# CHAPTER 4 PROJECT DESCRIPTION

## 4.1 Objective of the Project

The objective of the Project is to largely improve the agricultural productivity of the Project area, thereby contributing to the efforts of the Government of Bangladesh to raise the level of the self-sufficiency of food. To achieve this objective, the construction of flood embankment for the Project area, all of which suffers from drought in the dry season and more than half of which is flooded in the rainy season, is envisaged in addition to the construction and consolidation of a pumping station, irrigation canals and drainage canals to drain out the surplus rainwater during the rainy season and to pump in water from Lakhya River mainly during the dry season in view of irrigating the Project area throughout the year.

## 4.2 Examination of Requested Contents

The requested contents are as given in 2.4.2. The Government of Bangladesh has divided the Phase-I area under the Feasibility Study with D-N Road running in the east and west and has given priority to Area A which is located to the west of D-N Road and along Lakhya River. This Area A has been further divided into 3 blocks and Block A-1 has been designated as the highest priority area and subsequently the subject of this Project.

The reasons for Block A-1 having been selected as the highest priority area are as follows.

a) Land acquisition along Lakhya River is already in progress.
b) Flood embankment for Lakhya River have almost been completed.
c) With the recent completion of the road connecting Golakandail along D-N Road and Kanchan along Lakhya River, the new construction of a flood embankment surrounding Block A-1 is unnecessary except a relatively short distance.
d) As Block A-1 is adjacent to the successful Demonstration Unit, the understanding of local inhabitants regarding the necessity for the Project is fairly good and its construction is strongly desired. As a result, land acquisition and other related work can be easily carried out.
e) As the existing canals can be used from the water utilization and topographical viewpoints, the area has advantageous conditions for the implementation of the Project.
f) As the infrastructure, including roads and power supply, is well developed, the area has advantageous conditions in that the work can be immediately implemented with involving only an additional investment on the electric power supply.

In addition to the reasons given above, the implementation of the Project in Block A-1 can further demonstrate the effects of Japanese assistance as the subject area is adjacent to the Demonstration Unit which was also constructed with Japanese grant aid. Furthermore,

Project implementation in Block A-1 will effectively assist the self-help efforts of the Government of Bangladesh which has already commenced investment in the area. The selection of Block A-1 for this Project, therefore, appears a realistic and appropriate decision.

The requested contents cover almost all the items required for this type of project. With regard to the flood embankment, the original request was for the new construction of a flood embankment for 2km and the remodelling of the existing flood embankment and land acquisition along the planned new flood embankment has almost been completed. The Basic Design Study Team, however, found that a fair amount of flood embankment construction/remodelling work will be necessary along the entire length of the flood embankment (excepting D-N Road) and, therefore, the required land acquisition size is much larger than originally requested.

It was also found that the quantities of the requested facilities ware not calculated based on, for example, a master plan or preliminary design, but were decided based on the average quantities in similar projects. Consequently, it has been decided that new quantities will be introduced in the Basic Design.

The requested contents and planned contents in the Basic Design (see 5.3) are listed below for comparison.

| Facilities | Original Request | Basic Design | Remarks |
|---|---|---|---|
| Flood Embankment | | | |
| New Construction | 2km | 6.04km | Reconstruction: 3.57km |
| Remodelling | Existing Embankment | 12.24km | Improvement Work |
| Pumping Station (for both Irrigation and Drainage) | 1 | 1 | |

| | | | |
|---|---|---|---|
| Drainage facilities | | | |
| Main Canal | 12km | 10.70km | |
| Secondary Canal | 20km | 19.65km | |
| Tertiary Canal | 30km | 11.45km | |
| Regulator(s) | 1 | 3 | Included in Embankment Construction Work |
| Siphon(s) | 2 | 1 | Included in Irrigation Canal Construction Work |
| Pipe Slices | 4 | 5 | Included in Embankment Construction Work |
| Irrigation Facilities | | | |
| Main Canal | 15km | 11.13km | |
| Secondary Canal | 30km | 19.49km | |
| Tertiary Canal | 45km | 29.67km | |
| Regulators(Main Canal) | 10 | 9 | Turnouts |
| Regulators(Secondary Canal) | 80 | 47 | Turnouts |
| Turnouts(Tertiary Canal) | 200 | 78 | |
| Aqueducts | 4 | 2 | |
| Escape(s) | 2 | 1 | |
| Check Structures | 2 | 3 | |
| Dredging of Intake Canal | 1km | 40m | |
| Bridges and Culverts | | | |
| Bridges | 16 | 9 | Included in relevant Canal Construction Work |
| Culverts | 25 | 14 | Box Culverts |
| Others | | | |
| Footbridges | | 33 | |
| Pipe Culverts | | 214 | |
| Terminal Structures | | 44 | |
| Washing and Bathing Places | | 23 | |
| Subject Area | | | |
| Gross Area | 3,500ha | 3,000ha | Area inside Flood Embankment |
| Benefited Area | 3,000ha | 3,000ha | " |
| Irrigable Area | 2,600ha | 2,230ha | " |

| | | |
|---|---|---|
| Land Acquisition | | |
| Flood Embankment | 6.0ha | 51.2ha |
| Pumping Station | 0.5ha | 0.5ha |
| Drainage Canals | 8.0ha | 26.8ha |
| Irrigation Canals | 8.5ha | 78.1ha |
| Total | 23.5ha | 156.6ha |

## 4.3 Framework of the Project

### 4.3.1 Implementing Organization

The responsible organization for the implementation of the Project is the Bangladesh Water Development Board (BWDB) under the administrative control of the Ministry of Irrigation, Water Development and Flood Control. The BWDB is in charge of the implementation and the operation and maintenance of flood control, water resources development and major irrigation projects in Bangladesh. The Head of the BWDB is the Chairman, under whom are 5 Member. Below these 5 Members are several Chief Engineers or Directors and further down the hierarchy are Superintending Engineers and then Executive Engineers. Below the Executive Engineers are numerous sections.

The line of command for the implementation of the Project consists of the Member of O & M, Chief Engineer (N-E Zone), Superintending Engineer (Dhaka O & M Circle) and Executive Engineer (Dhaka O & M Div.-I) in that order. The signatory for the contracts is the Chief Engineer and the direct responsibility of the Project implementation is assigned to the Executive Engineer. The power transmission line construction work and land aquisition to be carried out by the Bangladesh side will be conducted by related organizations on the instruction of the BWDB. The Chief Engineer (Design) under the Member of Implementation is responsible for the detailed design.

Although the BWDB has been entirely responsible for operation and maintenance, the organization of farmers and the provision of technical guidance to farmers after the completion of previous projects, recent changes have resulted in the Bangladesh Rural Development Board (BRDB) of the Ministry of Local Government, Rural Development and Cooperatives being assigned the responsibility for organizing farmers and the Department of Agricultural Extension (DAE) of the Ministry of Agriculture being assigned the responsibility for educating farmers on the necessity of irrigated agriculture and providing technical guidance.

The implementation system of the Project and its line of command described above are schematically shown in Fig. 4-3-1.

### 4.3.2 Work Implementation Plan

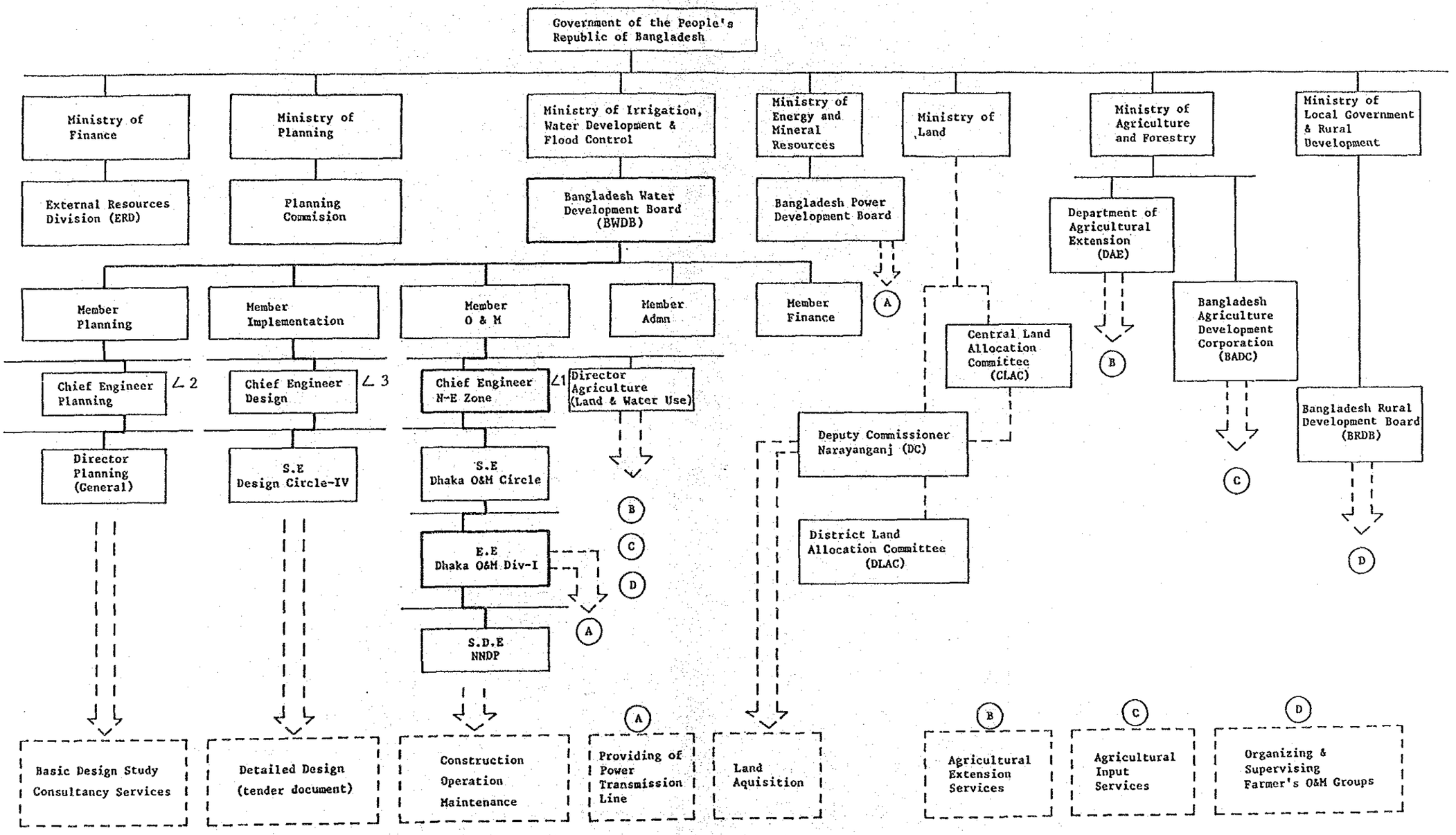
The work associated with the Project is divided into 4 fields, i.e. (1) facility construction work including provision of operation and maintenance equipment, (2) consultancy services and (3) work to be undertaken by the Government of Bangladesh.

(1) and (2) above are the subjects of the Japanese grant aid and will be implemented under the Japanese grant aid.

Following the signing of the Notes between the Bangladesh and Japanese Governments, the BWDB will select a Japanese consultant pursuant to the established system of grant aid cooperation by the Government of Japan. The consultant so selected will conduct the detailed design based (part of consultancy services (2) above) on a contract with the PWDB.

In regard to the construction work, the BWDB will use the consultant to carry out the tender procedure to select a contractor from the Japanese tenderers pursuant to the Japanese grant aid system. The contractor so selected will complete the construction ((1) above) of the Project within 30 months of signing the construction contract.

Fig. 4-3-1 Organization Chart of the Project Implementing Organization and Concerned Organizations




Notes: ∠1 The construction contract will be signed by the Chief Engineer.

∠2 The consultant contract will be signed by the Chief Engineer.

∠3 All design drawings and specifications will be approved by the Chief Engineer.

### 4.3.3 Outlien of Facilities

The facilities to be constructed under the Project are outlined below.

(1) Bangladesh Side

| | | |
|---|---|---|
| Power Transmission Line | 11KV | 2km |
| BWDB Site Office | | 1 set |
| Small-Scale Irrigation and Drainage Canal under 2cusec | | 1 set |
| Land Acquisition | | 1 set |

(2) Japanese Side

1) Flood Embankment

a) Flood Embankment

| | |
|---|---|
| New Construction and Reconstruction | 6.04km |
| Remodelling | 12.24km |
| Total | 18.28km |

b) Related Structures

| | |
|---|---|
| Regulators | 3 |
| Pipe Sluices | 5 |

2) Pumping Station

| | | |
|---|---|---|
| a) | Pumping Station | 1 |
| b) | Pumps | $\phi$1,000mm x 1.88$m^3$/sec x 4 pumps |
| c) | Pump House | 166$m^2$ |
| d) | Other Buildings (Office, Meeting Hall, Operator Shed, Guard Shed) | 1 each |
| e) | Dredging of Intake Canal | 40m |

3) Drainage Facilities

| | | |
|---|---|---|
| a) | Main Canal (10.70km) | 1 |
| b) | Secondary Canals (19.65km in total) | 9 |
| c) | Tertiary Canals (11.45km in total) | 15 |
| d) | Box Culverts | 14 |
| e) | Pipe Culverts (Secondary Canals) | 11 |
| f) | Pipe Culverts (Tertiary Canals) | 38 |
| g) | Bridges | 2 |
| h) | Footbridges | 2 |

4) Irrigation Facilities

| | | |
|---|---|---|
| a) | Main Canals (11.13km in total) | 2 |
| b) | Secondary Canals (19.49km in total) | 14 |
| c) | Tertiary Canals (29.67km in total) | 44 |
| d) | Check Structures | 3 |
| e) | Turnouts (Main to Secondary) | 9 |
| f) | Turnouts (Secondary to Tertiary) | 47 |
| g) | Turnouts (Tertiary to Field Canals) | 78 |
| h) | Aqueducts | 2 |
| i) | Syphon | 1 |
| j) | Escape | 1 |
| k) | Pipe Culverts (Secondary Canals) | 16 |
| l) | Pipe Culverts (Tertiary Canals) | 149 |
| m) | Bridges | 7 |
| n) | Footbridges | 31 |
| o) | Terminal Structures | 44 |
| p) | Washing Places | 23 |

# CHAPTER 5 BASIC DESIGN

## 5.1 Design Policy

The Project consists of 4 separate construction plans for the flood embankment, pumping station, drainage facilities and irrigation facilities, as well as the operation and maintenance equipment supply plan. The basic design policies for these plans are as follows.

### (1) General Design Policies

1) Local construction materials will be used where deemed possible.

2) Local construction methods will be used where deemed possible.

3) The area for land acquisition will be minimized.

4) The employment of local farmers for the workforce will be prompted where deemed possible.

5) All the facilities will be capable of functioning as independent facilities for Block A-1 without outside assistance for the foreseeable future.

### (2) Flood Embankment

1) Sufficient attention should be paid to the fact that the flood embankment to the south and west (along Lakhya River) of the Project area will form part of the flood embankment for the entire N-N area in the future.

2) In principle, the route of the flood embankment will be based on embankment constructed by the Government of Bangladesh and existing road routes.

3) The existing D-N Road will be used for the eastern part of the flood embankment.

4) As well as flood control, the flood embankment will also act as a trunk road in the area.

5) Measures should be introduced to prevent damage caused by rats.

6) Attention should be paid to the minimization of possible damage to Block A-2 due to the construction of flood embankment.

(3) Pumping Station

1) The pumping station will be used for both irrigation and drainage.

2) Lakhya River will be used as a water source and a place for flood water discharge.

(4) Drainage Facilities

1) Consideration should be given to the maximum use of the existing drainage canals.

2) The facilities should be capable of effecting gravity drainage during the low stage of the water level of the river.

(5) Irrigation Facilities

1) The irrigation system consists of main, secondary, tertiary and field canals and the supply of water to the fields should be made along this line.

2) Independent water management for each secondary and tertiary canal should be established.

3) It should be made possible to use the surplus pumping capacity to provide irrigation water to the Demonstration Unit.

## 5.2 Design Criteria

The basic conditions for the basic design are as follows.

(1) Design Flood Stage

Based on the water level records of the Demra Observation Station on Lakhya River, a flood level with a 25 year return period will be adopted as the design flood stage.

(2) Design Drainage Discharge

A 5 day rainfall with a 10 year return period will be used for the drainage plan. The runoff ratio will be 100% while the allowable flooding depth will be 30 cm will be 72 hours.

The target is to reduce the ratio of flooded farming fields where the duration of a flooding depth exceeding the allowable depth is more than 72 hours to less than 5%.

(3) Design Intake Water Level

A drought water level with a 10 year return period will be adopted as the design intake water level of Lakhya River.

(4) Required Irrigation Water Volume

The modified Penman method will be used to calculate the water requirement in the irrigation plan. The reference year for irrigation planning will be a drought year with a 10 year return period at the Dhaka Station.

(5) Cross Section of Flood Embankment

The crest level of the flood embankment will be 0.9 m (for freeboard) above the design flood water level. The crest width will be 6.0 m for the section to be continuously used as a flood embankment in the future in view of the facts that (i) this will be the main embankment for Lakhya River, (ii) it will

play an important role as a main road in the area, (iii) operation and maintenance activities requiring vehicles will be necessary and (iv) the width should be sufficient to prevent damage caused by rats. The crest width of the remaining section (between Golakandail and Kanchan) will be 5.0 m.

(6) Freeboard for Canals

The freeboard for the irrigation canals will be 60 cm, 45 cm and 30 cm for the main, secondary and tertiary canals respectively. In the case of the drainage canals, the freeboard will be 60 cm for the main and secondary canals and 30 cm for the tertiary canal.

(7) Pumping Station

The pumping station will be used for both irrigation and drainage purposes. The total pumping capacity will be decided assuming 22 hours operation a day at peak flooding time taking possible electric power failure and operation stoppages into consideration.

(8) Cropping Pattern

The cropping pattern to be proposed will be decided based on the cropping performance in the Demonstration Unit and similar project areas and the relevant policies of the Government of Bangladesh.

## 5.3 Basic Plan

### 5.3.1 Land Utilization Plan

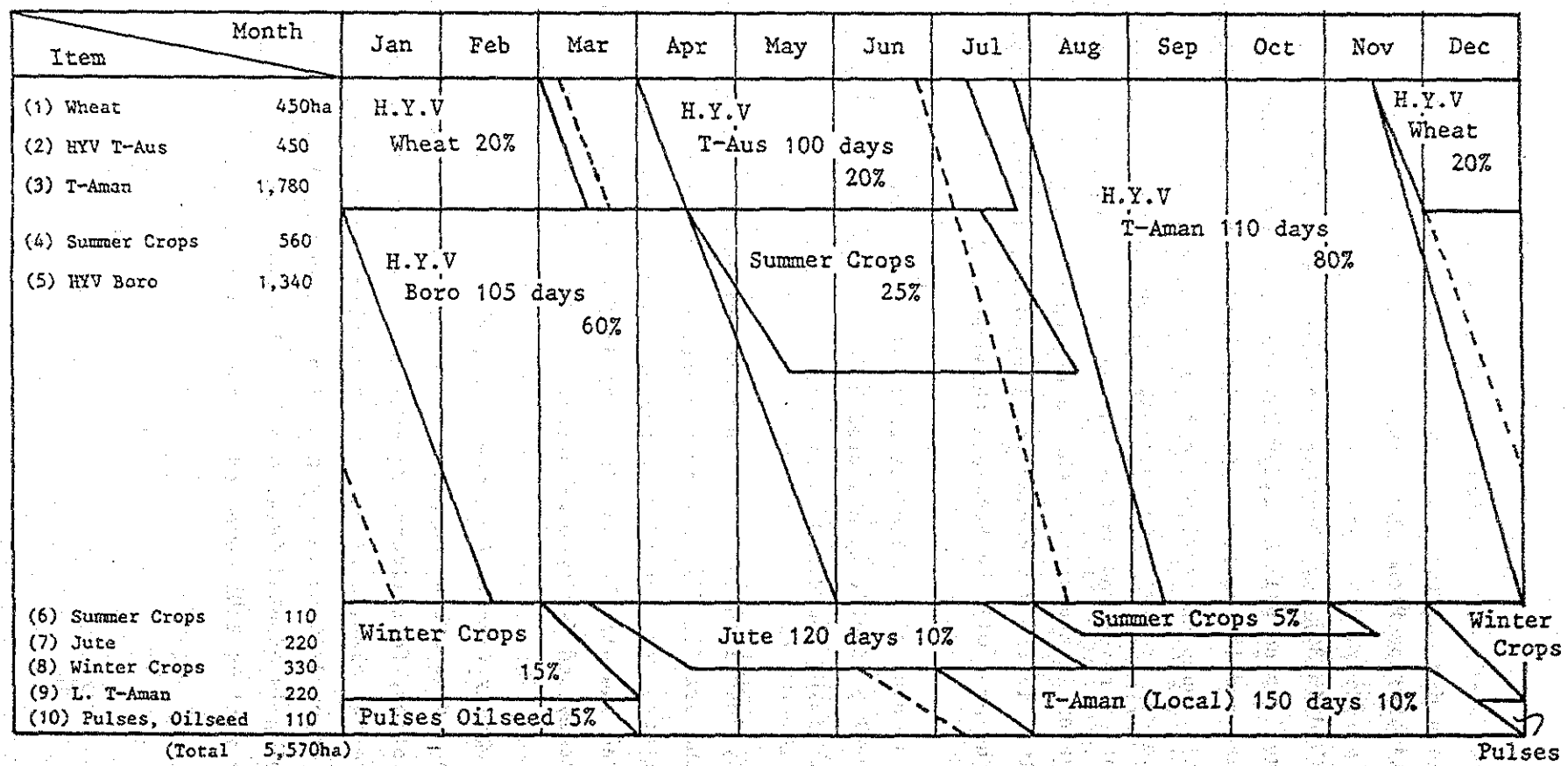
As described in 3.1, of the total benefited area of 3,000 ha, the net irrigable area will be 2,230 ha, excluding 620 ha for non-farming use and 150 ha for project facilities (drainage and irrigation canals, pumping station and farm roads, etc.).
As the Project area will be entirely surrounded by either the embankment or roads and as the planned pumping station will drain the rainwater in the area in the rainy season and pump in water from Lakhya River in the dry season for irrigation, agricultural production in the area will be possible throughout the year.

The real success of the Project will, therefore, depend on how agricultural productivity and production in the area is improved by highly utilizing the 2,230 ha of cultivable land.

As already described in the present conditions of the Project area, most of the area is flat except for scattered areas of high ground where villages are located. Consequently, no land reclamation will be required and all the land is suitable for cultivating given the proper supply and drainage of water.

The land utilization rate in the area can be increased by expanding the cropped area and by adopting an appropriate cropping pattern, crop varieties, fertilizers, agrochemicals and farming techniques. In the present plan, a cropping pattern where the main feature is 5 cropping of paddy rice in 2 years with some wheat, jute and vegetable cropping is adopted (Fig. 5-3-1). The resulting cropping intensity will be 250% compared to the current rate of 110%.

Fig. 5-3-1 Proposed Cropping Pattern




Intensity of Cropping = 250%

Cultivated Area = 2,230 ha

Cropped Area = 5,570 ha

Winter Crops(Vegetables)

- Rape & Mustard
- Masur
- Potato
- Kensari
- Chillies(Rabi)
- Onion
- Cabbage

Summer Crops(Vegetables)

- Brinjal
- Pumpkin
- Chillies(Bhadei)
- Turmeric
- Cucumber

### 5.3.2 Farming Plan

Based on the objective of the Project and through a series of discussions with BWDB, the farming plan has been decided taking the results of the Feasibility Study and actual results of the D-N-D area where the agricultural development plan has been completed and that of the Demonstration Unit into consideration.

(1) Introduced Crops and Proposed Cropping Pattern

The types of crops to be planted in the area and the cropping pattern have been decided aiming at achieving a self-sufficient supply of the main food, high profitability and increased employment opportunities taking the following points into consideration.

- o The Project is a model agricultural development project in the metropolitan area.
- o The achievement of the high utilization of limited land should be attempted.
- o An increasing the farmers' income level should be attempted.
- o The promotion of the settlement of rural inhabitants and an increase of employment opportunities should be attempted.
- o Some farmers already have knowledge relating to farming techniques and the necessity for organization, etc. through participating in the Demonstration Unit.

Rice cultivation will be the mainstay of farming, together with the production of wheat, jute, summer/winter vegetables, oilseeds and pulses, etc. The proposed cropping pattern based mainly on 5 croppings of paddy rice in 2 years is shown in Fig. 5-3-1.

The varieties of introduced paddy rice excluding the local T-Aman, and wheat are high yield varieties. The overall annual cropping intensity will be 250%.

(2) Input Supply and Target of Production

The agricultural input supply for the proposed cultivation such as seed, fertilizer and agro-chemicals/pesticide, and the target yield of each crop at the completion of the project works have been assumed on the basis of the data furnished by MPO (Master Plan Organization, Ministry of Irrigation, Water Development and Flood Control), as shown bellow:

| Crop | Input | | | Target Yield (ton/ha) |
|---|---|---|---|---|
| | Seed (kg/ha) | Fertilizer (kg/ha) | Pesticide (kg/ha) | |
| Local T-Aman | 30 | 78 | 0.30 | 3.88 |
| HYV. T-Aman | 30 | 280 | 0.75 | 4.14 |
| HYV. T-Aus | 30 | 423 | 0.75 | 4.87 |
| HYV. Boro | 30 | 311 | 0.75 | 4.73 |
| HYV. Wheat | 140 | 315 | 0.40 | 2.77 |
| Jute | 11 | 75 | 0.75 | 1.80 |
| Pulses | 35 | - | - | 1.00 |
| Vegetables | 8 | 327 | 0.25 | 12.43 |

(3) Marketing System

As the agricultural production will increase by 4-5 times of that of the present level, the number of crop types and the absolute volume to be marketed will show a large increase, necessitating the provision of warehouses. Warehouses for fertilizers and agrochemicals will also be required in view of their increased use.

Since the Project area is near Dhaka, a large consumption area, and since the flood embankment to be constructed under the Project will also act as a road, no problems in regard to product marketing are anticipated.

### 5.3.3 Flood Control Plan

This plan intends the surrounding of the Project area by a flood embankment to prevent the flooding of the area during the rainy season.

The design flood water stage, by which the crest elevation of the flood embankment is decided, is decided by the probability calculation based on the annual maximum river water levels in 21 years (1967 - 1987) observed at the Demra Gauging Post on Lakhya River which is the nearest gauging post to the area (see Table 3-3-3). The calculation results are as follows.

Probability Calculation of Flood Level

(Unit: m PWD)

| Method / Return Period | Thomas | Hazen | Gumbel | Remarks |
|---|---|---|---|---|
| 2 | 5.77 | 5.77 | 5.57 | |
| 5 | 6.12 | 6.09 | 6.04 | |
| 10 | 6.32 | 6.26 | 6.26 | |
| 25 | 6.53 | 6.45 | 6.52 | Design Year |
| 50 | 6.67 | 6.57 | 6.72 | |
| 100 | 6.79 | 6.68 | 6.92 | |

In accordance with the design criteria described in 5.2, the 6.52 m PWD obtained by the Gumbel method with a 25 year return period has been adopted as the design flood water stage at Demra. In view of the 6 km distance between Demra and the central point of the Project area and the hydraulic gradient of 1/80,000 at the time of the flooding of Lakhya River, it has been decided that the design flood water stage in the Project will be EL. 6.60 m PWD.

### 5.3.4 Drainage Plan

As the Project area will be surrounded by a flood embankment, there will be no flooding in the area. The drainage plan for the Project area will, therefore, consist of the drainage of surplus rainwater to the new pumping station on Lakhya River via drainage canals and its drainage outside the area, i.e. Lakhya River. Drainage at the time when the water level of Lakhya River is low will be conducted using the gravity method via regulators.

(1) Design Rainfall

With regard to the design rainfall, used to determine the design pumping drainage discharge, a 5 day rainfall with a 10 year return period has been estimated by the probability calculation using the daily rainfall data (1964 - 1985) of Dhaka Station (see 5.2). Consequently, the design rainfall is the maximum 5 day rainfall in a year with the nearest correspondence to the above value. Based on the calculation results given in the table below, 359.7 mm, which is the maximum 5 day rainfall in 1966 and which corresponds to the 10 year return period, is the design rainfall.

Probability Calculation Results of a 5 Day Rainfall

(Unit: mm)

| Return Period \ Method | Thomas | Hazen | Gumbel | Remarks |
|---|---|---|---|---|
| 2 | 250.4 | 250.4 | 248.7 | |
| 5 | 322.0 | 314.2 | 328.6 | |
| 10 | 367.1 | 353.7 | 381.6 | |
| 25 | 409.3 | 401.5 | 448.4 | Design rainfall |
| 50 | 462.1 | 435.4 | 498.0 | |
| 100 | 501.4 | 468.6 | 547.2 | |

(2) Discharge Calculation

The pumping drainage discharge to meet the required condition was calculated based on the estimated water balance between the runoff of the maximum 5-day rainfall in 1966 and the pumping discharge. The required condition here means that the flood duration where the flooding depth is above the allowable depth of 30 cm is less than 72 hours (see 5.2).

In view of the land in the Project area being virtually flat and as it will be divided into many small fields by field porders and the dikes of irrigation and drainage canals, the water storage capacity of the paddy fields was taken into consideration in the runoff calculation. In addition, the local variety of T-Aman, which is suitable for planting in lowland areas, is planned for 10% of the total irrigation area and the elevation of the design fields in the drainage plan is decided to be EL.3.0 m PWD (15% of the total area) in view of economy (see Fig. 5-3-2).

As a result of the water balance calculation, the design pumping drainage discharge is 594,000 $m^3$/day (see Fig. 5-3-3). Based on the 22 hours pumping operation assumed in 5.2, the design pumping capacity is 7.5 $m^3$/sec which is adopted as the design drainage discharge and the unit area drainage discharge is given as 2.5ℓ/sec/ha planned for the entire N-N Irrigation Project and the Demonstration Unit and the 2.5ℓ/sec/ha for D-N-D Project.

Fig. 5-3-2 Inundation Area and Volume - Depth Curve

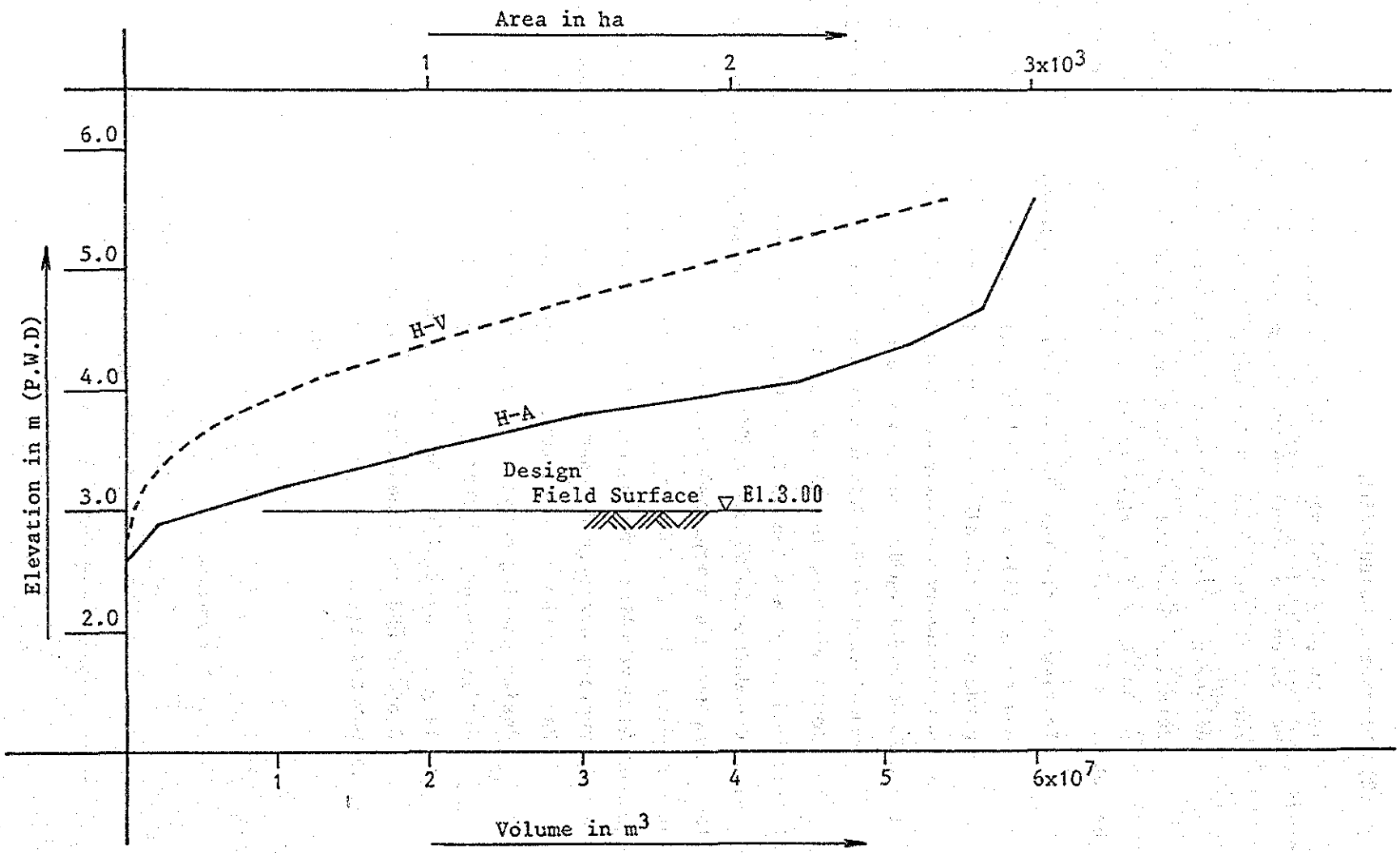
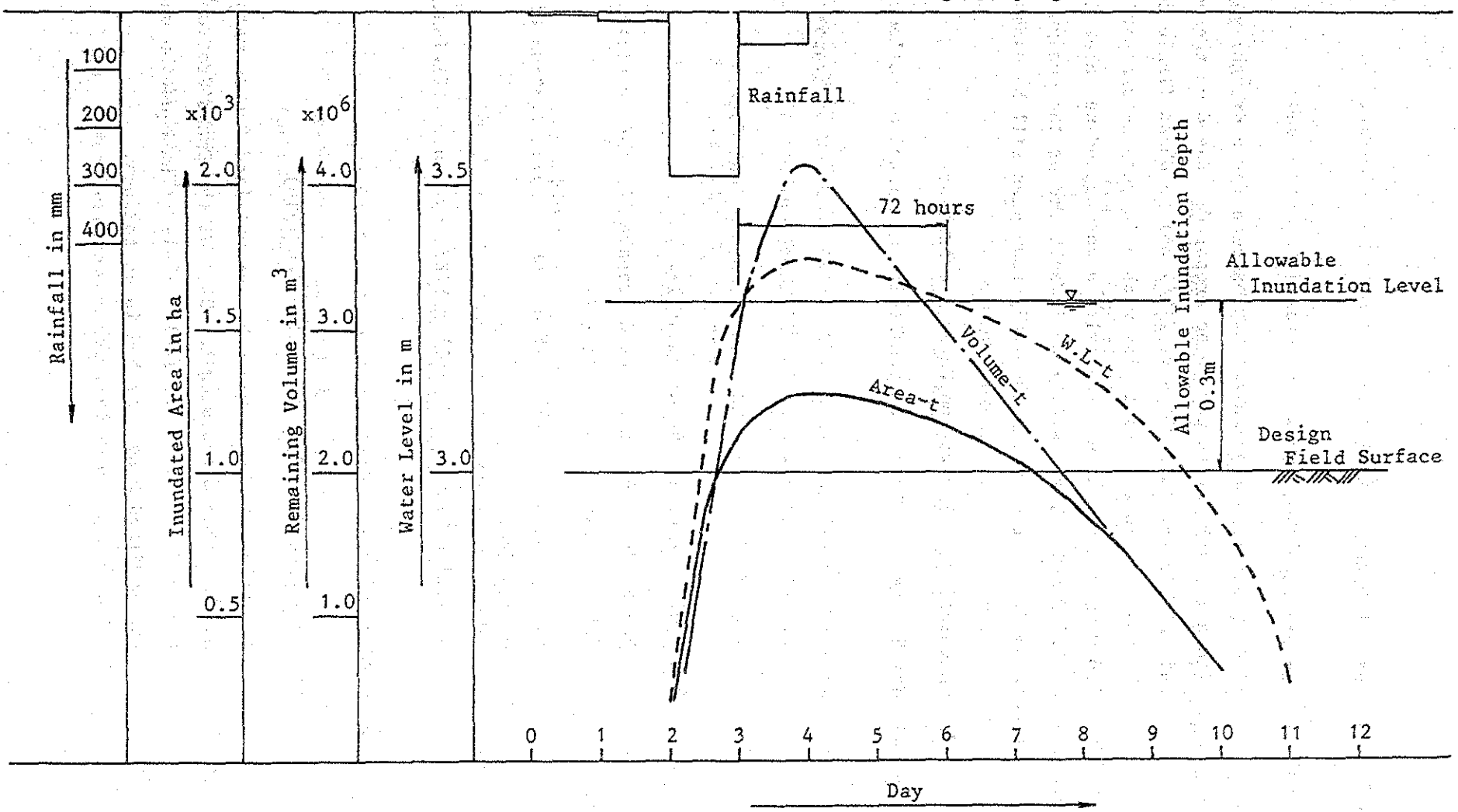


Fig. 5-3-3 Water Level, Inundation Volume and Inundation Area - Time Curve

( in case of design pumping discharge is 594,000 $m^3$/day )



### 5.3.5 Irrigation Plan

(1) Selection of Design Year

It is preferable that an irrigation plan for a drought year with a 10 year return period be prepared. Based on the annual rainfall in the last 20 years (1967-86) in Dhaka (Table 3-3-2), the rainfall in a drought year with a 10 year return period is 1,670 mm and the actual year with a corresponding value is 1969 (1,667.8 mm). Therefore, 1969 is selected as the design year in the Project on which the irrigation plan will be based.

(2) Calculation of Irrigation Water Requirement

The irrigation water requirement is calculated as follows.

1) Crop Water Requirement (ETc) = Reference Crop Evapotranspiration (ETo) x Crop Coefficient (Rc)

The ETo is calculated from meteorological data.

2) Field Irrigation Requirement (FIR)

For Paddy: FIR = ETc + Land Preparation (LP) + Field Loss (FL) - Effective Rainfall (ER)

For Upland Crops: FIR = (ETc + LP - ER)/Irrigation Efficiency (Ea)

3) Diversion Requirement (DR) = FIR/Conveyance Efficiency (Ec)

(3) Crop Water Requirement

1) Reference Crop Evapotranspiration (ETo)

The value of ETo is given by the modified Penman method based on the meteorological data of the Dhaka Station in the last 10 years (see Table 3-3-1). The equation used by the modified Penman method is as follows.

$$ETo = C \cdot [W \cdot Rn + (1-W) \cdot f(u) \cdot (ea-ed)]$$

Where, ETo : Reference crop evapotranspiration in mm/day

W : Temperature-related weighting factor

Rn : Net radiation in equivalent evaporation in mm/day

f(u) : Wind-related function

(ea-ed) : Difference between saturation vapour pressure at mean air temperature and mean actual vapour pressure of air, both in mbars

C : Adjustment factor to compensate for the effect of day and night weather conditions

The ETo calculation results using the above method are given in Appendix 2-2-4.

2) Crop Water Requirement

The crop evapotranspiration is calculated using the following equation.

$$ETc = ETo \times Kc$$

Where, ETo : Reference crop evapotranspiration (mm/day)

Kc : Crop coefficient

Chapter VII, Vol. 1 of the Bangladesh Land and Water Resources Sector Study (1972, IBRD) will be referred to for the crop coefficient (see Appendix 2-2-4).

(4) Water Requirement for Land Preparation, Field Loss and Irrigation Efficiency

1) Water Requirement for Land Preparation (LP)

The water requirement for the land preparation/puddling of paddy fields and upland fields is as follows.

| | | |
|---|---|---|
| Paddy Fields: | Boro Variety | 180 mm |
| | Aman Variety | 130 mm |
| Upland Fields: | | 80 mm |

2) Field Loss (FL)

The field loss in paddy fields is 130 mm/month, including the amount of percolation.

3) Water Utilization Efficiency (Ea)

The water utilization efficiency is used to calculate the irrigation water requirement for plowed fields. The rate adopted in the Project is 50%.

(5) Effective Rainfall (ER)

As 1969 is selected as the design year for the irrigation plan, the effective rainfall in 1969 is calculated in order to calculate the field irrigation water requirement.

Using daily rainfall data, the effective rainfall is calculated based on the following criteria and is compiled semimonthly.

1) For Paddy

Daily rainfall less than 5 mm .. effective rainfall = 0

Daily rainfall between 5 mm and 80 mm ..... effective rainfall = (R*-5) x 100%

Daily rainfall over 80 mm ..... effective rainfall = 80 mm

*R : Daily rainfall

2) For Upland Crops

Daily rainfall less than 3 mm .. effective rainfall = 0

Daily rainfall between 3 mm and 50 mm ..... effective rainfall = (R-3) x 80%

Daily rainfall over 50 mm ..... effective rainfall = 50 mm

The calculation results of the effective rainfall for the design year (1969) using the above criteria are given in Appendix 2-2-4.

(6) Irrigation Water Requirement

Based on the proposed cropping pattern (Fig. 5-3-1), the irrigation water requirement for Block A-1 is calculated as shown in Table 5-3-1.

(7) Diversion Water Requirement (DR)

1) Conveyance Efficiency (Ec)

All the irrigation canals in the Project will be simply excavated canals and, therefore, conveyance losses of 30%, including the diversion losses, is assumed with a resulting conveyance efficiency of 70%.

2) Diversion Requirement (DR)

The semimonthly diversion requirement (water requirement at source), calculated based on the above calculation results and assumptions, is given in Table 5-3-2. This table clearly shows that peak irrigation occurs in the first half of April with the discharge of 3.40 $m^3$/sec.

(8) Irrigation Plan

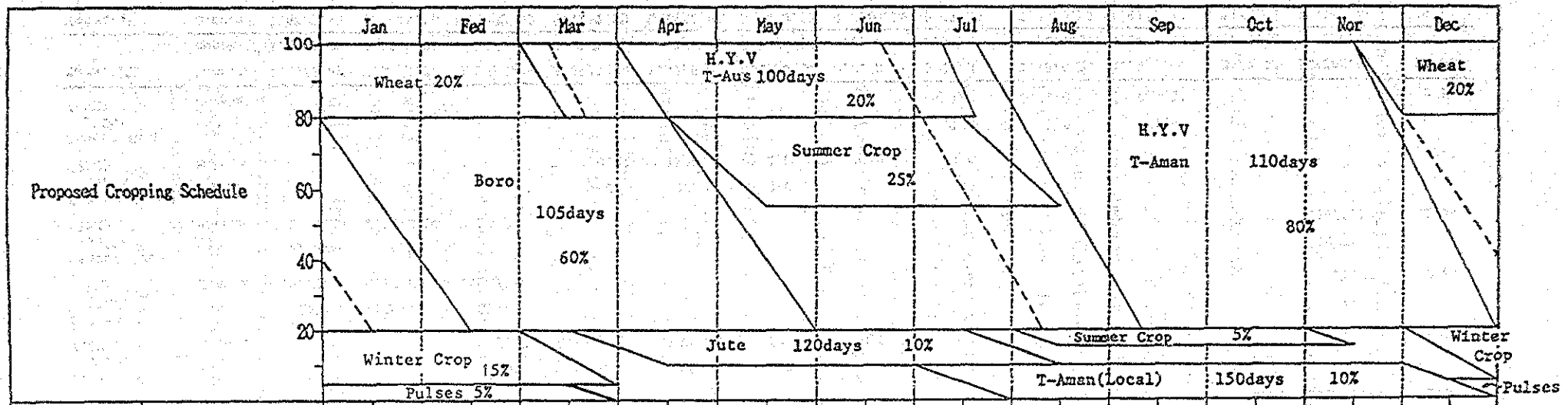
As the irrigation method in the Project presupposes the use of pumps, the design intake discharge and the design capacity of facilities are decided by the design operation hour of the pumping station.

Since the pumping station in the Project will be used for both irrigation and drainage purposes, its capacity has already been given as 7.5 $m^3$/sec in the drainage plan (see 5.3.4). Consequently, the irrigation capacity of the pumping station is well above the required stage. In the adjacent Demonstration Unit (irrigable area of 1,000 ha), however, timely irrigation using pumps cannot be conducted, resulting in inadequate land utilization in the dry season. Therefore, the irrigation plan in this Project permits water distribution to the Demonstration Unit using the surplus capacity of the pumping station described above. In view of the fact that the peak water requirement in the Demonstration Unit does not occur at the same time as in Block A-1 and also in view of the economical design of the irrigation facilities, the design distribution discharge to the Demonstration Unit will be 80% of the peak water requirement in the Demonstration Unit.

If 18 hours is given as the operation duration at the time of the peak water requirement, the design discharge for Block A-1 is 4.5 $m^3$/sec. As a result, it has been decided that 2.0ℓ/sec/ha is the unit irrigation requirement (in the facility design) for Block A-1. As 80% of the maximum water requirement in the Demonstration Unit is 1.76 $m^3$/sec, the design distribution discharge to the Demonstration Unit from the pumping station in Block A-1 is given as 2.35 $m^3$/sec.

Table 5-3-1 Cropping Pattern and Irrigation Water Requirement

(in m³/sec)




| Kind of Crops | | | Jan | | Fed | | Mar | | Apr | | May | | Jun | | Jul | | Aug | | Sep | | Oct | | Nor | | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boro | 1340ha | 0.83 | 1.24 | 1.52 | 1.51 | 1.73 | 1.36 | 1.74 | 0.89 | 0.55 | 0.04 | | | | | | | | | | | | | 0.01 | 0.32 |
| | T-Aus | 450ha | | | | | 0.01 | 0.18 | 0.50 | 0.36 | 0.44 | 0.47 | 0.13 | 0.28 | 0.14 | 0.01 | 0.0 | | | | | | | | | |
| | T-Aman | 1780ha | | | | | | | | | | | | | 0.0 | 0.0 | 0.0 | 0.0 | 1.71 | 0.28 | 0.93 | 1.97 | 1.60 | 1.63 | 0.86 | 0.29 |
| | T-Aman(Local) | 220ha | | | | | | | | | | | 0.0 | 0.0 | 0.01 | 0.07 | 0.0 | 0.0 | 0.19 | 0.03 | 0.11 | 0.24 | 0.20 | 0.24 | 0.16 | 0.05 |
| | Wheat | 450ha | 0.26 | 0.33 | 0.48 | 0.45 | 0.26 | | | | | | | | | | | | | | | | | 0.23 | 0.17 | 0.21 |
| | Jute | 220ha | | | | | | 0.07 | 0.14 | 0.0 | 0.10 | 0.16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | |
| | Pulses | 110ha | 0.05 | 0.07 | 0.09 | 0.10 | 0.13 | 0.0 | | | | | | | | | | | | | | | | | | 0.04 |
| | Winter Crop | 330ha | 0.12 | 0.17 | 0.26 | 0.25 | 0.22 | | | | | | | | | | | | | | | | | | 0.12 | 0.13 |
| | Summer Crop | 560ha | | | | | | | | 0.17 | 0.08 | 0.08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | | | | | | | |
| | Summer Crop | 110ha | | | | | | | | | | | | | | | 0.03 | 0.0 | 0.01 | 0.0 | 0.0 | 0.08 | 0.0 | | | |
| Net Irrigation Water Requirement | | | 1.26 | 1.81 | 2.35 | 2.31 | 2.35 | 1.62 | 2.38 | 1.42 | 1.17 | 0.75 | 0.13 | 0.28 | 0.15 | 0.08 | 0.03 | 0.0 | 1.91 | 0.31 | 1.04 | 2.29 | 1.80 | 2.10 | 1.32 | 1.04 |

Table 5-3-2 Irrigation Water Requirement under the Proposed Cropping Calender

| Crops | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boro 1,340ha | FIR | 83/124 | 137/136 | 173/136 | 168/86 | 55/4 | | | | | | | 1/32 | |
| (60%) | M.cu.m | 1.11/1.66 | 1.83/1.83 | 2.31/1.82 | 2.26/1.15 | 0.73/0.05 | | | | | | | 0.01/0.43 | 15.19 |
| T-Aus 450ha | FIR | | | 3/56 | 143/105 | 132/140 | 37/82 | 42/2 | 0/ | | | | | |
| (20%) | M.cu.m | | | 0.01/0.25 | 0.64/0.47 | 0.60/0.63 | 0.17/0.37 | 0.19/0.01 | 0/ | | | | | 3.34 |
| T-Aman(HYV) 1,780ha | FIR | | | | | | | 0/0 | 0/0 | 125/20 | 69/148 | 117/118 | 65/22 | |
| (80%) | M.cu.m | | | | | | | 0/0 | 0/0 | 2.22/0.36 | 1.23/2.63 | 2.08/2.11 | 1.16/0.39 | 12.18 |
| T-Aman(Local) 220ha | FIR | | | | | | 0/0 | 2/44 | 0/0 | 112/15 | 70/146 | 117/141 | 97/32 | |
| (10%) | M.cu.m | | | | | | 0/0 | 0.01/0.10 | 0/0 | 0.25/0.03 | 0.15/0.32 | 0.26/0.31 | 0.21/0.07 | 1.71 |
| Wheat 450 | FIR | 78/99 | 128/121 | 78/ | | | | | | | | /67 | 52/61 | |
| (20%) | M.cu.m | 0.35/0.45 | 0.58/0.54 | 0.35/ | | | | | | | | /0.30 | 0.23/0.28 | 3.08 |
| Jute 220ha | FIR | | | /40 | 85/0 | 59/98 | 0/0 | 0/0 | 0/ | | | | | |
| (10%) | M.cu.m | | | /0.09 | 0.19/0 | 0.13/0.22 | 0/0 | 0/0 | 0/0 | | | | | 0.63 |
| Pulses 110ha | FIR | 55/76 | 110/118 | 161/0 | | | | | | | | | /64 | |
| ( 4%) | M.cu.m | 0.06/0.08 | 0.12/0.13 | 0.18/0 | | | | | | | | | /0.07 | 0.64 |
| Winter Crop 330ha | FIR | 51/69 | 94/91 | 90/0 | | | | | | | | | 49/51 | |
| (15%) | M.cu.m | 0.17/0.23 | 0.31/0.30 | 0.30/0 | | | | | | | | | 0.16/0.17 | 1.64 |
| Summer Crop 560ha | FIR | | | | /40 | 20/20 | 0/0 | 0/0 | 0/0 | | | | | |
| (25%) | M.cu.m | | | | /0.22 | 0.11/0.11 | 0/0 | 0/0 | 0/0 | | | | | 0.44 |
| Summer Crop 110ha | FIR | | | | | | | | 40/0 | 11/0 | 0/104 | 0/ | | |
| ( 5%) | M.cu.m | | | | | | | | 0.04/0 | 0.01/0 | 0/0.11 | 0/ | | 0.16 |
| Total FIR | M.cu.m | 1.69/2.42 | 2.84/2.80 | 3.15/2.16 | 3.09/1.84 | 1.57/1.01 | 0.17/0.37 | 0.20/0.11 | 0.04/0 | 2.48/0.39 | 1.38/3.06 | 2.34/2.72 | 1.77/1.41 | 39.01 |
| | cumec | 1.26/1.81 | 2.35/2.31 | 2.35/1.61 | 2.38/1.42 | 1.17/0.75 | 0.13/0.28 | 0.15/0.08 | 0.03/0 | 1.91/0.31 | 1.04/2.29 | 1.80/2.10 | 1.32/1.04 | — |
| Total DR | M.cu.m | 2.40/3.46 | 4.06/4.00 | 4.50/3.09 | 4.41/2.63 | 2.24/1.44 | 0.24/0.53 | 0.29/0.16 | 0.06/0 | 3.54/0.56 | 1.97/4.37 | 3.34/3.89 | 2.54/2.01 | 55.72 |
| | cumec | 1.80/2.58 | 3.36/3.31 | 3.36/2.30 | 3.40/2.03 | 1.67/1.08 | 0.18/0.41 | 0.21/0.11 | 0.05/0 | 2.73/0.44 | 1.48/3.27 | 2.57/3.00 | 1.89/1.49 | — |

FIR : Field Irrigation Requirement (mm)
DR : Diversion Requirement = FIR/0.7
M.cu.m : 1,000,000m³
cumec : m³/sec

### 5.3.6 Rough Design of Facilities

#### (1) Layout Plan for Main Facilities

1) Flood Embankment

The route of the flood embankment will, in principle, follow Rupsi Road in the south of the Project area, the existing embankment and/or roads along Lakhya River bank in the west and Golakandail-Kanchan Road in the north. The present D-N Road in the east will also be followed. Access from D-N Road to Rupsi Road and Golakandail-Kanchan Road will be newly constructed to facilitate the water supply to the Demonstration Unit and drainage from Block A-2 respectively. The embankment route will be moved further inland in those places along Lakhya River where the roads are directly scoured by river water.

2) Pumping Station

As the pumping station will be used for both irrigation and drainage purposes, it must be located along Lakhya River. Two locations where fairly large drainage canals meet Lakhya River were studied as possible sites for the pumping station. The site at the river bend, however, has been rejected due to it involving a long intake canal. The other location (Baniadi) is considered suitable for the location of the pumping station as the required intake canal length is short, the water route is considered stable due to the straight river channel in the vicinity and suitable space is available.

3) Irrigation and Drainage Canals

The evaluation of the Project area, surrounded by a flood embankment and roads, is generally high in the west along Lakhya River and low along D-N Road. Consequently, it is

planned that the main irrigation and drainage canals will be situated in the west and east of the area respectively. In general, the water in the secondary and tertiary irrigation and drainage canals will flow towards the east.

4) Related Structures

The layout of supplementary or related facilities to the above main facilities will be discussed as part of the description of the main facilities in 5.3.6.

The types and number of the facilities to be constructed under the Project area given in 4.3.2 and their layout plans are shown in DWG No. 1.

(2) Flood Embankment

1) Design Flood Stage

The design flood stage for Lakhya River is EL 6.60 m PWD as decided in 5.3.3 - Flood Control Plan. This water level has a 25 year return period.

2) Design Crest Level of Embankment

The design crest level of the embankment is the design flood stage plus 0.9 m for freeboard as decided in 5.2 - Design Criteria, totalling EL 7.50 m PWD.

3) Design Crest Width of Embankment

As the flood embankment in question is part of the embankment for Lakhya River, excepting the section consisting of Golakandail-Kanchan Road, it will form part of the flood embankment for the N-N Irrigation Project, requiring sufficient safety.

As the flood embankment is a vital component of this type of project, it requires thorough operation and maintenance

and vehicle traffic must be permitted during the rainy season to guarantee that the operation and maintenance can be carried out. In addition, attention should be paid to possible damage caused by rats, as evidenced in the collapse of an embankment in the Demonstration Unit. Therefore, measures to prevent the nesting of rats in the embankment should be introduced. Furthermore, an adequate width should be allowed to prevent rat holes across the embankment, as well as measures to make it physically difficult for rats to make holes.

Villages are located along almost the entire length of Lakhya River in the Project area, in addition to factories, markets and river ports. The flood embankment will, therefore, play an important role as a transportation route for local products (agricultural and industrial) and as a communication route between villages.

In view of the above, the crest width of the new flood embankment will be 6 m and its surface will be paved with bricks. The width of the Golakandail-Kanchan Road section, however, will be 5 m as it will not directly play a flood embankment role after completion of the flood embankment of Block A-2 in the future.

4) Slope Gradient

The stability analysis results for the embankment using the soil investigation results are given below.

In general, it is recommended that a safety coefficient of 1.2 to 1.3 be adopted. In view of the judgement that a safety coefficient of 1.3, which was adopted in the Feasibility Study, should be secured for the present purposes, it is decided that the gradient to maintain embankment stability will be 1:2.5. Taking possible erosion into

consideration, however, the gradient of the river side slope will be 1:3.0.

Embankment Stability Analysis Results (Safety Coefficient)

| Type | Along Lakhya River | | | | Kanchan Road | | | |
|---|---|---|---|---|---|---|---|---|
| Slope Side | Inside | | Outside | | Inside | | Outside | |
| Water Level / Gradient | 1:2.5 | 1:2.0 | 1:3.0 | 1:2.5 | 1:2.5 | 1:2.0 | 1:2.5 | 1:2.0 |
| High Water Level WL = 6.60 m | 1.297 | 1.278 | 2.303 | 2.236 | 1.301 | 1.269 | 2.260 | 2.217 |
| Low Water Level WL = 3.40 m | 1.303 | 1.268 | 1.337 | 1.300 | 1.307 | 1.280 | 1.307 | 1.280 |

5) Borrow Pit

Borrow pit for the embankment will be located outside the embankment and at least 4.5 m distant from the slope bottom with a maximum excavation for the safety of the embankment. Compartments will be introduced at these sites to prevent the occurrence of turbulent water flow.

6) Extra Banking

Based on the embankment settlement volumes given below, calculated based on the soil test, 10 cm and 15 cm extra banking will be given to the Type A embankment and Type B, C and D embankments respectively (the definitions of these types are given later).

Embankment Settlement Volumes

| Banking Height (m) | Settlement Volumes Crest Width (5 m) | Crest Width (5 m) |
|---|---|---|
| 4.0 m | 35 cm | 33 cm |
| 3.0 m | 27 cm | 23 cm |
| 2.0 m | 17 cm | 16 cm |
| 1.0 m | 9 cm | 7 cm |

7) Standard Cross Section Type

The cross section of the embankment, excepting the section consisting of D-N Road, is classified into the following 5 types (the standard cross sections are given in DWG No. 2).

Type A ... Embankment which is directly affected by the running water of Lakhya River and which consists of the remodelled and elevated existing road.

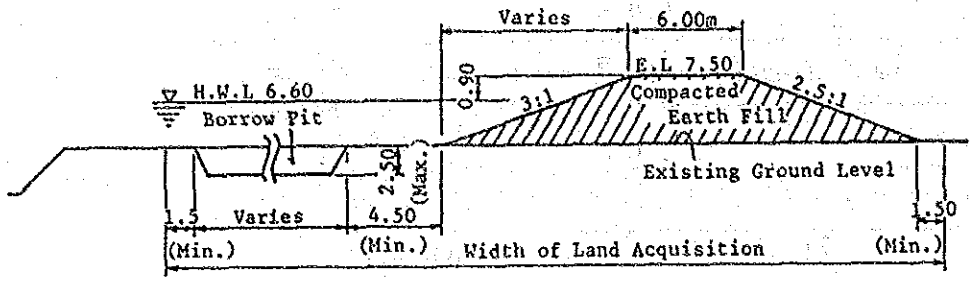
Type B ... Embankment which is located far from Lakhya River and which consists of the remodelled and elevated existing road.

Type C ... As the strength of the existing embankment is considered weak from the viewpoint of soil mechanics, the standard cross section will be introduced with reconstruction work.

Type D ... Embankment to be newly constructed.

Type E ... The embankment height is increased by brick retaining walls in those places where land acquisition is difficult due to existing roads running through villages or markets.

Standard Cross Section of Embankment




8) Related Structures

a) Regulators

Regulators with slide gates will be installed at the outfalls of the drainage canals to facilitate gravity drainage when the outside water level, i.e. the water level of Lakhya River, is lower than the inside water level and also to prevent the intrusion of outside water into the Project area when the outside water level is higher than that inside. There are currently 4 drainage canals directly discharging into Lakhya River and regulators have already been installed at the outfalls of 3 of them. One of these will become unnecessary with the construction of the pumping station and another will not be utilized due to its inconvenient position and gate structure vis-a-vis the Project requirements. The remaining one can be utilized without any alterations. As a result, 2 regulators will be newly introduced along Lakhya River and an additional regulator will be installed at the point where the main drainage canal meets Baliapara Khal in the northeastern corner of the Project area.

b) Pipe Sluices

There are 2 bridges and 2 culverts along Golankadail-Kanchan Road for the drainage of Block A-2. Culverts with gates will be introduced at these locations to make drainage from Block A-2 possible when natural drainage is underway in Block A-1. These culverts will be closed as soon as natural drainage becomes impossible. When culvert gates are closed, excess water in Block A-2 will flow into old Buramaput River via Baliapure Khal across D-N Road.

(3) Pumping Facilities

1) Design Pump Capacity

The design pump capacity is 7.5 $m^3$/sec for drainage and 6.85 $m^3$/sec for irrigation, as given in the respective plans.

2) Design Pump Head

a) Water Level of River Side

The water level of Lakhya River at the time of drainage is EL.6.60 m PWD, which is the design flood stage determined in 5.3.3. The water level of Lakhya River for irrigation purposes is based on the drought level with a 10 year return period. The actual values, based on the probability calculation using the relevant data of the Demra Gauging Post for the last 20 years (Table 3-3-3) are as follows.

| Return Period | Thomas Method | Hazen Method |
|---|---|---|
| 2 (years) | EL + 0.79 (m) | EL + 0.79 (m) |
| 5 | 0.69 | 0.70 |
| 10 | 0.65 | 0.66 |
| 25 | 0.60 | 0.64 |
| 50 | 0.57 | 0.62 |
| 100 | 0.55 | 0.57 |

Based on the above, it has been decided that the design water level of Lakhya River in the irrigation plan will be EL 0.65 m PWD.

b) Water Level of Inland Side

The lowest design water level for drainage is EL 2.00 m based on the design of the main drainage canal while the design water level for irrigation is EL 5.30 m based on the design of the main irrigation canal.

c) Design Actual Pump Head

The design water intake and discharge water levels for the pumps will be determined taking the head losses (including the screen loss) at the intake and the pump head losses (including the losses at the discharge tanks and intake canals at the outlets) into account for both drainage and irrigation purposes. The difference between the so determined discharge and intake water levels will be the actual head for the pumps. The results of these calculations are as follows.

| | Outside Water Level | Inside Water Level | Intake Loss | Discharge Loss | Intake Water Level | Discharge Water Level | Real Pump Head |
|---|---|---|---|---|---|---|---|
| Drainage | EL 6.6(m) | 2.00 | 0.30 | 0.10 | 1.70 | 6.70 | 5.00 |
| Irrigation | EL 0.65(m) | 5.30 | 0.10 | 0.05 | 0.55 | 5.35 | 4.80 |

d) Total Pump Head

The estimated loss relating to pumping operation of 0.40 m is added to the above actual pump head to obtain a total pump head of 5.40 m.

3) Number of Pumps

Based on the above design conditions, a comparative analysis was made between the cases where 3, 4, 5 and 6 pumps are installed to decide the required number of pumps. After a comprehensive appraisal of the construction cost, facility/equipment cost, risk diversification, adaptability to water demand fluctuations, economical operation and maintenance difficulties, etc., it has been decided that 4 pumps will be installed. The design discharge volume per pump is 1.88 $m^3$/sec with a diameter of 1,000 mm (see Appendix 2-2-3).

4) Pump Types

The design pump head is situated at the upper limit of an axial pump or at the lower limit of a mixed flow pump and, therefore, the axial pump has been selected due to the facts that the design pump head will be hardly exceeded and that the mixed flow pump would be some 10% more expensive. However, as operation with low pump head is expected to take place for the drainage, sufficient examination of the specific speed (Ns) will be required of the detailed design stage. The axial pump to be installed with be of the vertical shaft type.

5) Motor

An electric motor will be used to operate the pumps and the required output of the motor is calculated to be 131.4 kW based on the discharge volume of 1.88 $m^3$/sec, the pump head of 5.4 m, the pump efficiency of 0.8 and the excess motor coefficient of 0.06. Accordingly, the motor output has

been determined to be 132 kW. Details of the pump to be installed are as follows.

| | |
|---|---|
| Type | : Vertical shaft axial pump |
| Pump Nominal Diameter | : 1,000 mm |
| Discharge Capacity | : 1.88 $m^3$/sec |
| Pump Total Head | : 5.4 m |
| Motor Output | : 132 kW |
| Number of Pump Units | : 4 |

6) Pumping Station

The ground level for the pumping station will be EL 7.50 m PWD which is equivalent to the crest level of the embankment. As the proposed pumping station will be used for both irrigation and drainage purposes, a reinforced concrete structure with 2 floors will be introduced, as in the case of similar facilities. The pumping operation mode can be switched over by operating the gate. In view of the existence of a supporting layer 26 m below the existing ground level, an RC pile foundation suiting the local conditions will be used. Concrete piles of a 600 mm diameter will be placed at a 2.5 m pitch based on the pile foundation calculation results, as well as a cost comparison of different foundation types.

7) Supplementary Facilities at Pumping Station

In addition to the main building, 4 other buildings, i.e. office/warehouse/repair workshop complex, meeting hall, operator shed and guard shed, will be constructed.

(4) Drainage Facilities

1) Main Canal

In regard to the main canal leading to the pumping station, a new canal will be constructed along D-N Road and improvement work (expansion or dredging) will, in principle, be carried out for other routes using existing canals in order to facilitate drainage from the Project area. This canal will be simply excavated without lining and will have a water depth of 1.5 - 2.0 m. The slope gradient on both sides of the canal will be 1:2.0 in view of the stability analysis results.

Along D-N Road, a 4.5 m wide strip will be secured between the main canal and D-N Road in view of the road banking stability analysis results.

The required canal discharge is calculated by multiplying the unit drainage discharge q = 2.5ℓ/sec/ha given in 5.3.4 - Drainage Plan by the catchment area. The drainage system and the design discharge are schematically shown in Fig. 5-3-4.

In consideration of the flat land, it has been decided that the gradients will be 1/20,000, 1/10,000 and 1/5,000 for the main, secondary and tertiary canals respectively. The hydraulic calculation results for the main canal are given in Table 5-3-3 while the standard cross section is shown in DWG No. 6.

2) Secondary Canals

In principle, some of the existing canals will be either expanded or dredged for use as secondary canals. In regard to canal SD4 which runs along Golakandail-Kanchan Road, the ex-borrow pit for embankment construction will be used while canal SD5 will be newly extended to the regulator

location to be introduced for the flood embankment to facilitate gravity drainage. The hydraulic calculation results of the standard cross section for secondary canals are given in Table 5-3-4.

3) Tertiary Canals

It is planned that the tertiary canals will have a subject drainage area of 40 - 60 ha each. The discharge will be 0.100 - 0.150 $m^3$/sec. The standard cross section for tertiary canals is shown in DWG No. 6.

Table 5-3-7 gives the number of these 3 types of canals and their respective total lengths.

4) Related Structures

The following related structures are planned for the drainage canals.

a) Bridges

Bridges will be constructed across main canals at those places where the canals cross which connect with D-N Road.

b) Footbridges

Footbridges will be constructed at those points where canals are relatively narrow to restore the communication link which has been cut off by the introduction of the canals.

c) Box Culverts

Box culverts will be constructed across main and secondary canals with a wide cross section in those places where their provision is deemed necessary in view of the requirements of daily life, farm work and their operation and maintenance.

Fig. 5-3-4 Block Diagram of Canal System

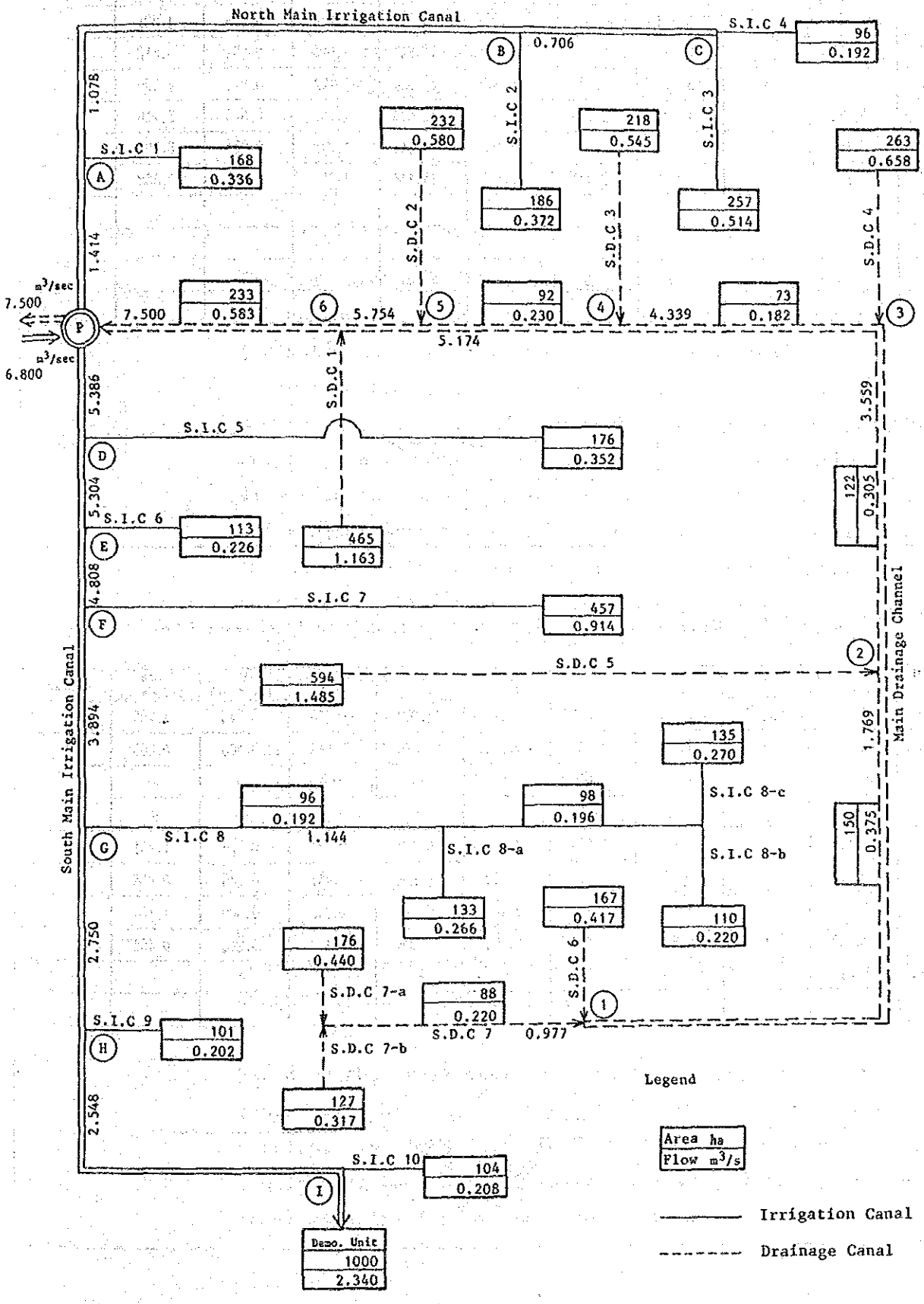


Table 5-3-3 Hydraulic Calculation of Main Drainage Canals

| | Q (m³/sec) | I | B (m) | d (m) | A (m²) | P (m) | R (m) | V (m/sec) | Qo (m³/sec) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| ①~② | 1.769 | 1/20,000 | 1.800 | 1.500 | 7.200 | 8.508 | 0.846 | 0.253 | 1.821 | |
| ②~③ | 3.559 | 〃 | 2.000 | 2.000 | 12.000 | 10.944 | 1.096 | 0.301 | 3.612 | |
| ③~④ | 4.339 | 〃 | 3.000 | 2.000 | 14.000 | 11.944 | 1.172 | 0.314 | 4.396 | |
| ④~⑤ | 5.174 | 〃 | 4.000 | 2.000 | 16.000 | 12.944 | 1.236 | 0.326 | 5.216 | |
| ⑤~⑥ | 5.754 | 〃 | 4.700 | 2.000 | 17.400 | 13.644 | 1.275 | 0.334 | 5.794 | |
| ⑥~Ⓟ | 7.500 | 〃 | 6.800 | 2.000 | 21.600 | 15.744 | 1.372 | 0.349 | 7.538 | |
| | | | | | | | | | | |
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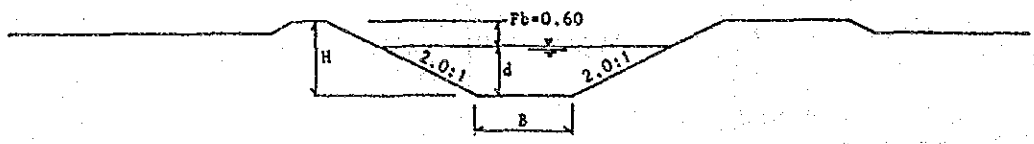
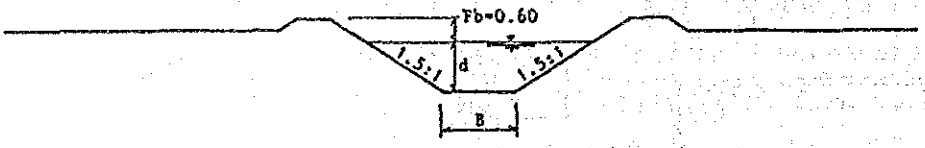



Table 5-3-4 Hydraulic Calculation of secondary Drainage Canals

| | Q (m³/sec) | I | B (m) | d (m) | A (m²) | P (m) | R (m) | V (m/sec) | Qo (m³/sec) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| S.D.C. 1 | 1.163 | 1/10,000 | 0.500 | 1.500 | 4.125 | 5.908 | 0.698 | 0.315 | 1.299 | |
| S.D.C. 2 | 0.580 | 〃 | 1.000 | 1.000 | 2.500 | 4.606 | 0.543 | 0.266 | 0.665 | |
| S.D.C. 3 | 0.545 | 〃 | 1.000 | 1.000 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C. 4 | 0.658 | 〃 | 1.000 | 1.000 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C. 5 | 1.485 | 〃 | 0.800 | 1.500 | 4.575 | 6.208 | 0.737 | 0.326 | 1.491 | |
| S.D.C. 6 | 0.417 | 〃 | 0.500 | 1.000 | 2.000 | 4.106 | 0.487 | 0.248 | 0.496 | |
| S.D.C. 7 | 0.977 | 〃 | 1.500 | 1.200 | 3.780 | 5.828 | 0.649 | 0.300 | 1.134 | |
| S.D.C.7-1 | 0.440 | 〃 | 0.500 | 1.000 | 2.000 | 4.106 | 0.487 | 0.248 | 0.496 | |
| S.D.C.7-2 | 0.317 | 〃 | 0.500 | 1.000 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| | | | | | | | | | | |



d) Pipe Culverts

Pipe culverts will be constructed across secondary and tertiary canals which have a small cross section in those places where the existing roads have been cut off by these canals.

(5) Irrigation Facilities

1) Main Irrigation Canals

The main drainage canal will divide the Project area into the northern and southern parts and, therefore, 2 main irrigation canals, i.e. north and south main canals, will be constructed with the pumping station at the starting point to provide irrigation to the respective parts of the Project area. These 2 canals will run in the north-south direction parallel to Lakhya River in the western part of the Project area where the ground level is higher than in the eastern part to minimize banking earth work. As a series of villages are located closely to each other along Lakhya River, however, the canals will be located to the east of these villages. The terminal point of the south main canal will be at the southern end of the Project area where a check structure will be constructed and irrigation water will be supplied to the Demonstration Unit through the check and under the bridge existing across D-N Road.

The canals will be unlined earth canal and, in view of minimizing banking and design discharge, etc., the water depth will be 1.0 m and 1.5 m for the north main canal and south main canal respectively.

Based on the cross section size, the slope gradient for the canals will be 1:1.5 in view of the stability analysis results. The crest widths of the embankments along these canals will be 2.5 m for the field side and 1.5 m for the other side in view of their smooth maintenance.

The cross section of the main irrigation canals will be decided based on the unit irrigation requirement of q = 2.0ℓ/sec/ha given in 5.3.5 - Irrigation Plan and the water volume to be distributed to the Demonstration Unit. The irrigation system, including the secondary irrigation canals, is schematically shown in Fig. 5-3-4.

The canal gradients have been decided to be as given below taking the Project area consisting of flat land and the need to reduce the flow velocity to less than 0.6 m/sec into consideration.

| | |
|---|---|
| Main Canals | : S = 1/10,000 |
| Secondary Canals | : S = 1/10,000 |
| Tertiary Canals | : S = 1/5,000 |

The hydraulic calculation results are given in Table 5-3-5 and the standard cross section is shown in DWG No. 8.

2) Secondary Irrigation Canals

The following points were especially noted in the selection of the routes for the secondary irrigation canals.

a) Priority should be given to elevated ground to minimize banking earth work.

b) Crossing with drainage canals should be avoided as much as possible.

c) Locations should be as near as possible to villages or existing roads in view of maintenance.

The hydraulic calculation results are given in Table 5-3-6.

3) Tertiary Irrigation Canals

It is planned that the tertiary irrigation canals will have a subject area of 40 - 60 ha each. The canal capacity will be 0.08 - 0.12 $m^3$/sec. DWG No. 8 shows the standard cross section for the tertiary canals.

The number of these 3 types of canals and their respective total lengths are given in Table 5-3-7.

4) Related Structures

a) Bridges

Bridges will be constructed across main or secondary irrigation canals at those places where the canals cross relatively wide existing roads.

b) Footbridges

Footbridges will be constructed near turnouts or at those points where villages are divided by canals.

c) Pipe Culverts

Pipe culverts will be constructed across canals at those points where drainage is difficult due to the introduction of irrigation canals. They will also be constructed at those points where secondary and tertiary irrigation canals with a small cross section run across existing roads.

d) Aqueducts

Aqueducts will be constructed at those points where main irrigation canals run across drainage canals.

Table 5-3-5 Hydraulic Calculation of Main Irrigation Canals

| | Q (m³/sec) | I | B (m) | d (m) | A (m²) | P (m) | R (m) | V (m/sec) | Qo (m³/sec) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| Ⓕ~Ⓐ | 1.414 | 1/10,000 | 3.100 | 1.000 | 4.600 | 6.706 | 0.686 | 0.311 | 1.431 | |
| Ⓐ~Ⓑ | 1.078 | 〃 | 2.200 | 1.000 | 3.700 | 5.806 | 0.637 | 0.296 | 1.096 | |
| Ⓑ~Ⓒ | 0.706 | 〃 | 1.200 | 1.000 | 2.700 | 4.806 | 0.562 | 0.272 | 0.734 | |
| Ⓟ~Ⓓ | 5.386 | 〃 | 6.300 | 1.500 | 12.825 | 11.708 | 1.095 | 0.425 | 5.451 | |
| Ⓓ~Ⓔ | 5.034 | 〃 | 5.800 | 1.500 | 12.075 | 11.208 | 1.077 | 0.420 | 5.072 | |
| Ⓔ~Ⓕ | 4.808 | 〃 | 5.500 | 1.500 | 11.625 | 10.908 | 1.066 | 0.416 | 4.852 | |
| Ⓕ~Ⓒ | 3.894 | 〃 | 4.300 | 1.500 | 9.825 | 9.708 | 1.012 | 0.403 | 3.959 | |
| Ⓖ~Ⓗ | 2.750 | 〃 | 2.700 | 1.500 | 7.425 | 8.108 | 0.916 | 0.377 | 2.799 | |
| Ⓗ~Ⓘ | 2.548 | 〃 | 2.400 | 1.500 | 6.975 | 7.808 | 0.893 | 0.371 | 2.588 | |
| Ⓘ~[illegible] | 2.340 | | 2.100 | 1.500 | 6.525 | 7.508 | 0.869 | 0.364 | 2.375 | |

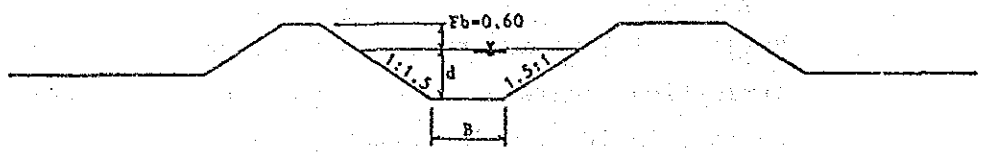



Table 5-3-6 Hydraulic Calculation of Secondary Irrigation Canals

| | Q (m³/sec) | I | B (m) | d (m) | A (m²) | P (m) | R (m) | V (m/sec) | Qo (m³/sec) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| S.D.C. 1 | 0.336 | 1/10,000 | 1.100 | 0.750 | 1.669 | 3.804 | 0.439 | 0.231 | 0.386 | |
| S.D.C. 2 | 0.372 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C. 3 | 0.514 | 〃 | 1.700 | 0.750 | 2.119 | 4.404 | 0.481 | 0.246 | 0.521 | |
| S.D.C. 4 | 0.192 | 〃 | 0.600 | 0.750 | 1.294 | 3.304 | 0.392 | 0.214 | 0.277 | |
| S.D.C. 5 | 0.352 | 〃 | 1.100 | 0.750 | 1.669 | 3.804 | 0.439 | 0.231 | 0.386 | |
| S.D.C. 6 | 0.226 | 〃 | 0.600 | 0.750 | 1.294 | 3.304 | 0.392 | 0.214 | 0.277 | |
| S.D.C. 7 | 0.914 | 〃 | 1.700 | 1.000 | 3.200 | 5.306 | 0.603 | 0.286 | 0.915 | |
| S.D.C. 8 | 1.144 | 〃 | 2.400 | 1.000 | 3.900 | 6.006 | 0.649 | 0.300 | 1.170 | |
| S.D.C.8-1 | 0.266 | 〃 | 0.600 | 0.750 | 1.294 | 3.304 | 0.392 | 0.231 | 0.386 | |
| S.D.C.8-2 | 0.220 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C.8-3 | 0.270 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C. 9 | 0.202 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | |
| S.D.C.10 | 0.208 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | 〃 | |

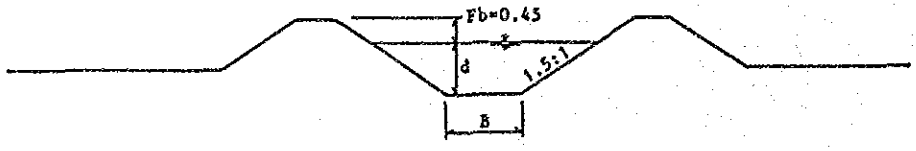


Table 5-3-7 Canal Length in Meter

| Irrigation Canal | Name | Main | Secondary | Tertiary | |
|---|---|---|---|---|---|
| | | | | Length | Number |
| | NMIC | 3,680 | - | - | - |
| | SMIC | 7,450 | - | - | - |
| | SIC 1 | - | 1,150 | 2,030 | 3 Nos |
| | SIC 2 | - | 1,100 | 2,570 | 4 |
| | SIC 3 | - | 1,950 | 2,960 | 5 |
| | SIC 4 | - | 950 | 1,790 | 3 |
| | SIC 5 | - | 3,700 | 2,140 | 3 |
| | SIC 6 | - | 950 | 1,080 | 2 |
| | SIC 7 | - | 3,350 | 5,070 | 8 |
| | SIC 8 | - | 2,700 | 5,100 | 5 |
| | SIC 8a | - | 1,070 | 1,760 | 3 |
| | SIC 8b | - | 1,070 | 1,380 | 2 |
| | SIC 8c | - | 700 | 1,430 | 2 |
| | SIC 9 | - | 550 | 1,260 | 2 |
| | SIC10 | - | 250 | 1,100 | 2 |
| | Total | 11,130 | 19,490 | 29,670 | 44 |

| Drainage Canal | Name | Main | Secondary | Tertiary | |
|---|---|---|---|---|---|
| | | | | Length | Number |
| | MDC | 10,700 | - | - | - |
| | SDC 1 | - | 1,500 | 2,130 | 3 Nos |
| | SDC 2 | - | 1,500 | 2,060 | 2 |
| | SDC 3 | - | 1,250 | 1,160 | 2 |
| | SDC 4 | - | 3,950 | 1,930 | 3 |
| | SDC 5 | - | 4,650 | 3,370 | 4 |
| | SDC 6 | - | 2,000 | - | - |
| | SDC 7 | - | 1,300 | 800 | 1 |
| | SDC 7a | - | 2,100 | - | - |
| | SDC 7b | - | 1,400 | - | - |
| | Total | 10,700 | 19,650 | 11,450 | 15 |

e) Siphon

A siphon will be constructed at the point where the main irrigation canal and drainage canal cross and where the construction of an aqueduct appears difficult.

f) Escape

An escape will be constructed in the upperstream of an aqueduct to automatically spill out surplus irrigation water generated by the stoppage of water distribution so that damage to the irrigation canals can be prevented.

g) Turnouts

Turnouts with gates will be constructed at the water distribution points from the main canals to the secondary canals and from the secondary canals to the tertiary canals. Division boxes with stop-logs will be constructed for the water distribution from the tertiary canals to the field canals.

h) Check Structures

Check structures will be introduced to regulate the water level so that the necessary water level for the turnouts can be secured. They will be located at the end of both the north and south main canals and at the immediate downstream of the turnout distributing a large volume of water to SI-8 from the south main canal. Since SI-8 is fairly long, an additional check structure will be constructed at its downstream.

i) Washing Places

These will be provided for the protection of the canal slopes and for both washing and bathing at those points where the main canals run through villages.

j) End Structures

Simple structures with stop-logs will be constructed at the end of each tertiary canal to control the water level, to regulate water distribution to field canals and to prevent ineffective discharge of irrigation water, etc.

(6) Power Transmission Line

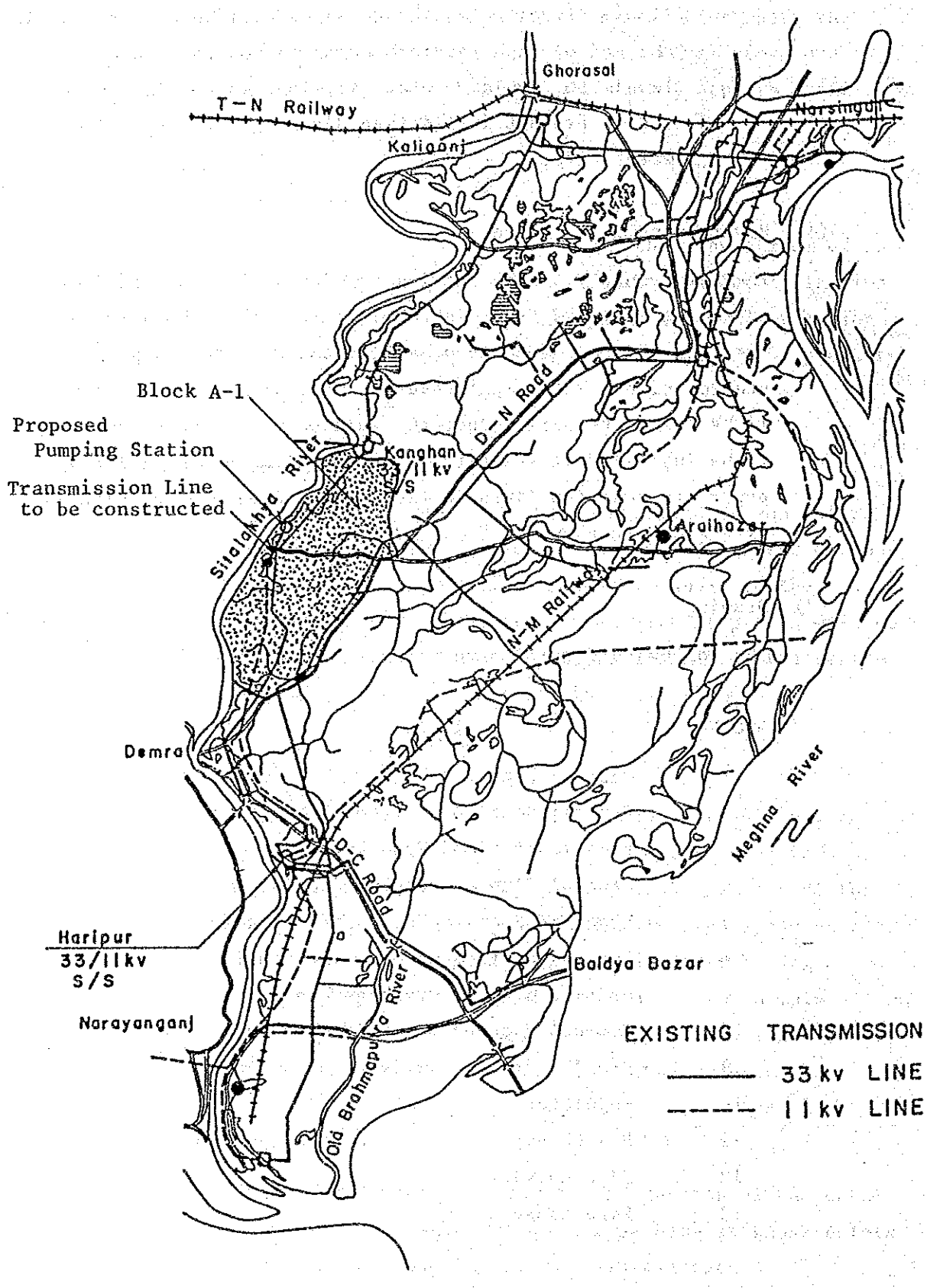
The power supply to the pumping station will be provided by extending an 11 kV transmission line from the substation at Murapara which is located some 2 km south of the pumping station site. The pumping station will directly receive this 11 kV power and will reduce the voltage using the transformer to be installed at the site. The locations of the existing power transmission lines in the Project Area and the planned extension are shown in Fig. 5-3-5.

(7) Drawings

The following drawings are attached in Appendix 2-1.

| DWG No. | Title |
|---|---|
| 1 | General Plan |
| 2 | Typical Section of Flood Embankment |
| 3 | Profile of Flood Embankment |
| 4 | General Plan of Pumping Station |
| 5 | Plan and Sections of Pumping Station |
| 6 | Typical Section of Drainage Canal |
| 7 | Profile of Main Drainage Canal |
| 8 | Typical Section of Irrigation Canal |
| 9 | Profile of Main Irrigation Canals |
| 10 | Regulator |
| 11 | Box Culvert |
| 12 | Pipe Culvert |
| 13 | Pipe Sluice |

Fig.5-3-5 Location of Transmission Line



| | |
|---|---|
| 14 | Turnout-I and Check Structure |
| 15 | Turnout-II, Division Box, End Structure |
| 16 | Aqueduct and Escape |
| 17 | Bridge and Footbridge |

5.3.7 Operation and Maintenance Equipment Supply Plan

The following equipment will be prepared for the Project operation and facility maintenance.

(1) Vehicles

| | |
|---|---|
| 4 Wheel Drive Vehicles (diesel) | 2 |
| Passenger Car (1,000 cc, petrol) | 1 |
| Mini Bus (10 seats) | 1 |
| Pick-up Truck (0.5 t) | 1 |
| Motorbike (95 cc) | 1 |

(2) Construction Equipment and Surveying Instrument

| | |
|---|---|
| Back Hoe (0.3 $m^3$) | 1 |
| Portable Soil Compactors | 3 |
| Bulldozers (8 t) | 1 |
| Surveying Instrument (theodolite, level, etc.) | 1 set |

(3) Speed Boat

| | |
|---|---|
| Speed Boat with Outboard Engine (40 - 50 HP) | 1 |

(4) Tools and Spare Parts 1 set

# CHAPTER 6 PROJECT IMPLEMENTATION PLAN

## 6.1 Project Implementation System

### (1) Project Implementation Body

The organization responsible for the implementation of the Project is the Bangladesh Water Development Board (BWDB) of the Ministry of Irrigation, Water Department and Flood Control which has been responsible for the implementation of flood control, water resources development and major irrigation projects conducted in Bangladesh so far. The BWDB is also responsible for the operation and maintenance of the facilities constructed under such projects.

The consultant will be selected pursuant to the established system for Japanese grant aid and will be commissioned by the BWDB to prepare the detailed design. Based on the detailed design, the BWDB will place a construction order to the contractor, selected in the same manner as the consultant, to commence the construction work under the supervision of the consultant.

The land acquisition and the construction of the power transmission line, both of which are indispensable for the implementation of the Project, will be undertaken by the BWDB in accordance with the Project schedule. The Project management and the operation and maintenance of the facilities after the completion of the Project will also be entrusted to the BWDB.

### (2) Consultant

The detailed design of the Project and the supervision of the construction work (including the supply of operation and maintenance equipment) to be carried out by the Japanese side

will be undertaken by the Japanese consultant which will be selected pursuant to the established system for Japanese grant aid.

In view of the Project's smooth implementation, the consultancy services will be divided into 2 parts, i.e. the detailed design and the tender/supervision of the construction work. A separate E/N will be concluded for the former while in the case of the latter, a consultancy contract will be made following the signing of the E/N for each part of the consultancy services in view of the fact that the Project will be implemented by Japanese grant aid. The signatory representing the BWDB will be the Chief Engineer (Planning) of the Planning Section and the Chief Engineer (Design) of the Implementation Section will be responsible for the approval of drawings and specifications.

(3) Contractor

The construction work of the Project-related facilities (including the supply of operation and maintenance equipment) will be undertaken by the Japanese contractor which will be selected pursuant to the established system for Japanese grant aid.

The Government of Bangladesh will entrust the consultant to conduct the tender for the entire construction work and will conclude the contract with the successful tenderer upon negotiation. The adoption of the turn-key method, where a blanket contract covering the commencement of the work to its completion, is assumed and the contractor must duly complete all the facilities within the agreed period of time.

In regard to the actual implementation of the work, the contractor will select sub-contractors from Bangladesh companies in the civil engineering and building fields and will also select a Japanese manufacturer as the sub-contractor for the manufacture and installation of the pumping equipment.

## 6.2 Division of Project Work

Of the basic design items, those for which the Japanese side is responsible for in terms of their implementation with grant aid are as follows.

(1) Consultancy service for the preparation of the detailed design.

(2) Construction of all facilities except those whose construction is to be undertaken by the Government of Bangladesh.

(3) Provision of operation and maintenance equipment.

(4) Consultancy service for facility construction.

The following items for which the Government of Bangladesh is responsible have already been agreed in the Minutes of Discussions concluded between the Government of Bangladesh and the Basic Design Study Team (see Appendix 1-4).

(1) To provide data and information necessary for the design and the construction.

(2) To acquire the lands timely necessary for the construction as per prevailing rules & regulations.

(3) To clear the Project Site before the start of the construction including the removal of existing obstacles.

(4) To construct irrigation and drainage canals under 2 cusec. (These canals will be constructed by beneficiaries under the technical advice and guidance of BWDB.)

(5) To construct any necessary structures except for the list of Annex 1 in the Minutes of Discussions.

(6) To provide electric power supply to the pumping station.

(7) To bear salary and daily and travel allowance for the counterparts who are assigned to the work in the Project.

(8) To ensure prompt unloading and customs clearance in Bangladesh of imported materials and equipment necessary for the execution of the Project as per Government Rules.

(9) To exempt Japanese nationals concerned from customs duties, internal taxes and other fiscal levies which may be imposed in Bangladesh on the occasion of the supply of goods and services for construction, as admissible under the relevant rules of the Government of Bangladesh.

(10) To provide and accord necessary permission, licences and other authorization required for the implementation.

## 6.3 Implementation Plan

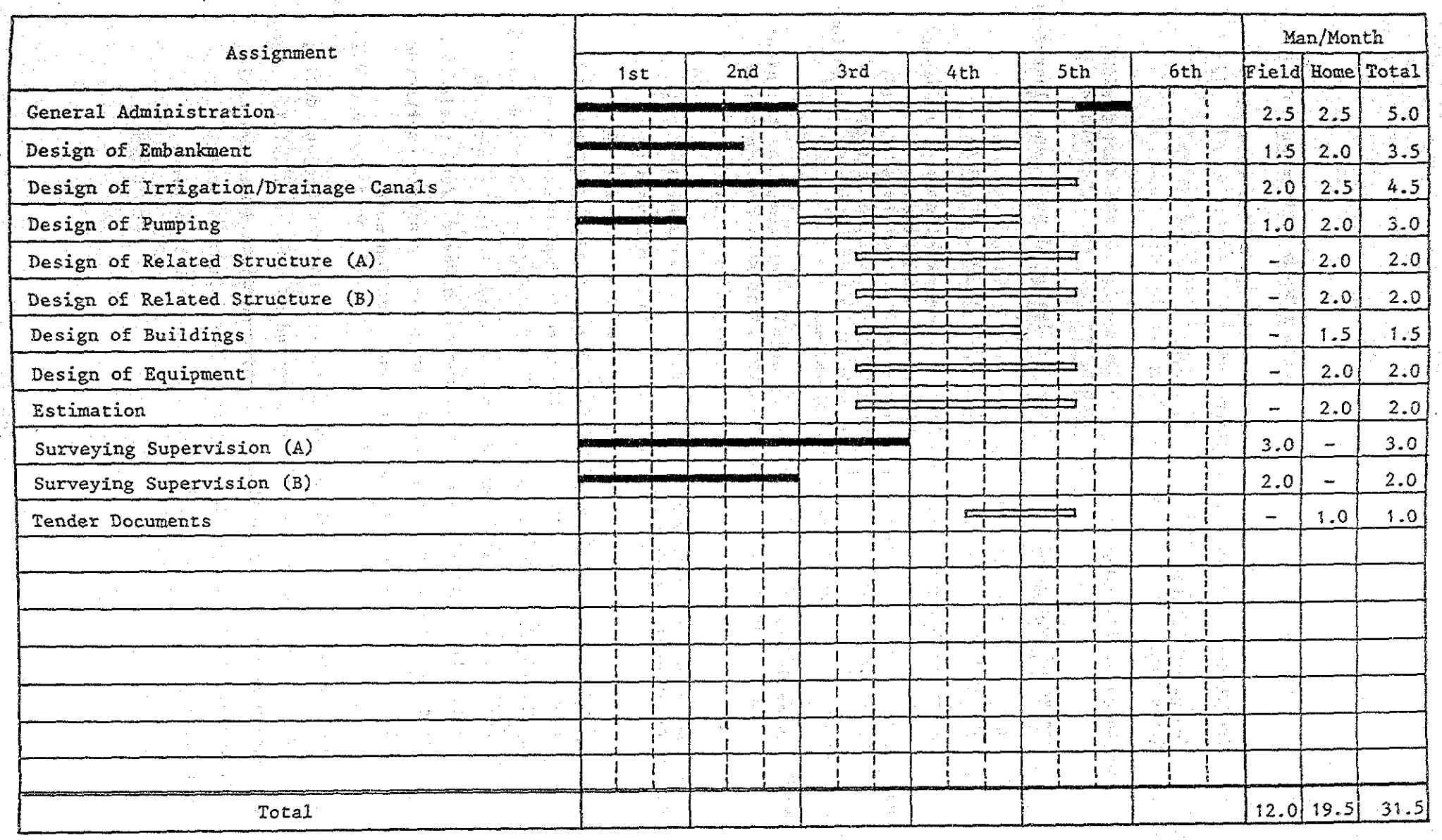
### 6.3.1 Detailed Design

As previously described in 6.1 (2), the detailed design will be prepared as required by the contract with the BWDB by the Japanese consultant who will be selected pursuant to the established Japanese grant aid system. The contents of and the required engineers for this detailed design work are given below (see Fig. 6-3-1 for the working schedule).

1) Review of Basic Design Study
2) Facility Layout Plan
3) Surveying
4) Soil Investigation
5) Detailed Facility Design
6) Construction Plan
7) Construction Cost Estimate
8) Preparation of drawings and technical specifications for tender

| Staff | Main Work Assignment |
|---|---|
| General Administration | General administration of the entire work. |
| Design of Embankment | Supervision of soil investigation, decision on embankment location stretching for 18 km and its detailed design. |
| Design of Irrigation/ Drainage Canals | Decision of locations for drainage canals (26 canals with a total length of 42 km) and irrigation canals (59 canals with a total length of 40 km) and their detailed design. |
| Design of Pumping Station | Detailed design of foundation work and intake canal for the pumping station. |

Fig. 6-3-1 Working Schedule of the Detailed Design



| Assignment | 1st | 2nd | 3rd | 4th | 5th | 6th | Man/Month Field | Home | Total |
|---|---|---|---|---|---|---|---|---|---|
| General Administration | | | | | | | 2.5 | 2.5 | 5.0 |
| Design of Embankment | | | | | | | 1.5 | 2.0 | 3.5 |
| Design of Irrigation/Drainage Canals | | | | | | | 2.0 | 2.5 | 4.5 |
| Design of Pumping | | | | | | | 1.0 | 2.0 | 3.0 |
| Design of Related Structure (A) | | | | | | | - | 2.0 | 2.0 |
| Design of Related Structure (B) | | | | | | | - | 2.0 | 2.0 |
| Design of Buildings | | | | | | | - | 1.5 | 1.5 |
| Design of Equipment | | | | | | | - | 2.0 | 2.0 |
| Estimation | | | | | | | - | 2.0 | 2.0 |
| Surveying Supervision (A) | | | | | | | 3.0 | - | 3.0 |
| Surveying Supervision (B) | | | | | | | 2.0 | - | 2.0 |
| Tender Documents | | | | | | | - | 1.0 | 1.0 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Total | | | | | | | 12.0 | 19.5 | 31.5 |

Legend ▬▬ Field Work
▭ Home Work

| Staff | Main Work Assignment |
|---|---|
| Design of Related Structures | Detailed design of 489 related structures |
| Design of Related Structures | As above |
| Design of Buildings | Detailed design of the shed for the pumping station and other buildings. |
| Design of Equipment | Detailed design of pumps and electrical facilities. |
| Estimation | Estimation of project costs. |
| Surveying Supervision A | Surveying supervision at drainage and irrigation canal sites. |
| Surveying Supervision B | Surveying supervision at flood embankment and drainage and irrigation canal sites. |
| Tender Documents | Preparation of drawings and technical specifications required for tender. |

### 6.3.2 Construction Work Policy

The construction work by the Japanese side needs a construction period of 3 years. In the case the work is implemented as a Japanese grant aid project, the work is accordingly divided into 3 parts and will be implemented stage by stage in the respective years. The facilities to be constructed, however, form their own entities and cannot be separated. Therefore, a single contractor will be responsible for the entire construction work.

The employment of local farmers as workers for the Project during the construction period will be promoted as much as possible. Local construction methods will also be employed where deemed suitable.

### 6.3.3 Points to Note for Construction Work

(1) The religious and secular customs in Bangladesh should be respected and sufficient attention should be paid to these customs in the planning of the work schedule.

(2) Local inhabitants should be given every consideration as the Project cannot succeed without their cooperation.

(3) As the construction work will not be completed in a single year, sufficient attention should be paid to not only water drainage in the Project area, but also in the adjacent Block A-2 area, throughout the construction period.

(4) Although the utilization of local labour and local construction methods is intended where deemed suitable, the technical standard of the construction work must be very reliable in view of the fact that the work is implemented by Japanese grant aid, generating high expectations on the Bangladesh side for the application of Japanese technologies.

(5) The construction work of any facility cannot commence unless the acquisition of the subject land has been completed. Therefore, the Government of Bangladesh should complete the land acquisition in line with the construction work schedule.

(6) As major earth work can be executed only in the dry season, the working efficiency must be raised by making due arrangements prior to the rainy season.

### 6.3.4 Construction Plan and Supervision Plan

(1) Construction Plan

The construction work will be conducted by the contractor with Japanese grant aid as a governmental contribution project which consists of 3 consecutive phases/years based on the following processes.

First Year

Selection of contractor through public notice → tender → decision on contractor → contract for first year's work → construction work, manufacture of equipment for pumping station and delivery of some operation and maintenance equipment.

Second Year

Contract for second year's work (negotiated contract) → construction work and installation of equipment for pumping station.

Third Year

Contract for third year's work (negotiated contract) → construction work and delivery of the remaining operation and maintenance equipment.

The contents of the work for each year are roughly as follows.

First Year

Flood Embankment (Rupsi - pumping station)

Manufacture and Transportation of Equipment

Drainage Facilities (main, secondary and tertiary canals between pumping station and D-N Road)

Delivery of Granted Vehicles

Second Year

Flood Embankment (remaining section)

Construction of Pumping Station

Installation of Equipment

Drainage Facilities (all remaining canals)

Irrigation Facilities (north main canal and related secondary and tertiary canals)

Third Year

Flood embankment (brick paving for section constructed in second year)

Irrigation Facilities (all remaining canals)

Delivery of the Remaining Operation and Maintenance Equipment (Construction Equipment and Speed Boat)

(2) Labour Plan

In principle, the necessary labour will be recruited locally excepting for the work requiring advanced techniques. Consequently, those engineers who will play a crucial role in technical supervision and the control of the construction schedule and those engineers required for the installation of the pumping equipment will be dispatched from Japan. These Japanese engineers and their respective assignments are listed below.

| Staff | Main Work Assignment |
|---|---|
| Project Manager | General manager for all aspects of the contracted work. |
| Civil Engineer A | Chief engineer responsible for the foundation of the pumping station, the smooth implementation of the work schedule, work completion, quality control, safety control and the guidance/education of local engineers. |
| Civil Engineer B | Responsible for the flood embankment and drainage facilities. |
| Civil Engineer C | Responsible for the irrigation facilities. |
| Civil Engineer C | Supervisor for the drainage and irrigation facilities construction work. |

| Staff | Main Work Assignment |
|---|---|
| Building Engineer | Responsible for the shed of the pumping station and other building work. |
| Controller | Responsible for the procurement and control of the equipment and materials. |
| Clerk | Responsible for accounting and documentation. |
| Mechanical Engineer | General management of the pumping equipment-related work. |
| Mechanical Engineer | Supervisor for the installation work for the pumping gate crane. |
| Electrician | Supervisor for the electrical work. |
| Test Engineer | Responsible for the test operation of the equipment and equipment inspection. |

(3) Tender and Construction Supervision Plan

The provision of tender services and the supervision of construction will be undertaken by the consultant on the basis of the contract with the BWDB. The main contents of this consultancy services are as follows.

1) Preparation of tender documents.

2) Act as an agent for the tender procedure and analysis/ assessment of tender documents.

3) Advice for negotiations between the Government of Bangladesh and the successful tenderer.

4) Supervision of the construction work.

5) Inspection of the manufacturing process of the pumping equipment.

6) Completion inspection.

7) Preparation of monthly progress reports.

The staff required to implement the above services and their main work assignments are as follows and the construction schedule in Fig. 6-3-2.

| Staff | Main Work Assignment |
|---|---|
| General Manager | General management of the entire Project |
| Civil Engineer A | Full-time manager working on-the-spot, technical and work schedule supervision for the entire work. |
| Civil Engineer B | Supervision of the foundation work for the pumping station. |
| Building Engineer | Supervision of the pumping station construction. |
| Mechanical Engineer | Supervision of the pumping equipment installation work. |
| Electrician | Supervision of the electrical work at the pumping station. |
| Spec-Writer | Preparation of tender documents, agent for tender procedure, advisor for the contract with the contractor and completion inspection. |

### 6.3.5 Equipment and Materials Procurement Plan

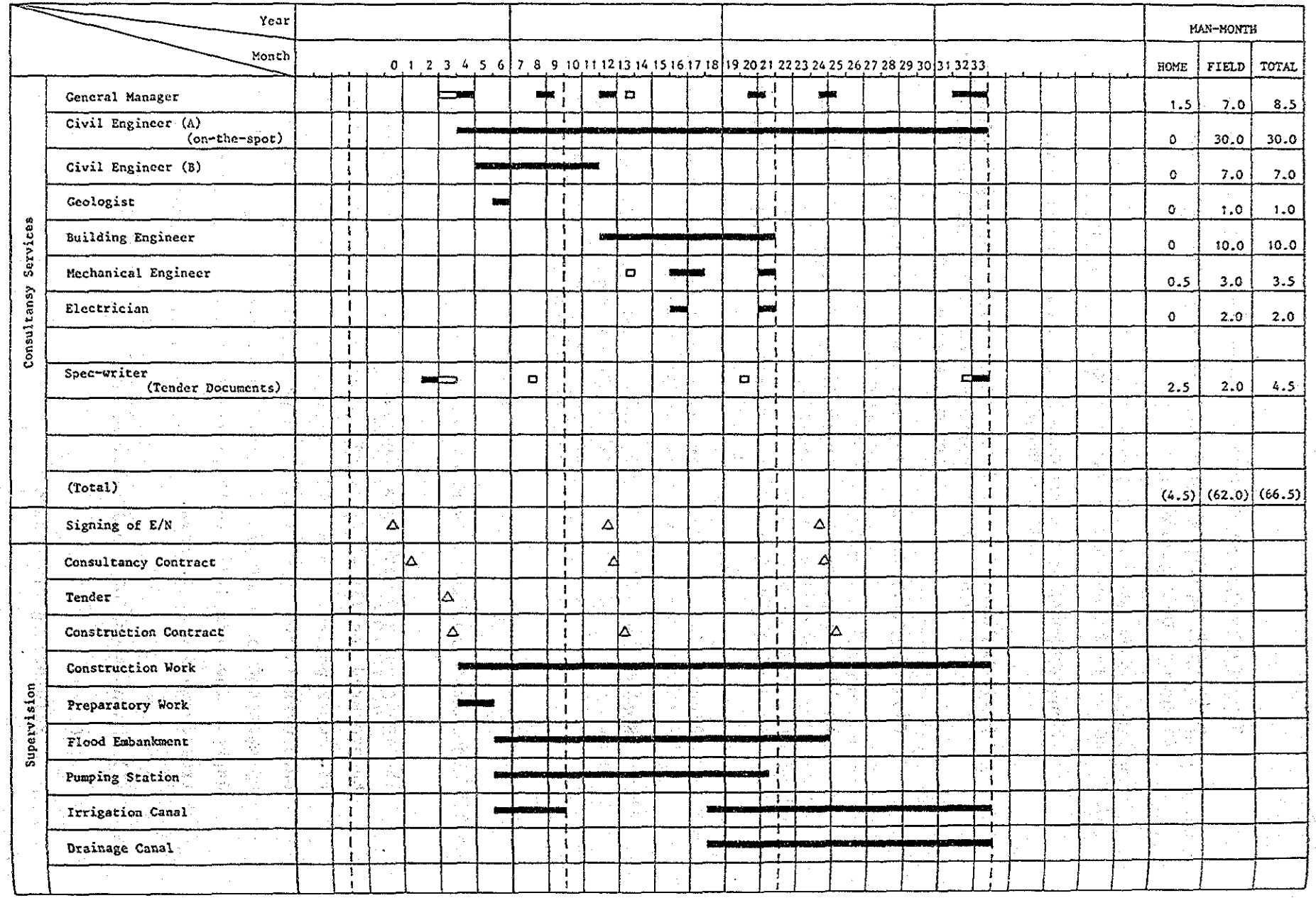
The equipment and materials required for the construction work will be procured locally where possible in accordance with the construction work policy. Those which cannot be procured locally, which have unsatisfactory quality or those of which a stable supply cannot be expected in terms of volume and price will be imported from Japan. The main items to be procured locally and to be imported from Japan are as follows.

(1) Main Items for Local Procurement

Cement

Reinforcing Plain Bars

Fig. 6-3-2 Construction Schedule



Reinforcing Deformed Bars
Sand for Concrete
Gravel for Concrete
Bricks
Brick Chips
Stone Chips
Rectangular Timbers (2" x 2", 2" x 4", 4" x 4")
PVC Pipes
RCC Pipes
Turf
Jute sandbags

(2) Main Items to be Procured in Japan (Excluding Granted Equipment)

Waterproof Plywood for Forms
Pipes (for Forms, Scaffolding and Centering)
Pipe Shores
Form Ties
Plastic Cones for Forms
Clamps (for Scaffolding and Centering)
Separation Agent for Forms
Vinyl Chloride Waterstops
Joint Bulkheads for Concrete Placing
Wire Ties (for Reinforcing Work)
Sheet Piles
H-Sections
Various Gates
Manhole Covers
Welding Rods
Equipment for Pumping Station
Aluminium Window Frames
Shutters
Building Installation Equipment

### 6.3.6 Construction Plan for Bangladesh Side

The work to be undertaken by the Government of Bangladesh has already been described in 6.2 and it is planned that the relevant construction work will be implemented as follows.

(1) Power Supply to Pumping Station

The power transmission line (11 kV) will be extended from the Sub-Station in Murapara to the pumping station. This work will be entrusted by the BWDB to the Ministry of Energy and Mineral Resources through the Ministry of Irrigation, Water Development and Flood Control. Based on this request, the Bangladesh Power Development Board (BPDB) of the Ministry of Energy and Mineral Resources will complete the work prior to the installation of the pumping equipment.

(2) Construction of Temporary Field Office

A temporary field office and a staff house will be constructed in Murapara for the smooth implementation of the Project. When the office building at the pumping station has been completed, their functions will be transferred to the new office.

(3) Construction of Small-Scale Irrigation and Drainage Canals

Simultaneously or subsequently to the construction of tertiary canals by the Japanese side, small-scale irrigation and drainage canals less than 2 cusec will be constructed by the beneficiaries, i.e. farmers, with the technical instruction of the BWDB staff who are responsible for the operation and maintenance of the Project.

(4) Land Acquisition

The required land will be acquired prior to the commencement of the construction work so that the Project can be implemented in accordance with the schedule. The land acquisition schedule is as follows.

First Year (Within 4 Months from Signing of Master E/N)

| | |
|---|---|
| Pumping Station | 0.5 ha |
| Flood Embankment (between Rupsi and pumping station) | 16.1 ha |
| Drainage Canals (main, secondary and tertiary canals between pumping station and D-N Road) | 9.4 ha |
| Sub-Total | 26.0 ha |

Second Year (Within 16 Months from Signing of Master E/N)

| | |
|---|---|
| Flood Embankment (all remaining section) | 35.2 ha |
| Drainage Canals (all remaining canals) | 17.4 ha |
| Irrigation Canals (north main canal and related secondary and tertiary canals) | 23.3 ha |
| Sub-Total | 75.9 ha |

Third Year (Within 24 Months from Signing of Master E/N)

| | |
|---|---|
| Irrigation Canals (all remaining canals) | 54.7 ha |
| Total | 156.6 ha |

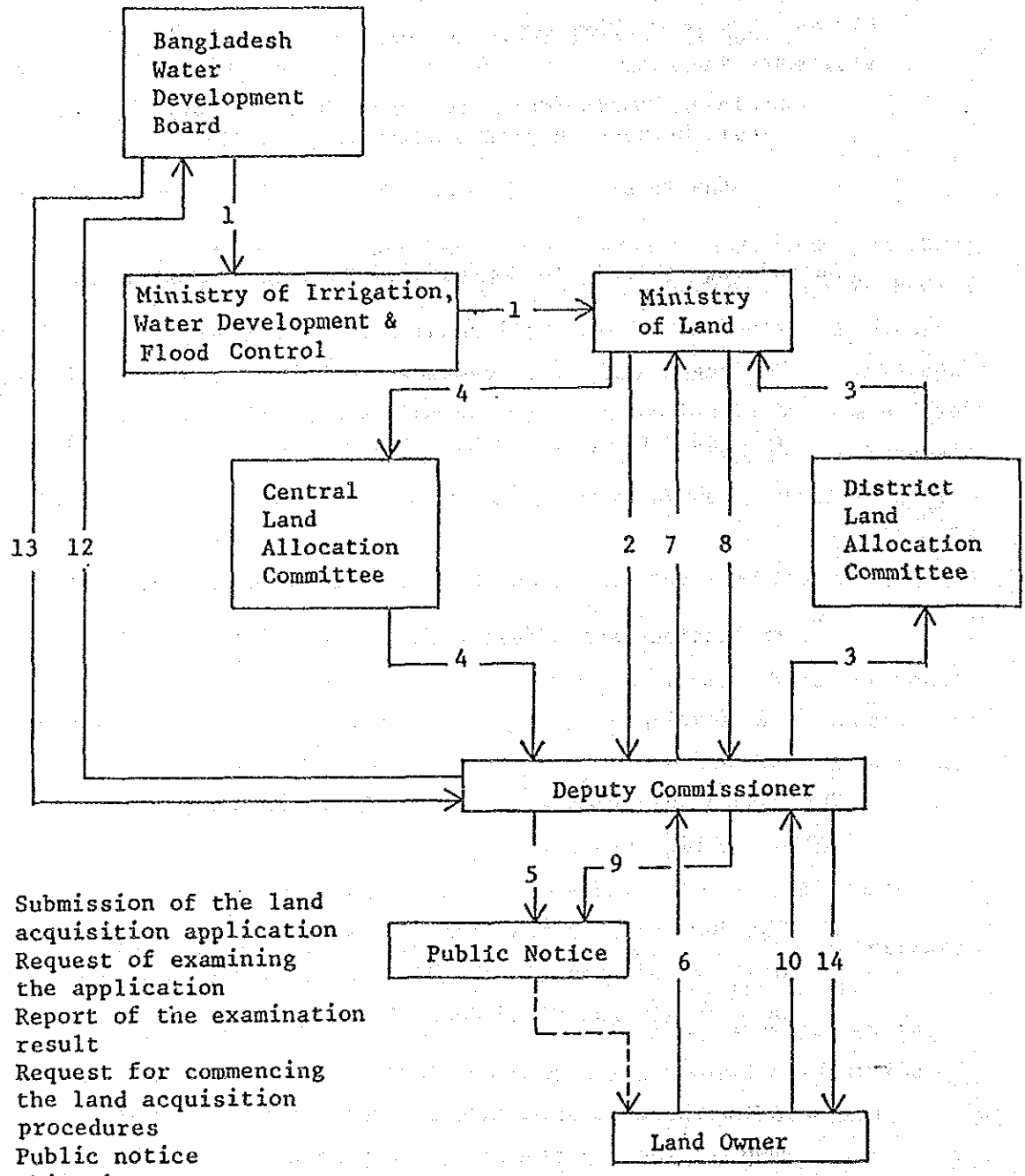
The land acquisition will follow the procedure given below (also see Fig. 6-3-3).

1) The BWDB submits the land acquisition application to the Ministry of Land via the Ministry of Irrigation, Water Development and Flood Control.

2) The Ministry of Land commissions the Deputy Commissioner (DC), who is responsible for the processing of land acquisition, to examine the application.

3) The DC reports the examination results (whether or not the requested land acquisition is deemed appropriate) of the District Land Allocation Committee (DLAC) to the Ministry of Land.

Fig. 6-3-3 Outline of Land Acquisition Procedures




1. Submission of the land acquisition application
2. Request of examining the application
3. Report of the examination result
4. Request for commencing the land acquisition procedures
5. Public notice
6. Objections
7. Report of the objections
8. Final governmental decision
9. Public notice
10. Declaration of the land price
11. Decision of the compensation amount
12. Claim of the land acquisition expenses
13. Remitance of the land acquisition expenses
14. Payment of the compensation

4) The Ministry of Land takes the matter to the Central Land Allocation Committee (CLAC) and requests the DC to proceed with the land acquisition after receiving approval from the CLAC.

5) The DC publicly notices the proposed land acquisition.

6) Any formal objections by landowners must be registered with the DC within 15 days of the public notice of the proposed land acquisition.

7) The DC compiles the landowners' objections and, together with his opinion on them, reports them to the Ministry of Land.

8) The Ministry of Land examines the report from the DC and makes the final governmental decision on the proposed land acquisition.

9) If the proposed land acquisition is approved by the Ministry in 8) above, the DC publicly informs the landowners of the land acquisition order.

10) The landowners must then make a declaration to the DC of how much of their property is affected by the land acquisition order within 15 days of the public announcement in 9) above.

11) The DC examines the declarations of the landowners and the land prices in the vicinity of the subject land in the previous 12 months and then decides on the compensation amount, including the amount for each landowner.

12) The DC claims the land acquisition expenses from the BWDB.

13) The BWDB remits the land acquisition expenses to the DC.

14) The DC pays the compensation to each landowner and the ownership of the acquired land is transferred to the BWDB within 7 days of the payment.

## 6.4 Implementation Schedule

### (1) Detailed Design

After the signing of the E/N by the Government of Bangladesh and the Government of Japan, the BWDB will conclude the contract for the detailed design work with the consultant. The consultant will conduct the field study for 2 months in the dry season and will then proceed with the design work in Japan, for which approximately 5 months will be required. The detailed design for the first construction year will, however, be completed within 4 months of the signing of the E/N.

### (2) Selection of Contractor and Construction Work in the First Year

The BWDB will conclude the consultancy contract immediately following the signing of the Master E/N and the Sub-E/N for the first year. The consultant will prepare the tender documents and will conduct the tender on behalf of the BWDB to select the contractor. After assessing the tenders, the consultant will decide the successful tenderer who will subsequently commence negotiations with the BWDB and will conclude the construction contract. This contract with the contractor will be completed within 3 months of the signing of the Master E/N. The construction work will commence within 1 month of the signing of the contract and will be completed within 12 months.

### (3) Construction Work in the Second Year

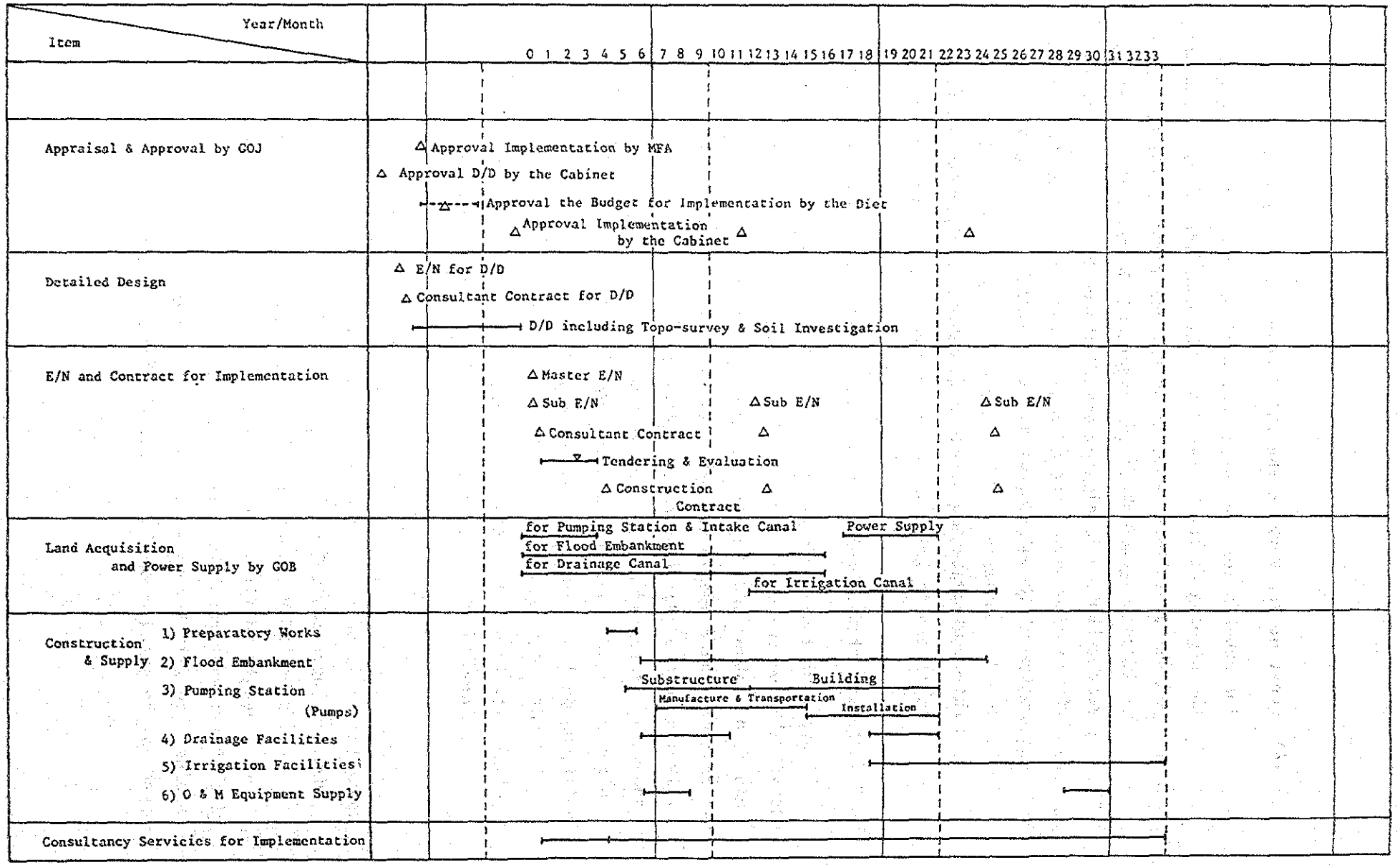
The Sub-E/N for the second year will be signed 12 months after the signing of the Master E/N. Following the signing of the Sub-E/N, negotiated contracts between the BWDB and the consultant, as well as the contractor, will be signed. The construction work in the second year will commence immediately following the signing of these contracts and will be completed within 12 months (within 24 months of the signing of the Master E/N).

(4) Construction Work in the Third Year

The Sub-E/N for the third year will be signed 24 months after the signing of the Master E/N. The contracts between the BWDB and the consultant, as well as the contractor, will be signed as in the case of the second year and the work for the third year will immediately commence. The work will be completed within 9 months of the signing of these contracts (within 33 months of the signing of the Master E/N).

This implementation schedule is schematically shown in Fig. 6-3-4.

Fig. 6-3-4 Implementation Schedule



## 6.5 Rough Estimate of the Project Cost

### 6.5.1 Rough Project Cost to be Borne by Bangladesh Side

(1) Power Transmission Line Construction Cost

| | | |
|---|---|---|
| 11 kV x 2 km | TK 500,000 | (Approx. ¥2.34 million) |

(2) BWDB Field Office Construction Cost

| | | |
|---|---|---|
| 80 $m^2$ x 1 | TK 250,000 | (Approx. ¥1.17 million) |
| 60 $m^2$ x 1 | TK 180,000 | (Approx. ¥0.84 million) |

(3) Instruction Cost for Field Canal Construction

-

(including in Operation and Maintenance Cost)

(4) Land Acquisition Cost

| | | |
|---|---|---|
| 156.6 ha | TK 50,900,000 | (Approx. 238 million) |
| Total | TK 51,830,000 | (Approx. 242 million) |

### 6.5.2 Rough Annual Project Cost to be Borne by Bangladesh Side

The rough annual Project cost to be borne by Bangladesh side is given below based on the implementation schedule.

| | | |
|---|---|---|
| First Year | TK 34,050,000 | (Approx. ¥159 million) |
| Second Year | TK 17,780,000 | (Approx. ¥83 million) |
| Third Year | - | |

# CHAPTER 7 OPERATION AND MAINTENANCE PLAN

## 7.1 Operation and Maintenance System

Projects for water resources development are often carried out in Bangladesh (409 completed and 123 currently in progress) and the BWDB is responsible for the maintenance of the facilities constructed under these projects. The facilities to be constructed under this Project will, therefore, be maintained by the BWDB after their completion. It has already been confirmed with the Government of Bangladesh that an operation and maintenance system for the Project facilities will be established utilizing 28 personnel in the Civil Engineering and Mechanical Sections. It is of interest that these personnel include staff dealing with the prevention of damage caused by rats.

| Personnel | No. | Remarks |
|---|---|---|
| Civil Engineering Section | | |
| Sub-Divisional Engineer | 1 | Concurrently serving the Demonstration Unit |
| Sub-Assistant Engineer | 1 | |
| Work Assistants | 4 | |
| Embankment Guards | 12 | |
| Mechanical Section | | |
| Sub-Divisional Engineer | 1 | Concurrently serving the Demonstration Unit |
| Sub-Assistant Engineer | 1 | |
| Foreman | 1/2 | Concurrently serving the Demonstration Unit |
| Operators | 5 | |
| Electrician | 1 | |
| Mechanic | 1 | |

## 7.2 Operation and Maintenance Plan

Based on the operation and maintenance system described in 7.1, the BWDB will carry out the operation, maintenance, inspection and repair of the facilities constructed under the Project (flood embankments, a pumping station, pumping equipment, irrigation and drainage facilities and related structures) utilizing to their full capacities the office, warehouse, repair workshop, meeting hall, vehicle, construction equipment, surveying equipment and speed boat, etc., which will be constructed or provided under the Project.

With regard to the irrigation water management, it is recommended that responsibility for the control of the main canals and the turnouts for the secondary canals be directly assigned to the BWDB and that control of the secondary canals and lower graded facilities be assigned to the farmers' organizations to be formed for each secondary canal. The BWDB will organize these farmers' organizations and provide them with instruction on water management, as in the case of the Demonstration Unit.

The flood embankment is the most import facilities in this Project. In view of the fact that the flood embankments will protect the property of farmers, public relations activities should be carried out to show farmers that the proper maintenance of these facilities is crucial. Therefore, it is recommended that a system be established whereby specific embankment sections are assigned as the responsibility of each Mouza (32 in total) in view of the implementation of self-maintenance efforts, including the blocking of rat holes.

## 7.3 Operation and Maintenance Cost

| | | |
|---|---|---|
| (1) | Personnel Cost | TK 1,300,000/year |
| (2) | Maintenance and Repair Cost of Facilities and Equipment including Cost of Overhaul to be Conducted Every 3 Years | TK 3,500,000/year |
| (3) | Pump Operation Cost | TK 2,700,000/year |
| (4) | Total annual Operation and Maintenance Cost | TK 7,500,000/year |

# CHAPTER 8 PROJECT APPRAISAL

## 8.1 Effects of Project Implementation

The economic internal rate of return (EIRR), which is regarded as an indicator to judge the economic suitability of the project implementation, was estimated for the project through an economic analysis.

It was assumed that economic benefits consist of incremental agricultural products, flood damage decreases and transportation benefited from using the proposed embankment as a main road within the project area, while economic costs are made up of the construction cost of the proposed facilities, incremental agricultural production costs and incremental O & M cost (see Appendix 2-2-5).

The EIRR was calculated based on the assumptions mentioned below.

1) The depreciation period is 50 years
2) Flooding occurs every 25 years
3) Benefits are generated following the completion of the Project
4) The depreciation period for the pumping equipment is 20 years and the equipment will be replaced in the 21st year

The resulting EIRR is 17.36%.

In order to estimate the impact of project risks, sensitivity analyses were performed on the following cases for reference purposes.

| Case | EIRR |
|---|---|
| 1) Production output is 10% lower than planned output | 15.22% |
| 2) Construction cost is 10% higher than planned cost | 16.20% |
| 3) Production cost is 10% higher than planned cost | 16.88% |
| 4) Combination of 2) and 3) above | 15.75% |

The following social and economic benefits can also be expected following the Project's completion.

a) Increased employment and improved employment rate
b) Increased consumption due to wages paid to workers engaged in the Project
c) Increased household consumption and improved standard of living due to increased agricultural production
d) Increased GNP due to the supply of domestically produced equipment and materials for the construction of Project-related facilities
e) Increased demand for agricultural production equipment and materials and promotion and establishment of Project-related industries
f) Prevention of rural exodus

Although the above effects and benefits cannot be quantified, they can be considered very significant, further stressing the value of the Project.

## 8.2 Suitability of Project Implementation

The suitability of the Project's implementation can be described as follows based on the economic analyses given above.

(1) Technical Suitability

In this Project, the flood control plan based on flood embankments and the irrigation and drainage plan using pumps for both irrigation and drainage are adopted in view of their proven effectiveness in the Demonstration Unit. However, through consultation with the BWDB, these plans have been further modified and improved, resulting in a carefully though-out plan incorporating technical improvements.

(2) Economic Suitability

As the EIRR calculated is 17.36%, which is higher than the opportunity cost of capital (12%), estimated for Bangladesh by the World Bank, it can be said that the project implementation is economically viable. As well as such direct benefits as increased agricultural production and improved transportation, the Project will also result invarious socioeconomic benefits for Bangladesh, including an increased GNP, promotion of village settlement and the transfer of techniques (operation, control and farming techniques) by means of increased employment, and increased household income and expenditures. The financial burden to be borne by the Government of Bangladesh does not pose any serious problem in view of the present size of the BWDB budget.

Based on the above considerations, the implementation of the Project is judged to be suitable.

# CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

## 9.1 Conclusion

Although Bangladesh is an agricultural country, it still suffers greatly from such basic problems as a chronic food shortage and poverty due to its severe natural conditions and rapid population growth. The National Development Plan proposes concrete targets based on the understanding that no development of Bangladesh can be achieved unless the three crucial problems of poverty, population and food are solved first. In particular, the Plan gives the highest priority to development in the agricultural sector to secure a self-sufficient food supply. The achievement of self-sufficient flood supply, however, presumes that solutions are found to such harsh natural conditions as floods and droughts and, therefore, the provision of flood control, irrigation and drainage facilities is the only way to overcome the severe natural constraints on agriculture in Bangladesh.

While the Project area has the potential for achieving high agricultural productivity, its current low productivity is the result of these natural conditions.

The implementation of the Project will free the Project area from flood and drought, making year-round irrigation and, therefore, greatly improving the agricultural production capacity which in turn will contribute to the achievement of a self-sufficient food supply. Moreover, such beneficial effects as increased employment opportunities, a large increase in agricultural income through increased agricultural production and an improved standard of living for the local inhabitants can also be anticipated. In short, the successful completion of the Project will greatly contribute to agricultural development, the main theme of Bangladesh's current development efforts, while also achieving important social and economic benefits.

As these effects and benefits have already been proven by the Demonstration Unit implemented in the neighbouring area, the success of the Project will further demonstrate the usefulness of this type of project.

It is, therefore, judged that the grant aid cooperation of the Government of Japan for the Project is both significant and appropriate and the early implementation of the Project is expected.

## 9.2 Recommendations

In order to implement the project smoothly and successful the project, the following are recommended to the Government of Bangladesh.

(1) The success of the Project will entirely depend on acquisition of the required land. Therefore, land acquisition must be carried out in line with the planned schedule. Since a programme of land acquisition required for the construction of the first stage has been prepared as a separate supplement of this report, necessary action for the land acquisition should be taken promptly as per the proposed programme. In the case the land acquisition is not executed, the project implementation will not be realized.

(2) After the completion of the Project, the safety of the Project area will be fully dependent on the flood embankments. The BWDB must, therefore, guide and educate farmers in the establishment of a flood embankment maintenance system to be operated by the farmers themselves.

(3) In order to have a full effect of the project as earlier as possible, the on-farm facilities i.e. irrigation and drainage canals under 2 cusec should be constructed by the Bangladesh side simultaneously or subsequently to the construction of tertiary canals.

(4) Irrigation water provided by pumps is extremely valuable. All farmers, regardless of whether they live on the upper stream or downstream of the irrigation system must be able to enjoy a fair share of the benefits generated by the Project. A water management organization should, therefore, be established using secondary canals as basic units. The BWDB should provide education, guidance and training so that farmers, the

beneficiaries of the Project, can conduct the necessary water control activities by themselves.

(5) From the viewpoints of engineering, economization and the mind of inhabitant, an integrated plan for development of the remaining area i.e. Phase-I area exclusive of Block A-1 and the demonstration unit, is required. In the case block by block development is necessary, a detailed plan for each block should be carried out under the integrated plan.

# APPENDICES

# APPENDIX I

1 - 1 Formation of the Basic Design Study Team

Member of the JICA Study Team and their assingnment are listed as follows:

Mr. Sumio KONDO, Team Leader
Construction Department
Chuugoku-Shikoku Agricultural Administration Office
Ministry of Agriculture, Forestry and Fisheries

Mr. Takeshi NARUSE, Planning Management
Grant Aid Planning & Survey Department
Japan International Cooperation Agency

Mr. Tsuneo AMANO, Irrigation and Drainage Planning
Japan Engineering Consultants Co., Ltd.

Mr. Masami MORISHITA, Facilities Design
Japan Engineering Consultants Co., Ltd.

Mr. Masashi NODA, Civil Works Design
Japan Engineering Consultants Co., Ltd.

Mr. Hiroshi YONEHARA, Farming Planning
Japan Engineering Consultants Co., Ltd.

Mr. Hiromi YAMAGAI, Geological Investigation
Japan Engineering Consultants Co., Ltd.

Mr. Kunihiko OKADA, Survey Supervisor
Japan Engineering Consultants Co., Ltd.

## 1－2 Itinerary of the Study

Day in ( ) indicates a holiday

| No. | Date/Day | Schedule | Contents of Study |
|---|---|---|---|
| 1. | Sep/19(Fri) | Tokyo-Bangkok | Departure of 1st party from Tokyo |
| 2. | 20 Sun | Bangkok-Dhaka | Arrival of 1st party at Dhaka |
| | | | Visit and discussion with Japanese Embassy and JICA. |
| 3. | 21 Mon | Tokyo-Bangkok (2nd.party) | Visit and submission of Inception Report to External Resources Division (ERD) and Bangladesh Water Development Boad (BWDB). Site reconnassance. |
| 4. | 22 Tue | | Visit and discussion with Planning Commission. |
| | | | Surveying the place of breached flood embankment in the Demonstration Unit. |
| | | Bangkok-Dhaka (2nd.party) | Arrival of 2nd party* at Dhaka. |
| | | | Discussion with Japanese Ambassador and JICA. |
| 5. | 23 Wed | | Visit and discussion with Ministry of Irrigation, ERD and Planning Commission. |
| | | | Discussion with BWDB on Inception Report. |
| 6. | 24 Thu | | Site inspection of the damaged embankment in the Demonstration Unit. |
| 7. | 25(Fri) | | Study on the measures to be taken to meet the damage of embankment in the Demonstration Unit. |
| 8. | 26 Sat | | Site reconnaissance Visit Rupganj Upazila Head Quarters. |
| | | | Preparation of Inspection Report on the damaged flood embankment. Commencement of survey of existing flood embankment |
| 9. | 27 Sun | | Explanation and discussion with BWDB on Japnese Grant Aid system, Inception Report and Questionnaire. Cost estimation for the rehabilitation of Demonstration Unit. Site survey. |

| No. | Date/Day | Schedule | Contents of Study |
|---|---|---|---|
| 10. | Sep/28 Mon | Tokyo-Bangkok (Agronomist) | Submmission of Inspection Report on the damaged flood embankment in the Demonstration Unit to Japanese Embassy.<br>Site reconnaissance.<br>Discussion with an U.P. Member of Murapara Union Parishad. |
| 11. | 29 Tue | Bangkok-Dhaka (Agronomist) | Discussion with BWDB on the minutes.<br>Submission of revised Inception Report.<br>Commencement of soil investigation/boring.<br>Arrival of Agronomist at Dhaka. |
| 12. | 30 Wed | | Signature on the "Minutes of Meeting"<br>Site survey. |
| 13. | Oct/ 1 Tur | | Site survey including survey of embankment,<br>Soil investigstion.<br>Data collection.<br>Discussion with BWDB and local government officials.<br>Submission of Inspection Report on damaged flood embankment in Demonstration Unit to BWDB (Oct.5).<br>Sorting out and analysis of data collected.<br>Preparation of preliminary plans.<br>Preparation of Field Report. |
| | 13 Teu | | Departure of 2nd party * from Dhaka(Oct.2) |
| 26. | 14 Wed | | Discussion with BWDB on survey results and basic conditions for the Basic Design.<br>Final site reconnaissance. |
| 27. | 15 Thu | | Submission of Field Report to BWDB.<br><br>Courtesy calls to Bangladesh government agencies concerned.<br><br>Reporting the survey results to Japanese Embassy and JICA Dhaka office. |
| 28. | 16(Fri) | Dhaka-Bangkok | Departure from Dhaka. |
| 29. | 17 Sat | Bangkok-Tokyo | Arrival at Tokyo |
| | | | Notes: * The 2nd party concists of Team Leader and Planning Manager. |

| No. | Date/Day | Schedule | Contents of Study |
|---|---|---|---|
| — | Explanation of Draft Report | — | |
| 1. | Jan/14 Thu | Tokyo-Bangkok | Departure from Tokyo |
| 2. | 15(Fri) | Bangkok-Dhaka | Arrival at Dhaka Discussion with JICA |
| 3. | 16 Sat | | Visit and discussion with Planning Commission, ERD and BWDB |
| 4. | 17 Sun | | Visit and discussion with BWDB, Ministry of Irrigation and Japanese Embassy |
| 5. | 18 Mon | | Site reconnaissance |
| 6. | 19 Tue | | Explanation and discussion with BWDB on the draft report. Signature on the "Minutes of Discussions" |
| 7. | 20 Wed | | Preparation of amswer to the comments |
| 8. | 21 Thu | | - do - |
| 9. | 22(Fri) | Dhaka-Bangkok (Leader & Morishita) | Departure from Dhaka |
| 10. | 23 Sat | Bangkok-Tokyo | Arrival at Tokyo |
| 11. | 24 Sun | | Discussion with BWDB on the surveying |
| 12. | 25 Mon | | Discussion with MPO on the comments<br>Dicussion with a local survey company on the surveying |
| | | Bangkok-Dhaka (Survey Supervisor) | Arrival at Dhaka |
| 13. | 26 Tue | | Discussion with JICA on the Surveying |
| 14. | 27 Wed | | Discussion with BWDB on the answers to the Comments and Surveying.<br>Preparation of answers to the comments<br>Correction and revision of the Report<br>Route alignment<br>Centering Survey<br>Estabrishment of BMS<br>Longitudinal Cross sectional Survey<br>Topographcal Survey |
| 52. | Mar/5 Sat | | Preparation the survey drawings and report on the surveying |
| 53. | 6 Sun | | Reporting the survey results to Japanese Embassy, JICA Dhaka Office and BWDB |
| 54 | 7 Tue | Dhaka-Bangkok | Departure from Dhaka |
| 55 | 8 Wed | Bangkok-Tokyo | Arrival at Tokyo |

## 1-3 Concerned Personnel

### (1) Bangladesh Government

#### 1) Planning Commission

| | |
|---|---|
| Mr. M.A. Khaleque | Joint Chief |
| Mr. Kamal Ahmed | Deputy Chief (Irrigation Wing) |

#### 2) Ministry of Finance

| | |
|---|---|
| Mr. Md. Nasim | Deputy Secretary (Japan Branch, E.R.D) |
| Mr. Kamal Uddin Ahmed | Research Officer (E.R.D) |

#### 3) Ministry of Irrigation, Water Development & Flood Control

| | |
|---|---|
| Dr. A.T.M. Shamsul Huda | Joint Secretary |
| Mr. Shafiur Rahman | Ex-Joint Secretary |
| Mr. Luqueman Ahmed | Section Chief |

#### 4) Bangladesh Water Development Board (B.W.D.B)

| | |
|---|---|
| Mr. Amjad Hossain Khan | Chairman |
| Mr. G.H.A. Islam Jaigirdar | Member Implementation cum Chief Engineer, North Eastern Zone |
| Mr. Shamsur Rahman | Member Planning cum Chief Engineer, Planning |
| Mr. Md. Taslimuddin | Director Planning (General) |
| Dr. M.A. Sattar | Director, Land & Water Use |
| Mr. Md. Lutfor Rahman | Superintending Engineer Dhaka O & M Circle |
| Mr. Abdul Khaleque | Ex-S.E. Dhaka O & M Circle |
| Mr. Sadhan Chandra Das <1 | Superintending Engineer Design Circle - IV |
| Mr. Syed Moazzem Hossain | Superintending Engineer Design Circle - I |
| Mr. Taslim Uddin Ahmed | Director, Planning (General) |
| Mr. Yousuf Ali <2 | Executive Engineer, Dhaka O & M Division-I |
| Mr. Md. Noajesh Ali | Ex-E.E. Dhaka O&M Division-I |
| Mr. M. A. Karim <3 | Deputy Chief Extension Officer, Directorate of Land & Water Use. |

| | |
|---|---|
| Mr. Alamgir Hossain <4 | Deputy Director, Ground Water Circle-II |
| Mr. Nur Mohammad Khan <5 | Sub-divisional Engineer, NNDP,Dhaka O&M Division-I |

5) Master Plan Organization

| | |
|---|---|
| Mr. Zakiul Alam | Chief Engineer |
| Mr. Mujibul Huq | Chief, Agronomy Section |
| Mr. Md. Khaliquzzaman | Superintending Engineer |

(2) Bangladesh Local Government

| | |
|---|---|
| Mr. Alhaj Rafizuddin Bhuiya | Chairman<br>Kanchan Union Parishad<br>Rupganj Upazila |
| Mr. Alhaj Ayat Ali Bhuiya | Chairman<br>Tarabo Union Parishad<br>Rupganj Upazial |
| Mr. Md. Mofizuddin | Member of Murapara U.P. |
| Mr Md. Alauddin | Engineer, Rupganj Upazila |
| Mrs. Mahfuza Khatoon | Agriculture Officer,<br>Rupganj Upazila. |

(3) Japanese Government

| | |
|---|---|
| Mr. Yoshitomo Tanaka | Ambassador of Japan |
| Mr. Toshihiro Takahashi | Minister-Counsellor,<br>Embassy of Japan |
| Mr. Minoru Nakano | First Secretary,<br>Embassy of Japan |
| Mr. Norio Matsuzawa | Resident Representative<br>in Bangladesh<br>Japan International Co-operation Agency (JICA) |
| Mr. Keizo Egawa | Deputy Resident<br>Representative, JICA. |

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<1: Counterpart person for Mr. Noda & Mr. Morishita, Design Engineer.
<2: Counterpart person for Mr. Amano, Leader.
<3: Counterpart person for Mr. Yonehara, Agronomist.
<4: Counterpart prson for Mr. Yamagai, Geologist.
<5: Person in charge of the N-N Project.

1-4

# MINUTES OF MEETING ON CONSTRUCTION OF N-N IRRIGATION PROJECT (BLOCK - A-I)

In response to the request made by the Government of Bangladesh for the construction of Irrigation Facilities in Narayanganj-Narsingdi Irrigation Project Area (hereinafter referred to as "the Project"), the Government of Japan has sent, through the Japan International Cooperation Agency (hereinafter referred to as "JICA"), a team headed by Sumio KONDO to conduct a Basic Design Survey for 29 days from Sep. 19, 1987. The team had a series of discussions and exchanged views with the authorities concerned.

Both parties have agreed to recommend to their respective Governments to examine the results of the survey toward the realization of the Project.

Sep. 30, 1987

Sumio KONDO
Team Leader of
Basic Design Survey Team,
JICA.

30/9/87

SHAMSUR RAHMAN
Chief Engineer,
Planning, Bangladesh
Water Development Board,
Dhaka.

1. Both parties reviewed and confirmed the items agreed in Minutes of Meeting which was signed on 10th June, 1987 at the Preliminary Study.

2. Bangladesh side understood in general the principle of using a Japanese Consultant Firm for Detail Design and Supervision and a Japanese General Contractor for Construction.

3. The Japanese Survey Team will convey the desire of the Government of Bangladesh to the Government of Japan that the latter will take necessary measures to cooperate in implementing the Project and will provide the Irrigation Facilities as listed in Annex 1 within the scope of Japanese economic cooperation in grant form.

4. The Government of Bangladesh will take necessary measures on condition that the grant assistance by the Government of Japan is extended to the Project:

a) to provide data and information necessary for the design and the construction

b) to acquire the lands timely necessary for the construction as per prevailing rules & regulations.

c) to clear the Project Site before the start of the construction including the removal of existing obstacles

d) to provide other items as listed in annex 2

e) to ensure prompt unlaoding and customs clearance in Bangladesh of imported materials and equipment necessary for the execution of the Project as per Govt. rules

f) to exempt Japanese nationals concerned from customs duties, internal taxes and other fiscal levies which may be imposed in Bangladesh on the occasion of the supply of goods and services for construction, as admissible under the relevant rules of the Government of Bangladesh

g) to provide and accord necessary permission, licences and other authorization required for the implementation.

ANNEX 1

Items requested by the Government of Bangladesh whose cost will be borne by the Government of Japan:

(quantity is subject to be reviewed through Basic Design Study and detail Design Study )

| No. | Item | Quantity (approximate) |
|---|---|---|
| 1. | Flood embankment | |
| | a) New | 2 km |
| | b) Remodelling of existing Embkt. | 1 item |
| 2. | Pumping Station | 1 No. |
| 3. | Drainage Facilities | |
| | a) Main Canal | 12 km |
| | b) Secondary Canal | 20 km |
| | c) Tertiary Canal | 30 km |
| | d) Regulator | 1 No. |
| | e) Syphon | 2 Nos. |
| | f) Pipe Sluice | 4 Nos. |
| 4. | Irrigation Facilities | |
| | a) Main Canal | 15 km |
| | b) Secondary Canal | 30 km |
| | c) Tertiary Canal | 45 km |
| | d) Regulators | |
| | - Main to Secondary | 10 Nos. |
| | - Secondary to Tertiary | 80 Nos. |
| | e) Turnout | |
| | - Tertiary to Field Channel | 200 Nos. |
| | f) Aquiduct | 4 Nos. |
| | g) Escape | 2 Nos. |
| | h) Check Structures | 2 Nos. |
| | i) Dredging of Intake Channel | 1 km |

| No. | Item | Quantity (approximate ) |
|---|---|---|
| 5. | Bridges and Culverts | |
| | a) Bridges | 16 Nos. |
| | b) Culverts | 25 Nos. |
| 6. | Survey and Soil Investigation | 1 item |
| 7. | Operation and Maintenance Equipment | |
| | a) Vehicle | 1 item |
| | b) Equipment | 1 item |
| | c) Speed boat | 1 item |
| | These items may be brought during the construction period if required. | |
| 8. | Engineering Service | 1 item |

ANNEX 2

Items whose cost will be borne by the Government of Bangladesh:

1) Construction of on Farm Facilities

   - Irrigation and Drainage Canal under 2 cu.sec (to be constructed by the beneficiaries as per technical advise and guidance of BWDB)

2) Other structures except for the list of Annex 1

3) Power Supply to the Pumping Station

4) Salary and daily and travel allowance to the counterparts who are assigned to work in the Project.