12 Survey, Design and Procurement

This chapter aims to cover survey, design and data collection, and the steps leading to the award of contracts.

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Contents

Survey and design data collection[edit | edit source]

Briefing Materials

The following materials illustrate concepts, interventions, outcomes and lessons learnt, including through stories from community members.

Thematic brochures

• Improved water distribution and drainage through rehabilitation of water management infrastructure

Manuals

• Water Management Manual - pictorial version (Bangla)

Survey

Topographical surveys are required for design purposes for earthworks and new structures. then for measurement purposes at pre-contract and post-contract stages – during which joint measurements are taken, attended by representatives of BWDB, the contractor and the TA team.

As part of the crash program recommended by the 2016 Annual Review Mission (see Chapter 13), a budget was allocated so that local firms could be contracted directly by the BWDB Field Executive Engineer to carry out surveys.

Design Data

Design data is collected by the BWDB Divisions and sent to the BWDB Design Circles.

Design[edit | edit source]

Using the survey and design data provided by the BWDB Divisions, designs are prepared by the BWDB Design Circles.

Embankment Design Criteria[edit | edit source]

There are three types of full flood protection embankment aimed to prevent entry into the polder of the highest flood flows, and, in coastal areas, to prevent entry of tidal floods and surges, and saline water:

1. **marginal** dykes along small rivers/canals
2. **interior** dykes along big rivers
3. **sea dykes** along sea faces or large rivers close to the sea.

The embankment crest level is designed either: (a) for a 1 in 20 year flood plus a freeboard allowance to protect agricultural assets; or (b) for a 1 in 100 year flood plus a freeboard allowance to protect against loss of human life, property and installations (especially along Jamuna, Padma and Meghna Rivers). The free board depends on the fetch (the normal distance from windward shore to the embankment affected) and wind characteristics. It allows for wave height, wave run-up height and a factor of safety against overtopping. For BWDB embankments in the coastal region, freeboard usually varies from 0.30m to 1.00m depending on the type of embankment.

Table 12.1 Embankment Types, Slope and Crest Width

Dyke		Slope	Crest width (m)
Marginal	country side river side	1V:2H 1V:2H	2.44
interior	country side river side	1V:2H 1V:3H	4.30
sea dyke	country side river side	from 1V:2H to 1V:3H from 1V:5H to 1V:7H	by calculation

Table 12.2 Design Crest Levels and Widths for Blue Gold Polders[1]

Polder	Type	Crest Level (m PWD)	Crest Width (m)
2	interior	4.30	4.30
22	interior	4.30	4.30
25	interior	4.30	4.30
26	interior	4.30	4.30
27/1	interior	4.30	4.30
27/2	interior	4.30	4.30
28/1	interior	4.30	4.30
28/2	interior	4.30	4.30
29	interior	4.30	4.30
30	interior	4.30	4.30
31-part	interior	4.30	4.30
34/2-part	interior	4.30	4.30
43/1A	marginal interior	4.30 4.30	2.44 4.30

43/2A	marginal interior	4.30 4.30	2.44 4.30
43/2B	marginal interior	4.30 4.30	2.44 4.30
43/2D	marginal interior	4.30 4.30	2.44 4.30
43/2E	marginal interior	4.30 4.30	2.44 4.30
43/2F	marginal interior	4.30 4.30	2.44 4.30
55/2A	marginal interior	4.30 4.30	2.44 4.30
55/2C	marginal interior	4.30 4.30	2.44 4.30
47/3	marginal interior	4.57 4.88	2.44 4.30
47/4	marginal interior sea dyke	4.57 4.88 6.10	2.44 4.30 4.30

Climate Change Effects[edit | edit source]

Some of the direct effects of climate change on water infrastructure in the coastal zone includes:

- A rise in sea level resulting in drainage congestion and prolonged waterlogging within the polders
- More frequent cyclones and tidal surges damaging water infrastructure, properties and livelihoods as well as endangering polder communities
- Increased siltation in tidal rivers resulting in reduced drainage capacity, that impedes drainage flows from the polders.

To account for climate change effects in design, consideration was given by BWDB to harmonising Blue Gold design criteria - for raised embankment crest levels, and replacing sluices/outlets compatible with the raised embankment crest heights and with increased numbers of vents - with other projects (including WMIP, ECRRP and CEIP).

It was quickly realised that the direct costs of raising embankment crest levels and replacing regulators exceeded the Blue Gold budget allocation by many orders of magnitude[Notes 1]. And this would be compounded by the requirement for significant land acquisition (of a strip of land 4 to 5 times the height increase for marginal and interior bunds, and significantly more for sea dykes) and compensation (eg for the relocation of assets and loss of crops).

During the first years of the project, Blue Gold intended to adopt climate change design levels including a benchmark (BM) correction partly for Polders 26, 31-part and 2. However, due to budget constraints, the 2015 Annual Review Mission recommended that the established design levels (as shown in Table 11.2) should be adopted for the rehabilitation of all Blue Gold polders.

The limited available budget for infrastructure has meant that: (a) the choice of polders for Blue Gold has avoided those requiring high levels of investment; and (b) it has not been possible to achieve embankment crest levels which can meet the 25 year return period maximum surge height (used by CEIP-1), or to upgrade existing structures or construct new structures to suit this higher crest level, or indeed to construct the wider structures (requiring longer culvert barrels) for the higher levels of traffic on roads along the embankments.

Mean Sea Level (MSL) Datum Adjustment[edit | edit source]

Corrections were made to Survey of Bangladesh (SoB) levels over the period 1994 to 2008[Notes 2]. The Institute of Water Modelling (IWM) was engaged by Blue Gold to establish the new SoB benchmark levels to first 12, then all, polders selected by Blue Gold. From IWM's report on the first 12 polders, existing design levels of embankments need to be raised by 0.30m to 0.90m to compensate for the MSL/BM correction.

Design of Structures[edit | edit source]

In many cases, the standard 4m carriageway width over a regulator or inlet/outlet structure or culvert is insufficient for the much higher volumes of traffic now using the roads maintained by the Roads and Highways Department (RHD) or Local Government Engineering Department (LGED). RHD is responsible for national and regional highways and District roads, whilst LGED is responsible for Upazila, Union and village roads.

The tables below give recommended road carriageway widths. For future designs, carriageway widths over BWDB structures should be a minimum of 5.5m, and possibly even 6.2m – the width recommended by RHD.

Table 12.3 LGED Geometric Design Standards

Category	Design Type	Traffic (DCVs)	Carriageway (m)	Hard Shoulder (m)	Verge (m)	Crest Width (m)
	4	600	5.5		2.15	9.8
Upazila Roads	5	300	3.7	0.9	0.9	7.3
	6	200	3.7		1.8	7.3
Union Roads	7	100	3.7		0.9	5.5
	8	50	3.0		1.25	5.5
Village Roads						

Note: DCVs = daily commercial vehicles

LGED recommends bridge carriageway widths of 5.5m for Union and Upazila roads, except in the case of a Union road with a bridge length of less than 30m where a bridge carriageway width of 3.7 m is accepted.

Table 12.4 RHD Carriageway Widths

Width (m)	Design Type
3.7	This is the standard single lane carriageway width and is suitable for the more lightly-trafficked Feeder Roads. Vehicles travelling in opposing directions can pass each other by putting their outer wheels on the shoulder.
5.5	This is a minimum width two-lane carriageway. Large vehicles can pass each other at slow speed.

6.2	This is the lowest economic cost option for a very wide range of traffic volumes. It allows most vehicles to pass with sufficient clearance to avoid the need to slow down or move aside.
7.3	This is a high standard two-lane single carriageway.
11	This is a three-lane carriageway as one half of a dual 3-lane road.

Design Issues[edit | edit source]

Life Cycle Costing[edit | edit source]

After compiling all costs for an element of water infrastructure over its lifespan – including construction, operation, repair, maintenance and rehabilitation – the total can be reduced to a present value with expected return on investment (ROI). The purpose of life cycle costing is to achieve a balance between performance (serviceability requirements), risks and overall life cycle cost. In Europe, asset management is based on life cycle costing.

In January 2015, a Reconnaissance Mission by the Dutch Water Authorities (DWA) prepared a report[2] for BWDB to consider As a result, senior BWDB officials visited the Netherlands and UK in November 2015 for briefings on policy approaches to asset management.[3] In May 2016, DWA submitted a proposal for training in life cycle costing and design[4] from different angles: theory and practice on technical, managerial, institutional and financial aspects and stakeholder interests. In September 2016, twelve mid-level BWDB engineers attended a course on ‘Advanced Level Design and Life Cycle Costing of Sustainable Water Management Infrastructure’[5]. And in October 2016, a presentation was made by Poly Das (BWDB Design Circle) to the Mid-Term Review Mission about the outcome of her attendance at the September 2016 course.

Gates – importance of fundamental design review[edit | edit source]

For sluices and regulators to be functional, the gates must act to prevent saline river water from entering the polder (the purpose of the flap gates on the river side), to allow excess water to be drained (by opening the vertical gates on the country side), or to allow freshwater in the rivers - during the monsoon months - to be stored in khals for subsequent use for irrigation (ie operating as a “flushing sluice” when flap gates are raised using a pulley system mounted on a lifting frame).

If the gates are of poor quality or are not properly fitted, then they quickly become inoperable, and thus the major investment in the overall structure becomes quickly un-useable. Although the cost of manufacturing and installing gates on a new regulator varies from 3.3% (1-V) to 6.5% (4-V) of the total cost of the regulator, the functionality of the structure depends on the operability of the gates. Whilst many gated structures in the coastal zone date from the 1960s, gates have a much shorter lifetime. There is a strong case for reviewing the design, manufacture and installation of gates to maximise their operating lifetime – taking account of the experience with life cycle costing approaches and the use of composite materials.

Gates in the coastal zone are manufactured from steel, which is subject to corrosion in the aggressive coastal environment. During a visit to the Netherlands in September 2016 for a course in Life Cycle Costing and Design, BWDB mid-level design engineers were *inter alia* introduced to gates made from composite materials which are inert and resistant to corrosion. As a result, investigations were started under the Blue Gold Innovation Fund into the testing of composite gate materials, in preparation for major investments in water infrastructure under the Delta Plan. From December 2017, this early work was taken-up by Deltares and the Institute of Water Modelling (IWM) under the Water Management Knowledge and Innovation Program (WMKIP).

Siting of Regulators[edit | edit source]

The siltation of a river channel into which a regulator discharges, is likely to result in the regulator falling into disuse and the loss of a considerable capital investment (of up to €500k for a 4-vent structure), as well as the loss of agricultural benefits within the catchment drained by the regulator. The siting of new regulators on a river channel that will remain active for the 50+ year life of a regulator is a difficult task and relies on expertise in tidal river morphology and historical records.

In cases where regulators become blocked by sediment, internal drainage systems within the polder are re-routed to discharge water to regulators on active rivers. This is assisted by the relatively flat terrain within a polder, and the cross-linking of drainage khals. The drainage capacity of a regulator (ie the number of vents) is determined from the sluice catchment area. By including additional drainage capacity (ie more vents in a regulator) during the design process, it would be possible to reroute and dispose of drainage water from an adjacent regulator which falls into disuse because of sedimentation.

Concrete blocks – The cost of providing revetment to structures can be expensive (some 8 to 13% of the total cost of a new structure). Because of the high cost of rock in Bangladesh (mostly found in the riverbeds in the north-east of the country), concrete blocks are provided as revetment to structures in the coastal zone (on both the river-side and country-side). There is a case for phasing the revetment – providing an acceptable minimum to guard the structure from side-cutting and then monitoring the development of scour over the first year of operation and extending the revetment as required.

Preparation and Award of Contracts[edit | edit source]

After the design and bill of quantities (BoQ) has been prepared by the BWDB Design Circle, the following activities are required for the preparation and award of infrastructure contracts:

Activity	Responsibility	Duration
Estimate preparation	BWDB Field Office	1 week
Estimate vetting	Technical Assistance team	1 week
e-Tendering process	Tenderers	2 weeks
Notification of Award (NOA)	BWDB Field Office	2 to 4 weeks
Work Orders	BWDB Field Office	1 week
Contract mobilisation	Contractor	1 week

Role of Technical Assistance (TA) Team[edit | edit source]

All estimates submitted by BWDB field offices are formally vetted by the TA Team.

References[edit | edit source]

1. ↑ *Standard Design Criteria*. Standard Design Manual. Volume 1. Standard Design Manual Committee, BWDB Chief Engineer (Design). June 1995.
2. ↑ *Mission Report, Reconnaissance mission Bangladesh - 16-28 January 2015* (PDF). Dutch Water Authorities (DWA). 2015.
3. ↑ *International Water Week and Netherland/UK Policy Approaches* (PDF). Blue Gold Program.

December 2015.
4. ↑ *Proposal Training Life Cycle Costing and Design for Water Systems* (PDF). Dutch Water Authorities (DWA). 2016.
5. ↑ *Advanced Level Design and Life Cycle Costing of Sustainable Water Management Infrastructure* (PDF). Dutch Water Authorities (DWA). 2016.

Notes[edit | edit source]

1. ↑ Under Blue Gold, the investment in infrastructure totalled BDT 28,686 lakh (equivalent to €28.7 million). Thus, the average level of investment in the infrastructure to each of the 22 polders is around €1.33 million. By comparison, the investment in 17 CEIP polders is USD 286 million (ref CEIP Project Appraisal Document 29th May 2013) an average of USD 16.8 million per polder (equivalent to €15.3 million - or more than ten times the Blue Gold investment in infrastructure per polder - assuming a USD-€ exchange rate of 0.91.
2. ↑ All existing design crest levels of embankment were based on previous SOB (Survey of Bangladesh) levels transferred from Mean Sea Level in India (Arabian Sea). Since these levels were transferred over very long distances, there were considerable uncertainties and sources of errors in these levels, which were confirmed during 1990s (by IWM). In 1993, SOB/JICA initiated a project which set up a new permanent Tidal Observation Station at Rangadia, Chittagong and established a tentative Mean Sea Level (MSL) of the Bay of Bengal. With respect to this new MSL a National Vertical Datum was also established at Gulshan, Dhaka in 1994. With reference to this Vertical Datum a national Control Network was established. SOB carried out 3,800 km of 1st order level survey to determine the MSL height of 849 benchmarks (BMs) from 1994 to 2004. To intensify the number of vertical control points, about 3,500 km of 2nd order level survey was carried out to establish 237 more BMs from 2002 to 2004. From 2004 to 2008, SOB also carried 1,600 km of 2nd order level surveys to establish another set of 150 BMs. The 1st order level surveys were carried out from the Vertical Datum at Gulshan, Dhaka and the 2nd order level surveys were carried out by IWM from the 1st order BMs.

See more[edit | edit source]

Previous chapter: **Chapter 11: Investments for Polder Safety and Water Management**	**Blue Gold Lessons Learnt Wiki** **Section C: Water Infrastructure**	Next chapter: **Chapter 13: Construction: Progress, Modalities and Lessons Learnt**

Section C: Water Infrastructure

Chapter 10: Coastal Infrastructure	Chapter 11: Investments for Polder Safety and Water Management	Chapter 12: Survey, Design and Procurement
1. Coastal Zone 2. Background to Dutch-Bangladesh cooperation in the coastal region	1. Polder Investments 2. Revisions to Polder Infrastructure Investments 3. Investments by Polder and by BWDB Division 4. Emergency Repairs	1. Survey and design data collection 2. Design
Chapter 13: Construction: Progress, Modalities and Lessons Learnt		
1. Analysis of Progress 2. Nature of Works 3. Contractors 4. Construction quality		

A defined set of temporary activities through which facilitators seek to effect change

Bangladesh Water Development Board, government agency which is responsible for surface water and groundwater management in Bangladesh, and lead implementing agency for the Blue Gold Program

Technical Assistance

Earthen dyke or bundh raised above surrounding ground level, for example so that roads or railway lines are above highest flood levels, or so that an area is empoldered to protect it from external floods and saline waters.

An area of low-lying land surrounded by an earthen embankment to prevent flooding by river or seawater, with associated structures which are provided to either drain excess rainwater within the polder or to admit freshwater to be stored in a khal for subsequent use for irrigation.

the south-western coastal zone is characterised by broad tidal flats and fluvio-tidal plains, lying approximately 1 metre above sea level, with drainage provided by numerous tidal creeks and channels a some major rivers. Empolderisation now protects the intrusion of sea water to agricultural areas but restricts the deposition of sediments to within the channels, thus reducing the drainage capacity of the rivers and channels, causing drainage congestion.

Soil is regarded as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail. In agriculture, various crops need air (specifically, oxygen) to a greater or lesser depth in the soil. Waterlogging of the soil stops air getting in. How near the water table must be to the surface for the ground to be classed as waterlogged, varies with the purpose in view. A crop's demand for freedom from waterlogging may vary between seasons of the year.

A livelihood is a way of making a living. It comprises capabilities, skills, assets (including material and social resources), and activities that households put together to produce food, meet basic needs, earn income, or establish a means of living in any other way.

Typically undesirable increase in concentration and deposition of water-borne silt particles in a body of water.

river whose flow and level are influenced by tides

Water Management Improvement Project (WB-funded)

Coastal Embankment Improvement Project

A culvert is a structure that allows water to flow beneath a road, railroad, trail, or similar obstruction from one side to the other.

Institute of Water Modelling

the principal function of a regulator or drainage sluice is to allow the drainage of water from the polder into a peripheral river when there is a differential head across the regulator (ie when the polder or country-side water level exceeds the level in the tidal river). The regulator is provided with a lift gate on the country-side (to allow freshwater to be held in the khal for irrigation during the dry season) and a flap gate on the river-side (to prevent water entry from the river channel into the polder during high tide conditions). A frame is provided on the river-side so that the flap gate can be lifted when there is freshwater in the river (during the monsoon flood season), thus allowing freshwater to be stored in the khal within the polder and used for irrigation during the dry season. The size of the culvert is determined from the drainage area served by the structure.

Structure designed to only admit (fresh or saline) water across an embankment.

gated structure (typically with only a flap gate on the river-side) designed to drain water through the polder embankment to an external tidal river channel

Local Government Engineering Department

the adjustment of gates in water management infrastructure to control hydraulic conditions (water levels and discharges) in a water management system.

actions taken to prevent or repair the deterioration of water management infrastructure and to keep the physical components of a water management system in such a state that they can serve their intended function.

Return on Investment

The practice of admitting (fresh or saline) water for irrigation (or shrimp production) through regulators or inlets.

A vertical gate to control the flow of water; also referred to as 'regulator'

Water Management Knowledge and Innovation Program - starting in December 2017 and led by Deltares and the Institute of Water Modelling (IWM) with the aim of contributing to the long term development goals for the Southern Coastal Region as well as to objectives of the Blue Gold Program through tested and sustainable water management innovations, knowledge development and participatory action research.
https://www.deltares.nl/en/news/developing-water-management-innovations-local-communities-bangladesh/

Sedimentation is the process by which fine particles of silt and clay suspended in river water settle out, for example when there is a drop in velocity.

Bangladesh Taka

Namespaces

- Page
- Discussion

Variants

Category:

- CS1: long volume value

Blue Gold Program Wiki

The wiki version of the Lessons Learnt Report of the Blue Gold program, documents the experiences of a technical assistance (TA) team working in a development project implemented by the Bangladesh Water Development Board (BWDB) and the Department of Agricultural Extension (DAE) over an eight+ year period from March 2013 to December 2021. The wiki lessons learnt report (LLR) is intended to complement the BWDB and DAE project completion reports (PCRs), with the aim of recording lessons learnt for use in the design and implementation of future interventions in the coastal zone.