

Structuring the cost for this MFF considers that the ADB loan and the Government DPP use different categories. In order to provide a practical starting point, costs have been structured in a detailed table with line items that can be clearly associated to ADB and DPP investment categories.

Table 7-3 explains the cost structure as per ADB and DPP categories and Table 7-4 provides the breakdown Tranche-wise cost breakdown per project component. Table 7-2 and Table 7-5 in the successive sections detail the investment cost per subproject including dredging allocations.

Table 7-2 Summary of Tranche-1 and 2 Works and Costs

Tranche Period	**Structural Works**	**Estimated Cost**
Tranche-1: August 2014 to June 2020 (+ 5.8 years)	- River bank protection: 17.8 km - Flood embankment: 21.3 km Strengthening/Adaptation and repair works	US$ 108 million
Tranche-2: January 2020 to December 2023 (+ 4.0 years)	- River bank protection: 15.5 km - Precautionary protection: 10.5 km - Flood embankment: 25.3 km - Channel choking with sediment - 9 regulators/fish passes - Strengthening/Adaptation and repair works	US$ 361.3 million
Total	- River bank protection: 33.8 km - Flood embankment: 44.3 km - 8 fish passes and 2 regulators - Strengthening/Adaptation and repair works - Land reclamation: 7,700 ha	**US$ 469.3 million**

Table 7-3 Cost structure: Detailed ADB and DPP investment categories

DETAILED CATEGORIES (ADB)		DPP CATEGORY
A Civil Works		
A1	Riverbank protection work	Riverbank protection
A2	Embankment earth works	Embankment
A3	Embankment pavement works	Embankment
A4	Embankment drainage structure	Embankment
A5	Emergency dumping for Erosion Control	Riverbank protection
A6	Land Recovery Pilot Works	Pilot works
B Materials (Geotextiles)		
B1	Geotextile Materials	Riverbank protection
B2	Geotextile Material (Emergency and Strengthening/Adaptation)	Riverbank protection
C Vehicles and Equipment		
C1	Vehicle (BWDB)	Equipment& Vehicles BWDB
C2	Office Equipment (BWDB)	Equipment & Vehicles BWDB
C3	Survey Equipment (BWDB)	Equipment & Vehicles BWDB
C4	DDM Office Equipment	Equipment & vehicles DDM
D Consultancy		
D1	ISPM Consultant	Consulting Services
	Task 1: Implementation	Surveys and investigations
	Task 2: Knowledge base	Surveys and investigations
	Task 3: Feasibility Study T-3	Surveys and investigations
D2	Livelihood support (INGO)	NGO services
D2	Environmental Mgmt. (INGO)	NGO services
D2	Resettlement (INGO)	NGO services
D3	CbFRM Program (INGO)	NGO services
D4	Multi-beam echo sounder survey	Surveys and investigations
D4	Erosion prediction	Surveys and investigations
E Capacity Development (Training)		
E1	BWDB Training & Study Tours	Capacity development BWDB
E2	DDM Training	Capacity development DDM
E3	MIS Development	Capacity development BWDB
F Land Acquisition and Resettlement		
F1	Land Compensation	Cash Compensation under Law
F2	Resettlement Benefit	Resettlement Benefits
G Program Management		
G1	BWDB PMO&SMO Salaries	Program management BWDB
G2	BWDB PMO&SMO Operation	Program management BWDB
G3	PMU-DDM Operation	Project management DDM
G4	BWDB River Survey	Surveys and Investigations
I Interest during Construction		
I3	Interest during construction	Interest during construction

Table 7-4 Detailed Categorization by Component

Detailed Categorization by Component	Tranche-1	Tranche-2
A Strengthening Institutional System for Flood and Riverbank Erosion Risk Management	**12.7**	**12.92**
A1 Institutional Capacity Strengthening for Sustainable River Management	1.3	2.43
A2 Knowledge-base Development	11.39	10.49
B Flood and Riverbank Erosion Risk Management Measures at Priority Reaches	**70.54**	**301.18**
B1 Infrastructure Improvement	67.69	295.77
B2 Community-based Flood Risk Management	1.58	1.05
B3 Participatory Regular O&M	0.3	0.36
B4 Livelihood Support for Project Affected People	0.96	3.96
C Project Management	**10.93**	**9.23**
Total Baseline Cost (Subtotal A+B+C)	**94.17**	**323.33**
Physical Contingencies	4.47	3.00
Price Contingencies	2.44	29.48
Total PROJECT COSTS	**101.08**	**355.81**
Interest During Implementation 2%	2.19	5.47
Total Costs to be Financed	**103.27**	**361.27**

7.3 Cost Summary

Table 7-5 Total cost of BWDB Design - excluding financial contingencies (in million US$)

Tranche-2						
Sub project	**Work item**	**Length of works**	**Work details**	**Cost M USD**	**Dredging cost**	**Dredging share**
JRB 1	Benotia	3.5	RBP at bank	34.9	1.8	5%
	Shahjadpur	7.9	embankment	6.1	2.4	39%
JLB 2	US Chauhali	12	RBP at bank	119.7	6.7	6%
	Solimabad closure	1	dredging of main channel	33.4	33.4	1.0
	Solimabad protection	10.5	between bank and char	11.1	3.8	34%
PLB 1	Harirampur-Dohar	17.4	embankment	37.4	16.8	45%
Unallocated	Strengthening/ Adaptation	40	CC blocks and geobags	15.3	4.7	0.3
	Emergency	5.0	Emergency works	-	-	-
	Fish sanctuaries		Excavation of sanctuaries	2.2	2.2	100%
Total				**260.0**	**71.8**	**28%**
Other project cost				**63.3**	**0**	**0%**
Interest during implementation 2%				**5.5**	**1.4**	
Total project cost				**323.3**		
Contingencies				**3.0**		
Total cost				**331.80**	**73.2**	

7.4 Estimated Tranche-3 Work Components and Cost

Table 7-6 summarizes the work components and estimated cost for the Tranche-3 works.

Table 7-6 Indicative Tranche-3 work

Work items	Works	Indicative cost
Embankment	40 km	60.7
River bank protection	0 km new protection and 9 km wave protection	8.1
Strengthening/Adaptation and emergency	15 km	4.0

7.5 FRERMIP Cost Estimates as per Program Components

Costs amounts by component and Tranche are tabulated below, (NHC., 2013). The total cost of the FRERMIP project at US$ 676 million, represents less than 15% of the total cost of the River Stabilization Plan with estimated total costs in the order of US$ 4.6 billion, (NHC/EMM, November 2016).

Table 7-7 FRERMIP Program Cost and Funding by Tranche (PPTA 2013)

Component	Cost Amounts [a]				
	Tranche-1	Tranche-2	Tranche-3	Total	%
A. Institutional System for Flood and Riverbank Erosion Risk Management Strengthened	12.70	0.95	0.68	14.33	4.52%
1. Institutional Capacity for Sustainable River Management Strengthened	1.30	0.74	0.45	2.49	
2. Knowledge Base Developed	11.39	0.21	0.23	11.83	
B. Flood and Riverbank Erosion Risk Management Measures at Priority Reaches Implemented	70.54	111.44	93.27	275.25	86.91%
1. Infrastructure Improved	67.69	108.25	90.67	266.61	
2. Community-based Flood Risk Management Developed	1.58	1.76	1.76	5.10	
3. Participatory Regular Operation and Maintenance Developed	0.30	-	-	0.30	
4. Livelihood Support for Project Affected People Implemented	0.96	1.42	0.83	3.21	
C. Program Management Strengthened	10.93	10.28	5.92	27.13	8.57%
Total BASELINE COSTS [b]	**94.17**	**122.67**	**99.86**	**316.70**	**100%**
Physical Contingencies [c]	4.47	6.13	4.99	15.59	4.92%
Price Contingencies [c]	2.44	14.26	17.78	34.48	10.89%
Total PROJECT COSTS	101.08	143.06	122.63	366.77	
Interest During Implementation [d]	2.19	2.27	2.21	6.67	2%
Total Costs to be Financed	**103.27**	**145.33**	**124.84**	**373.44**	**117.81%**

[a.] Including taxes and duties of US$ 54.0 million to be financed by the government.
[b.] In mid-2013 prices.
[c.] Physical contingencies are computed at between 0% and 5%. Price contingencies computed on foreign exchange costs at 0% in year 1, 1.9% in year 2 and 1.8% thereafter, and on local currency cost at 0% in year 1, 6.5% in years 2 and 6.5% thereafter.
[d.] Includes interest computed at 2.0% per year.
Source: PPTA, Final Report 2013

Table 7-8 Updated FRERMIP Program Cost and Funding by Tranche

Detailed Categorization by Component	Tranche-1	Tranche-2	Tranche-3	Total
A Strengthening Institutional System for Flood and Riverbank Erosion Risk Management	**12.7**	**12.92**	**2.86**	**28.5**
A1 Institutional Capacity Strengthening for Sustainable River Management	1.3	2.43	1.26	**5.0**
A2 Knowledge-base Development	11.39	10.49	1.59	**23.5**
B Flood and Riverbank Erosion Risk Management Measures at Priority Reaches	**70.54**	**301.18**	**179.78**	**551.5**
B1 Infrastructure Improvement	67.69	295.77	174.62	**538.1**
B2 Community-based Flood Risk Management	1.58	1.05	0.96	**3.6**
B3 Participatory Regular O&M	0.3	0.36	0.33	**1.0**
B4 Livelihood Support for Project Affected People	0.96	3.96	3.87	**8.8**
C Project Management	**10.93**	**9.23**	**5.54**	**25.7**
Total Baseline Cost (Subtotal A+B+C)	**94.17**	**323.33**	**188.18**	**605.7**
Physical Contingencies	4.47	3.00	5.61	**13.1**
Price Contingencies	2.44	29.48	14.22	**46.1**
Total PROJECT COSTS	**101.08**	**355.81**	**208.01**	**664.9**
Interest During Implementation 2%	2.19	5.47	3.76	**11.4**
Total Costs to be Financed	**103.27**	**361.27**	**211.77**	**676.3**

8 ECONOMIC ANALYSIS AND RISK ASSESSMENT

8.1 Introduction

The main objectives of the economic assessment are to:

(i) Update and revise the economic analysis undertaken by the PPTA in 2013 [53] with respect to the assumptions for the three main benefit streams, i.e. avoided erosion losses, avoided flood losses and incremental agricultural benefits;

(ii) Identify additional benefit streams (such as char land reclamation) which are relevant to the shifting focus from passive riverbank protection works to more active river stabilization;

(iii) Estimate the economic benefits and costs of mitigating riverbank erosion, alleviating flooding, and developing char land at three priority sub-projects along the Jamuna and Padma rivers;

(iv) Assess the economic viability of investments being implemented under Tranche-1 and Tranche-2 of the ADB's Multi-tranche Financing Facility (MFF) (the Program).

Three priority sub-projects were included in the economic assessment, namely: (i) Jamuna Right Bank 1 (JRB-1), (ii) Jamuna Left Bank 2 (JLB-2); and (iii) Padma Left Bank 1 (PLB-1).

- Table 7-1 summarizes the main interventions (client preferred BWDB design) for each priority sub-project under Tranche-2 of the Multi-tranche Financing Facility (MFF). The river bank protection and embankment works constructed along the river reaches at JLB 1 (Chauhali) and PLB 1 (Harirampur) under Tranche-1 of the MFF are also presented.

8.2 Methodology and Key Parameters

In the economic analysis, an incremental approach was adopted which contrasts the "future with" and "future without" project interventions. The analysis evaluated the benefits and costs as well as the economic viability of proposed interventions, e.g. riverbank protection and flood embankments, for each of the three sub-project areas.

For each sub-project, economic viability is assessed by determining the following economic criteria: (i) economic internal rate of return (EIRR) and (ii) net present value (NPV). These economic criteria are also subjected to sensitivity analysis to evaluate the impact of changes in benefits and costs. Switching values are also calculated to estimate the percentage by which project benefits and costs would need to change to reach an EIRR of 12% and an NPV of zero.

The economic analysis uses the domestic price numeraire approach. All domestic financial prices were converted to economic prices by adjusting for transfer payments such as subsidies, taxes, import duty, and VAT. For non-traded local goods, a standard conversion factor (SCF) of 0.9 was used. Where appropriate, the prices of the main internationally traded commodities have been estimated according to import and export parity prices based on border equivalent values.

Other key features of the economic analysis methodology include:

(i) Economic life of the project is 30 years, so EIRRs and NPVs have been estimated on the basis of a 30-year incremental net benefit stream;

[53] Main River Flood and Bank Erosion Risk Management Program, Final Report, Annex G: Economic Assessment, December 2013 (Project Preparatory Technical Assistance 8054 BAN)

(ii) Constant 2017/18 prices have been used for both costs and benefits over the 30 year period, so price contingencies were omitted;

(iii) No residual value of capital investment has been assumed at the end of the period;

(iv) The financial price of unskilled labor engaged in project construction and in farming activities has been converted to an economic value by the application of a shadow wage rate factor (SWRF) of 0.85, while the SCF was applied to the price of skilled labour;

(v) Capital investment and O&M costs have been converted to economic values by the application of specific conversion factors. These are estimated on the basis of the proportions of foreign costs, labor, materials, and transport in financial prices and the application of conversion factors as appropriate (i.e. SCF or SWRF).

(vi) Tax and duty components of financial prices were omitted as they are transfer payments with no economic cost. Economic prices for foreign costs remained unchanged from their financial values; and

(vii) A discount rate of 12% (i.e. opportunity cost of capital in Bangladesh) has been used to estimate NPVs and is the cut-off rate against at which economic viability is assessed.

8.3 Economic Benefits

Economic benefits are expected to be derived from various sources depending on the type and scale of work undertaken in each sub-project area. The benefits of the interventions are both direct and indirect, and comprise: (i) reduction in land and assets lost to riverbank erosion, and (ii) mitigation of flood damages/losses and increased agricultural production, (iii) restoration of char land; (iv) improved road transport, and (v) enhanced navigation.

Riverbank Protection and River Stabilization

At Chauhali and Harirampur, land and settlements are now being protected from riverbank erosion by the revetment works which were built under Tranche-1 and it has been estimated that 1,440 hectares at JLB-2 (Chauhali) and 1,350 hectares of land at Harirampur (PLB-1) will be protected from bank erosion over the 30 year life of the project.

Under Tranche-2, it is estimated that the revetment works and channel closure at JLB-2 would protect a further 2,245 hectares of mainland along the Jamuna right bank, as well as 2,500 hectares of char land, during the project lifetime. Furthermore, the proposed 3.5 km of revetment at JRB-1 is expected to protect about 575 ha of mainland at Benotia.

The value of land and assets which will be saved from bank erosion were estimated at an average of BDT 4.57 million per hectare in PLB 1, BDT 6.18 million per hectare in JLB 2 and BDT 7.28 million per hectare for JRB-1. For charland areas protected from bank erosion at JLB-1, a land value of BDT 1.24 million per hectare was used.

Based on the NPV of annual benefits over a 30 year period, the economic benefits of mitigating riverbank erosion are shown in Table 4.2 and it can be seen that economic benefits from river bank protection works range from BDT 1,160 million at JRB-1 to BDT 6,800 million at JLB-2. While the economic benefits of the proposed river stabilization works at PLB-1 are estimated at BDT 1,889 million.

8.3.1.1 Flood Mitigation

It is estimated that an area of 25,000 hectares at JRB 1 and 12,000 hectares at PLB 1 would benefit from the construction of 28.9 km flood embankment at JRB-1 (under Tranche-1 and 2) and a 17.4 km flood embankment at PLB-1 (under Tranche-2). The economic benefits will be derived from: (i) reduced flood damage, and (ii) increased agricultural and fisheries production.

The proposed embankments are the same as the original project design, so the NPVs of the economic benefits from flood mitigation remain unchanged at BDT 12,431 million for JRB-1 and BDT 2,914 million for PLB-1 (Table 5.2).

8.3.1.2 Char land Development

The economic benefits of char land development will comprise: (i) increased agricultural, livestock and fisheries production, (ii) establishment of rural settlements including houses, shops, schools, health centres and community buildings as well as associated public infrastructure. It is anticipated that the 1,700 ha of char land will be developed at PLB 1 and 6,000 ha at JLB-2 in accordance with the original proposals. However, the development of the Central char at JRB-1 would not be implemented due to the continued risk of riverbank erosion.

The overall economic benefits from char land development at PLB-1 and JLB-2 are therefore assumed to remain the same as the original plan. Calculated on a net present value basis, the economic benefits are estimated at BDT 2,151 million for Solimabad and BDT 2,302 million for Harirampur (Table 4.2).

8.3.1.3 Road Transport

It is envisaged that roads would be constructed on the flood embankments at JRB-1 and PLB-1 following the completion of the embankment works. The design and construction of the roads would be the responsibility of LGED, so this is regarded as an indirect benefit of the project.

With respect to the economic benefits of embankment roads, the vehicle operating costs (VOC) approach (as recommended by the LGED guidelines, 1999) was adopted to determine the benefits of improved accessibility resulting from the construction of paved roads on embankments. The VOC approach is based on the estimated reduction in VOCs of motorized and non-motorized vehicles following the implementation of a road project.

The without project annual average daily traffic flow was estimated for the roads within close proximity of the planned embankment road. A traffic survey was undertake to count the following categories of vehicles: motorized vehicles (auto-rickshaw, taxi, car, motorcycle, pick-up, microbus, bus, minibus, truck, tractor); non-motorized vehicles (bicycle, bullock cart, rickshaw, rickshaw van); and pedestrians.

As the traffic counts were only conducted during the day time (once on a market day and once on a non-market day), the following assumptions were made to derive the annual average daily traffic (AADT). The day-time 12-hour data was converted to 24-hour data using factors of 30 % for night-time traffic on non-hat days and 45% for night-time traffic on hat days. The number of hat and non-hat days per week is assumed to be two and five, respectively. Furthermore, traffic during the wet season is assumed to be 20% less than in the dry season.

The economic benefits of road construction were then derived from: (i) existing traffic on nearby roads which will probably be diverted, and (ii) estimated increases in traffic volume generated by the new embankment road. In addition, an 8% annual increase in the traffic volume is assumed (based on a 5.5 % economic growth rate).

Based on the annual VOC savings, the results of this analysis indicated that the economic benefits from the construction of an embankment road would generate an NPV of BDT 804 million at PLB-1 and BDT 1,266 million at JRB-1, of which about 75% would be generated by existing traffic and 25% would be obtained from new traffic (Table 8-1).

8.3.1.4 Navigation

The bank protection works proposed are not expected to lead to the stabilisation of the Lower Jamuna river in order to facilitate navigation. Consequently, it has been assumed that there would be no economic benefits due to improved navigation.

8.3.1.5 Overall Economic Benefits

The incremental economic benefits from riverbank protection works, flood embankments and char development are combined together in Table 5.2 and it can be seen that total economic benefits are estimated at BDT 7.9 billion for PLB-1, BDT 8.95 billion for JLB-2 and BDT 14.86 billion for JRB-1.

Erosion mitigation makes a significant contribution to the economic benefits in JLB-2 (76%) and PLB-1 (24%). Flood mitigation provides the main benefit (83%) in JRB-1 and accounts 37% of the benefits in PLB-1. For the JLB-2 and PLB-1, char land development is also important and accounts for 24% and 29% of the economic benefits respectively. Improved transport also contributes 9% and 10% to the economic benefits in JRB-1 and PLB-1 respectively.

Table 8-1 Incremental Economic Benefits of Project Interventions

Project Intervention	JRB -1		JLB-2		PLB-1	
	Econ. Benefit (BDT M)	% of total	Econ. Benefit (BDT M)	% of total	Econ. Benefit (BDT M)	% of total
Riverbank protection	**1,160**	**8%**	**5,675**	**73%**	**1,889**	**24%**
Flood mitigation	**12,431**	**83%**	**0**	**0%**	**2,914**	**37%**
Reduced damage	*11,484*	77%	0	**0%**	*2,514*	32%
Incremental agriculture	*947*	6%	0	**0%**	*400*	5%
Char land development	**0**	**0%**	**2,151**	**27%**	**2,302**	**29%**
Agriculture	*0*	0%	*1,200*	15%	*635*	8%
Settlements	*0*	0%	*951*	12%	*1,667*	21%
Road Transport	**1,266**	**9%**	**0**	**0%**	**804**	**10%**
Navigation	**0**	**0%**	**0**	**0%**	**0**	**0%**
Total	**14,857**	**100%**	**7,826**	**100%**	**7,909**	**100%**

N.B. Economic benefits based on net present value (NPV) over 30 years discounted at 10% per annum.

8.3.1.6 Cost Estimates

The financial investment costs of interventions proposed for the design of Tranche-2 were combined with expenditure incurred under Tranche-1 in order to derive the total costs of Tranche-1 and 2 for each sub-project. The detailed financial costs are presented in A4.1: Feasibility Level Cost Estimates. The financial costs for Tranche-1 and 2 were then converted to economic values using economic conversion factors for foreign costs, local materials, skilled labour, unskilled labour,

machinery/transport and taxes/duties (Table 3.8). In addition to the economic costs of the project interventions under Tranche-1 and 2, the economic analysis also included the costs of constructing embankment roads at PLB 1 and JRB 1. With respect to agricultural development on the char lands, the costs of soil improvement measures were also included the investment costs at each location.

The total economic costs of the project interventions as well as associated agricultural and road developments amounted to BDT 9.35 billion (US$ 112.6 million) for JRB-1, BDT 14.40 billion (US$ 173.5 million) for JLB-2 and BDT 7.60 billion (US$ 91.6 million) as indicated in Table 8-2. The costs of bank protection works accounted for the largest proportion of base costs at JLB-2 (90%) and JRB-1 (33%). While bank protection works comprise 15% of total costs at PLB-1. The costs of flood embankments and land acquisition/resettlement accounted for the highest proportion of total costs at PLB-1 with 68%. Support and program management also represent a significant proportion of base costs with between 6% (PLB-1) and 15% (JRB-1).

- Annual operation and maintenance (O&M) costs as a percentage of capital costs have been estimated at the rates of 2% for riverbank protection works and 5% for flood embankments, roads and other structures (e.g. regulators).

Table 8-2 Economic Investment Costs for Tranche-1 and 2

Project Intervention	**JRB -1**		**JLB -2**		**PLB-1**	
	Econ. Cost (BDT M)	**% of total**	**Econ. Cost (BDT M)**	**% of total**	**Econ. Cost (BDT M)**	**% of total**
Land Acquisition/Resettlement	**2,076**	24.0%	**142**	1.1%	**2,322**	33.0%
Flood Embankment Works	**1,334**	15.4%			**2,484**	35.0%
Riverbank Protection Works	**2,834**	32.7%	**12,043**	90.3%	**1,057**	15.1%
Road Development	**725**	8.4%			**429**	6.1%
Soil Fertility Improvement	**0**	0.0%	**236**	1.8%	**79**	1.1%
Vehicles and Equipment	**8**	0.1%	**7**	0.1%	**5**	0.1%
Social & Environmental Mgt	**24**	0.3%	**24**	0.2%	**20**	0.3%
Sub-project Management	**43**	0.5%	**43**	0.3%	**32**	0.4%
Unallocated Protection Works	**250**	2.9%	**277**	2.1%	**170**	2.4%
Disaster Risk Management	**66**	0.8%	**25**	0.3%	**20**	0.3%
Support & Program Management	**1,294**	14.9%	**540**	4.1%	**422**	6.0%
Base Cost	**8,654**	100%	**13,337**	100%	**7,040**	100%
Physical Contingency	**692**		**1,067**		**563**	
Total Cost (BDT million)	**9,346**		**14,404**		**7,603**	
Total Cost (US$ million)	***112.6***		***173.5***		***91.6***	

Economic Viability of Tranche-1 and 2 Investments

The results of the economic analysis for Tranche-1 and 2 indicate an overall EIRR of 11.6% (see Table 8-3). This shows that the investments under Tranche-1 and Tranche-2 are economically viable for the overall project.

Table 8-3 Economic Viability of for Tranche-1 and 2 Investments

Investment Tranche	Overall	
	EIRR	NPV (BDT M)
Tranche-1	14.7%	3,361
Tranche-1 & 2	11.6%	2,899

8.4 Economic Analysis of Tranche-1, 2 and 3

Main Interventions

The following table summarises the main interventions of the design proposed for each sub-project area under Tranche-3 and it can be seen that a 40 km flood embankment would be built from Aricha to Chauhali to protect land within the JLB-2 and PLB-1 sub-project areas from flooding. In addition, 9 km of concrete blocks would be constructed on the bank protection works at PLB-1. No other bank protection works would be required at JLB-2 and JRB-1 as the works would have been completed under Tranche-2.

Table 8-4 Main Interventions at Priority Sub-projects under Tranche-3

Sub-project	River Bank Protection	Flood Embankment	Regulatory Structures
JRB-1	0 km	0 km	
JLB-2	0 km	40.0 km	5 Structures
PLB-1	9.0 km (cc blocks only)	0 km	
Total	9.0 km	40.0 km	

8.4.1.1 Economic Benefits

It is estimated that an area of 62,000 hectares at JLB 2 and 24,500 hectares at PLB 1 would benefit from the construction of a 40 km flood embankment at JLB-2. By applying the methodology used in the Tranche-1 and 2 analysis, the economic benefits of constructing a flood embankment between Aricha and Chauhali were estimated at BDT 22.7 billion at JLB-2 (see Table 8-5).

For the construction of a GFM on the revetment works a PLB-1, it has been assumed that the works would sustain the economic benefits of the bank protection works constructed under Tranche-1 and 2, so no additional benefits were included for the GFM work under Tranche-3 .

Overall, it can be seen from Table 8-5 that the incremental economic benefits of the project interventions under Tranche-1, 2 and 3 are expected to total BDT 14.86 billion at JRB-1, BDT 30.47 billion at JLB-2 and 9.70 billion at PLB-1.

8.4.1.2 Economic Costs

The total economic costs of the project interventions under Tranche-1, 2 and 3 amounted to BDT 9.35 billion (US$ 112.6 million) for JRB-1, BDT 20.76 billion (US$ 250.1 million) for JLB-2, and BDT 8.98 billion (US$ 108.2 million) for PLB-1 as indicated in Table 8-6.

The costs of bank stabilisation and dredging account for the largest proportion of base costs at JLB-2 (64%). While bank protection works comprised 33% at JRB-1 and 21% at PLB-1 respectively. Flood embankments, regulators/fish passes and roads also account for a high proportion of base costs at JRB-1 (24%) and PLB-1 (35%). Land acquisition and resettlement also represents between 24% (JRB-1) and 28% (PLB-1) of base costs.

Table 8-5 Economic Benefits of Interventions under Tranche-1, 2 and 3

Project Intervention	JRB -1		JLB-2		PLB-1	
	Econ. Benefit (BDT M)	% of total	Econ. Benefit (BDT M)	% of total	Econ. Benefit (BDT M)	% of total
Riverbank protection	**1,160**	**8%**	**5,675**	**19%**	**1,889**	**20%**
Flood mitigation	**12,431**	**83%**	**22,647**	**74%**	**4,709**	**48%**
Reduced damage	*11,484*	77%	20,749	68%	*3,910*	40%
Incremental agriculture	*947*	6%	1,898	6%	*799*	8%
Char land development	**0**	**0%**	**2,151**	**7%**	**2,302**	**24%**
Agriculture & Fisheries	*0*	0%	*1,200*	*4%*	*635*	7%
Settlements	*0*	0%	*951*	*3%*	*1,667*	17%
Road Transport	**1,266**	**9%**	**0**	**0%**	**804**	**8%**
Navigation	**0**	**0%**	**0**	**0%**	**0**	**0%**
Total	**14,857**	**100%**	**30,473**	**100%**	**9,704**	**100%**

N.B. Economic benefits based on net present value (NPV) over 30 years discounted at 10% per annum.

Table 8-6 Economic Investment Costs for Tranche-1, 2 and 3

Project Intervention	JRB -1		JLB -2		PLB-1	
	Econ. Cost (BDT M)	% of total	Econ. Cost (BDT M)	% of total	Econ. Cost (BDT M)	% of total
Land Acquisition/Resettlement	**2,076**	24.0%	**1,623**	8.6%	**2,322**	27.9%
Flood Embankment Works	**1,334**	15.4%	**4,029**	21.4%	**2,484**	29.9%
Riverbank Protection Works	**2,834**	32.7%	**12,043**	63.9%	**1,741**	21.0%
Road Development	**725**	8.4%			**429**	5.2%
Soil Fertility Improvement	**0**	0.0%	**236**	1.3%	**79**	0.9%
Vehicles and Equipment	**8**	0.1%	**7**	0.0%	**8**	0.1%
Social & Environmental Mgt	**24**	0.3%	**30**	0.2%	**24**	0.3%
Sub-project Management	**43**	0.5%	**60**	0.3%	**43**	0.5%
Unallocated Protection Works	**250**	2.9%	**431**	2.2%	**354**	4.3%
Disaster Risk Management	**66**	0.8%	**38**	0.2%	**43**	0.5%
Support & Program Management	**1,294**	14.9%	**728**	3.8%	**786**	9.5%
Base Cost	**8,654**	100%	**19,223**	100%	**8,313**	100%
Physical Contingency	**692**		**1,538**		**665**	
Total Cost (BDT million)	**9,346**		**20,761**		**8,978**	
Total Cost (US$ million)	***112.6***		***250.1***		***108.2***	

8.4.1.3 Economic Viability for Tranche-1, 2 and 3 Investments

By combining the economic benefits and costs of Tranche-3 works with the benefits and costs of Tranche-1 and Tranche-2 interventions, the economic viability of Tranche-1, 2 and 3 was

determined. The results of the economic analysis are presented in Table 8-7 and indicate that the EIRRs are 16.7% for JRB-1, 12.9% for JLB-2 and 17.6% for PBL-1. This clearly shows that the investments are economically viable for all three sub-projects and the overall EIRR for the MFF program is 14.9%.

Table 8-7 Economic Viability of Investments under Tranche-1, 2 and 3

Investment Tranche	JRB -1		JLB -2		PLB-1		Overall	
	EIRR	NPV (BDT M)	EIRR	NPV (BDT M)	EIRR	NPV (BDT M)	EIRR	NPV (BDT M)
Tranche-1, 2 & 3	16.7%	4,520	12.9%	3,768	17.6%	3,356	14.9%	11,644

9 BIBLIOGRAPHY

ADB. (2014a). *Facility Administration Manual. Multi-tranche Financial Facility - Flood and Riverbank Erosion Risk Management Investment Program.*

ADB. (2014c). *Report and Recommendation of the President to the Board of Directors. Proposed Multitranche Financing Facility, Peoples Republic of Bangladesh: Flood and Riverbank Erosion Risk Management Investment Program.*

ADB. (2014d). *Framework Financing Agreement.*

ADB. (June 2014). *Report and Recommendations of the President.*

ADB-GoB. (January 2018). *Resettlement Framework, FRERMIP, Project No. 44167-014.*

Best, J. (2019). Anthropogenic stresses on the world's big rivers. *nature geoscience*, 7-21.

BWDB. (2017, September 17). 3rd Technical Advisory Committee. *Meeting Minutes*. Dhaka, Bangladesh.

BWDB. (2018, October 8). Technical Committee. *Meeting Minutes*. Dhaka.

Collingridge, D. (1980). *The Social Control of Technology.* London: Frances Pinter Publisher.

Consultants, J. T. (2001). *Bank Protection and River Training (AFPM) Pilot Project FAP21/22 Final Project Evaluation Report .* Dhaka: Water Resources Planning Organization.

Gales, R. (1938). The Principles of River Training for Railway Bridges and their Application to the Case of the Hardinge Bridge over the Lower Ganges at Sara. *Institution of Civil Engineers (UK)*, p. Paper No. 5167.

GED; Bangladesh Planning Commission; GoB. (2018). *Bangladesh Delta Plan 2100.* Dhaka: General Economics Division, Bangladesh Planning Commission.

GoB. (2014). *Development Project Proforma, Flood and Erosion Risk Management Investment Program - Tranche 1.*

GoB, B. G. (2014). *Participatory Water Management Rules.*

Haasnoot, M., Kwakkel, J. H., Walker, W. E., & ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crefting robust decisions for a deeply uncertain world. *Global Environmental Change*, 485-498.

Halcrow. (1994). *River Training Studies of the Brahmaputra River, Final Report.* Dhaka: Bangladesh Water Development Board.

Hotopp, D. O. (2008). Scour development alongside riverbank proteciton in a braided river - selected cases from Bangladesh. *4th International Conference on Scour and Erosion.* Tokyo.

ISMPC. (2016). *Draft Preliminary River Management Master Plan.* NHC/EMM.

ISPMC. (2016). *Strategic Framework for River Stabilisation and Development: Jamuna-Padma and Dependent Areas.* NHC/ EMM.

Lauterjung, H., & Schmidt, G. (1989). *Planning of Water and Hydropower Intake Structures.* Eschborn: GTZ.

Maunsell|AECOM. (2011). *Padma Multi-purpose Bridge Design Report, River Training Works, Final Design Report.* Dhaka: Bangladesh Bridge Authority.

NHC. (2006a). *Jamuna-Meghna River Erosion Mitigation Project, Part B; Special Report 11 Physical Model Study (Vancouver, Canada) Final Report.* Dhaka: Bangladesh Water Development Board.

NHC. (2006b). *Jamuna-Meghna River Erosion Mitigation Project, Part B, Special Report 21 Site Data and Details of Work.* Dhaka: Bangladesh Water Development Board.

NHC. (December 2006a). *Jamuna-Meghna River Erosoin Mitiagation Project Part B, Special Report 21 Site Data and Details of Work.* Dhaka: Bangladesh Water Development Board.

NHC. (December 2006b). *Jamuna-Meghna River Erosion Mitigation Project Part B, Special Report 23 Design Brief for Riverbank Protectoin implemented under JMREMP (update).* Dhaka: Bangladesh Water Development Baord.

NHC. (May 2006). *Jamuna-Meghna River Erosion Mitigation Project Part B, Special Report 17 Geobag Revetments .* Dahak: Bangladesh Water Development Board.

NHC., i. a. (2013). *Main River Flood and Bank Erosion Risk Management Program, Final Report. PPTA.*

NHC/EMM. (2016). *Strategic Framework for River Stabilisation and Development: Jamuna-Padma and Dependent Areas.*

NHC/EMM. (2016a). *Inception Report.*

NHC/EMM. (2017). *Chauhali Interim Construction Completion Report, FRERMIP.*

NHC/EMM. (2018a). *draft Feasibility Report for Tanche-2.*

NHC/EMM. (February 2018). *Mid-Term Report, FRERMIP Tranche-1.*

NHC/EMM. (February 2018). *The FRERMIP Preliminary Regional Plan.*

NHC/EMM. (Februrary 2018). *Draft Preliminary Regional Plan, FREMIP.*

NHC/EMM. (July 2016). *Initial Environmental Examination (IEE) of River Stabilisation Works in Tranche-2 Sites.*

NHC/EMM. (June 2016). *Technical Note 9. Planning the Use of Stabilised and Reclaimed Land, Procedure and Issues.*

NHC/EMM. (May 2017). *Site Selection and Initial Economic Assessment.*

NHC/EMM. (May 2017). *Strategic Framework for River Stabilization and Development: Jamuna-Padma and Dependent Areas.*

NHC/EMM. (November 2016). *Strategic Framework for River Stabilisation, FREMIP.*

NHC/EMM. (November 2017). *Environmenal Impact Assessment, Tranche-2.*

NHC/EMM. (November 2017). *Summary River Stabilisation Plan for Jamuna and Padma Rivers in Bangladesh.*

NHC/EMM. (September 2018). *Strategic Environmental and Social Assessment (SESA) of River Stabilisation.*

NHC/EMM. (updated February 2018). *Environmental Impact Assessment, Tranche 2.*

NHC/RPMC. (2015). *Small Scale Water Resources Development Project, Project Completion Report, JICA.*

Oberhagemann, K., & Al-Kamal, S. (19 to 21 October 2004). Geobag Protection in Bangladesh . *4th International Conference on Filters and Drainage in Geotechnical and Environmental Engineering.* Stellenbosch, South Africa.

Oberhagemann, K., & Haque, A. A. (2016). Development of Low Cost Riverbank Protection in Bangladesh. *8th International Conference on Scour and Erosion.* Oxford.

Oberhagemann, K., & Hossain, M. (2010). Geotextile bag revetments for large rivers in Bangladesh. *Geotextiles and Geomembranes*.

Oberhagemann, K., Diggelmann, P., & Mukhles-uz-zaman. (2008). Understanding Falling Aprons - Experience from the Lower Brahmaputra / Jamuna River. *4th International Conference on Scour and Erosion.* Tokyo.

Planning Commission, G. (August 2015). *Bangladesh Delta Plan 2100: Water Resources.*

Planning Commission, G. (September 2015). *Bangladesh Delta Plan 2011: Agriculture and Food Security.*

Ragsdale, e. (2008). *Involuntary Meets Disaster Mitigation Resettlement: A Case Study from Erosion Mitigation on the Lower Brahmaputra/Jamuna River in Bangladesh.* Memphis: The Society for Applied Anthropology.

RRI. (2016, September). Investigation on launching characteristics of different materials to find out the cost-effective and sustainable solution for river bank protection. *Repert No. 01/2014-2016*. Faridpur, Bangladesh.

Thiel, B. (2002). *Behaviour of a falling apron made from 'poorly sorted' material.* Delft: Delft University.

Thompson, A., Oberhagemann, K., She, Y., & Haque, A. (2018). The behavior of self-launching geotextile bag aprons - latest investigatios from the Lower Brahmaputra in Bangladesh. *The 9th International Conference on Scour and Erosion.* Taiwan: ICSE.

US Army Corps of Engineers, U. (1991). *Engineering Manual 1110-1601.*

van der Hoeven, M. (2002). *Behaviour of a falling apron.* Delft: Delft University.

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APPENDIX A

DESIGN AND MONITORING FRAMEWORK FOR TRANCHE-2

FRERMIP PROGRAM DESIGN AND MONITORING FRAMEWORK (ADB, 2014a) **WITH UPDATES**

Design Summary	Original Performance Target	Revised Targets/ Comments
Impact Improved livelihoods in project area	By 2028 in program districts: • Monsoon crop average yields increased to 3.75 t/ha (2.75 t/ha in 2013) • Average annual per capita income increased to Tk136,000 (Tk 74,380/capita in 2012)	By **2029** in program districts: • Monsoon crop average yields increased to 3.75 t/ha (2.75 t/ha in 2013) • Average annual per capita income increased to Tk136,000 (Tk 74,380/capita in 2012)
Outcome Reduced flood and riverbank erosion risks in the subproject areas	By 2023: • 122,000 ha of land protected from inundation damages (baseline = 0) • About 2 million of population protected from inundation damages (baseline = 0) • 461 ha of lands with assets protected from bank erosion (43 ha in 2013)	By **2024**: • **75,000 ha** of land protected from inundation damages (baseline = 0) • About 2 million of population protected **directly or indirectly** from inundation damages (baseline = 0) • **4600** ha of lands with assets protected from bank erosion (43 ha in 2013)
Outputs 1. Flood and riverbank erosion risk mitigation functioning at priority reaches	By 2023 in subproject areas: • 60 km of riverbank protected by applying appropriate technology and methodology (baseline =10 km) • 89 km of climate-resilient flood embankment constructed, rehabilitated, or upgraded against 100-year probable floods (baseline = 0 km in good condition • 66 km of paved roads on embankments (baseline = 0) • 8 regulators and other hydraulic structures installed (baseline = 0) • 200 community-based disaster management units operate disaster-resilience action plan against flood and erosion disasters, with a minimum of 33% of units led by women (baseline = 0) • 11 community groups, with at least 50% women participants, operate livelihood support programs (baseline = 0)	By **2024** in subproject areas: • 60 km of riverbank protected by applying appropriate technology and methodology (baseline =10 km) • **87 km of flood embankment with 65km climate-resilient** constructed, rehabilitated, or upgraded against 100-year probable floods (baseline = 0 km in good condition • 66 km of paved roads on embankments **considered by other agencies** (baseline = 0) • **15** regulators and other hydraulic structures installed (baseline = 0) • 200 community-based disaster management units operate disaster-resilience action plan against flood and erosion disasters, with a minimum of 33% of units led by women (baseline = 0) • 11 community groups, with at least 50% women participants, operate livelihood support programs (baseline = 0)
2. Strengthened Institutional system for flood and riverbank erosion risk management	• MIS for flood and riverbank erosion, with sex-disaggregated data, developed and operated by BWDB by 2021 • 5-year budgetary plan for riverbank protection O&M and emergency work	• MIS for flood and riverbank erosion, with sex-disaggregated data, developed and operated by BWDB by 2021 • 5-year budgetary plan for riverbank protection O&M and emergency

	for the main rivers endorsed by BWDB by 2018 • Long-term strategic river stabilization plan taking climate change impact into account, endorsed by BWDB by 2016 • BWDB project website containing database of flood and river survey and knowledge products by 2023	work for the main rivers endorsed by BWDB by 2018 • Long-term strategic river stabilization plan taking climate change impact into account, endorsed by BWDB by **2017** • BWDB project website containing database of flood and river survey and knowledge products by 2023
3. Operational program Management system	Outputs completed on time within budget	Outputs completed on time within budget
Activities with Milestones		**Current status/ comments**
1. Flood and riverbank erosion risk mitigation functioning at priority reaches *1.1 Infrastructure improvement* 1.1.1 Complete land acquisition (2016, 2018, and 2021) 1.1.2 Complete construction works of structural measures (June 2023) *1.2 Community-based flood risk management* 1.2.1 Engage NGO, and develop project-specific methodologies and instructions for implementation NGOs 1.2.2 Formulate community disaster management units with necessary training (December 2022) *1.3 Community capacity enhancement for participatory regular O&M* 1.3.1 Complete awareness campaign and training (December 2022) *1.4 Livelihood support for project-affected people (June 2023)*		• The start-up delay of one year indicates a shift of deadlines by one year. • Additional resettlement is required particularly at Chauhali, to flatten riverbank slopes above water. Resettlement costs keep increasing, in part due to September 2017 Land Acquisition Act under which compensation for land is set at 3 times the land price (up from 1.5 previously). • Construction of structural measures is proceeding well, except for paved roads which are to be provided by others (LGED/ DRH). • NGO has yet to be engaged/ start work for community based flood risk management. • Community participatory O&M has yet to start, but piloting is planned. • Livelihood support has been postponed to Tranche-2
2. Strengthened institutional system for flood and riverbank erosion risk management *2.1 BWDB institutional capacity strengthening for river management and sustainable asset management* 2.1.1 Conduct training for BWDB staff in river management, and O&M (January 2015–2022). 2.1.2 Support initial setup of Office of Chief Engineer (River Management) (2014–2023). 2.1.3 Develop flood MIS project management module by December 2016, asset inventory by 2016, followed by O&M module by 2018. 2.1.4 Conduct annual workshops for information sharing, inviting other agencies (2015–2023).		• Various trainings have been provided to BWDB staff including study tours. • Many of the sanctioned posts for the office of the Chief Engineer (River Management) are not yet filled. • Dedicated/ specialist design cell for river training and bank protection design work remains to be set up. • MIS system for project/ program management is developed and being used to inform reporting and progress. Designs and ToRs for: (i) a risk based O&M management database, and (ii) an ADP MIS database, have been prepared, taking into account various existing databases. These are to be piloted, and the rolled out under Tranche-2. • 3 annual workshops have been held.

2.2 Data and knowledge base development 2.2.1 Complete studies and preliminary river master planning for long-term strategic river management (June 2016). 2.2.2 Complete land recovery and river training piloting (April 2014–June 2021). 2.2.3 Conduct flood and river surveys (June 2015–June 2023) and establish improved flood and river survey database (December 2017). 2.2.4 Update existing short-term erosion prediction model (September 2016) and guidelines for riverbank protection works (December 2022).	• Studies and preliminary regional (master) plan prepared, and also river stabilisation plan. • Various pilots planned under remaining years of Tranche-1, including grout filled mattress, use of grasses (vetiver) for land recovery/ stabilisation. • Multibeam underwater surveys have been carried out; piloting of sediment monitoring and database planned. • Erosion prediction model being updated (CEGIS).
3. Operational program management systems *3.1 Engage institutional strengthening and project management consultant (2014, 2017, and 2020)* *3.2 Loan processing of Tranche-2 (signed in 2017), and of Tranche-3 (to be signed in 2020)*	• ISPMC for Tranche-1 were engaged in September 2015. • Tranche-2 loan is expected to be processed and signed in October 2018.

SUGGESTED TRANCHE-2 DMF TO JUNE 2022

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
Impact	Not applicable		
Outcome Reduced vulnerability against flood and riverbank erosion risks in the subproject reaches and char land reclamation	By 2023 in subproject areas: 30,000 ha of main land protected from extreme flooding, About 1 million people directly or indirectly protected from extreme flooding (in JLB-1 and PLB-1) 3,000 ha of land protected from erosion and loss (43 ha from existing JMREMP work in 2013). 6,500 ha of char land recovered from the river for development.	Districts' flood damage records BWDB's dry season satellite image analysis (outsourced to CEGIS)	**Assumptions** • BWDB allocates adequate O&M budget **Risks** • Floods exceed design return periods • River morphological change exceeds the planned range
Outputs 1. Improved flood and riverbank erosion risk mitigation measures at priority reaches.	By 2022 in subproject areas: 41.8 km (17.8 from Tr-1 and 23.5 from Tr-2) of riverbank protection constructed applying appropriate technology and methodology. Flow redistribution work chokes 15km of Solimabad channel for development (baseline = 0 km)	BWDB project progress and completion reports	**Risks** • Delay in land acquisition by Deputy Commissioner • Delay in tendering and construction of works • Quality of construction works

Flood and Riverbank Erosion Risk Management Investment Program

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
1.1 Structural Works Component	40km of strengthening/ adaptation works implemented (baseline =0)		• Failure to implement repair and strengthening/ adaptation works in the year(s) following construction of primary bank protection • Failure to carryout regular O&M
	46.8 km (21.3 Tr-1 and 25.5 Tr-2) of flood embankment constructed (baseline= 0 km) 9 regulators/ fish passes constructed (baseline=0)	BWDB project progress and completion reports BWDB project progress and completion reports	
1.2 Non-Structural Component	100 community-based disaster management units operate disaster-resilience action plan against flood and erosion disasters with minimum 50% of units led by women (baseline=0)	Implementation NGO's reports BWDB project progress reports	• Cooperation between PMO-BWDB and PMU-DMM • Interest of local persons living on/ near the river bank
	10 WMOs/ community organisations set up and active in participating regular O&M works,	Implementation NGO's reports BWDB project progress reports	• WMOs/ community organisations can be registered and mechanism is in place for participation in regular O&M • Provision of support to APs following livelihood training.
	2,000 affected persons attend on-site 1-day trainings, and about 800 persons attend 2-5 day residential trainings to support livelihood enhancement activities. Half of the trainees shall be women. Also 12 fish sanctuaries established. (baseline=0)	Implementation NGO's reports BWDB project progress reports	
2. Strengthened institutional systems for flood and riverbank erosion risk management 2.1 Institutional Capacity	Office of the CE-River Management established, staff trained and office operational	BWDB project progress reports	• CE-WM office has support from MoWR-BWDB with operating budget.
	Information and management systems including: (i) Project Website and Database with sex-disaggregated data as appropriate in use, (ii) Asset web-based database developed and piloted, (iii) ADB/ Smart Project Monitoring and Management Information System (SPMMIS) database refined and piloted.	BWDB project progress reports	• Cooperation with others concerned with database development. • Support from BWDB and agreement on database design and rollout. • Staff have access and use data base
	5-year budgetary plan for riverbank protection O&M and	BWDB's annual budgetary plan	• Support for more flexible funding for O&M of bank protection works

Design Summary	Performance Targets and Indicators with Baselines	Data Sources and Reporting Mechanisms	Assumptions and Risks
	emergency work for the main rivers endorsed by BWDB	BWDB's construction material stockade plan	
2.2 Data and Knowledge base	Long-term river stabilization and river management master plans finalised/ refined (including for char lands development), endorsed by BWDB and used for planning projects	BWDB project reports	• Approval of RSP and River Management Master Plans including char lands development plans
	Studies to add to quality of planning and design guidelines for river bank protection and river training, distributaries flows and management, land reclamation and development, modernisation of agriculture, and also concerning fisheries, resettlement and the environment. Pilots focussing on core program activities, river management and training and bank protection.	BWDB project reports	• Support for studies and pilots
	Flood and river surveys carried out each year with data entered into web-based database	BWDB project reports	• Support for comprehensive annual surveys
3. Program management systems operational	Tranche-2 outputs completed on time within budget	BWDB project progress and completion report	

Activities with Milestones	Inputs ($ million)
1. Flood and riverbank erosion risk mitigation measures at priority reaches	
1.1 Infrastructure improvement (1) Complete land acquisition (June 2019) (2) Complete construction works of structural measures (June 2022)	ADB (loan): 135 GoB 223 Netherlands(grant): 3 **Total** **207**
1.2A Community-based flood risk management (1) Engage NGO and refine methodologies and guidelines (by April 2019) (2) Form community disaster management units, with necessary training in subproject areas (June 2021)	
1.2B Regional flood risk management (1) Refine and disseminate flood response plan	
1.3 Community capacity enhancement for participatory regular O&M (1) Prepare strategy and plan (April 2019) (2) Form, register and train WMOs/ groups in subproject areas (May 2019-June 2022)	

Activities with Milestones	Inputs ($ million)
(3) WMOs/ groups carrying out regular O&M (June 2021 to June 2022) 1.4 Livelihood support for project affected people in subproject areas (1) Identify APs, suitable livelihood support activities and interest (April 2019) (2) Establish fish sanctuaries, 12 No. (June 2020 – June 2022) (3) Contracted agencies/ NGOs/ others implement livelihood trainings and support (May 2019 – June 2022) **2. Strengthening institutional system for flood and riverbank erosion risk management** 2.1 BWDB institutional capacity strengthening for river management and sustainable asset management (1) Conduct training for BWDB staff with focus on staff for office CE-River Management, in design of river and flood protection works, river management and O&M (May 2019 – June 2022) (2) Support CE River Management office (Oct 2018 – June 2022) (3) Develop, test and rollout MISs: (i) Project Website and Database, (ii) Asset web-based database, and (iii) ADB/ Smart Project Monitoring and Management Information System database (Oct 2018 – June 2022) (4) Conduct annual workshops for information sharing inviting other agencies (2019 – 2022) 2.2 Data and knowledge base development (1) Refine the long-term river stabilization and river management master plans prepared in Tranche-1, including for char lands development, and present to BWDB and department/ agencies of other Ministries for wider adoption in project planning (2019-2020) (2) Undertake studies to add to quality of planning and design guidelines covering: (i) river management, river training and bank protection, (ii) distributary flows and rehabilitation, (iii) land reclamation and development, (iii) modernisation of agriculture (May 2019 – June 2022), (iv) fishery development, and (v) resettlement and environment impact. (3) Extend/ refine pilots started in Tranch-1, i.e. concerning grout-filled mattresses, vegetative protection using katkin/ vetiver grasses for flood embankments, river bank slopes and for reclaimed land, and morpho-hydraulic design for distributary off take(s). (4) Conduct flood and river surveys and also distributary surveys, and enter data into web-based (project) database (2019 – 2022) **3. Program management** (1) Loan processing of Tranche-2 (sign in October 2018). (2) Implementation Arrangements reconfirmed, with institutional set up extended and revised with PMO as part of office of CE-River Management (by October 2018). (3) Engage/ extend services Institutional Strengthening and Project Management Consultant, ISPMC (January 2019). (4) Planning of tasks/ activities.	

Activities with Milestones	Inputs ($ million)
(5) Timely procurement and supervision of works carried out by contractors. (6) Timely procurement and management of services to be delivered by 3rd party firms and NGOs. (7) Coordination with Partner Agencies: BWDB-DDM-DC, etc. (8) Management and use of MIS systems and databases. (9) Activity and progress monitoring and timely and quality reporting. (10) Preparation of documents required for Tranche-3, including feasibility and safeguards, DPP and loan documents.	

ADB = Asian Development Bank, BBS = Bangladesh Bureau of Statistics, BWDB = Bangladesh Water Development Board, CE = Chief Engineer, DAE = Department of Agriculture Extension, DAM = Department of Agricultural Marketing, DDM = Department of Disaster Management, ha = hectare, ISPMC = Institutional Strengthening and Project Management Consultant, MIS = management information system, NGO = nongovernment organization, O&M = operation and maintenance.

1 Review Context for the Design and Monitoring Framework

1.1 Reviewed Impacts, Assumptions and Risks

The currently stated Impact of FRERMIP is for improved livelihoods by 2028. This Impact as stated in the Design and Monitoring Framework (DMF) of the Financing Framework Agreement (FFA) and agreed between Government and ADB, remains valid.

Assumptions and risk may consider additional Government priorities and past flood developments. More recently Government has shifted towards consideration of a more comprehensive role for the major rivers in Bangladesh's development as a middle income country, relevant to the assumptions of the DMF. While government continues to attach high priority to flood and riverbank erosion protection, it looks now at a broader set of benefit streams, including:

(i) The stabilization and development of some 150,000 hectares of floodplain lost during the widening process of the Jamuna from the early 1970s until 2000s, which the river stabilization plan (NHC/EMM, Strategic Framework for River Stabilisation and Development: Jamuna-Padma and Dependent Areas, 2016) suggests can be recovered from the river;

(ii) Improved navigation along the substantially stabilized river corridor of the Padma and Jamuna, often referred to as restoring navigation; and

(iii) Stable dry season flow in the distributaries of the North-central Zone, particularly the Old Brahmaputra and Dhaleswari River System.

With respect to the Outcome risks stated in the DMF, both the 2016 and 2017 flood seasons were high causing larger than average morphological changes. Compounded by a one-year construction delay, the river morphology has changed from the assumptions during the project preparatory study in 2012/13 to an extent that requires an adjustment of the construction program as indicated in the "Site Selection and Initial Economic Assessment" report (NHC/EMM, May 2017) and agreed between Government and ADB during the July and December 2017 Consultation Missions[54], as well as

[54] Aide Memoires of Consultation Mission 23 – 30 July 2017 and Aide Memoire of Consultation Mission 26 November – 1 December 2017

accepted by the Technical Advisory Committee meeting chaired by the Chief Planning on 17 September 2017.

The Design and Monitoring Framework as per Facilities Administration Memorandum (ADB, 2014a) is summarised in Appendix A for the original performance targets, and with revised targets and comments. In addition, a draft DMF for Tranche-2 is provided. Some changes are envisaged, based on reassessment of benefits, lessons, performance under Tranche-1 and reassessment of priorities for Tranches-2 and -3, see Chapter 1. For example:

(i) Adjust the end date to August 2024 to cope with river changes and an initial one-year delay.

(ii) Adjustment to lengths of new erosion protection and flood embankment in different tranches.

(iii) Introduction of innovative technologies, originating from Tranche-1 piloting (grout-filled jut mattresses for permanent wave protection and reed plantation for char land build-up) and introduced during Tranche-2 for river training purposes (specifically flow redistribution and char development by dredging a pilot channel in extension of the channel pattern as per river stabilization plan and using the dredge material for "choking" an eroding bankline channel and building-up the land for future use).

1.2 Reviewed Outcomes – Flood Reduction and Benefitted Population

The currently stated outcomes of FRERMIP focus on reduced flood and river bank erosion risks, with 122,000 ha of land protected from flooding by 2023 (i.e. 49.3% of the total area of JRB1, JLB2 and PLB1), benefitting some 2 million people (some 70% of the population in the priority subprojects), and 460 ha of land with assets protected from bank erosion, up from 43 ha in 2013, (ADB, 2014c). The first two are correlated with the large area impact of flooding. The provided outcomes have been reviewed during the preparation of this updated feasibility study.

The ISPMC has conducted extensive flood modelling to reassess the flood benefits and the total area potentially benefitted. This flood modelling departs from the historic model approach of flooding the floodplain in parallel with the water level increase in the main rivers, established through one dimensional model runs. Historic modelling was typically based on the floodplain topography of the 1964 irrigation maps converted to a digital elevation model with one elevation point for each 300x300m parcel. During the PPTA (NHC., 2013) this historic modelling approach was improved by calibrating the typically overestimated flooded areas against observed flood season inundation areas, derived from RADARSAT satellite imagery. For this study, the flood model has been rebuilt from scratch, using the latest available, complete river cross section for both main river (2013 and 2017) and interior river systems, and, more importantly, an updated digital terrain model derived from NASA's Shuttle Radar Topography Mission which was flown in February 2000. Recognizing that the floodplain of Bangladesh today is highly fractured through the ever increasing network of highways and local roads, we have conducted an extensive (1300km) survey of the main road network alongside the main rivers at the end of 2017 to establish their locations and crest levels. This road network impacts on the flood patterns, as it retains lower floods but often is overtopped and partly destroyed during higher floods[55]. In addition, the flood modelling has abandoned the earlier approach of replicating observed flood hydrographs, for synthetic hydrographs corresponding

[55] In future the extension of the road network including existing drainage structures would contribute to the development of 2-D flood models that can predict flooding and drainage patterns and help the local population to better plan cropping patterns but also plan for disaster.

with a defined return period. For the computations the both the 1998 and the latest 2017 hydrograph have been applied, scaled to the discharges of the different design events (from 2 to 200-year flood). The results presented in the following are based on the most recent 2017 flood characteristics.

Through some 160 flood model runs for different scenarios, the flood impacts for different development phases could be established:

(i) The scenarios for the combined impact after T-1 + T-2, after T-3, and after T-4 (the implementation of the full embankments in line with the river stabilization plan).

(ii) The return periods of 2, 20, 50, 100, 200, and 500 years, acknowledging the recently increased design water level to a 200-year flood and the need to check the river stabilization plan against a future very high event.

(iii) Different scenarios for distributary closure. While the PPTA assumed that both the Ghior Khal, or Old Dhaleswari, and the Dhaleswari would be equipped with flood barriers at the end of Tranche-3, this assumption has been updated to the Old Dhaleswari only. The reason is that the main channel downstream of Bangabandhu (Jamuna) Bridge has been destabilized and turned from a predictable straight channel into a curved channel with the Dhaleswari now taking off from the outer bend. While this is a positive development in terms of long-term offtake stabilization, it remains unclear how far the bend will develop before it gets stabilized and the offtake finally formed. After Tranche-4, all distributaries will be equipped with flood barriers, including the Old Brahmaputra, and downstream of Bangabandhu (Jamuna) Bridge the Pungli, Dhaleswari and Old Dhaleswari.

The following tables and graphs present two results:

(i) Total flood protected areas (Table A-1 and Figure A-1)

(ii) F0 and F1 land changes (Table A-2 and Figure A-2), in line with the key benefit assumptions of the PPTA.

Table A-1 Summary flood free areas (note that T-1 + T-3 and T-3 are limited to the priority subprojects JRB-1, JLB-2, and PLB-1) (in ha)

Scenario	2-years	20-years	50-years	100-years	200-years
T-1+T-2	5,698	19,438	14,237	11,604	10,688
T-3	23,847	77,234	62,127	59,684	60,272
T-4	146,617	267,058	380,138	482,812	554,618

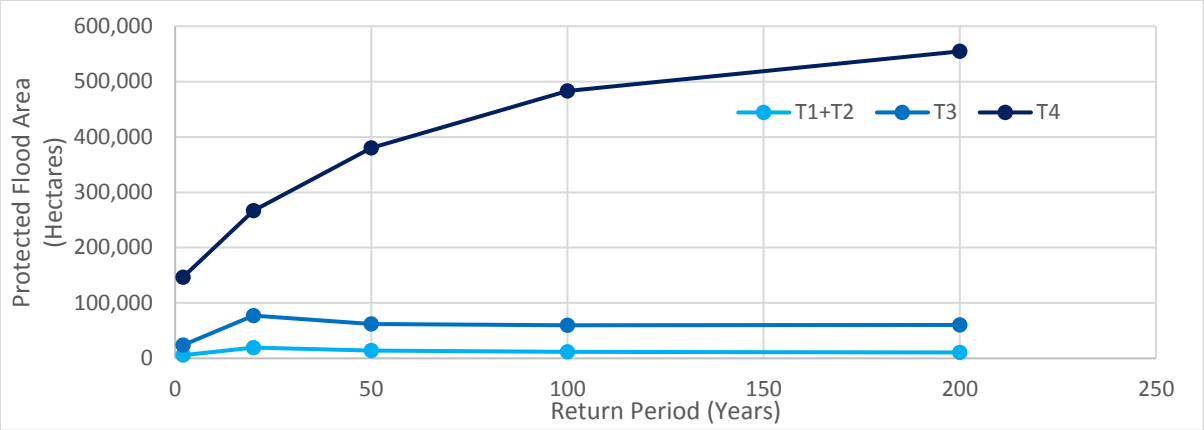

Figure A-1 Total flood protected area for the three priority subprojects (JRB-1, JLB-2, and PLB-1) and different project scenarios and return periods

Table A-2 Summary F0 and F1 land increase (note that T-1 + T-3 and T-3 are limited to the priority subprojects JRB-1, JLB-2, and PLB-1)

Scenario	2-years	20-years	50-years	100-years	200-years
Base Case (total flood free area)	94,209	79,425	69,605	66,927	63,287
T-1+T-2	968	2,255	1,632	1,141	197
T-3	2,497	5,842	10,789	6,357	5,408
T-4	5,756	12,895	14,394	20,030	24,249

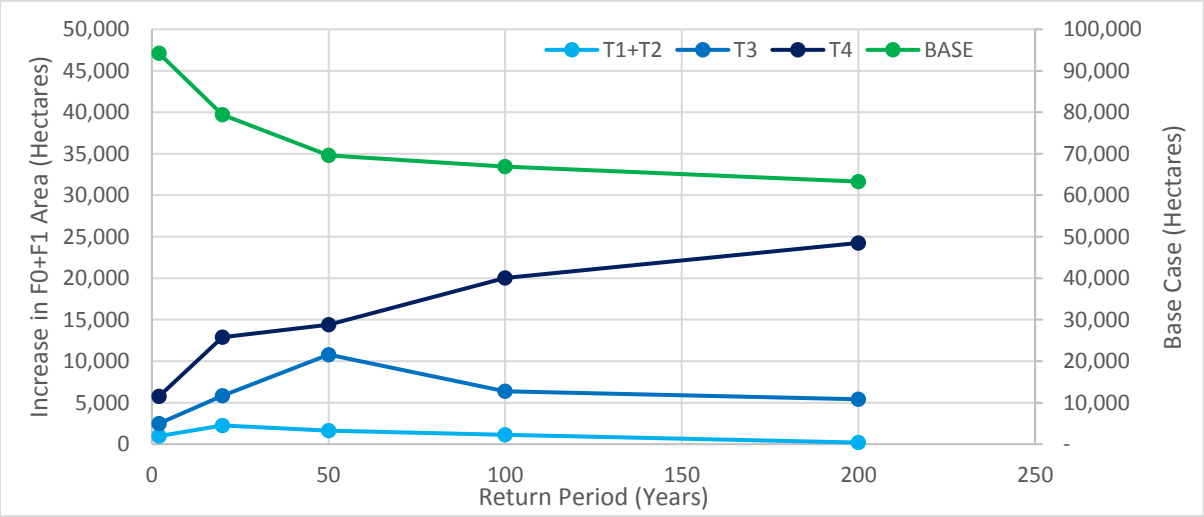

Figure A-2 FO and F1 land – total per priority subprojects (JRB-1, JLB-2, and PLB-1) and changes for different project scenarios and return periods

The PPTA study provides key information on the improvements after project implementation Table A-3). It identified a total increase in F0 and F1 land after Tranche-3 of some 56,000ha for the 2007 moderate flood condition (estimated return period: 20 years). Translating this improvement to the total benefitted area, results in some 830,000 people benefitted, as per 2011 census survey used during the 2012/13 PPTA. For 2024, applying the predicted population increase of the country (Table A-4), roughly 950,000 persons will be benefitted.

Table A-3 Key area information from the PPTA study** (NHC., 2013), **2007 flood condition

Area Classification (ha)	JRB-1	JLB-2	PLB-1	Total

Total area (adjusted project area - APA)	41,067	82,927	52,070	176,064
Net Cultivable Area	30,000	61,740	36,643	128,383
NCA percentage of APA				
F0 + F1 land (without project)	8,299	17,095	14,563	39,957
F0 + F1 land (with project)	15,958	51,619	28,954	96,531
F0+F1 land (improvement)	7,659	34,524	14,391	56,574
Total flooded cultivable area (without project)	22,581	47,844	22,788	93,213
Total flooded cultivable area (with project)	17,568	21,078	13,356	52,002
Cultivable area not flooded with project (2007)	-5,013	-26,766	-9,432	-41,211
Percentage of NCA flooded (2007)	-17%	75%	46%	
Area improvement of total APA	6,862	35,951	13,403	**56,216**
Population density (2011)	2,370	1,340	1,400	
Total population benefitted as per 2011 data	162,636	481,745	187,641	832,023
Population density in 2024 (see Table A-4)	2715	1535	1604	
Total population benefitted as per 2024 extrapolation	186,327	551,920	214,974	**953,221**

Table A-4 Predicted population growth

Year	total population (million)	annual change (%)	JRB-1	JLB-2	PLB-1
2011	152.86		2370	1340	1400
2012	154.7	1.19%	2398	1356	1417
2013	156.6	1.21%	2427	1372	1434
2014	158.22	1.02%	2452	1386	1449
2015	159.86	1.03%	2477	1401	1463
2016	161.51	1.02%	2503	1415	1478
2017	163.19	1.03%	2528	1430	1494
2018	164.88	1.02%	2554	1444	1509
2019	166.59	1.03%	2581	1459	1524
2020	168.31	1.02%	2607	1474	1540
2021	170.06	1.03%	2634	1489	1556
2022	171.82	1.02%	2661	1504	1572
2023		1.02%	2688	1520	1588
2024		1.02%	2715	1535	1604

The comparison of the refined flood modelling results[56] with the PPTA approach (Table A-5) reveals quite a difference between that the order of magnitude of the benefitted area after Tranche-3, an increase to some 75,000ha (from 56,000ha) for the 20-year flood could be justified. The 20-year flood has a higher than three quarter probability of exceedance during the 30-year lifetime of the project (Table 2-2). Selecting a flood of higher return period would not be justified due to the lower aggregate risk of exceedance during the 30-year lifetime and consequently a potential overestimation of economic returns. In summary and in line with the flood modelling results, we recommend updating the outputs from 122,000 ha of land protected from flooding by 2023, to 75,000ha of land protected from flooding. The number of people benefitted is some 950,000 people directly. Indirectly benefitting are: (i) people on chars from char land development (10,000 ha with potentially 50,000 people at a population density of 500/km²), (ii) labour employed in construction works during economic development of the area, and (iii) people indirectly affected by flooding due

[56] Climate change is part of Climate Risk and Vulnerability Assessment.

the disruption to transport network, access to schools, hospitals etc. in the rest of the subproject areas, but also outside. The assumption could be that one third of the total subproject population could be benefitted indirectly[57] and consequently the total would amount to 2million.

Table A-5 Comparison of benefited areas (in hectares): PPTA vs. new flood modelling

Scenario	PPTA 2007 (20-year)	20-year return period[58]	100-year return period	200-year return period
T1 + T2		19,438	11,604	10,688
T3	56,216	77,234	59,684	60,272
T4		267,058	482,812	554,618

We recognize that during intermediate implementation stages, higher flood levels could occur in bordering areas. The partly completed embankment lines could increase the water levels to some extent particularly during very high floods. (Table A-6 and Figure A-3) provide details. While this sound worrying, the overall risk of actually occurring is rather low, given that the river stabilization plan is scheduled for systematic and continuous implementation over a period of some 15 years and that the embankment gaps will exist only for few years at a time. During these few years the occurrence of a 100- or even 200-year flood event is very unlikely (for details also refer to Table 2-2).

Table A-6 Flood area changes for different development stages and return periods

Intervention	Return Period (years)	VALUE1=DRIER (ha)	VALUE2 = NO CHANGE (ha)	VALUE3 = WETTER (ha)	TOTAL AREA (ha)
T1+T2	2	5,698	1,739,862	25,739	1,771,299
T1+T2	20	19,438	1,699,101	52,760	1,771,299
T1+T2	50	14,237	1,725,311	31,751	1,771,299
T1+T2	100	11,604	1,713,210	46,485	1,771,299
T1+T2	200	10,688	1,748,514	12,097	1,771,299
T3	2	23,847	1,718,957	28,494	1,771,299
T3	20	77,234	1,609,478	84,587	1,771,299
T3	50	62,127	1,598,937	110,234	1,771,299
T3	100	59,684	1,582,093	129,522	1,771,299
T3	200	60,272	1,572,092	138,935	1,771,299
T4	2	146,617	1,419,909	204,773	1,771,299
T4	20	267,058	1,329,771	174,470	1,771,299
T4	50	380,138	1,295,668	95,492	1,771,299
T4	100	482,812	1,199,930	88,556	1,771,299
T4	200	554,618	1,131,275	85,406	1,771,299

[57] This would allow maintaining the original number of 2Million people, as the total population borders 3 Million.

[58] Excludes the case of embankment breach at Enayetpur at the subproject JRB-1, which will be prevented through by constructing some 4km of riverbank protection works, and has been estimated during the PPTA to potentially effect some 11,000ha of land.

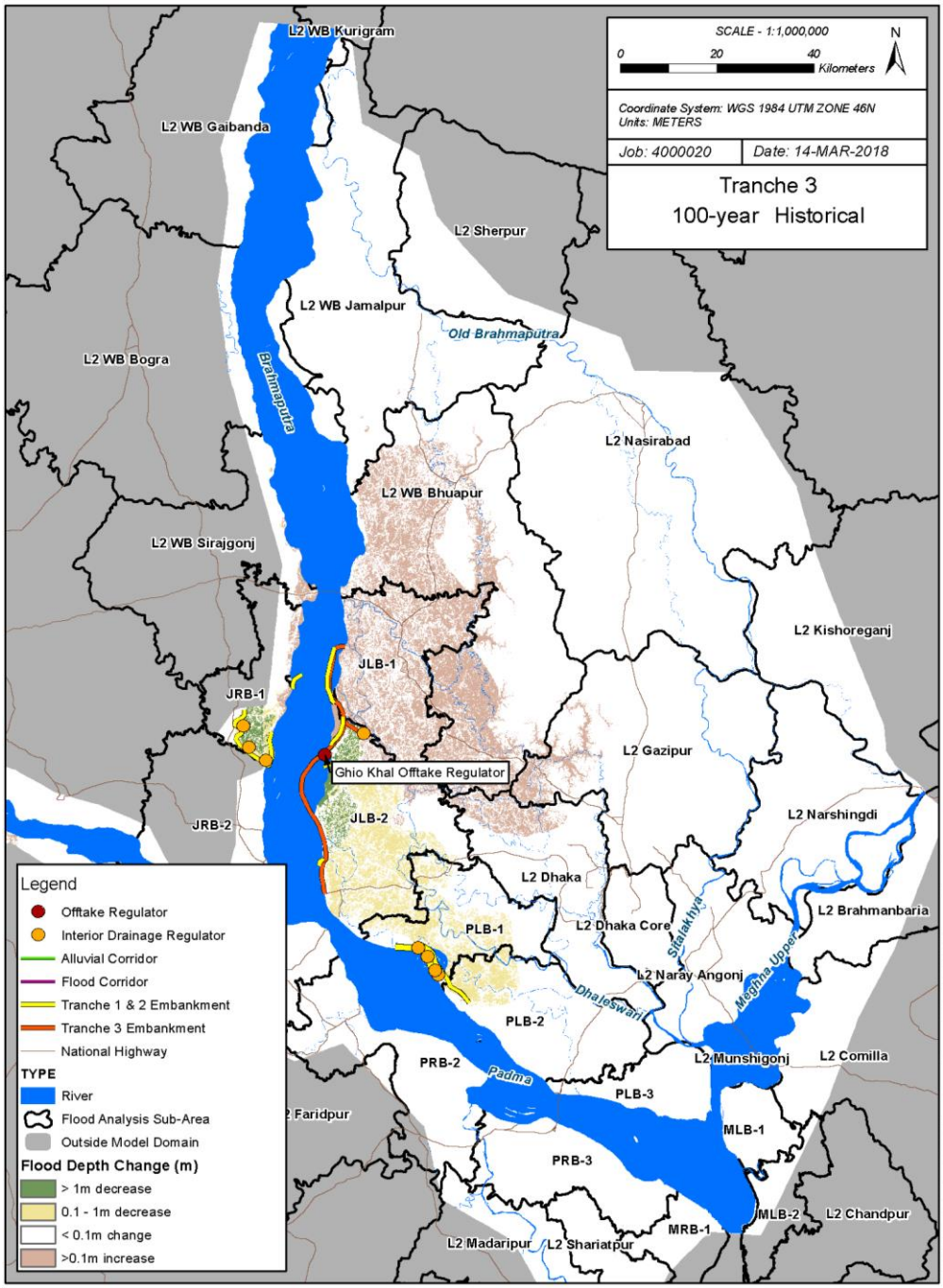

Figure A-3 Flood level differences for T-3 and 100-year flood: light red = greater than 0.1m deeper; cyan/green = greater than 0.1m shallower; Red, mustard, = 0.1m – 1.0m shallower.

1.3 Reviewed Outcomes – Protection against Riverbank Erosion

It is evident that avoided erosion can only be based on past trends without knowing future flood scenarios or even earthquake induced sediment waves that destabilize the river over decades. The PPTA attempted to estimate erosion trends, particularly recurrent erosion intervals based on morphological analysis of the site conditions. This pre-project assessment is still valid, however has been updated to account for the actual bankline at project start (as opposed of the assumption during the PPTA), the work built during Tranche-1 and the plans for Tranche-2 and -3. During Tranche-1 much has been done to stop riverbank erosion, and particularly at Chauhali the success of riverbank protection is visible: despite some surficial failures the bankline has not changed during

the two higher 2016 and 2017 flood season, and despite severe deepening of the channel (from some 5m during the dry season to some 20m depth). At Harirampur the Padma River had started deeply eroding into the attached char between 2012 and 2016, when the work started, and some 1,000ha of land were lost. For the flood season 2016, 165ha of erosion loss were predicted.

The comparison of PPTA data with updated erosion numbers and computation is provided in Table A-7. We have distinguished between the years 2029, the revised date for impact assessment, and 2043 – the end date for the 30-year economic life time. The overall avoided erosion losses after 30-years have reduce marginally from 7,210ha to 6,880ha. By 2029, five years after the project around 4,670ha of erosion have been prevented, or two thirds. This number is explained by the periodic nature of erosion and the fact that FRERMIP responded to critically eroding river reaches.

While the flooded area appeared to be overstated in the DMF, the area protected against erosion appears to be understated. Overall, we recommend to increase the present number of erosion protected land from 460ha (with a baseline of 43ha in 2013) to 4,600ha. This area converts to a strip of some 770m width alongside the total protected banks (including the Solimabad channel), and therefore is a conservative estimate. For comparison the riverbank at Chauhali has shifted by nearly 2km between 2012 and the Tranche-1 work start in 2016. In addition, the support for an overall stabilized river corridor has not been accounted for.

Table A-7 Erosion rates and avoided erosion losses

Parameter	**JRB-1**	**JLB-2**	**PLB-1**	**Total**
Annual Erosion rate	125 m	100m	300m (Harirampur) 50m (Dohar)	
Total planned riverbank protection at PPTA	12km	19km	7km (Harirampur) 5km (Dohar)	43km
Total avoided erosion (ha) until 2028[59]	775ha	1090ha	2,375ha	4,240ha
Total avoided erosion (ha) until 2043	2075ha	2520ha	2615ha	**7,210ha**
Total works built during Tranche-1	0km	9km	9km	18km
Total avoided erosion loss after T-1 (until 2029)	0ha	720ha	1,700ha	2,420ha
Total works planned for Tranche-2	11.5km	12km 15km[60]	0km	23.5km
Total avoided erosion loss after T-2 (until 2029)	720ha	600ha 750ha	0ha	2,070ha
Total works planned for Tranche-3	0km	4km	0km	4km
Total avoided erosion loss after T-3 (until 2029)	0ha	200ha	0ha	200ha
Total work length after Tranche-3	11.5km	25km 15km	9km	**45.5km** **15km**
Total avoided erosion (ha) until 2029	720ha	2,270ha	1,700ha	**4,670ha**
Total avoided erosion (ha) until 2043	2,010ha	3,170ha	1,700ha	**6,880ha**

[59] Five years after the planned end date.

[60] Through choking the Solimabad channel from a combination of dredging and "building with nature"

APPENDIX B

TECHNICAL COMMITTEE OCTOBER 2018

বাংলাদেশ পানি উন্নয়ন বোর্ড

ফোন ঃ
অফিস ঃ ৯৫১১২৯৩, ৯৫৫৫১৩৩
ফ্যাক্স ঃ ৮৮-০২-৯৫৬৪৭৬৩

সচিবালয়
ওয়াপদা ভবন, মতিঝিল বা/এ, ঢাকা-১০০০।

Phone :
Office : 9511293, 9555133
Fax : 88-02-9564763

স্মারক নং-বাপাউবো(সচি)/পরি-১/বিবিধ-৩/২০১৮(১ম খন্ড)/৯১৫ তারিখঃ ০১-১০-২০১৮ খ্রিঃ

দপ্তরাদেশ

"Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)-Tranche-2" শীর্ষক প্রকল্পের Tranche-2 এর সম্ভাব্যতা সমীক্ষা সম্পাদনে পূর্ত কাজের নকশা পর্যালোচনাপূর্বক চূড়ান্তকরণসহ প্রাক্কলিত ব্যয় নিরূপণের নিমিত্ত বাপাউবোর নকশা, পরিকল্পনা, প্রকল্প ব্যবস্থাপনা ও মাঠ দপ্তরে কর্মরত প্রকৌশলী সমন্বয়ে একটি কারিগরি কমিটি গঠন করা হলো। উক্ত কারিগরি কমিটি প্রকল্পের Tranche-2 এর সার্বিক বিষয়াদি পর্যালোচনা করে ToR অনুযায়ী একটি রিপোর্ট প্রদান করবেন।

ক্রমিক নং	নাম/পদবী	কমিটিতে অবস্থান
১।	অতিরিক্ত মহাপরিচালক (পরিকল্পনা), বাপাউবো, ঢাকা।	আহবায়ক
২।	অতিরিক্ত মহাপরিচালক (পশ্চিম রিজিয়ন), বাপাউবো, ঢাকা।	সদস্য
৩।	প্রধান পরিকল্পনা, বাপাউবো, ঢাকা।	সদস্য
৪।	প্রধান প্রকৌশলী, নকশা, বাপাউবো, ঢাকা।	সদস্য
৫।	তত্ত্বাবধায়ক প্রকৌশলী, নকশা সার্কেল-২, বাপাউবো, ঢাকা।	সদস্য
৬।	তত্ত্বাবধায়ক প্রকৌশলী, ময়মনসিংহ পওর সার্কেল, বাপাউবো, ময়মনসিংহ ।	সদস্য
৭।	তত্ত্বাবধায়ক প্রকৌশলী, ঢাকা পওর সার্কেল, বাপাউবো, ঢাকা ।	সদস্য
৮।	তত্ত্বাবধায়ক প্রকৌশলী, পাবনা পওর সার্কেল, বাপাউবো, পাবনা ।	সদস্য
৯।	ড. শ্যামল চন্দ্র দাস, নির্বাহী প্রকৌশলী, প্রধান পরিকল্পনা দপ্তর, বাপাউবো, ঢাকা।	সদস্য
১০।	প্রকল্প পরিচালক, PMO-FRERMIP, বাপাউবো, ঢাকা	সদস্য-সচিব

কমিটির কার্যপরিধিঃ

i) Review and finalize Feasibility Study Report of Tranche-2 complying study output the ToR of ISPMC in line with contract agreement.
ii) Review and finalize the detailed structural design of Tranche-2 works.
iii) Advice PMO for preparing DPP of Tranche-2.

২। মূল প্রতিবেদনের Soft Copy(Text) অতিরিক্ত মহাপরিচালক (পরিকল্পনা) মহোদয়ের adgpl.bwdb@gmail.com ঠিকানায় E-mail যোগে প্রেরণ করবেন।

৩। মহাপরিচালক মহোদয়ের অনুমোদনক্রমে এ আদেশ জারী করা হলো।

(মোঃ সামিউল ইসলাম খান)
উপ-সচিব (পরিকল্পনা)
বাংলাদেশ পানি উন্নয়ন বোর্ড
ঢাকা।

বিতরণ (জ্ঞাতার্থে ও কার্যার্থে) (জ্যেষ্ঠতার ভিত্তিতে নহে)ঃ

১। অতিরিক্ত মহাপরিচালক (পরিকল্পনা), বাপাউবো, ঢাকা।
২। অতিরিক্ত মহাপরিচালক (পশ্চিম রিজিয়ন), বাপাউবো, ঢাকা।
৩। প্রধান পরিকল্পনা, বাপাউবো, ঢাকা।
৪। প্রধান মনিটরিং, বাপাউবো, ঢাকা (দৃঃআঃ সিস্টেম এনালিস্ট)। বাপাউবো'র ওয়েব সাইটে প্রকাশের অনুরোধসহ।
৫। প্রধান প্রকৌশলী, নকশা, বাপাউবো, ঢাকা।
৬। তত্ত্বাবধায়ক প্রকৌশলী, নকশা সার্কেল-২, বাপাউবো, ঢাকা।
৭। তত্ত্বাবধায়ক প্রকৌশলী, ময়মনসিংহ পওর সার্কেল, বাপাউবো, ময়মনসিংহ ।
৮। তত্ত্বাবধায়ক প্রকৌশলী, ঢাকা পওর সার্কেল, বাপাউবো, ঢাকা ।
৯। তত্ত্বাবধায়ক প্রকৌশলী, পাবনা পওর সার্কেল, বাপাউবো, পাবনা ।
১০। ড. শ্যামল চন্দ্র দাস, নির্বাহী প্রকৌশলী, প্রধান পরিকল্পনা দপ্তর, বাপাউবো, ঢাকা।
১১। প্রকল্প পরিচালক, PMO-FRERMIP, বাপাউবো, ঢাকা

অনুলিপি (জ্যেষ্ঠতার ভিত্তিতে নহে)ঃ

১। সিএসও টু মহাপরিচালক, বাপাউবো, ঢাকা।
২-৩। ব্যক্তিগত সহকারী, অতিরিক্ত মহাপরিচালক (পরিকল্পনা/ওয়েস্টার্ন রিজিয়ন), বাপাউবো, ঢাকা।

বাংলাদেশ পানি উন্নয়ন বোর্ড
Bangladesh Water Development Board

Project Management Office: PMO-FRERMIP
Flood and Riverbank Erosion Risk Management Investment Program
Firoz Tower (12th Floor).
152/3/B, Bir Uttam Nuruzzaman Road,
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প্রকল্প ব্যবস্থাপনা দপ্তর :পিএমও-এফআরইআরএমআইপি
ফ্লাড এন্ড রিভার ব্যাংক ইরোশন রিস্ক ম্যানেজমেন্ট ইনভেস্টমেন্ট প্রোগ্রাম
ফিরোজ টাওয়ার (১৩ তলা),
১৫২/৩/বি, বীর উত্তম নূরউজ্জামান রোড,
পান্থপথ (গ্রীণ রোড), ঢাকা-১২০৫
ফোনঃ ৮৮০-২-৯১৪১৬৯১, ফ্যাক্সঃ ৮৮০-২-৯১৪১৮৮৭
ই-মেইল: pdjmremp@gmail.com

Memo no: PMO-FRERMIP/C-2/305 02 December 2018

To

The Team Leader
ISPMC, FRERMIP
BWDB, Dhaka.

Subject: Submission of minutes of the Technical Committee for Proposed FRERMIP (Tranche-2) Project.

Ref: This office Memo No. : PMO-FRERMIP/C-2/199; Date: 16/10/2018.

Dear Team Leader

With reference to above subject, I would like to inform you that a meeting of the Technical Committee for Proposed FRERMIP (Tranche-2) Project was held on 08 October 2018 in the conference room of the Director General, BWDB, Dhaka. In that meeting a detailed discussion was carried out for reviewing of the proposed interventions, Designs and draft Feasibility Study Report of FRERMIP Tranche-2 project. The minutes of the meeting is enclosed herewith. You are hereby requested to follow the minutes during the finalization of the Proposed FRERMIP (Tranche-2) Project.

You are also requested to submit the final version at the earliest with complying all commemts/decisions of the meeting.

Please treat it as most important & urgent.

Yours faithfully

02.12.18

(**Md. Rafiqul Islam Choubey**)
Project Director
PMO-FRERMIP, BWDB, Dhaka.

Memo no: PMO-FRERMIP/C-2/305/1(9) Date: 02 December 2018

Copy forwarded for kind information/information and necessary action to:

1) Additional Director General (Western Region), BWDB, Dhaka.
2) Additional Director General (Planning), BWDB, Dhaka.
3) Chief Planning, BWDB, Dhaka.
4) Chief Engineer, Design, 72, Green Road, Dhaka.
5) CSO to DG, BWDB, Dhaka.
6) Country Director, BRM, ADB, Sher-E-Bangla Nagar, Dhaka.
7) Mr. Zahir Uddin Ahmad, Team Leader, Water Resources Management, BRM, ADB, Sher-E-Bangla Nagar, Dhaka.
8) Deputy Team leader, ISPMC-FRERMIP, Dhaka.
9) Office Copy.

FRERMIP ISPMC
05 DEC 2018
INCOMING

Project Director
PMO-FRERMIP, BWDB, Dhaka.

Minutes of the Technical committee meeting on FRERMIP Tranche-2 Project held on 08 October 2018 in the Conference Room of the Director General, BWDB, Dhaka.

The meeting of the Technical Committee (TC) on Flood and Riverbank Erosion and Risk Management Investment Program (FRERMIP) – Tranche-2 was held in the conference room of the Director General, BWDB, Dhaka at 4.00 PM on 08 October 2018 regarding reviewing & finalization of detailed structural design including Feasibility Study of Tranche-2 Project. Mr. Md. Delwar Hossain, Additional Director General (Planning), BWDB, Dhaka and Chairperson of the TC presided over the meeting. The list of TC members who attended the meeting is furnished in attachment-1. Honorable Director General, BWDB, Dhaka was kind enough to attend the meeting and make the meeting more effective through active participation.

The Chairperson welcomed the participants and invited Mr. Md. Rafiqul Islam Choubey, Project Director, FRERMIP and Member Secretary of TC to shortly describe the project outline and present the detail objectives of today's Technical Committee meeting.

Mr. Md. Rafiqul Islam Choubey, Project Director, FRERMIP described the project in brief, different phases of the project and the objectives of today's meeting. He described that GoB, ADB and GoN agreed a Loan/Grant Agreement to finance a Multi-tranche Financing Facilities investment program named "Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)" and this Investment program will be implemented in 3 tranches. According to the agreement, ADB will provide a loan of 255.00 million USD and GoN will provide a grant of 15.30 million USD for three Tranches. The program will be implemented in three tranches from August 2014 to June 2023 with individual DPP for each tranches. Presently, BWDB is implementing the project of "Flood and Riverbank Erosion Risk Management Investment Program (Tranche-1)" project. Under this project feasibility study for tranche-2 project will be completed. He then stated in the meeting that the River Stabilization Plan of FRERMIP project has been incorporated in the approved Delta Plan and then he explained about the different interventions of FRERMIP project in map of his slide presentation. He stated that according to the received Draft Feasibility Study report of Tranche-2 Project from

ISPMC, they consider River bank protection works at Pukuriya, Chauhali, Salura, Omarpur, Enayetpur & Benotia following River Stabilization Plan. He then mentioned in the meeting that from concern design office's of BWDB, River bank protection works at places of Salura, Omarpur, Enayetpur has been dropped from Tranche-2 as these places are lying on the charland within the mighty Jamuna river and also there is no study report regarding the sustainability of these proposed works. All the members of the committee agreed to exclude charland protection works at Salura, Omarpur, Enayetpur after detailed discussion.

The Project Director then described that Embankment construction works along the right bank of Jamnua river from kaijuri to benotia is going on and Benotia is under immediate threat of erosion, which is approximately 90 meter setback distance from the present alignment. According to the draft Feasibility Study report, ISPMC consultant consider 1 km river bank protection works at Benotia. But at present condition, river bank protection works at Benotia should be increased from 1 km to 3.50 km. Mr. Motahar Hossain, Chief Engineer, Design, BWDB, Dhaka stated in the meeting that at this place 3.50 km river bank protection works should be taken for encounter the erosion along with sustainability of the ongoing Embankment construction works. All the members of the committee agreed with this.

The Project Director then explained briefly about the adaptation works. He stated in the meeting that, adaptive Management Approach means that riverbank protection works will be implemented during the dry period with low cost technology and will be monitored during the flood period through bathymetric/under water survey. If any damage on launching apron is observed from the monitoring report, the damaged/launched portion will be repaired by additional dumping of geo-bags. It will be continued till sustainability. Accordingly, River bank protection works under JMREMP and FRERMIP Tranche-1 project has been completed. The ISPMC consultant also consider this adaptation technology in the Feasibility Study report of Tranche-2 Project. According to their proposed design, only sand filled geo-bags will be used in under water as a dumping materials and in above water as a slope protection. They proposed sand filled geo-bags dumping volume of approximately 70.94 cum/m which is consist of approx. 35 cum/m as initial protection, 16.47 cum/m as 1st adaptation, 12.98 cum/m as 2nd adaptation, 6.49 cum/m as 3rd adaptation.

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Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka opposed to apply adaptation technology in case of river bank protection works. He stated in the meeting that, from past experience it has observed that capital cost is less in respect to maintenance cost and so many times in many places damages occurred in Chauhali during the flooding period of 2017 along with 3 times damages this year. For this reason, adaptation technology along with bank protection with only geo-bags may not be considered in mighty river like Jamuna & Padma river as no regret consideration. In this context Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka stated in the meeting that, total cost in favour of adaptive management not reduces than the permanent bank protection cost as usual practice of BWDB. So, we reviewed the bank protection works design and provide dumping volume of approximately 75 cum/m (50% CC Blocks and 50% geo-bags) at apron and 3.25 cum/m at berm (1 cum/m geo-bags & 2.25 cum/m CC blocks).

Mr. Motahar Hossain, Chief Engineer, Design, BWDB, Dhaka stated in the meeting that bank protection work with only geo-bags will not applicable further. He also explained that, from his past experiences CC blocks with geo-bag is more effective than only geo-bags as a dumping materials.

The Project Director stated in the meeting that, if we use 50% CC Block as a dumping materials the implementation of the work will be very difficult due to crisis of stone chips which will be used for CC block manufacturing purposes and the project cost will also be higher than planned in the PPTA. The Project Director also stated that management of CC blocks normally take more times which causes delaying the project completion. Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka replied in this context that, in this case we may use hard rock instead of CC block although hard rock having more durability and availability. He also stated that in that case, GoB contribution may be higher or scope of work may be reduced and remaining work may be implemented under Tranche-3 in case of higher project cost.

The Project Director stated that according to the received Feasibility Study report of Tranche-2 Project from ISPMC, they proposed char development works with sand plugging at Solimabad following River Stabilization Plan. According to the

discussion with the ISPMC consultant, he described that using the innovative technology of a "sand engine" developed in Holland, basically a sand plug, which could be overtopped to move the sediment into the channel and then rebuild during the next dry season. After some years the bank line channel will be choked and the existing work at Chauhali will be extended in downstream direction to guide the flow along the silted up mouth of the channel. He then mentioned in the meeting that from concern design office's of BWDB consider cross bar at Solimabad and with this huge amount of land will be reclaimed in the downstream of this area. The Project Director also stated that Dr. Mohammad Shariful Islam, Professor, Dept. of Civil Engineering, BUET, Dhaka has been found with vast experience for providing a new view on the technology of vetiver plantations and plantation of vetiver on the Solimabad char will started immediately for sedimentation and land development. In this context Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka suggested to incorporate Doincha tree along with vetiver grass. He also explained that Doincha tree having high capacity to retain sand.

Mr. Md. Aminul Haque, Chief Planning, BWDB, Dhaka described in the meeting that Old Dhaleswari Offtake suffer from substantial variability of flows resulting from erosion or deposition at the mouth. The Old Dhaleswari still falling dry during the lean season as huge sand bar observed at the mouth. He also opined to manage Dhaleswari Offtake by ensuring water during the dry period.

In this context Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka said that we have to reclaim land from river considering the future demand in respect to Government's Vision 2041. He suggested to alive Old Dhaleswari Offtake. He also mentioned that by constructing well planned and proper designed offtake management structures, we can open the channel during flood season and can pump river water to the channel during dry season. He also instructed for conducting detailed hydro-morphological study based on present topographical & hydrographical survey data. In that case, we can contact River Research Institute (RRI) for physical modelling or we can go for numerical/mathematical modelling. The model should run with regular/high flow, proper velocity and with sediment loaded flow. He emphasized that, this structure can be a model structure for future river stabilization activities in Jamuna and Padma rivers. Furthermore, he suggested to incorporate lining work at the upstream & downstream of the offtake

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along with radial gated structure, if necessary. He also suggested to prepare DPP of Tranche-2 considering the intervention find out from physical/mathematical model result at solimabad along with other intervention as embankment construction works, regulators/Fish-pass structure, bank protection works etc. & in this DPP there should be a provision for detailed technical study in favor of offtake management by forming a Technical advisory committee. According to him, in this DPP procurement plan should be as Embakment/Regulator/bank protection works started from 1st year and solimabad intervention should started from 2nd year. All the members of the committee agreed with this views.

The Project Director stated that according to the Feasibility Study report of Tranche-2 Project, 17.40 km embankment construction works along with 4 nos. regulator will be implemented from Dohar to Harirumpur. He also stated that, the superintending Engineer, Design Circle-II suggested to include 3(three) more regulator in this area for ensuring proper drainage. Taking a part of the discussion of this issue, Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka stated in the meeting that, ISPMC did not consider the local people's demand and they did not discuss with them. There is a demand of local people to construct a regulator over Ichamati river at Kaishakhali Closure point and a regulator over Gosail khal. But they did not consider in their study. He also stated that the demand of the local people is to intrude fresh water during dry season and to ensure adequate drainage facilities. He also stated that detailed depth study is needed in a holistic approach instead of piecemeal way for determination of location, size, number of regulators. Mr. Abdul Matin Sarker, Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka informed in the meeting that in Dohar area flushing is the main requirement of them & he also stated that local peoples are not so much concern about the project. He also stated that presently the local people wanted a regulator at Kaishakhali closure point. All the member of the committee agreed to conduct detail technical study of this area considering irrigation planning map or DEM data by ISPMC considering with the views of the concern officials of BWDB's O&M Division and local peoples and their representative.

Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka asked the Project Director about the design & specifications of this embankment. The Project

Director replied that the height of the embankment is 3.50 m to 9.60 m, top width is 6 m and bottom width is 50 m to 80 m. Then the Director General, BWDB, Dhaka sought to know about the foundation treatment of the embankment due to high sections. Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka replied that there is a provision of Perforated Vertical Drain (PVD) for foundation treatment. The Director General, BWDB, Dhaka also wanted to know about the return period of this embankment design. Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka informed in the meeting that we consider 100 year return period for protective work. The Director General, BWDB, Dhaka suggested that now we can consider 200 years return period in case of embankment construction & 100 years in case of revetment works in line with the Delta plan of the developed country.

Mr. Abdul Matin Sarker, Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka informed in the meeting that 8.80 km river bank protection work has been completed under FRERMIP –Tranche-1 project & upstream of this completed work severe bank erosion took place. For this immediate action is required for sustainability of this work, otherwise there is a possibility of outflanking. In this issue, the Project Director replied that there is no scope to consider this part under FRERMIP Tranche-2 project. Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka instructed to the Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka to form a Technical Committee immediately for preparing a separate DPP from GoB fund.

Mr. Abdul Matin Sarker, Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka stated in the meeting that placed sand filled geo-bags in some portion of the slope of 8.80 km protection work at Harirumpur damages due to expose to the sunlight. Mr. Motahar Hossain, Chief Engineer, Design, BWDB, Dhaka opined to remove these geo-bags and to place CC block immediately. Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka responses in this regard that there is a provision of CC block placing under FRERMIP Tranche-3 project & he suggested to placing with CC block under Tranche-2. Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka informed that Geo-bags should not be exposed and should be used only under water protection purposes. He then suggested to place geo-bags in slope as a temporary

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protection for a period of 1 year only and after that placed geo-bags should be replaced by CC blocks.

The Project Director stated that approximately 100,000 (one lac) CC blocks (placing & dumping) are available at Chauhali work site as stock piles & local peoples are very much worried as stock piles occupied their cultivable land & they did not getting any compensation. He wanted to a decision about the stock piles. Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka instructed to use the stock pile as a placing and dumping & costing may be incurred from the BWDB's O&M budget.

The Project Director wanted to know in the meeting that 17.80 km bank protection work completed under FRERMIP Tranche-1 project and 17.00 Km bank protection work completed under JMREMP project , if any damages occur during flooding or receding time how he address? Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka suggested to keep maintenance budget provision as strengthening/emergency works in the DPP of Tranche-2.

The Project Director stated that 2.00 km bank protection work completed at Zafarganj under Tranche-1 & a school building saved from erosion considering humble request from the Deputy Commissioner of Manikganj & other local allied persons. Presently, in front of this school look like a Spur shape & may be threaten in future due to scouring. Mr. Abdul Matin Sarker, Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka informed in the meeting that we have geo-bags & costing of filling & dumping may be incurred from BWDB's O&M budget. All the members of the committee agreed with this views.

The Project Director stated that construction of 21.30 km embankment started in continuation with BRE embankment along the right bank of Jamuna River and will end at the place named Ahmedpur along the left bank of Hurasagar River. Construction of embankment will continue for 1.70 km length along the left bank of Hurasagar River & another 6.00 km along the left bank of Korotoya to meet the existing Shahzadpur – Koijuri road under Tranche-2 project. So, with the construction of additional 7.70 km under Tranche-2, the construction of embankment will be completed and the flood control benefit will be achieved. He also stated that if 7.70 km is not constructed under Tranche-2 or DPP of Tranche-2 is not taken then purpose of the project will not be achieved. In that case he

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requested to take another separate DPP from the GoB fund. Mr. Md. Mahfuzur Rahman, Director General, BWDB, Dhaka agreed with his proposal & instructed to form a Technical Committee to prepare a DPP of Incomplete work of completed project. Mr. Mohammad Harun-Ur-Rasheed, Superintending Engineer, Design Circle-II, BWDB, Dhaka replied that there is already a report of the Technical Committee.

Supporting the above issues, the chairperson suggested to finalize the draft Feasibility Study report of Tranche-2 Project at the earliest.

The decisions of the meeting were:

I. Proposed river bank protection works at Salura, Omarpur & Enayetpur may be excluded from Tranche-2 as these are charland protection and there is no study report regarding the sustainability of these works.
II. Riverbank protection work will be implemented at Chauhali (from Km 7.00 to Km 19.00=12.00 Km) and at Benotia (from Km 10.00 to Km 13.50=3.50 Km) under Trenche-2, as these two points are vulnerable.
III. Riverbank protection works may be implemented considering dumping volume of approximately 75 cum/m (50% CC Blocks/Hard rock and 50% geo-bags) at apron and 3.25 cum/m at berm (1 cum/m geo-bags & 2.25 cum/m CC blocks).
IV. Plantation of Doincha along with vetiver grass on the char Solimabad for sedimentation and land development may be adapted.
V. prepare a DPP of Tranche-2 considering the intervention according to the result of physical or mathematical model at solimabad along with other intervention as embankment construction works, innovative regulator structure, bank protection works etc. & in this DPP there should be a provision for detailed technical study by forming a Technical advisory committee for Old Dhaleswari offtake management by Conducting a physical/mathmatical model study. In this DPP procurement plan should be as Embakment/Regulator/bank protection works will start from 1st year and solimabad intervention should start from 2nd year.

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VI. GoB contribution may be higher or scope of work may be reduced and remaining work may be implemented under Tranche-3 in case of higher DPP cost of Tranche-2 than planned in the PPTA.

VII. ISPMC have to conduct detailed technical study in a holistic approach with inclusion of the opinions of BWDB officials and local representatives for determination of alignment of embankment and location, size, number of innovative regulators including consultation with the stakeholders for Dohar to Harirumpur embankment.

VIII. The Draft Feasibility Study Report of Tranche-2 Project may be finalized later subject to comply all comments/observations of the technical committee's.

IX. Committee decided to form a technical committee for implementation of river bank protection works at the upstream of Harirumpur bank protection work for preparing a separate DPP from GoB fund.

X. Placement of geo-bags in slope as a temporary protection will be for a period of 1 year only and after that placed geo-bags must be replaced by CC blocks in Tranche-2 Project.

XI. Stock pile at Chauhali will be used for placing and dumping & costing may be incurred from the BWDB's O&M budget.

XII. Provision of sufficient maintenance budget for completed works of JMREMP & FRERMIP Tranche-1 project as strengthening/emergency works in the DPP of Tranche-2.

XIII. Received geo-bags from FRERMIP under Tranche-1 project may be used at Zafarganj & costing of filling & dumping may be incurred from BWDB's O&M budget.

XIV. If DPP of Tranche-2 is not taken, Committee decided to form a technical committee for implementation of 7.70 km embankment construction work along with other interventions appropriate for better sustainability of Hurasagar Sub-project for preparing a separate DPP from GoB fund.

The meeting was ended with a vote of thanks from the chair.

14/10/2018

(Md. Delwar Hossain)
Additional Director General (Planning)
BWDB, Dhaka.
&
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Chairperson, Technical Committee

"Attachment-1"

"Flood and Riverbank Erosion Risk Management Investment Program (Tranche-2)" শীর্ষক প্রস্তাবিত প্রকল্পের সম্ভাব্যতা সমীক্ষা চূড়ান্তকরণসহ পূর্ত কাজের নকশা চূড়ান্ত করণের লক্ষ্যে গঠিত কারিগরী কমিটির সভা।

সূত্র: স্মারক নং- বাপাউবো(সচি)/পরি-১/বিবিধ-৩/২০১৮(১ম খণ্ড)/১১৫; তারিখ: ০১/১০/২০১৮ খ্রিস্টাব্দ এবং স্মারক নং- পিএমও-এফআরইআরএমআইপি/এম-১(৩য় খন্ড)/১৭৬; তারিখ: ০৪/১০/২০১৮ খ্রিস্টাব্দ।

তারিখ: ০৮/১০/২০১৮ খ্রিস্টাব্দ।
সময়: বিকাল ৪:০০ ঘটিকা
স্থান: মহাপরিচালকের সভাকক্ষ, ওয়াপদা ভবন, মতিঝিল বা/এ, ঢাকা।

সভায় উপস্থিতির তালিকা:

ক্র. নং	নাম ও পদবী	কারিগরী কমিটিতে পদবী	স্বাক্ষর
১।	জনাব মোঃ মাহফুজুর রহমান মহাপরিচালক, বাপাউবো, ঢাকা।	-	
২।	জনাব মোঃ দেলোয়ার হোসেন অতিরিক্ত মহাপরিচালক (পরিকল্পনা), বাপাউবো, ঢাকা।	আহ্বায়ক	
৩।	জনাব খন্দকার খালেকুজ্জামান অতিরিক্ত মহাপরিচালক (পশ্চিম রিজিয়ন), বাপাউবো, ঢাকা।	সদস্য	
৪।	জনাব এ, এম, আমিনুল হক প্রধান পরিকল্পনা, বাপাউবো, ঢাকা।	সদস্য	
৫।	জনাব মোতাহের হোসেন প্রধান প্রকৌশলী, নকশা, বাপাউবো, ঢাকা।	সদস্য	
৬।	জনাব হারুন উর রশিদ তত্ত্বাবধায়ক প্রকৌশলী, নকশা সার্কেল-২, বাপাউবো, ঢাকা।	সদস্য	
৭।	জনাব এ, কে, এম, সফিকুল হক তত্ত্বাবধায়ক প্রকৌশলী, ময়মনসিংহ পওর সার্কেল, বাপাউবো, ময়মনসিংহ।	সদস্য	
৮।	জনাব মো. আব্দুল মতিন সরকার তত্ত্বাবধায়ক প্রকৌশলী, ঢাকা পওর সার্কেল, বাপাউবো, ঢাকা।	সদস্য	
৯।	জনাব এস, এম, শহিদুল ইসলাম তত্ত্বাবধায়ক প্রকৌশলী, পাবনা পওর সার্কেল, বাপাউবো, পাবনা।	সদস্য	
১০।	ড. শ্যামল চন্দ্র দাস নির্বাহী প্রকৌশলী, প্রধান পরিকল্পনা দপ্তর, বাপাউবো, ঢাকা।	সদস্য	
১১।	জনাব মোঃ রফিকুল ইসলাম চৌধে প্রকল্প-পরিচালক, পিএমও-এফআরইআরএমআইপি, বাপাউবো, ঢাকা।	সদস্য-সচিব	
১২।	[illegible]	—	

Memo no: PMO-FRERMIP/M-1/199/1(14) Date: 16 October 2018

Copy forwarded for kind information/information and necessary action:

1. Director General, BWDB, Dhaka.
2. Additional Director General (Planning), BWDB, Dhaka.
3. Additional Director General (Western Region), BWDB, Dhaka.
4. Chief Planning, BWDB, Dhaka.
5. Chief Engineer, Design, BWDB, Dhaka.
6. Superintending Engineer, Design Circle-II, BWDB, Dhaka.
7. Superintending Engineer, Pabna O&M Circle, BWDB, Pabna.
8. Superintending Engineer, Mymensingh O&M Circle, BWDB, Mymensingh.
9. Superintending Engineer, Dhaka O&M Circle, BWDB, Dhaka.
10. Dr. Shaymal Chandra Das, Executive Engineer, Office of the Chief Planning, BWDB, Dhaka.
11. Executive Engineer, Tangail O&M Division, BWDB, Tangail.
12. Executive Engineer, Manikganj WD Division, BWDB, Manikganj.
13. Executive Engineer, koitala Construction Division, FRERMIP, BWDB, Koitala, Bera, pabna.
14. Office Copy.

16.10.18

(Md. Rafiqul Islam Choubey)
Project Director
PMO-FRERMIP
BWDB, Dhaka
&
Member-Secretary of the
Technical Committee

10

Flood and Riverbank Erosion Risk Management Investment Program

Compliance of Technical Committee Recommendations in the updated Feasibility Report Tranche-2

Option 1 designs are designs contained in the April 2018 Feasibility Report

Option 2 designs are designs proposed by the BWDB (January 2019)

Nr	Technical Committee Recommendation	Feasibility Report Action
1	Proposed river bank protection works at Salura, Omarpur & Enayetpur may be excluded from Tranche-2 as these are charland protection and there is no study report regarding the sustainability of these works	Option 2 designs, approved by the Design Office, exclude Charland protection (e.g. Feasibility Study Report (FSR) section 7.1)
2	Riverbank protection works will be implemented at Chauhali (from Km 7.00 to Km 19.00=12.00 Km) and at Benotia (from Km 10.00 to Km 13.50=3.50 Km) under Trenche-2 as these two points are vulnerable	Option 2 includes the riverbank protection at Chauhali and Benotia, which designs are approved by the Design Office (e.g. FSR S. 7.1)
3	Riverbank protection works may be implemented considering dumping volume of approximately 75 cum/m (50% CC Blocks and 50% geo-bags) at apron and 3.25 cum/m at berm (1 cum/m geobags & 2.25 cum/m CC blocks)	Option 2 includes the riverbank protection design approved by the Design Office (e.g. FSR S. 7.1)
4	Plantation of Doincha along with vetiver grass on the char Solimabad for sedimentation and land development may be adopted	The feasibility study considers plantation of different types of vegetation. (e.g. FSR S. 4.1)
5	Prepare a DPP of Tranche-2 considering the intervention according to the physical or mathematical model at Solimabad along with other intervention as embankment construction works, innovative regulator structure, bank protection works etc. & in this DPP there should be a provision for detailed technical study by forming a Technical advisory committee for Old Dhaleswari offtake management by conducting a physical/mathematical model study. In this DPP procurement plan should be as Embankment/Regulator/bank protection works will start from 1st year and Solimabad intervention should start from 2nd year.	Tranche 2 includes provisions for a detailed offtake study in line with the recommendations. The implementation of the works, depending on the study outcome and detailed cost estimate is scheduled for Tranche-3, expected to start one year after Tranche-2. (e.g. FSR S. 4.3)
6	GoB contribution may be higher or scope of work may be reduced and remaining work may be implemented under Tranche-3 in case of higher DPP cost of Tranche-2 than planned in the PPTA	Option 2 contains the full allocation of all work as per approved design of the Design Office. (e.g. FSR S. 7.4)
7	ISPMC have to conduct detailed technical study in a holistic approach with inclusion of BWDB officials and local representatives for determination of alignment of embankment and location, size, number of innovative regulators including consultation with the stakeholders for Dohar to Harirampur embankment	The designs for Tranche-2 are based on a comprehensive stakeholder consultation process. This involves changes of the alignment based on comments from the local population, but also adding additional structures, following discussions with local people and BWDB officials. (e.g. FSR S. 4.1)

8	The draft Feasibility Study Report of Tranche-2 Project may be finalized later subject to comply all comments/observations of the technical committee's.	Feasibility study finalized complying with all comments/ observations of the technical committee related to the Feasibility study report.
9	Committee decided to form a technical committee for implementation for river bank protection works at the upstream of Harirumpur bank protection work for preparing a separate DPP from GoB fund	Not part of this Feasibility Study. BWDB will take action.
10	Placement of geo-bags in slope as a temporary protection will be for a period of 1 year only and after that placed geo-bags must be replaced by CC blocks in Tranche-2 Project	The Feasibility study includes the replacement of the temporary geobag protection at Harirampur by hard protection under Tranche 3. (e.g. FSR S. 4.1)
11	Stock pile at Chauhali will be used for placing and dumping & costing may be incurred from BWDB's O&M budget.	Not part of this Feasibility Study
12	Provision of sufficient maintenance budget for completed works of JMREMP & FRERMIP Tranche-1 project as strengthening/emergency works in the DPP of Tranche-2	Tranche 2 includes provisions for 40 km of adaptation/ strengthening works and 5 km of emergency works (e.g. FSR S. 7.4)
13	Received geo-bags from FRERMIP under Tranche-1 project may be used at Zafarganj & costing of filling & dumping may be incurred from BWDB's O&M budget.	Not part of this Feasibility Study
14	If DPP of Tranche-2 is not taken, Committee decided to form a technical committee for implementation of 7.70 km embankment construction work along with other interventions appropriate for better sustainability of Hurasagar Sub-project for preparing a separate DPP from GoB fund.	Not part of this Feasibility Study

APPENDIX C

COMMENT RESPONSE MATRIX TO OBSERVATIONS FROM REVIEW COMMITTEE

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Decision of Technical Committee: "Draft Feasibility Report for Tranche-2" under Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) was submitted on March'2018. A meeting on this Draft report was held on October 8, 2018 with ADG (Planning), BWDB in the chair as Chairperson of the Technical Committee. DG, BWDB were also present at that meeting. In that meeting this Draft Report were discussed elaborately and some concrete and definite decision were taken. Some of the decision of that meeting are as follows : a) Charland protection work at Salura, Omarpur & Enayetpur were decided to excluded as there are no study regarding the stability of these char. b) Location of bank protection work was finalized at Chouhali & Benotia for a length of (km 7.00 to km 19.00 =) 12.00km and (km10.00 to km 13.50=) 3.50km respectively. c) Dumping volume of bank protection work was finalized as 75cum/m with 50% CC Block/Hard Rock and 50% Geobag. d) Intervention at Solimabad will be undertaken after physical / mathematical modelling. '	ISPMC is aware of the decisions of the Technical Committee. A comment response matrix showing compliance of the updated report to the decisions of the meeting is included as Appendix B to the Feasibility report.	No action	closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
	e) Old Dhaleswary Offtake Management will be undertaken after physical / mathematical modelling. f) This "Draft Feasibility Report for Tranche-2" are to be finalized subjected to comply all comments/observation of the Technical Committee.			
A1.	When a Feasibility Report submitted to BWDB, BWDB send this Report to relevant offices for their comments. By incorporating those comments, Draft Feasibility Report are finalized. For this "Draft Feasibility Report for Tranche-2", Technical Committee meeting were held in presence of DG, BWDB. In that meeting directives were given to finalized the Draft Report by incorporating comments/observations of the Technical Committee. Instead of incorporating the comments/observations of the Technical Committee of BWDB, the structure of previously submitted Draft Feasibility Report was altered This is an unacceptable approach. As such Final Feasibility Report is not an acceptable one. In the Draft Feasibility Report, there were no Option. Final Feasibility Report was submitted with Two Options without any engineering justification. Benefits or disbenefits of different components of this Two Option were not explained. They have the opportunity to generate many options, if it is needed, during their study. But it was not done. Options have generated after submitting Draft Feasibility Report, although there were no comments for generation of Options. This indicates inefficiency of ISPMC in preparation of Feasibility Report. This is an unacceptable approach. As such Final Feasibility Report is not an acceptable one.	The second updated version does not show alternative options and focusses on the Client preferred option as per October Technical Committee recommendation. Background: The Office of the Chief Engineer Design reviewed and commented on an early version of the updated feasibility study. This version was updated based on comments received from the Superintending Engineer Design II on 6th May 2019. Subsequently comments from the Project Director during the last week of June 2019 were incorporated and the updated version was provided on 1st July 2019. In line with international best-practice, feasibility studies provide alternatives or	No Action	Closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
	Option-I was made with the location of work & which was rejected by Technical Committee. Option-2 was made considering the location of work & design recommended by Technical Committee. Options in a feasibility report cannot made in this way. As such Final Feasibility Report is not an acceptable one. t) Final Feasibility Report does not follow the decisions of Technical Committee. As such Final Feasibility Report is not an acceptable one.	options in justification of the preferred approach. The original feasibility study from March 2018, was based on the principles of the agreed Framework Financing Agreement, 2014, detailed in the approved Site Selection and Initial Economic Assessment report of May 2017 which was approved by the Technical Advisory Committee in September 2017.		
A2.	Comments made on the "Draft Feasibility Report for Tranche-2 from different offices has not been addressed in "Updated Feasibility Report for Tranche-2". As such this Final Feasibility Report is not an acceptable one.	Comments were only received from the BWDB Design Circle 2. These have been incorporated in the Feasibility Study Report	No action	Closed
A3.	One of the major problems with this ISPMC is that they frequently change the length & location of work, since 2012. There is no consistency with different proposal and report submitted by them time to time. So, it is very difficult to make comment or follow their proposal and report.	The length and location of works has to be changed based on the changed morphology of the river. Due to the relatively long time periods under the FRERMIP, changes between tranches can be substantial. This approach is part of the Framework Financing Agreement, agreed by BWDB and ADB in 2014.	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
A4.	Jurisdiction of FRERMIP is from D/S of Bangabandhu Bridge to Alicha for Jamuna River and Pangsa to Chandpur for Padma River. FRERMIP taken the responsibility of River Bank Protection with Flood Embankment on both banks, approximately for 168+178 346 km. Total Project period is from 2014 to 2024. Accordingly, the location & length of bank protection work and embankment were proposed & approved for Trench-I, Trench-2 & Trench-3. In the original Feasibility Study, there were no proposal for char protection. FRERMIP taken a vast area with a tiny amount of money. More than 40% of their project period (for 3 Trench) is over. But their progress is very negligible. It indicates the inexperience and incapability of ISPMC. In Trench-I, FRERMIP addressed only 17.80 5.20% by 2018. Out of this 17.80 km, complete protection was provided for 7.00km only. Rest 16.00km is proposed to complete in Trench-3. Chouhali 5.00 km Full Protection, 2.00 km Precautionary Protection (It was not proposed in original FS) Zafargonj 2.00 kn Full Protection, Harirampur 7.00 Ion Full Protection, Temporary protection on above water 1.80 km Precautionary Protection (It was not proposed in original FS)	The feasibility study for FRERMIP, 2013 has selected three priority sites out of 13 in the stated area for priority interventions, namely JRB-1, JLB-2 and PLB-1, and considered the Jamuna and Padma for a river stabilization plan to provide the overall framework for more holistic interventions over a longer time horizon. The outline of this approach is part of the Bangladesh Delta Plan, 2100 In line with the FRERMIP Framework Financing Agreement and the Loan for Tranche-1 agreed by the BWDB and the ADB in 2014, future work for Tranche-2 and 3 shall be adjusted, to: account for morphological changes in the river (see for example Schedule 4 of the Framework Financing Agreement), and reflect the results of the river stabilization plan (see for example the Bangladesh Delta Plan, 2100 for an outline)	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Hurasagar 21.3 km Embankment, No slope protection work was included in original feasibility Study. Later on, some experimental slope protection work was done. But still slope at some vulnerable location are unprotected. In "Updated Feasibility Report for Tranche-2", ISPMC proposed 11.00km for bank protection work and 14.00 km for Protection Work of Charland under Option 1.	In passing it is noted that the bridge at Harirampur was proposed by the BWDB design office. This will be finalized through the Arial Beel Integrated Development Project, which study is part of the FRERMIP Tranche 2 main consultancy.		

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Chouhali 5.00 km Full Protection, Temporary protection on above water. Pukuria 5.00 km Full Protection, Temporary protection on above water Light (Precautionary) Protection Benotia 1.00 km Full Protection, Temporary protection on above water. Enayetpur 4.00 km Char Protection, Temporary protection on above water Salura 4.00 km Char Protection, Temporary protection on above water Omarpur 6.00 km Char Protection, Temporary protection on above water Hurasagar 7.00 km Embankment. Still slope at some vulnerable location are unprotected. Harirampur 17.00 km Embankment. 1 (one) Bridge proposed without any justification. Nothing mentioned about Kaishakhali Closure.			
A4a.	Length & Location proposed for Trench-2 in this Report, are complete deviation from Original Feasibility Study Report of 2013.	Please see explanations provided in comment A4 above	No action	Closed
A4b.	The project was taken for protection of river bank with embankment. ISPMC changed the concept of the project and shifted to Protection Work	In line with the Technical Committee recommendations, the updated feasibility	No action	Closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
	for unstable Char land without any study. There is no demand for char Protection work. This char Protection work is very very less important in comparison to Original land Protection Work at Benotia, Dawn Tarotia, Hatpachil, Pukuria, Solimabad, Daulatpur, Horirampur, Dhulsura, Brah bazar, Majirchar, Noria etc.	study does not include riverbank protection on charland. Background In line with the Framework Financing Agreement and the Loan Document, the river stabilization plan results are to be incorporated into the Tranche-2 and -3 works. Protection works at Salura, Omarpur and Enayetpur as part of a more holistic stabilization effort of the Lower Jamuna in line with the river stabilization plan were approved by the Technical Advisory Committee in 2017 The feasibility study report of 2015 provided details of the requirement and justification for river stabilisation on the bifurcation and at strategic locations in Annexe 5.		
A4c.	The chars of Jamuna are unstable and not permanent. Most of the char lands are submerged during High Water Level.	Noted. Background This statement is correct and the reason for formulating a river stabilization plan as per	No action	Closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
		agreement between BWDB and ADB from 2014. As a consequence, charland will receive riverbank protection in future, as important element to guide the river in a more predictable and navigable form. The BWDB has applied char protection work from 2012 onwards up- and downstream of Sirajganj.		
A4d.	ISPMC proposed protection work at Chouhali, Pukuria, Salura, Omarpur & Enayetpur, But they proposed no embankment at this location. This is a deviation from the concept of originally approved Feasibility Study.	An embankment from Aricha to Chauhali is planned under Tranche 3 as per original project concept. Protection works at Salura, Omarpur and Enayetpur has been excluded from the FSR.	No action	Closed
A4e.	There is serious bank erosion at Benotia & Dawn Tarotia, for a length of at least 3.50 km. The embankment of Hurasagar is within 50 to 100m from river bank at this location. If no protection work was done here, then embankment of Hurasagar Project of Trench-I will be engulfed by Jamuna. ISPMC proposed only 1.00 km protection work at this location, which is very very insufficient and it could not save the embankment of Hurasagar Project.	The proposed protective length is 3.5km. Background Acknowledging the low predictability of the river morphology, the Tranche-2 provides for 5km of emergency works to counter unpredictable erosion. The Benotia erosion happens in a deposition zone downstream of a protected large outer bend. Periodically the meander cuts	No action	Closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
		through this deposition to form a shortcut to the downstream channel influenced by the Hurashagar river flows. The latest survey in this location from 24/25 July 2019 indicates a deep channel of around 1km in length.		
A4f.	In Hurasagar Project, WS slope of embankment at some vulnerable location are unprotected. ISPMC proposed no slope protection here.	Under Tranche 1, already about 3.2 km of wave protection in the form of Grout-filled Jute Mattress has been provided and other reaches have been provided with vetiver plantation to counter wave action. The embankment will be closely monitored during Tranche 2 and if required additional works will be included under Tranche 3, which is timewise overlapping with Tranche 2.	No action	Closed
A4g.	There is serious bank erosion on the U/S Harirampur. If this bank erosion is not addressed now, it will cause outflanking of 9.00km protection work of Trench-I.	The current erosion is being addressed by a separate DPP under the BWDB O&M division Dhaka, which will provide about 4 km of protection upstream of Harirampur.	No action	Closed
A4h.	In Harirampur, 17.00km Embankment was proposed on a charland without any study. Bank erosion are observed at & near Dhulsura. There is a possibility of outflanking of newly build 9.00km protection work. This bank erosion threatened the proposed embankment. ISPMC proposed no	The provided design was approved by the BWDB Design Circle II and Chief Engineer Design on 23/12/2018	No action	Closed

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
	protection work here. It is foolishness to do a large investment for 17.00km embankment, without doing any bank protection work. It is to be mention here that there is no demand for embankment. This 17.00km Embankment is very very less important in comparison to Bank Protection Work at Benotia, Dawn Tarotia, Hatpachil, Pukuria, Solimabad, Daulatpur, Horirampur, Dhulsura, Brah bazar, Majirchar, Noria etc.	The design for implementation will be finalized during Tranche 2 as part of the Arial Beel study (see Comment A4)		
A4i.	Moreover, ISPMC illogically proposed 14.00km unstable Char Protection, instead of bank protection. There is a possibility of washing out, this 14.00km unstable Char Protection work, after first flood. ISPMC does not provide any proper engineering justification for the selection and objectives of such unstable Char Protection	This has been excluded from the latest version of the report. For background please refer to A4c and A4d	No action	Closed
A4j.	It is to be noted here that alignment of char protection works at Salura & Enayetpur placed in such a way that it will easily outflank from U/S. Moreover, alignment of char protection work at Salura, placed in such a way that it will cause oblique flow towards Bank Protection Work at Chouhall So, alignment of char protection W01k at Sakura & Enayetpur are also not acceptable	See response to Comment A4i	No action	Closed
A4k..	Under the above situation, who will take the responsibility when a. Embankment of Hurasagar Project will be engulfed by Jamuna River. b. Slope of embankment of Hurasagar will be damaged by wave action. c. 9.00 km Protection work of Harirampur will be outflanked from UIS. d. 17.00km Embankment at Harirampur will be eroded by Padma River.	The responsibility for maintenance is stipulated in Schedule 5 of the loan agreement. a. Some emergency works have already been implemented by BWDB over a length of about 1 km. Further 3.5 km of full	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	e. When 14.00km unstable Char Protection work will be washed out after first flood. f. 2.00 km Light Protection at Pukuria be damaged and it will be a cause of damage for the adjacent protection work.	protection is included in Tranche 2 (see response to Comment A4e) b. see response to Comment A4f c. see response to Comment A4g d. see response to Comment A4h e. see response to Comment A4i f. see response to Comment A4i		
A4l.	In the "Updated Feasibility Report", there is no explanation, for selecting very very unimportant unstable char area like Salura, Omarpur & Enayetpur by excluding more imponant and vulnerable original land located at Benotia, Dawn Tarotia, Hatpachil, Pukuria, Solimabad, Daulatpur, Hoffampur, Dhulsura, Brah bazar, Majirchar etc. There is also no explanation, for selecting unimportant 17.00km embankment by excluding the above important and vulnerable area. There is no permanent habitation on the char. People comes here temporarily during Low Water Level period. During High Water Level period, peoples leaves this char. On the other hand, Benotia, Dawn Tarotia, Hatpachil, Pukuria, Solimabad, Daulatpur, Horirampur, Dhulsura, Brah bazar, Majirchar, Noria are original land. Peoples lives here. Homestead, school, college, private & public installation is here. Under no circumstances, unimportant unstable char area like Salura, Omarpur & Enayetpur or 17.00 km embankment can be priorities over protection of original land like Benotia, Dawn Tarotia, Hatpachil, Pukillia,	see response to Comment A4h	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Solimabad, Daulatpur, Horirampur, Dhulsura, Brah bazar, Majirchar, Noria etc.			
A4m.	Under the above circumstances, Option-I shall be deleted from this "Updated Feasibility Report for Tranche-2"	This option has been deleted.	No action	Closed
A5.	Page viii : Last para: It is that "The adaptive approach formed the basis for the FRERMIP, with the BWDB committing to maintain all implemented work. Observation : BWDB made no such commitment to maintain all of FRERMIP or JMREP work. Such false statement shall be deleted.	This statement is factually incorrect Background: Section 22 (p.21) of the signed Loan Agreement states “The Borrower and BWDB shall ensure that (a) BWDB inspects and maintains the embankments, regulators and riverbank protection works rehabilitated or constructed under the Project” and “(c) the Borrower will allocate in its annual budget adequate resources for BWDB to carry out such maintenance and repair works” The Framework Financing Agreement contains covenants Tranche-2 contains substantial allocations for adaption works, covering a substantial part of what otherwise is considered maintenance, as well as emergency allocations.	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
		As per decision of the Technical Committee, double layer protection is included		
A6	Page ix : 3rd para Design recommended by BWDB termed as Option 2 and draft design enclosed in "Draft Feasibility Report for Tranche-2" termed as Option I Observation: . A Draft and Lumpsum design were proposed in "Draft Feasibility Report for Tranche-2". This design was reviewed by BWDB. Technical Committee for FRERMIP recommended to include the reviewed drawing in the "Final Feasibility Report". So, newly generated Option 1 & Option 2, on the basis of Draft Drawing and Final Drawing is meaningless. Moreover, it is violation of recommendation of Technical Committee for FRERMIP. Such approaches shall be given up. Option I & Option 2 shall be deleted and Report shall be formulated as per recommendation of Technical Committee.	This option was not included in the most recent version of the feasibility study.	No action	Closed
A7.	Page 6 : 3rd para: It is written that "Trench I built on successful completion of JMREMP". Page 18 : 2nd Line: It is written that "geobag revetments confirm their two main and interrelated characteristics : cost-effectiveness and sustainability"	The concept of JMREMP was cost effective during implementation from 2004 to 2013 Attachment 1 shows that the right channel was dominant from 2001 until 2007 – the BWDB asked for the protection work in 2000 and signed the loan in 2002. The right	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Observation: Still JMREMP cannot be considered as a successful one. Because main flow of Jamuna not yet flown through that channel on which JMREMP work was done. JMREMP work not yet experienced the real scour depth of Jamuna River. At Bera part during implementation, at some section, no Falling Apron was provided, only Areal Coverage was provided. At some section, Falling Apron was placed at -13.00, -4.00, -10.00, -5. 00 m (PWD). Dumping volume was provided 11.50 m^3/m to 22.50 m^3/111 At Shajadpur part during implementation, Falling Apron was placed at 0.83, -1.03, -3.39 m (PVVD)I Bed level at damaged was observed +1.15, -16.50, -13.00, -10.00, -15.00, -11.00 m (ND) during 2017. In Chouhali, scour level was observed as -23.00m(PWD). In Bera or Shajadpur area similar or deeper scour level may be occurred. In that situation, work of JMREMP will not sustain. So, on the basis of unsustainable JMREMP approach, further work cannot be taken up. So, all such line or recommendation shall be deleted	channel only declined substantially after 2012. After implementation, the work performed successfully, proven by the fact that critical parts of the embankments of the two irrigation schemes PIRDP and MDIP are protected against erosion since some 15 years. Neither adaptation nor substantial maintenance has been performed since implementation. Consequently, some parts of the works are damaged today, particularly along the Kaijuri revetment.		
A8.	Page 18 : 2nd & 3rd Line: In 2018 cost, conventional revetments and RCC spurs are a factor of 25 and 10 times more than expensive and typically entail major adaptation or reconstruction works. The work at Chauhali is less costly than the one at the PIRDP built 15 years earlier, despite including 3.8 km of adaptation works, accounting for 10% of the total cost.	This section has been deleted in the updated report.	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Observation: Here they compared the cost with Sirajganj Hard Point which is not conventional revetment by BWDB. In the table, they have shown the cost as 2,785 million BDT, which is anomalous. Revised DPP cost are only 400 million BDT and they are protecting approx. 5.5 km of riverbank, where protection cost per km is only 72.7 million BDT. Moreover, huge land was reclaimed from the river (apprx 22.5 Ha) which is 1/3 of the cost of JMREP and after all these maintenances, the cost per km of riverbank protection is much less than the JMREP cost			
A9.	Page 18 : para: It is written that "Chouhali is less Costly than one at the PIRDP" Observation: It is not true. In PIRDP dumping volume was 11.50 m^3/m to 22.50 m^3/m. But in Chouhali dumping volume was 32.50 m^3/m. So, such line shall be deleted.	This sentence was deleted from the FSR		
A10.	Page 16 : 1 st Line: "The after effect of Capital Pilot Dredging in the area of Bangabandhu Bridge has destabilized the downstream. While the capital pilot dredging achieved the purpose of protecting against outflanking of the Western Guide Bund, the pilot channel dredged through the stable mid-channel char under the bridge has triggered a major river change and disturbed the stable flow pattern in the downstream, some 15 km long straight channel. As a consequence the channel develops a curved alignment with	The comments confuse the erosion immediately downstream of Bangabandhu Bridge with the erosion triggered by the narrowing of the river through the guide bunds. Background: During the Padma Bridge studies the additional erosion at Chauhali and	12 to be included in the feasibility report to provide justification for statement	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	erosion at the Tangail bank immediately downstream of the bridge (Figure 2-3, location 2a), and a general widening tendency further downstream with massive riverbank erosion alongside the left bank (Figure 2-3, location 2b)". Page 27 : Last Line: "Experience from the Capital Pilot Dredging at the Bangabandhu Bridge shows that a pilot channel to destabilized the downstream river course over a distance of some 20 kilometers over decades. Observation: This is not true. Capital Pilot Dredging was done during 2012-2013. But serious bank erosion on left bank near Chouhali area was observed from 2003 or before, BWDB has made several studies at that time, and undertaken protection work at Chouhali area during 2006 and onward. Such irrelevant comment shall be deleted.	downstream of Enayetpur as a consequence of the narrowing of the river through the guide bunds built from 1996 to 1998 could be established (see for example the Padma Bridge reports and related publications). The erosion immediately downstream of the bridge crossing on the left bank is a consequence of the capital dredging project (refer for example to the background documents for the river stabilization plan). The erosion history at Chauhali can be derived from superimposed historic satellite imagery – see 11 Additional information is available from large-scale river survey data (refer to Annexe 2) demonstrating the destabilization and increased bank erosion alongside both banks of the straight channel upstream of the Enayetpur – Chauhali bifurcation. (see 12)		

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
A11.	Page 16 : Last Line: "At the end of 2018, BWDB proposed modification to the concept (BWDB, Technical Committee, 2018), restricting the work initially to the floodplains before stabilizing also the chars Observation: This is not true. BWDB does not proposed any modification to the concept. Rather ISPMC deviate from the original Feasibility Report. ISPMC changed the concept of the project and shifted to unnecessary Protection Work for unstable Char land without any study. BWDB Technical Committee, advised and recommend to come back to the concept of original Feasibility Report. ISPMC does not present any proper engineering justification for the selection of unstable Char Protection, which is subjected to washout in one flood	Protection on chars has already been excluded Based on the decision of the Technical Committee, only 2-layer protection is considered Please also refer to A1 and A4b	No action	Closed
A12.	. Page 24 : 3rd para: Here it is mentioned that 30,000 ha main land in JLB-I & PLB-I (25,000 ha in JRB-I & 4740 ha PLB-I) will be protected from flood in Trench-2. Observation: In Trench 2, 17.00 km embankment was proposed along a char land at a distance of 4.00km on the R/S of existing BWDB embankment. This embankment will provide the flood protection for the area (4740 ha)	In compliance with the Client's desire no work on chars is presented. The comment confuses embankment construction in different places with the provision to stabilize the river course and recover lost floodplain land, an activity required before embankment construction.	No action	

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	enclosed within existing BWDB embankment and Proposed 17.00 km embankrnent. In Trench 2, no embankment was proposed in JLB-I. So, in this report, there are no explanation how 25,000 ha in JLB-I will be protected from flood in Trench-2. So, this statement shall be corrected and 25,000 ha shall not be considered as benefit for economic analysis.			
A.13.	. Page 30 : Option 2 : 17.00 km embankment : Bridge at Kaftikpur and 7 Regulator: Observation: A Bridge at Kattikpur and 7 Regulator was proposed without any study. In this report nothing mentioned about Kaisllakahli closure, which is the most and buming issue. Issue of Titpal (Bilchari) khal, Joiklisnawpur Khal, Gosail Khal are also not discussed. It indicates that ISPMC has not the capability to perform a Flood management & drainage project. Before including 17.00 km embankment in Harirampur, in Trench-2, ISPMC shall study the whole Arial Beel area, total catchment area oflchamti River from Kaishakahli closure to it's outfall at Dhaleswary River, water logging issue, flood issue, erosion issue Before including 17.00 km embankment in Harirampur, in Trench-2, ISPMC shall study the whole Arial Beel area, total catchment area of lchamti River from Kaishakahli closure to it's outfall at Dhaleswary River, water logging issue,	See response to Comment A4 and Annex 5 of the FSR The studies recommended will be performed as part of the Arial Beel Study in Tranche 2	Clarification if the design office has changed its opinion and revokes the approved design. (The provided design was approved by the BWDB Design Circle II and Chief Engineer	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	flood issue, erosion issue, environmental degradation issue etc. Based on detail study, size and invert level of regular shall be determined, ISPMC shall identify what are the problems of the whole area and what are the solutions. All this issue shall be described in the report elaborately. Before detail study, 17.00 km embankment in Hafirampur cannot be included in Trench-2. There is no demand for this embankment. Moreover, this costly embankment will give benefit to a small char area which is mostly covered by Katkin grass i,e very low benefit. Most of the alignment of embankment is subjected to engulfed by river erosion. To include this 17 00km at least following two things are needed Detail study of whole area. River Bank protection on the UIS and DJS of existing protection work i,e in Gopinathpur, Boyra and Dhulsura. Otherwise selection of this 17.00 Ian embankment in Harirampur cannot be justified.		Design on 23/12/2018)	
A14.	Page 78 : Ali 8.3.1.2 : Flood mitigation : Here it is mentioned that Benefited Area from Flood Embankment in JRB-I is 30,000ha and from PUB-I is 12,000ha. Benefit from Flood Embankment in JRB-I is 12,431 mBDT and from PLB-I is 2,914 mBDT. Observation: In JRB-I, Benefited area from completed and proposed Flood Embankment of Hurasagar Project is 6000ha. In PLB-I, Benefited area	a) In Harirampur, the area is larger as indicated, as the old embankment several meters below the proposed embankment (200 year flood level plus freeboard) and in the downstream part has also breached repeatedly over the past.		

	Comment from Design Office	**ISPMC Notes / Reply to Project Management Office**	**Action**	**Status**
	from proposed Flood Embankment in Harirampur is 4740 ha. As such, the benefit showm here is not correct It shall be corrected accordingly. There is serious river erosion in Benotia & Dawn Tarotia. Embanlanent of Hurasagar Project is within 50m to 100m from river bank. The project life is considered as 30year. In Trench-2, only 1.00 km Bank protection work was proposed, which is insufficient. So, within I or 2 year Embankment at Benotia & Dewan Terotia of Hurasagar Project will be eroded. So, there will be no benefit from the investment for Embankment of Hurasagar Project. The Economic Analysis shall be corrected accordingly, There is serious river erosion on the U/S and DJS of existing protection work i,e in Gopinathpur, Boyra and Dhulsura.. Proposed 17.00 km Embankment of Harirampur is under threat from river bank erosion. The project life is considered as 30year. No Bank protection work was proposed here in Trench-2 & Trench-3. So, there is a possibility that within 3 or 4 year Embankment of Harirampur will be eroded. So, there will be no benefit from the investment for Embankment of Halirampur. The Economic Analysis shall be conected accordingly.	Based on Annex D of the PPTA feasibility study, 2013, the area benefitted by the embankment and river training works Is beyond the area enclosed by the embankment. In this context, benefitted does not mean flood-free, but also refers to a reduction of flood levels with changes of land type, for example from F4 to F3 and therefore increasing the agricultural production. b) refer to Comment A4e c) See response to Comment A4h		
A15.	Benefit from Protection work The project life is considered as 30year. There is a possibility outflanking and damage of Char protection work at Salura (4.00km), Ommpur (6.00km) & Enayetpur (4.00km). There is a possibility outflanking and damage of 1.00km bank protection work at Benotia due to insufficient length.	Bank protection works on chars already has been excluded The considered length is 3.5 km (see comment A4e) See response to comment A4h and g	No action	Closed

<table>
<tr><th></th><th>Comment from Design Office</th><th>ISPMC Notes / Reply to Project Management Office</th><th>Action</th><th>Status</th></tr>
<tr><td></td><td>There is a possibility outflanking and damage of 9.00km bank protection work at Harirampur due to serious erosion on U/S and DJS. All the above protection work will not sustain for 30 years. So, there will be no benefit from the investment. So, Economic analysis shall be corrected accordingly.</td><td></td><td></td><td></td></tr>
<tr><td>A16.</td><td>Table 8-7 of page 84 is misleading. It shall be corrected accordingly.</td><td>Option 1 and the table were removed in the latest version of the feasibility report.</td><td>No action</td><td>Closed</td></tr>
<tr><td>A17.</td><td>Data of Table 8-7, Table 8-9, Table 8-10, Table 8-11, Table 8-15, Table 8-16 shall be matched with one another.</td><td>These tables refer to different types of economic analysis and different design options however are based on the same data. Please confirm which items should be matched with each other. Further, please note that in the latest version of the feasibility report Table 8-11 and Table 8-16 are not included.</td><td>No action</td><td>Open</td></tr>
<tr><td>A18.</td><td>Jurisdiction of FRERMIP is from D/S of Bangabandhu Bridge to Aricha for Jamuna River and Pangsa to Chandpur for Padma River. FRERMIP taken the responsibility of River Bank protection with Flood Embankment on both banks approximately for 168+178 346 Ian. Different Component of FRERMIP is as below :
<table>
<tr><td>Component</td><td>Trench-I</td><td colspan="3">Trench-2</td></tr>
<tr><td>River Bank Protection</td><td>Jafargonj 2.00km (full)</td><td>Chouhali 5.00 km
Pukuria 5.00 km
2.00 IQ1(pre)</td><td>5.00km</td><td>29.00 km
6.00km</td></tr>
</table></td><td>The outputs noted here were agreed by the ADB and the Bangladesh Economic Relations Division in the Framework Financing Agreement (Schedule 2, Page 21) in May 2014.

From an economic point, riverbank protection is often not justifiable due to the high cost and the comparatively small area protected, indicating that resettlement of</td><td>No action</td><td>Closed</td></tr>
</table>

<table>
<tr><th></th><th>Comment from Design Office</th><th>ISPMC Notes / Reply to Project Management Office</th><th>Action</th><th>Status</th></tr>
<tr><td></td><td>
<table>
<tr><td>Work</td><td>Horirampur 7.00 km(full)
2.00 Ian (pre) Chouhali 5.00km(full)
2.00 km(pre)</td><td></td><td></td><td>(pre)</td></tr>
<tr><td>Embankment</td><td>Hurasagar 21.3 Ian</td><td>Hurasagar 7.9 km
H01frampur 17.0km</td><td>40km</td><td>86km</td></tr>
</table>
From the above Table, it was found that vast area of FRERMIP, left unprotected against erosion and subjected to flooding. Important and sensitive area like Benotia, Dawn Tarotia, Hatpachil, Pukuria, Solimabad, Daulatpur, Gopinathpur, Boyra, Dhulsura, Brah bazar, Majirchar, etc. left unprotected against erosion.
In FRERMIP area River Bank Protection Work is much more essential than embankment. There is no such demand for embankment. But there is serious demand for River Bank Protection Work. But in Trench 2 & 3, ISPMC considered 57.00km embankment which is very very less important
Under this situation, it seems that Trench 1, 2 & 3 is not well-planned.</td><td>affected persons would be a more economic option. Consequently, the economic feasibility study combines the high cost (and low economic benefits) for riverbank protection with the low cost (and high economic benefits for flood protection). To this end, embankment construction is the logical completion of the work, in order to obtain sufficient economic feasibility.

During Tranche-2 additional benefit streams were added, for example from improved land transport over more direct embankment lines and the more intensive use of recovered former char land. This has further improved the economic feasibility.

From above considerations it is evident that abandoning the planned embankments is not in line with the agreement signed between the BWDB and ADB in 2014.</td><td></td><td></td></tr>
<tr><td>A19.</td><td>Page 33 : Footnote 50:
Observation:</td><td>Training in the use of the river database of Tranche 1 was provided to the BWDB, more specifically Mr. Masbahul Islam (BWDB</td><td>No action</td><td>Open</td></tr>
</table>

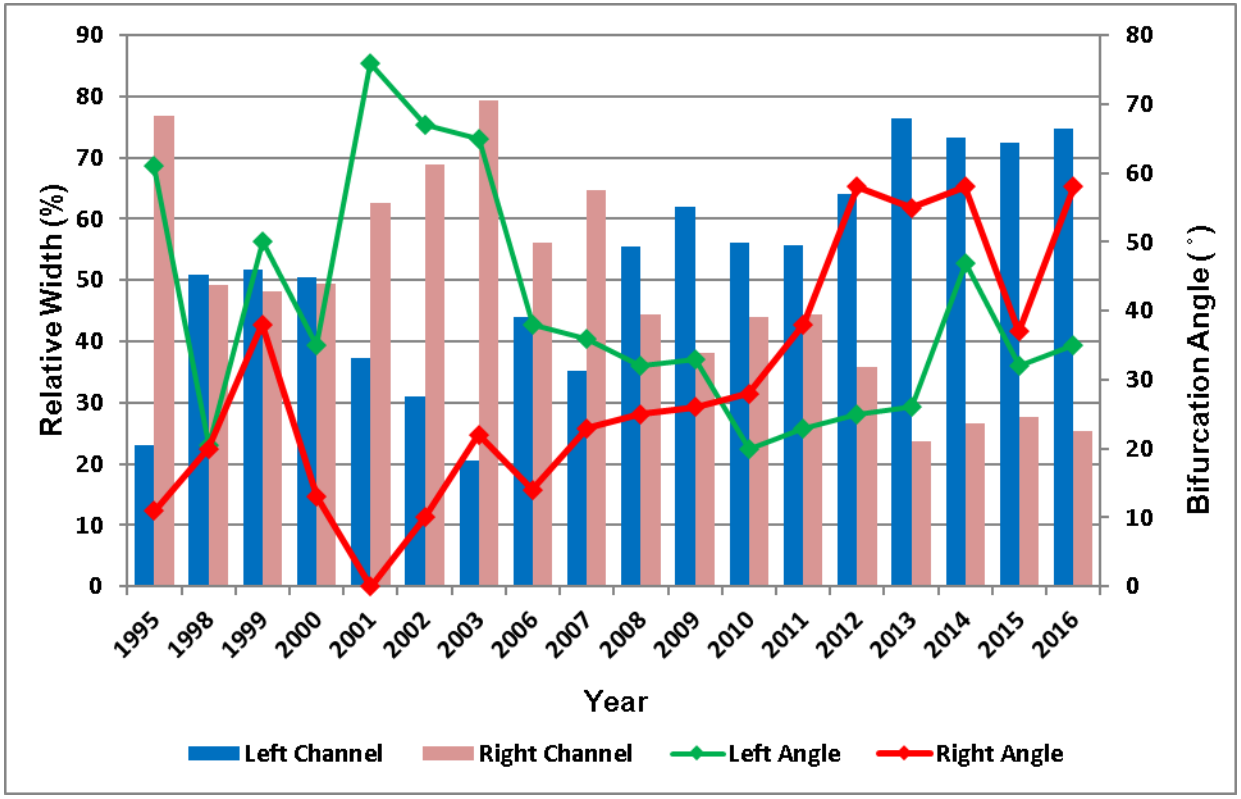
	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	ISPMC cannot handed over river database of Trench-I to BWDB.	Design Circle II), who was selected following a workshop in January and February 2019. The handover of the river data base will take place in October 2019		
A20.	Page 33 : Para: Here it was is written," BWDB remains in favour of strong in-house capacity, particularly with respect to design. While this assures full control over the design process, a rapidly increased workload could lead to overloading and delays". Observation : Strong in-house capacity is essential for a specialized professional organization like BWDB. BWDB as well as other organizations or institutions of Bangladesh are benefited from such "Strong in-house capacity". Moreover, one of the major benefit of this "Strong in-house capacity" goes to consultants who work with BWDB. It is to be mentioned here that all donor aided study report including this "Updated Feasibility Report for Tranche-2" urges and gives special emphasis for the "Capacity Building" and "institutional strengthening" of BWDB and government organization. This urge or approach is contradicting with the above statement. This statement made here in a negative way. Moreover, this statement is not relevant to this Study. So, this statement shall be deleted.	This statement was rephrased in the most recent revision of the report prior to the review through the office of Chief Engineer Design.	No action	Closed
A21.	Page 33 : Footnote 38:	This footnote was deleted	No action	Closed

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	Here it was is written," BWDB implements work for around 6,000 crore with some 6000 staff, the LGED implements around 20 times the amount of work with double staff. A major reason for achieving around 10-times as much annual tumover per head is systematic outsourcing. Observation : This statement is not true. Nature of activities of BWDB & LGED are not similar. BWDB, RHD, PWD, BPDB, Bangladesh Railway etc. are specialized professional organization work with a specific sector. But LGED is a generalized organization work in many sectors. LGED works almost in all sector such as road, bridge, culveft, building, growth centre etc. but in a small scale. LGED also work in small scale water sector project. BWDB builds a project on their own land, through Land acquisition. Land acquisition is a complex and lengthy process. Most of the cases implementation delays for Land acquisition. LGED needs no Land acquisition. LGED implements projects on others land, e,g BYOB's embankment etc. LGED made carpeting on existing road for which no complex planning or Land acquisition is needed. LGED build Bridge or culvelt over existing Khals or river for which no Land acquisition is needed. LGED build building on the land of respective departments. For the projects of LGED, no complex study is needed It is to be mentioned here that BWDB needs no Land acquisition for Bank Protective work. But for the projects on ADB loan, BWDB had to do Land acquisition, which causes delay in implementation.			

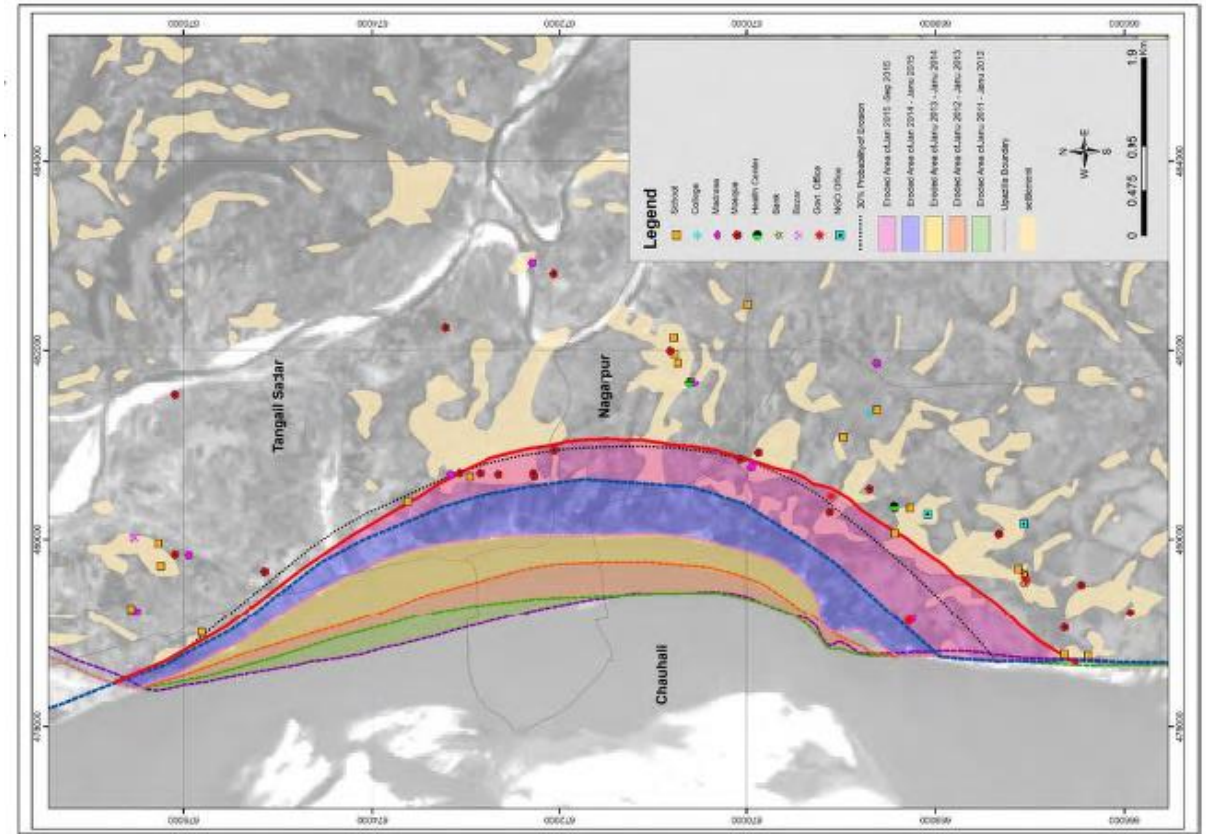
	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	For the projects on ADB or WB loan re-settlement work had to do. But for the projects of LGED normally no re-settlement is needed, because they need no Land acquisition. LGED can continue their construction work throughout the year. But for implementation BWDB has a very limited time in a year. BWDB has to fight flood, cyclone, tidal surge each year, which LGED had not to do. Moreover, 'Footnote 38' is not relevant to this Study. So, this Footnote shall be deleted.			
A22.	Page 33 : Para . Here it was is written, "The role of local level BWDB staff in Upazila and District coordination committee is limited". Observation : This statement is not true. Moreover, this statement is not relevant to this Study. So, this statement shall be deleted.	This sentence has been deleted from the FSR	No action	Closed
A23.	Page 32 : 3.4.1 (ii.) . Here it was is "Introducing a heavier design with concrete blocks that shows a visual evidence of better launching in a small scale physical model and is termed as "No regret" (Option2)". Observation : Here the statement is very offensive. Whether the consultant is authorized to pass such a comment against the employer? BWDB has been using this combination for a long period in Padma & Brahmaputra	This sentence has been revised to: Visual inspection indicates that the area coverage of a mix of geobags and concrete blocks is more complete. Background	No action	Open

	Comment from Design Office	ISPMC Notes / Reply to Project Management Office	Action	Status
	river and found to be in good condition (Annex-I). Whereas the construction done by the recommendations of the same consultant in JMREP and FRERMIP has got a series of damages with the only 30% flow in Jamuna river (Annex2). Moreover, in one meeting and presentation by Dr. Hybam mentioned that in Europe, Geo-bags are used only for emergency works because of its low durability. Durability or Lifetime of Geotextile (Geobag) not yet fully understood or determined. It is to be mentioned here that "Test for Durability or Lifetime of Geotextile" has not yet passed by Geotextile of Local & Foreign origin. Without assuring "Durability or Lifetime of Geotextile (Geobag)", (later on FRERMIP) recommending to use Geobag in a permanent bank protection work. Until "Durability or Lifetime of Geotextile (Geobag)" are ascertained, we cannot depend on Geobag alone for riverbank Protection Work. It would be better, if we can use hard rock or boulder or CC Block alone as a protection material in bank protection work and have been used worldwide. But availability and cost are an issue. To minimize the cost, combination of CC Block with Geobag is a better solution. RRI model test gives us a basis, to use the combination of CC Block & Geobag.	The ISPMC was only provided with the RRI model study report in support of the better performance of a double layer (mix of concrete blocks and geobags) underwater protection system. Geobags are not used widely in Europe, as rock in large quantities is available. Geobags have been used in places, as well as mega containers. Dr. Heibaum explained that there are latest standards to test the durability of both, PP and PES. The accelerated tests provide clarity about the performance also for longer periods, for example 50 or a 100-year lifetime. Both, single layer geobag protection as well as geotextile bag filter covered with rock are presently implemented for Padma Bridge. The technical specifications stipulate durability tests.		

10 FLOW DISTRIBUTION BETWEEN RIGHT AND LEFT CHANNEL IN THE JAMUNA RIVER

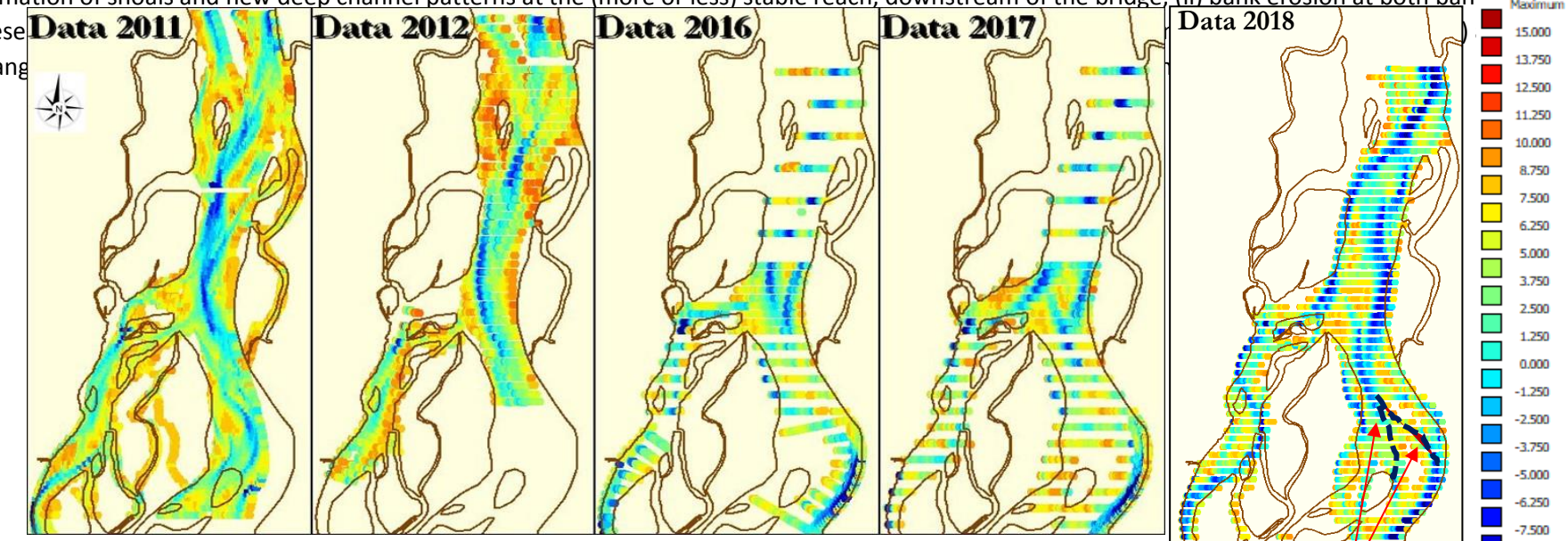


11 DEVELOPMENT OF BANKLINE AT CHAUHALI



12 CAPITAL DREDGING

This dredging trench had worked as expected due to several reasons: (i) favorable approach flow (narrow inflow with higher magnitude and favorable orientation), (ii) short trench, (iii) higher land char, so the low and medium flows could be channelized for longer time that could erode the trench already before rising the flow, (iv) use of sand closure and groynes at the right channel (that led to flow diversion away from the banks towards the direction of dredged trench). It had apparently solved one problem, but it appears to have created some other problems like: (i) large morphological activities, i.e. formation of shoals and new deep channel patterns at the (more or less) stable reach, downstream of the bridge, (ii) bank erosion at both ban[illegible] these chang[illegible]



Changes in deep channel alignment

Possible future alignment of deep channels formation

APPENDIX D

GENDER ACTION PLAN FOR TRANCHE-2

Output/Activities		Indicators and Targets	Responsi -bility	Time frame
Output I: Integrated flood and riverbank erosion disaster risk mitigation measures functioning at priority reaches				
Sub-Component A1: Infrastructure improvement				
Activity:	A1-1 Construction of riverbank protection structures using appropriate technology and methods A1-2 Rehabilitation/construction of embankments			
Tasks:	- Ensure women benefit from employment in construction - Ensure gender-related aspect of labor standard including equal wage for women and men for equal work - Ensure Occupational health and safety, safe water supply, sanitation (including separate toilets)	1. Specific condition included in contractors' bid document whereby 5% unskilled labor opportunities be given to women in 2. - Orientation sessions targeting 120 PMO/Design office/SMO staffs (at least one orientation in PMO and one in each SMO and minimum 2 times over the project period) i.e. XEN, design engineers, SDE, Section Officers, surveyors and contractors' site manager, site engineer and supervisors to verify and ensure that conditions are met 3. Provisions for either separate toilets for women or arrangements for use of facilities in nearby communities and/or households 4. Sex disaggregated information in field monitoring reports and contractors' compliance reports quarterly basis	PMO and work contract ors	Entire T-2 period
Sub-Component A2: Community-based Flood Risk Management				
Activity:	**A2-1. Formulating community disaster management units**			
Tasks:	– Form 80 Community Disaster Management Units (CDMUs) – Develop a community flood assessment and	5. CDMUs 80 - consisting of 15 male and female volunteer/each established with minimum 33% units lead by women	PMU-DDM and commun	End of T-2

	community risk reduction plan	6. **Community flood risk assessment report** prepared identifying : (i) risks for women, men, children and vulnerable groups, and (ii) disaster response coping mechanism related to flood and erosion warning; 7. **Community risk reduction plan** (40 plans) prepared for 80 Units through participation of women volunteers specifying roles, provision for women and men in terms of disaster preparedness at HH and community level risk reduction measures; 8. Identified 120 locations and build community flood markers for flood warning information	ity disaster management NGO	
Activity:	A2-2. Capacity development for community disaster management Unit			
Tasks:	- Initiate community-based flood warning dissemination procedures building on indigenous techniques - Disseminate regular warning messages relevant to local context/language in line with the national warning network	9. 50% (40 nos.) of the units have flood warning mechanisms 10. 40 knowledge events held [Target: 200 women] -11. 50% of the households, including low-income households, and poor women living on the embankment participate have increased resilience through preventive measures at household level	PMU-DDM and community disaster management NGO	End of T-2
Sub-Component A3: Participatory Regular O&M				
Activity:	A3-1 Capacity development of communities			
Tasks:	- Training on gender awareness and leadership	12. 30% women including management committee members should receive gender awareness and leadership training	PMO and community disaster management NGO	End of T-2
Sub-Component A4: Livelihood support for project affected people				
Activity:	A4-1. Construction of resettlement areas with basic infrastructure and facilities			

Tasks:	- Ensure effective consultation with women in the affected areas and maintain sex-disaggregated data on Project Affected Persons (PAPs) along with entitlement benefits, as per Resettlement Plan (RP) Ensure that gender issues are considered when planning resettlement villages and community facilities	13. Full compensation for 100% women PAPs, as per RP entitlement. 14. 33% women involved in planning meetings 15. At least 30% women participants will operate livelihood support programs in the community groups in and around resettlement areas.	PMO and Partner NGOs	T-2
Activity:	A4-2. Support for project affected people			
Tasks:	- Build up linkage with government line agencies i.e. Departments of Agriculture, Fisheries, Cooperatives, Women's Affairs, etc. - Provide special training and financial support for women-headed households and for women in ultra-poor households -	16. During any field level training relevant government line agencies must be invited which will lead to buildup linkages for future support 17. Priority needs to be given for special training and financial support to the groups organized having women-headed households and women in ultra-poor households that identified by resettlement surveys,.	PMO and resettlement NGOs	End of T-2
Output II: Strengthening Institutional System for Flood and Riverbank Erosion Risk Management				
Sub- Component B1: Institutional capacity strengthening for flood and riverbank erosion risk management				
Activity:	B1-1 Capacity enhancement of BWDB			
Tasks:	- Integrate a gender-specific module in the BWDB training - - Build capacity of female staff in BWDB	18. Gender aspects integrated in the relevant training program/module and 10% women in training programs 19. Provide 6 training (2 in BWDB HQ, 2 in design office and 2 in 3 SMOs) to at least 120 staff in BWDB on working while minimum 15% must be women	BWDB	End of T-2
Output III: Efficient program management system established				
Component C: Program Management				

Activity:	C-1: Implementation management			
Tasks:	- Establish MIS system with sex disaggregated data base for project reporting	20. Identify gender indicators, incorporate in monitoring system and ensure regular reporting on progress of GAP implementation	BWDB	Entire T-2
Activity:	C1-2: Preparation for Tranches 2 and 3			
Tasks:	- Incorporate gender issues in the planning process	21. Prepare gender action plans for Tranche-3	BWDB	End of T-2

APPENDIX E

DRAFT SUMMARY POVERTY REDUCTION AND SOCIAL ASSESSMENT

Country:	Bangladesh	Project Title:	Flood and Riverbank Erosion Risk Management Implementation Program
Lending / Financing Modality:	Multi-tranche Financing Facility	Department / Division:	South Asia Department Environment, Natural Resources and Agriculture Division (SAER)

I. POVERTY AND SOCIAL ANALYSIS AND STRATEGY

Targeting classification: Geographic dimension of inclusive growth (T1-G)

A. Links to the National Poverty Reduction and Inclusive Growth Strategy and Country Partnership Strategy

Bangladesh has made considerable progress in reducing poverty, and has made good progress toward meeting the Millennium Development Goals and now working towards Sustainable Development Goals (SDGs). The population living below the national poverty line fell to 31.5% in 2010, a decline of 1.7% per annum since 2005. Despite good progress, poverty remains a dominant problem. The Bangladesh Bureau of Statistics conducted the survey between April 2016 and March 2017. The previous survey was done in 2010. According to the latest survey results, the poverty rate in rural areas was 26.4 percent, while urban poverty was 18.9 percent. The current rate of extreme poverty is 12.9 percent, compared to 17.6 percent six years ago.

The first year of the 7th Five Year Plan coincides with the launch of the UN post 2015 Sustainable Development Goals (SDGs). In the backdrop of these factors, the 7th Plan centers on three themes:

- GDP growth acceleration, employment generation and rapid poverty reduction;
- A broad-based strategy of inclusiveness with a view to empowering every citizen to participate full and benefit from the development process.
- A sustainable development pathway that is resilient to disaster and climate change; entails sustainable use of natural resources; and successfully manages the inevitable urbanization transition.

The economic growth strategy of 7th FYP includes four pivotal themes:

- Break out of the sphere of 6% growth and raise the annual average growth rate to 7.4%.
- Growth will be inclusive, pro-poor, adapt well to the urban transition and be environmentally sustainable.
- By the end of the 7th FYP, poverty and extreme poverty will be substantially lowered.
- All the additional labour force will be gainfully employed, including much of the underemployed

. The Asian Development Bank (ADB) will adopt a broad-based approach in order to respond flexibly to the needs and demand of the country over the country partnership strategy (CPS) period (2016–2020). ADB assistance is strongly aligned with the government's Vision 2021 and its Seventh FivD-Year Plan, which lays out a roadmap for higher, sustainable and inclusive growth. Freeing the country from poverty and inequality remains a major though separate challenge. Currently, 12.9% of the population is in extreme poverty. Unless specific actions are taken, extreme poverty in parts of the country and inequality between regions will likely remain, even as the country's economy continues to grow. Effective implementation of the government's social protection strategy is needed to elevate people out of extreme poverty. Priorities include housing and basic services—including primary health care—for the poor, and disaster risk management to reduce vulnerability and build resilience to extreme weather conditions.

The proposed investment program is directly linked to the government's five year plan and ADB's country partnership strategy. It will protect riverine erosion and flood-prone fringe lands, which are usually occupied by the landless poor. The proposed investment program will directly protect these poor residents along the rivers from riverbank erosion and flood inundation. Institutional strengthening of riverbank erosion and flood risk management will contribute to the sustainability of the risk reduction. The investment program will also include community level capacity strengthening programs. Labor-intensive construction works will create jobs for the poor and women. It will thus contribute to the improvement of livelihoods and economic conditions of the poor population in the project area, with a population of about 2 million.

B. Results from the Poverty and Social Analysis during Due Diligence

1. Key poverty and social issues. Riverbank erosion along the main rivers is a prominent problem in Bangladesh, and is a perennial phenomenon caused by dynamic channel shifting of the rivers. Riverbank erosion annually affects about 100,000 people, who face significant social hardships, such as loss of homestead, lands, crops, and/or livelihoods. It also forces repeated displacement. Riverine fringe lands, which are prone to riverbank erosion and flood disasters, are usually occupied by the landless poor, and the majority of them are erosion victims who had been displaced by past riverbank erosions. Although poverty is falling in Bangladesh, poverty remains extensive in the project areas where poverty incidence (35%–39%) is higher than the national average.

Justification for classification: TI-G is justified as the investment program will improve the livelihoods of people in the project areas along the Jamuna, Padma, and Ganges rivers by reducing flood and riverbank erosion risks. About 70% of project benefits will go to the $2-a-day poor, in terms of stability in the livelihood activities and employment in project-related works.

2. Beneficiaries. The riverside vulnerable population affected by floods and land erosion (about 100,000) will be the direct beneficiaries. They will benefit through avoided loss of land and assets; protection and enhancement of agricultural and fishery production within the embankments; increased economic activity; increased security of population, livestock, and assets; and strengthening of local communities for sustainable risk management in the medium term. Secondary beneficiaries are the people beyond riverine lands.

3. Impact channels. The impact channels comprise (i) protection against loss of income, crops, and houses; (ii) improved agricultural productivities; (iii) community participation and capacity development support programs; and (iv) new jobs in project-related works for the $2-a-day poor.

4. Other social and poverty issues. Employment opportunities are lacking in the area. Most people work as wage earners in agricultural fields or small-scale weaving establishments. For gender-targeted activities, civil society organizations, funded by development partners, organize women labor groups and secure contracts for them on government infrastructure projects.

5. Design features. The project proposes to address the key poverty and social issues related to food production and income, as indicated in the performance indicators for the project impact in the design and monitoring framework, by increasing by 2028 the monsoon crop average yields in project districts to 3.75 tons per hectare (t/ha) (2.75 t/ha in 2013) and average annual per capita income to Tk136,000 (Tk74,380/capita in 2012). The protection by embankments will increase the income of the poor.

II. PARTICIPATION AND EMPOWERING THE POOR

1. *Summarize the participatory approaches and the proposed project activities that strengthen inclusiveness and empowerment of the poor and vulnerable in project implementation:* Consultations were held with a focus on women, the landless, and other vulnerable groups in the subproject areas regarding (i) relocation and livelihood issues, including agriculture, and fisheries; (ii) flood and riverbank erosion disaster management; (iii) possible solutions to resolve the constraints identified; and (iv) institutional mechanisms to address those constraints. The performance indicators relating to output 1 of the design and monitoring framework reflect the participatory approach, which is also reflected in the loan agreement and facility administration manual (FAM).

2. *If civil society has a specific role in the project, summarize the actions taken to ensure their participation:*

Civil society will be engaged for the project implementation. Refer to item 4.

3. *Explain how the project ensures adequate participation of civil society organizations in project implementation:* Civil society participation is ensured through (i) carrying out consultations with project displaced persons for their relocation, (ii) income and livelihood restoration, and (iii) facilitating the grievance redress process.

4. *What forms of civil society organization participation is envisaged during project implementation?* In addition to the resettlement plan implementation, nongovernment organizations (NGOs) will be involved (on a competitive basis) in designing and implementing livelihood support for the project displaced households, participatory operation and maintenance of infrastructure, and community-based flood risk management. Adequate resources were allocated for their engagement.

[X] Information gathering and sharing H [X] Consultation H [X] Collaboration M [X] Partnership M

5. *Will a project level participation plan be prepared to strengthen participation of civil society as interest holders for affected persons particularly the poor and vulnerable?*

[X] Yes No

A consultation and participation plan has been prepared as part of the resettlement plan and gender action plan implementation. While the activities in the gender action plan are mainstreamed, adequate resources have been allocated in the resettlement plan for project level consultation and participation.

III. GENDER AND DEVELOPMENT

Gender mainstreaming category: Effective Gender Mainstreaming (EMG)

A. Key issues. While the main occupation of women in the project area relates to home and family, and involves tasks related to the immobile assets of house and kitchen garden, they play an important role in agricultural production related to seeds, storing of crops, and domestic livestock. The houses of poor families are built at or near ground level, and experience deep and prolonged inundation during higher floods. During times of flooding, women face multiple challenges: providing for a family from limited food and drinking water supply, heading the household while men search for income opportunities, and being forced to sleep and live in public spaces during evacuation. Erosion of homes and land forces families to change income patterns, with the adult male family members leaving to find work opportunities and leaving the women to head and manage the households. While implementation of civil works provides income generation, gender imparity is a common issue—lower wages, lack of segregated sanitation facilities, and health hazards (e.g., from carrying heavy loads).

B. Key actions

The investment program formulated a broad range of measures targeted at achieving higher gender parity: (i) increasing women's participation in the executing agency, as staff members and training participants; (ii) obliging contractors to employ 15% women as unskilled labor with equal wage payment (It was narrow down from 15% to 5% during Tranche-1 During ADB's MTR Mission held in February 2018, as most of the activities shifted to Tranche-2 and design changed for geo-bags from 125kg to 250kg and other reasons. Based on those GAP has been revised with ADB's consent during ADB MTR Mission for t-1), and with focusing on reducing the occupational health risk associated with menial work; (iii) establishing community-based disaster management units with 33% women unit heads, assuring the inclusion of gender issues in the planning process of preventive and preparedness measures; and (iv) providing additional livelihood support for special groups, such as women-headed households, and very poor families.

[X] Gender action plan Other actions or measures No action or measure

1. Participatory infrastructure operation and maintenance: 30% women participation in training
2. Conduct early warning dissemination in the community: 30% poor women who live on the embankment
3. Livelihood support training: 50% female participants

IV. ADDRESSING SOCIAL SAFEGUARD ISSUES

A. Involuntary Resettlement **Safeguard Category:** [X] A B C FI

1. Key impacts. For the embankment and riverbank protection construction in the Jamuna Right Bank-1 (JRB-1) subproject area, a total of 148.9 ha of land will be acquired. A total of 2322 households will be

affectedon the embankment. This includes 22 agricultural plot user households; 2131 residential (including title, non-title & tenant HHs); 157 commercial and 12 CPR; Total 40,331 numbers of trees (18240 seedlings, 9132 Non-Fruit bearing & 12918 Fruit-Bearing/Grown Up).will also be affected. For the Tranche-2, in the Padma Left Bank-1 (PLB-1) subproject area, the embankment starts in Harirampur and ends in Dohar at the market; the total length is 17 km and major portion of the embankments will be built on open agriculture land; a total of 112 ha of land need to be acquired while 180 households will be affected.

2. Strategy to address the impacts. A resettlement plan has been prepared based on extensive consultations that provides for compensation at replacement cost, and has provisions for grievance redress. A resettlement framework has been prepared for the entire investment program that will guide the preparation of other resettlement plans as required.

3. *Plan or other Actions.*

[X] Resettlement plan Combined RP and IPP

[X] Resettlement framework Combined RF and IPPF

ESMS Social impact matrix No action

B. Indigenous Peoples **Safeguard Category:** A B [X] C FI

1. Key impacts. No impact. No indigenous peoples, as defined in ADB's Safeguard Policy Statement (2009), reside in the project area.

Is broad community support triggered? Yes [X] No

2. Strategy to address the impacts. Not applicable

3. Plan or other actions.

Indigenous peoples plan

Indigenous peoples planning framework Combined RP and IPP

ESMS Combined RF and IPPF

Social impact matrix IPP elements integrated in project with a summary

[X] No action[61]

V. ADDRESSING OTHER SOCIAL RISKS

A. Risks in the Labor Market

Relevance of the project for the country's or region's or sector's labor market.

L unemployment L underemployment L retrenchment L core labor standards

2. Labor market impact. Not applicable

B. Affordability Not applicable

C. Communicable Diseases and Other Social Risks

1. Indicate the respective risks, if any, and rate the impact as high (H), medium (M), low (L), or not applicable (NA):

L Communicable diseases L Human trafficking

Others (please specify) Not applicable

2. Describe the related risks of the project on people in project area. Not applicable

[61] Tranche-1 is categorized C for the indigenous peoples safeguard. As the subsequent tranches would also be categorized C, an indigenous peoples planning framework was not prepared. Source: Asian Development Bank estimates.

VI. MONITORING AND EVALUATION
Targets and indicators: By 2028, in the program districts along the main rivers: (i) per capita income increased to Tk136,000 from Tk74,380 in 2012 (Bangladesh Bureau of Statistic and other government-published reports and statistics); and (ii) average transplanted aman (monsoon season rice crop) yield rises from 2.75 t/ha in 2013 to 3.75 t/ha (Bangladesh Bureau of Statistics, Department of Agriculture Extension, Department of Agricultural Marketing, and other government-published reports and statistics). By 2022 (program completion), under the investment program: (i) livelihood support training provided to totalling 4,000 participants with a minimum 50% of female participants; and (ii) community-based disaster management training provided to 200 groups, with a minimum 33% of female leader participants. (project progress and completion reports, and implementation NGO's reports) 2. Required human resources: (i) implementing NGO for resettlement, (ii) implementing NGO for livelihood support programs, and (ii) individual specialists in the consulting team. 3. Information in FAM: The FAM indicates the key requirements for monitoring. Regular monitoring will be done by the project management office to measure the effectiveness and quality of activities. Quarterly progress will be reported in progress reports. 4. Monitoring tools: A management information system will be developed for monitoring benefits and project implementation. The loan agreement and FAM will describe the monitoring requirements of the social safeguards and gender issues. The project management office will monitor project performance, including poverty and social indicators. Resettlement will also be monitored by external experts.