

BASIC DESIGN STUDY
ON
THE PROJECT FOR THE CONSTRUCTION
OF
N-N IRRIGATION FACILITIES (BLOCK A-1)
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

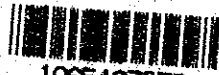
MARCH, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan has decided to conduct a basic design study on the Project for the Construction of N-N (Narayanganj - Narsingdi) Irrigation Facilities (Block A-1) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team headed by Mr. Sumio Kondo, Construction Department, Chugoku-shikoku Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries (MAFF) from September 19 to October 17, 1987.

The team had a series of discussions on the Project with the officials concerned of the Bangladesh Government and conducted a field survey in the N-N Block A-1 area, Rugganj Upazila, Narayanganj District, Dhaka Region. After the team returned to Japan, further studies were made for preparation of a draft report. And, subsequently, for the explanation and discussion of the report and the survey to decide the location of the facilities, a mission headed by Mr. Sumio Kondo was sent to Bangladesh from January 14 to March 8, 1988. As a result, the present report has been completed.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

March, 1988

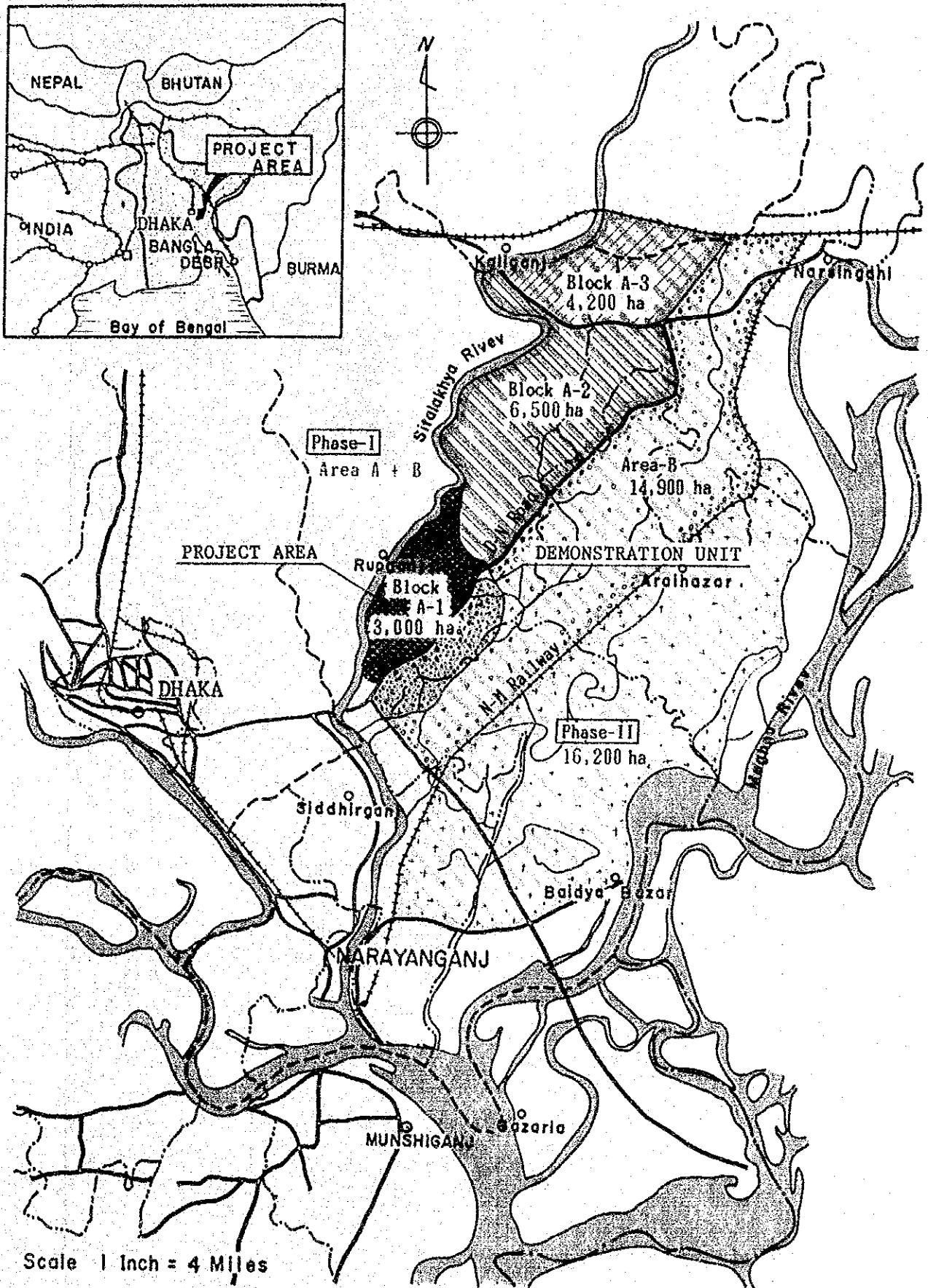


Kensuke Yanagiya

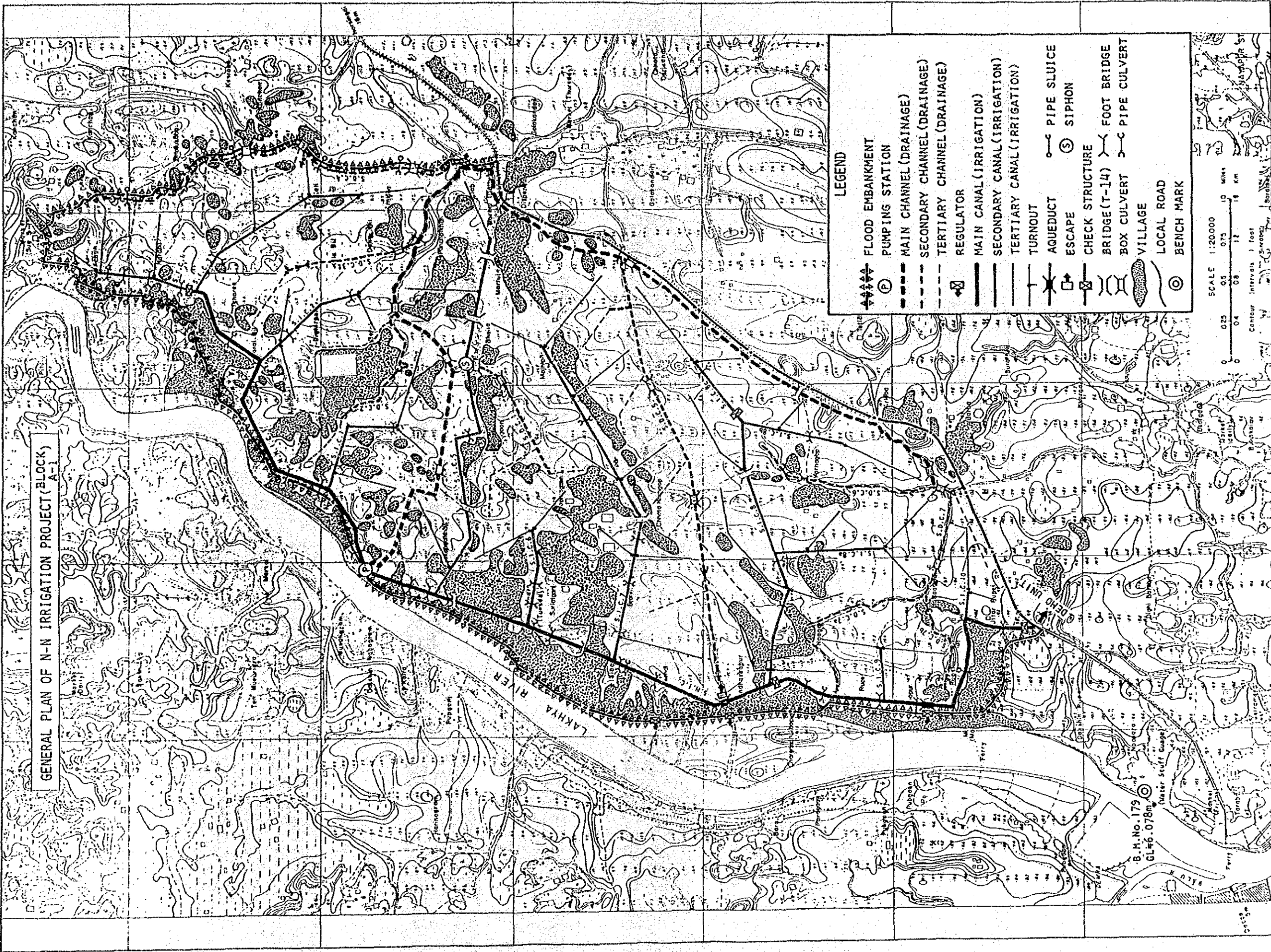
President

Japan International Cooperation Agency

LOCATION MAP



GENERAL PLAN OF N-N IRRIGATION PROJECT (BLOCK A-1)



LEGEND

- ▲▲▲▲ FLOOD EMBANKMENT
- ⊙ PUMPING STATION
- MAIN CHANNEL (DRAINAGE)
- - - SECONDARY CHANNEL (DRAINAGE)
- ⊠ REGULATOR
- MAIN CANAL (IRRIGATION)
- - - SECONDARY CANAL (IRRIGATION)
- - - TERTIARY CANAL (IRRIGATION)
- ⊥ TURNOUT
- ⊥ AQUEDUCT
- ⊥ ESCAPE
- ⊥ CHECK STRUCTURE
- ⊥ BRIDGE (T-14)
- ⊥ BOX CULVERT
- ⊥ VILLAGE
- ⊥ LOCAL ROAD
- ⊙ BENCH MARK
- ⊥ PIPE SLUICE
- ⊙ SIPHON
- ⊥ FOOT BRIDGE
- ⊥ PIPE CULVERT

SCALE 1:20,000
 0 0.25 0.5 1.0 Miles
 0 0.4 0.8 1.6 Km
 Contour Intervals 1 foot

B.M. No. 179
 G.L. 6.078m
 Water Staff Gauge

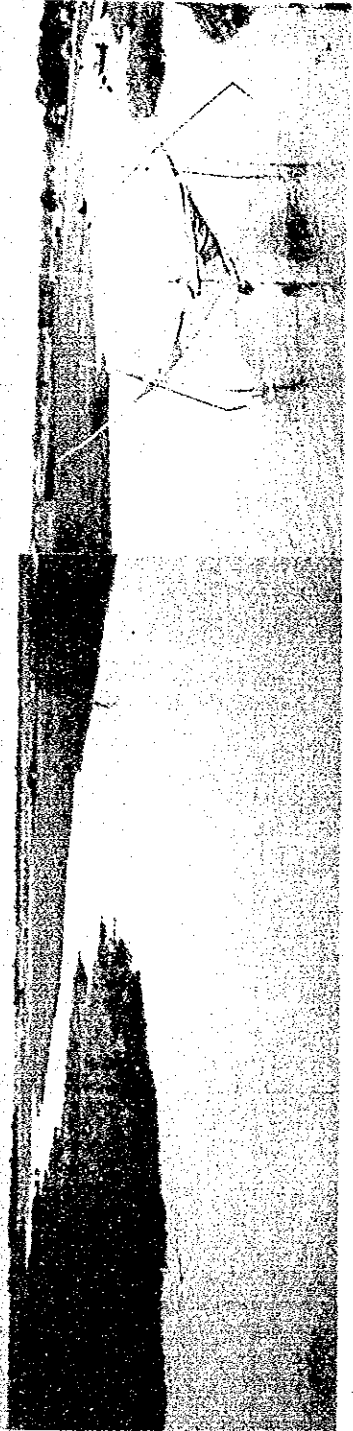


(A) Aerial view of Lakhya River and the Project area in the rainy season. In the front is the Demonstration Unit where the effects of drainage can be clearly seen.



(B)

(B) View of Golakandail - Kanchan Road and the Block A-1 area from D-N Road (Dry season)



(C)

(C) View of Golakandail - Kanchan Road and the Block A-1 area from D-N Road (Rainy season)



(D) D-N Road
The Huts on the left
are for those evacuated
from the Demonstration
Unit.

(D)



(E) View of Rupsi Road from
D-N Road (Dry season)

(E)



(F) View of Rupsi Road from
D-N Road (Rainy season)

(F)



(G)

(G) Flood embankment constructed by BWDB in 1986/87 (Work still in March, 1987)



(H)

(H) Flood embankment constructed by BWDB in 1986/87 (Photo taken in September, 1987)



(I)

(I) Proposed construction site for the pumping station (Boring test in progress)



(J) Existing road along Lakhya River in southern part of the Project area (near Ghandarbapur)

(J)



(K) Existing road along Lakhya River in northern part of the Project area (near Mashinbad)

(K)



(L) Golakandail -Kanchan Road

(L)

SUMMARY

The People's Republic of Bangladesh has a total land area of 144,000 km² and occupies a part of the Bengal Delta formed by the great Ganges Padma and Brahmaputra Jamuna rivers which traverse Bangladesh and flow into the Bay of Bengal. With a population of some 104 million (1986), Bangladesh is one of the most dense populated countries in the world. 90% of the total land is categorized as low land; of which two-thirds is farmland. And 90% of the population lives in the countryside and two-thirds of the total working population is engaged mainly in paddy cultivation; these facts make Bangladesh a predominantly agricultural country.

While paddy cultivation is possible throughout the year with an adequate water control, over 60% of the arable land is flooded during the rainy season (June - October) due to the heavy rainfall and large inflow of river water from up-stream countries. In comparison, little rainfall in the dry season (November - February) causes drought. The country suffers from such basic problems as chronic food shortage and poverty due to harsh natural conditions and rapid population increase. The National Development Plan proposes concrete targets and, simultaneously, emphasizes 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 a self-sufficient food supply, however, presumes the solutions against such harsh natural conditions as floods and droughts and, therefore, the provision of flood control embankment and irrigation and drainage facilities is the only way to overcome the severe natural constraints on agriculture in Bangladesh.

According to this background, the Government of Bangladesh made a request to the Government of Japan in 1976 for the provision of assistance for an irrigation, drainage and flood control project of some 45,000 ha in the Narayanganj - Narsingdi (N-N) area which is located 20 km east of Dhaka, the capital of Bangladesh, spreading both north and

eastwards. As the Location Map shows, the subject area lies within an agricultural zone in the vicinity of the capital area and is bordered by the Lakhya and Meghna rivers.

In response to the request, the Government of Japan entrusted the Japan International Cooperation Agency (JICA) to conduct the Feasibility Study for part of the subject area, consisting of 29,000 ha (Phase I) between 1977 and 1987. And this Feasibility Study concluded that the N-N Irrigation Project is technically feasible and economically viable. The subject area of the present Project for a grant aid constitutes a part of the whole N-N Irrigation Project Area.

Following the Feasibility Study, the Narayanganj - Narsingdi (N-N) Terminal Irrigation Facilities Construction Project for some 1,300 ha in the southern part of the N-N Irrigation Project Area was subsequently initiated by the grant aid cooperation of the Government of Japan in 1981 and completed in March, 1984 as the Demonstration Unit.

With the success of the Demonstration Unit, the Government of the People's Republic of Bangladesh worked out the implementation plan for the entire N-N Irrigation Project. Although the self-supported construction of a flood embankment was initially started by the Government of Bangladesh in the area designated by the Feasibility Study as the Phase-I area, the construction work became stagnant on the half-way due to financial constraints. The Government of Bangladesh consequently submitted a request to the Government of Japan for the grant aid cooperation for the Construction of Irrigation Facilities in Block A-1 of the Phase-I area. In response to the request, JICA sent the Basic Design Study Team to Bangladesh for the period between September 19 and October 17, 1987 to examine the Project's viability as a grant aid project in view of the necessary and most appropriate contents and size of the Project.

In the course of the field study, the Study Team examined the current conditions of agriculture and agricultural development plan in Bangladesh and implementation scheme and operation and maintenance system of the Project, which aims at flood control, drainage and irrigation. The Study Team also conducted a technical study to determine the most appropriate Project plan as a grant aid project.

Moreover, the scope of the conveniences to be provided and of the work to be undertaken by the Government of Bangladesh (during the Project implementation period) were affirmed and the Minutes of Discussions were concluded.

Based on the field survey and analysis and examination of the collected data, the Project appraisal were conducted. The results of these analysis and examinations were compiled in the Draft Final Report and JICA sent a team to Bangladesh to explain the contents of this Draft Final Report to the Government of Bangladesh from January 14 to January 23, 1988. The Basic Design proposed in this report was subsequently agreed by the Bangladesh side and the Minutes of Discussions were concluded. Subsequent to the explanation of the draft report, land survey was carried out until March 8, 1988 by the team to decide the location of the facilities to be constructed in the first stage of the project implementation.

The objective of the Project is to largely improve the agricultural productivity in the target area and, thereby the efforts of the Government of Bangladesh, to raise the self-sufficient food production.

To achieve these objectives, the construction of flood embankments to release the target area from the drought in the dry season and the flood in the rainy season is planned together with the construction and consolidation of a pumping station, irrigation canals and drainage canals to make the area irrigable throughout the year. These flood embankments, pumping station, irrigation facilities and drainage facilities will be constructed by the grant aid cooperation of the Government of Japan. The outline of the Project is shown below.

Project Area: N-N Irrigation Project
Block A-1

Benefited Area/Irrigable Area: 3,000 ha/2,230 ha

Construction of Flood Embankment: 18 km

Construction of a Pumping Station: ϕ 1,000 mm x 1.88 m³/sec x 4 pumps

Construction of Drainage Facilities:

Main Canal	11 km
Secondary Canal	20 km
Tertiary Canal	11 km

Construction of Irrigation Facilities:

Main Canal	11 km
Secondary Canal	19 km
Tertiary Canal	30 km

Provision of Operation and Maintenance Equipment:
Vehicle, Construction Equipment, Boat

Provision of Consultancy Services: Detailed Design, Tender and Supervision of Construction Work

Construction of Power Transmission Line:
11 kv x 2 km

Construction of BWDB Site Office: 2 Buildings

Land Acquisition: 156.6 ha

Rough Project Cost to be borne by Bangladesh Side:
TK 51,830,000

The implementing organization for the Project is the Bangladesh Water Development Board (BWDB) under the umbrella of the Ministry of Irrigation, Water Development and Flood Control which is responsible for the implementation and the operation and maintenance of all flood control projects, water resources development projects and major irrigation projects in Bangladesh.

Following the signing of the Exchange of Notes between the Bangladesh and Japanese Governments, the BWDB will implement the Project in accordance with the Japanese grant aid system. The construction work of the Project will take some 30 months to be completed. The Government of Bangladesh will carry out the land acquisition and construction of power transmission lines necessary for smooth implementation of the Project in accordance with the schedule of the construction work at its own expense.

Water resources development projects such as the Project in question are often carried out in Bangladesh (409 completed and 123 in progress) and the maintenance of the facilities constructed under these projects is conducted by the BWDB. The facilities to be constructed under this Project will, therefore, be maintained by the BWDB after the completion. It is assumed that an operation and maintenance system for the Project will be established utilizing 28 personnel in the Civil Engineering and Mechanical Sections. With regard to the control of irrigation water, it is recommended that the responsibility for the control of the main canals and the turnout for the secondary canals is directly assigned to the BWDB and the control of the secondary canals and lower graded facilities are assigned to the farmers' organizations formed on each secondary canal. The BWDB will organize these farmers' organizations and provide them with instruction about water management, as in the case of the Demonstration Unit.

The flood embankments are the most important facilities in this Project. In view of the fact that the flood embankment protects the property of farmers, public relations activities shall play an important role to make farmers understood that the proper maintenance of the facilities is crucial.

Therefore, it is recommended that the responsibility for the maintenance system on specific embankment sections is assigned to each Mouza (32 in total) in view of the implementation of self-maintenance efforts, including the blocking of rat holes.

The implementation of the Project will free the Project area from floods and droughts and enable it year-round irrigation with an increased crop intensity of 250% compared to the current figure of 110%. And, therefore, the greatly improved agricultural productivity will contribute to the achievement of a self-sufficient food supply. Furthermore, increase of employment opportunities, increase of agricultural income resulted from increased agricultural production and improvement of living standard 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, and also achieving important social and economic benefits. As well as the effects and benefits have already been proven by the Demonstration Unit implemented in the neighboring area, the success of the Project will further demonstrate the usefulness of this type of project. It is, therefore, certain that the grant aid cooperation of the Government of Japan for the Project is both viable and justifiable. Thus the Project's early implementation is expected.

Timely land acquisition in accordance with the implementation schedule and the establishment of farmers' organizations for the maintenance of the flood embankment and the irrigation water management are extremely important for the success of the Project.

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ABBREVIATIONS

GOB	:	Government of Bangladesh
GOJ	:	Government of Japan
MFA	:	Ministry of Foreign Affairs
JICA	:	Japan International Cooperation Agency
BWDB	:	Bangladesh Water Development Board
ERD	:	External Resources Division
PDB	:	Power Development Board
DAE	:	Department of Agricultural Extension
BADC	:	Bangladesh Agricultural Development Corporation
BRDB	:	Bangladesh Rural Development Board
CLAC	:	Central Land Allocation Committee
DLAC	:	District Land Allocation Committee
BRRI	:	Bangladesh Rice Research Institute
U.P.	:	Union Parishad
UCCA	:	Upazila Central Cooperative Association
K.S.S.	:	Krishak Shamabay Somity (Village Cooperative Society)
DC	:	Deputy Commissioner
S.E.	:	Superintending Engineer
E.E.	:	Executive Engineer
S.D.E.	:	Sub-Divisional Engineer
O & M	:	Operation and Maintenance
N-N	:	Narayanganj - Narsingdi
NNDP	:	N-N Demonstration Project
D-N-D	:	Dhaka - Narayanganj - Demra
FAO	:	Food and Agriculture Organization
ADB	:	Asian Development Bank
E/N	:	Exchange of Notes
B/D	:	Basic Design
D/D	:	Detail Design
T.B.M.	:	Tentative Bench Mark
H.W.L.	:	High Water Level
S.O.B.	:	Survey of Bangladesh
P.W.D.	:	Public Works Department
D-N Road:		Dhaka - Narsingdi Road
D-C Road:		Dhaka - Chittagong Road
T-N Railway:		Tungi - Narsingdi Railway
N-M Railway:		Narsingdi - Madanganj Railway
TK	:	Taka
¥	:	Yen

CONVERSION TABLE

Length

1 foot	= 30.48	cm
1 foot	= 0.305	m
1 inch	= 2.54	cm
1 yard	= 91.44	cm
1 statute mile	= 1.61	km
1 US naut. mile	= 1.85	km
1 Int. naut. mile	= 1.85	km

Area

1 in ²	= 6.45	cm ²
1 ft ²	= 929.03	cm ²
1 yd ²	= 0.835	m ²
1 acre	= 0.405	ha
1 sq. stat. mile	= 2.59	km ²

Volume

1 in ³	= 16.39	cm ³
1 ft ³	= 28316.8	cm ³
1 ft ³	= 28.32	litre (l)
1 gallon (US)	= 3.79	l
1 gallon (Imp.)	= 4.55	l
1 acre foot	= 1233.5	m ³

Temperature

°F = 1.8°C + 32
 °C = (°F - 32) 5/9

Velocity

1 knot	= 0.515	m/sec
	= 1.85	km/hr
1 foot/sec	= 0.305	m/sec
	= 1.095	km/hr
1 foot/min	= 0.51	cm/sec
	= 0.18	km/hr
1 mile/min	= 2682	cm/sec
	= 1.61	km/min
1 m/sec (24 hr)	= 86.4	km/day
1 foot/sec (24 hr)	= 26.33	km/day
1 mile/hour (24 hr)	= 38.6	km/day
1 knot (24 hr)	= 44.5	km/day

Pressure

1 atmosphere	= 76	cm Hg
1 atm	= 1.013	bar
1 inch Hg	= 0.0334	atm
1 inch H ₂ O	= 2.49	mbar
1 mbar	= 0.75	mm Hg
1 lb/in ²	= 51.72	mm Hg

Radiation to equivalent depth of evaporation

1 cal/cm ²	= 1/59	mm
1 cal/cm ² min	= 1	mm/hr
1 mW/cm ²	= 1/70	mm/hr
1 mW/cm ² (24 hr)	= 0.344	mm/day
1 cal/cm ² min (24 hr)	= 24	mm/day
1 Joule/cm ² min (24 hr)	= 5.73	mm/day

CHAPTER 1 INTRODUCTION

In 1976, the Government of Japan received a request from the Government of the People's Republic of Bangladesh to conduct a feasibility study for an irrigation and flood control project for some 45,000 ha in the Narayanganj - Narsingdi (N-N) area located at the centre of Bangladesh and near Dhaka, the capital. Commissioned by the Government of Japan, the Japan International Cooperation Agency (JICA) conducted the Feasibility Study between 1977 and 1978 and found the project to be both technically feasible and economically viable. The Narayanganj - Narsingdi (N-N) Terminal Irrigation Facilities Construction Project for some 1,300 ha along the Dhaka - Narsingdi (D-N) Road in the Rupganj area at the centre of the target area was subsequently initiated with the grant aid cooperation of the Government of Japan in fiscal year 1981. The actual construction work commenced in April, 1982 and was completed in March, 1984 as the Demonstration Unit which has proved extremely beneficial for the local inhabitants.

The success of this Demonstration Unit further strengthened the confidence of the Government of Bangladesh in the feasibility of the entire N-N Irrigation Project, providing a strong incentive for the main project's early implementation. The self-supported construction of a flood embankment was consequently started by the Government of Bangladesh, commencing in the area designated by the Feasibility Study as the Phase I area. Due to financial constraints, however, the future of this construction effort became uncertain and, therefore, the Government of Bangladesh submitted a request to the Government of Japan for the provision of grant aid cooperation for implementation of the Project in Block A-1 of the Phase I area.

In response to this request, the Government of Japan commissioned JICA to send the Preliminary Study Team, headed by Mr. Kenji Niino of the Economic Affairs Bureau of the Ministry of Agriculture, Forestry and Fisheries, to Bangladesh in June, 1987. Based on the results of the Preliminary Study, the Government of Japan decided to implement the Basic

Design Study for the Project and JICA sent the Basic Design Study Team, headed by Mr. Sumio Kondo of the Chugoku - shikoku Agricultural Administration Office of the Ministry of Agriculture, Forestry and Fisheries, to Bangladesh from September 19 to October 17, 1987 in order to further examine the Project's suitability as a grant aid project of the Government of Japan and also to prepare the Basic Design concerning the required, as well as most appropriate, contents and size of the Project.

In the course of the field study, the Study Team examined the current conditions of agriculture and agricultural development in Bangladesh and the background, requested contents, implementation system and operation and maintenance system of the Project, which aims at flood control, water drainage and irrigation. The Study Team also conducted a technical study to determine the most appropriate Project plan as a grant aid project. Moreover, the scope of the conveniences to be provided during the Project implementation period and of the work to be undertaken by the Government of Bangladesh were affirmed and the Minutes of Discussions were concluded.

Based on the findings of the field study and analysis and examination of the collected data related to each study item, preparation of the Project plan, the basic design of the facilities and the Project appraisal were conducted. The results of these analyses and examinations were compiled as the Draft Final Report and a team headed by Mr. Sumio Kondo was then sent to Bangladesh to explain the contents of this Draft Final Report to the Government of Bangladesh from January 14 to January 23, 1988. The Basic Design proposed in this report was subsequently agreed to by the Bangladesh counterpart. Subsequent to the explanation of the draft report, a surveying was carried out till March 8, 1988 by the JICA team to decide the location of the facilities to be constructed in the first stage of the project implementation in order that the Government of Bangladesh can smoothly acquire necessary land.

CHAPTER 2 BACKGROUND OF THE PROJECT

2.1 General Conditions of Bangladesh

(1) Land, Population and Climate

Bangladesh is located at the eastern end of the Indian subcontinent between Lat. 20° and 26°N and Long. 88° and 92°E. It has a total land area of 144,000 km², mostly an elevation of less than 100 feet (30m) and is mainly located in the delta formed by the Ganges and Brahmaputra Rivers.

Bangladesh is estimated to have a population of 104.26 million as of 1986 and a population density of 724 persons/km². The population growth rate is 2.4% (1984/85).

The country belongs to the tropical monsoon zone and has an annual mean rainfall of 2,300 mm. The dry season is from November to February, the transitional period to the rainy season from March to May and the rainy season from June to October. January is the coldest month with a mean minimum temperature of 12°C while April is the hottest month with a mean maximum temperature of 33°C. The mean annual temperature of Bangladesh is 26°C.

(2) National Economy

The GDP of Bangladesh in fiscal year 1985 was 16,054 million dollars and the national income per capita was 113 dollars. The economic growth rate in fiscal year 1985 was 4.9%. The economy in fiscal year 1985 presented a severe outlook for the future as imports of food grains amounted to more than 2 million tons, the price of jute, the country's main product declined and the population growth rate was still high.

With regard to foreign trade in 1985, the export value and import value totalled 950 million dollars and 2,493 million dollars respectively, showing an import value excess of 1,543 million dollars. The main export items are jute, jute products, leather, leather goods, frozen foods, tea and clothes, etc. Large importers are the US, Belgium, Japan, the UK and Italy. Food, oil, machinery, raw materials and chemicals comprise the main import items with Singapore, Japan, the US, Korea and China being large exporters.

As of 1986, the standing foreign debt was 6,569 million dollars and total loans and gifts received since independence amounted to 8,858.6 million dollars.

(3) National Development Plan

The Government of Bangladesh announced its Third Five Year Plan (July, 1985 - June, 1990) in December, 1985 which reconfirmed the understanding that no effective promotion of economic, as well as social, development plans would be possible unless the 3 crucial problems of poverty, population and food were firstly solved and, therefore, introduced the following 8 targets to achieve comprehensive development based on a long-term strategy.

- 1) Reduction of population growth
- 2) Expansion of productive employment.
- 3) Universal primary education and human resources development.
- 4) Development of technological base for bringing about a long term structural change.
- 5) Food self-sufficiency.
- 6) Satisfaction of minimum basic needs of people.
- 7) Acceleration of economic growth.
- 8) Promotion of self-reliance.

2.2 Agriculture in Bangladesh

(1) Bangladesh is located in the delta formed by 3 large rivers, i.e. Ganges, Brahmaputra and Meghna. Some 80% of the country's land area of 144,000 km² is alluvial plain. 91% of the population lives in rural areas and over 75% of the working population is engaged in agriculture.

More than 50% of the domestic production comes from agriculture, centering on the cultivation of rice, and agricultural products (mainly jute) and their processed products account for more than 50% of the total export value.

Despite the fact that Bangladesh is one of the major rice producing countries in Asia, it suffers from a chronic food shortage and is forced to import a large volume of food annually. This chronic food shortage cannot be overcome unless food production is increased and the high population growth is arrested.

Severe natural conditions are the main reason preventing Bangladesh from increasing its food production. While 90% of the land is a flat delta area and Bangladesh has good mean annual rainfall of over 2,000 mm. 70% of this rainfall is concentrated in the rainy season (June - October) which, coupled with the increased discharge from India in rivers in Bangladesh, causes flooding of more than 60% of the arable land.

In comparison, only 5% of the total annual rainfall is recorded in the dry season (November - February) and, therefore, agriculture cannot be sustained in most areas without irrigation. As a result, increased agricultural production and its resulting self-sufficiency cannot be achieved without first overcoming this natural cycle of flooding and drought.

Of the total land area of 14.40 million ha, cultivable land comprises some 65% or 9.425 million ha (1984/85), of which 8,648 million ha is actually under cultivation (1984/85, 60% of the total land area). Single cropping is carried out on 54% of this cultivated land while double cropping and triple cropping is carried out on 39% and 7% of the land respectively, resulting in a cropping intensity of 153%. 22% of the total cultivated area is currently irrigated.

With regard to the landholding conditions, 20% of the farmers have no land while 40%, 23% and 2.6% have less than 0.4 ha, 0.4 - 1.2 ha and more than 4 ha respectively.

(2) Food Production and Rural Economy

Crop production accounts for some 37 of the total agricultural production (the latter comprising more than 50% of the GDP). As shown in Table 2-2-1, rice is the main crop and is grown on more than 75% of the cultivated land, followed by jute and wheat (4 - 7%) while potatoes (sweet potatoes), pulses, edible oilseeds and sugar cane, etc. only account for 1 - 3% each of the cultivated land. The grain production volume is 15.86 million tons (1985/86) with rice and wheat production accounting for 14.8 million tons (93%) and 1.02 million tons respectively. The production of wheat and vegetables has shown a rapid increase due to the recent governmental efforts to diversify agricultural products.

Since the introduction in 1967 of the new rice variety IR-8 developed by the International Rice Research Institute (IRRI), new varieties have been developed by the Bangladesh Rice Research Institute (BRRI) and consequently, the use of High Yield Varieties (HYVs) has gradually been adopted. The average unit yield of 1.0 t/ha prior to the introduction of the new varieties has improved to 1.3 - 1.4 t/ha but the current figure is still lower than the Asian average of 1.6 t/ha. As a result,

Table 2-2-1 Acreage, Production of Agricultural Crops
in Bangladesh

Crops	1983-84		1984-85		1985-86	
	Acreage 1,000Ac	Production 1,000t	Acreage 1,000Ac	Production 1,000t	Acreage 1,000Ac	Production 1,000t
Rice	26,064	14,279	25,263	14,392	25,695	14,803
Wheat	1,300	1,192	1,671	1,440	1,335	1,026
Jute	1,435	931	1,671	913	2,234	1,357
Potato (Sweet Potato)	433	1,850	427	1,813	406	1,687
Pulses	694	176	676	201	641	191
Edible Oilseeds	611	173	615	177	604	175
Spices	369	289	361	293	354	289
Sugar	446	7,475	437	7,152	427	6,890
Tobacco	128	47	128	49	132	46
Tea	110	42	110	37	110	43
Winter Vegetables	216	605	220	618	219	613
Summer Vegetables	125	277	122	256	120	272
Other	815	1,663	789	1,689	797	1,639
Total	32,746	28,999	32,490	29,030	33,124	29,081

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self-sufficiency in food production has not yet been attained, necessitating food grain imports of more than 2 million tons annually. Although Bangladesh has a GNP per capita (1985) of 113 dollars, the annual income of most farmers is well below this level.

(3) Current Conditions of Agricultural Administration

The 3 ministries relating to agriculture are the Ministry of Irrigation, Water Development and Flood Control, the Ministry of Agriculture and Forestry and the Ministry of Local Government, Rural Development and Cooperatives. The implementing organization for this Project is the Bangladesh Water Development Board (BWDB) of the Ministry of Irrigation, Water Development and Flood Control.

After completion of the Project, such rural administration as operation and maintenance of the facilities, farming instruction, farmers' organization and agricultural finance, etc. will be executed by the Ministry of Irrigation, Water Development and Flood Control, the Ministry of Agriculture and Forestry, the Ministry of Local Government, Rural Development and Cooperatives, and local administration organizations.

The Government of Bangladesh's stress on agricultural development based on the understanding that agriculture is the mainstay of the economy of Bangladesh can be seen in the high ratio (30%) of public investment in the agricultural sector (agriculture, water resources and rural development) in the Second Five Year Plan. The ratio of investment in this sector in the Third Five Year Plan is planned to be 28% of the public investment.

2.3 Related Plans

2.3.1 Agricultural Development

Of the targets of the current Third Five Year Plan (TFYP), top priority is given to development plans in the agricultural sector in view of the fact that the economy of Bangladesh is largely dependent on agriculture. The main target of agricultural development is the self-sufficiency of food production (leading to an expansion of employment opportunities and the attainment of the minimum basic needs). Water resources development will play the most important role in the achievement of this target. Therefore, the improvement of flood control, drainage and irrigation facilities and increased grain production (16.1 million tons in 1984/85 to 20.7 million tons in 1989/90) are given as the concrete objectives of water resources development in the TFYP.

The N-N (Narayanganj - Narsingdi) Irrigation Project (benefited area: 45,200 ha) corresponds to the policy of the national development plan described above and when completed according to the Feasibility Study, the current cropping intensity of 130% will be improved to 210% with a grain production increase of 175,000 t/year, therefore contributing to the expansion of employment opportunities in the agricultural sector in general and new employment relating to the implementation of the Project.

As the planned area for the N-N Irrigation Project (Block A-1) is located near Dhaka, the capital of Bangladesh, the improvement of the agricultural productivity in the area will be of both social and economic significance. Since the appropriateness of the Project has already been confirmed by the Feasibility Study and its effects proven by the Demonstration Unit, the early implementation of the Project is strongly hoped for and, in fact, some investment efforts have already been initiated using the financial resources of the Government of Bangladesh.

2.3.2. Outline of the N-N Irrigation Project

Block A-1, which is the subject of the present Basic Design Study, is part of the N-N Irrigation Project area. The N-N Irrigation Project intends the irrigation, drainage and flood control in the Narayanganj - Narsingdi area near Dhaka and has been judged technically and economically feasible by the Feasibility Study conducted by JICA between 1977 and 1978 based on a request made by the Bangladesh Government to the Japanese Government.

The Project area of 45,200 ha which is given in the Feasibility Study Report on the N-N Irrigation Project (July, 1978) is bordered by the Maghna River to the east and south, Lakhya River to the west and the T-N railway to the north. The Feasibility Study report designates the north-western side of the N-M railway which runs across the Project area from the southwest to the northeast to be the Phase-I area for the priority implementation of the Project. The Feasibility Study report gives the main contents of the N-N Irrigation Project (Phase-I) to be as follows.

Project Area

Gross Area/Net Irrigable Area 29,000 ha/23,080 ha

Flood Embankment

Total Length of New Embankment (Lakhya River) 34.6 km

Total Length of Additional Embankment:

N-M Railway 18.6 km

D-C Road 5.4 km

Crest Elevation of Planned Embankment:

Lakhya River 8.08 - 7.14 m PWD

N-M Railway 7.84 - 7.17 m PWD

Crest Width of New Embankment 6.1 m

Slope Gradient of Embankment:

River Side 3:1

Land Side 2.5:1

Related Structures:

Regulating Gates	6
Closures	9

No. 1 Pumping Station Area

Gross Area/Net Irrigable Area	11,910 ha/9,640 ha
Catchment Area for Drainage	150 km ²

No. 1 Pumping Station:

Capacity	35 m ³ /sec
Pumps	φ1,650mm x 550kw x 6 units
Main Irrigation Canal	58.3 km
Secondary Irrigation Canal	110.4 km
Main Drainage Canal	10.1 km

Related Structures:

Turnouts	22
Check Gates	4
Aqueducts	15
Bridges	208
Siphons	4
Regulating Gates	1

No. 2 Pumping Station Area

Gross Area/Net Irrigable Area	17,090 ha/13,450 ha
Catchment Area for Drainage	140 km ²

No. 2 Pumping Station

Capacity	35 km ² /sec
Pumps	φ1,650mm x 600kw x 6 units
Main Drainage Canal	55.2 km
Secondary Irrigation Canal	131.6 km
Main Drainage Canal	13.7 km

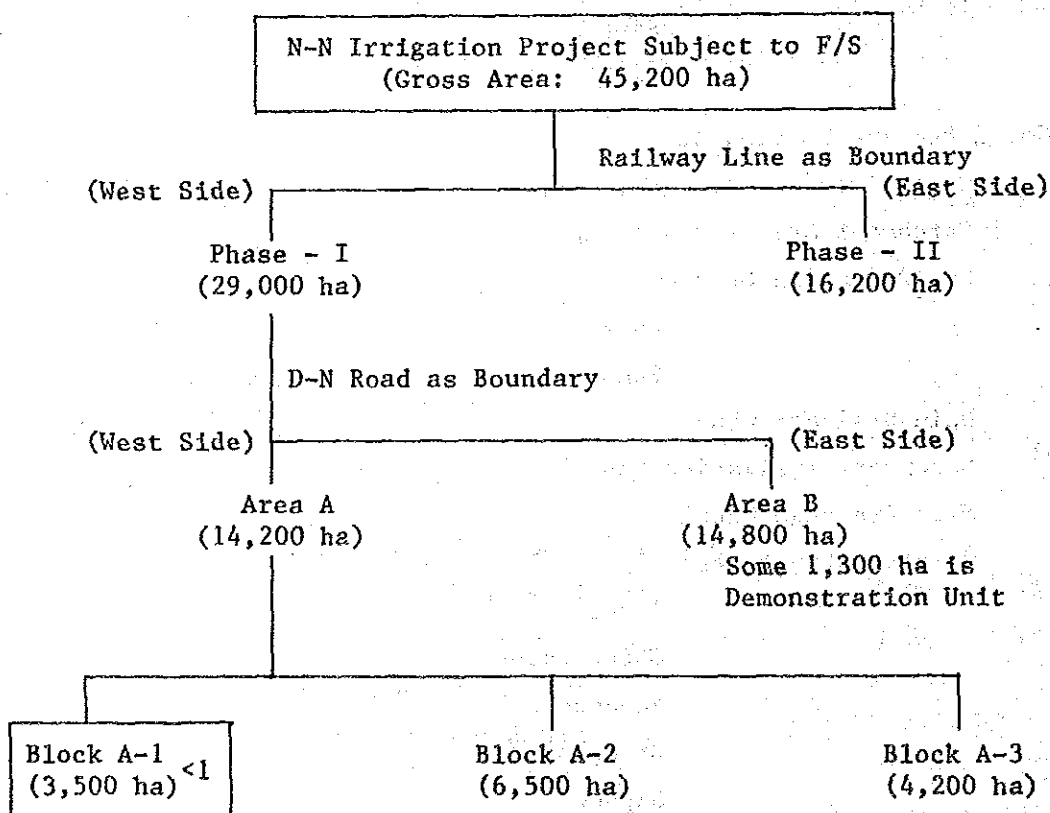
Related Structures:

Turnouts	20
Check Gates	4
Aqueducts	8
Bridges	190
Siphon	1

The Government of Bangladesh introduced a stage plan dividing the Phase I area in the Feasibility Study into 2 areas by the D-N Road, i.e. Area A to the west of the road along Lakhya River and Area B to the east of the road. Area A was designated as the priority area and was further divided into 3 blocks and the Project implementation for Block A-1 located at the southern end of the Phase-I area commenced.

Prior to the Project implementation in Block A-1, however, an area of 1,300 ha at the southern end of Area B (adjoining Block A-1 to the west) was developed as the Demonstration Unit for the N-N Irrigation Project with grant aid of the Government of Japan.

The following chart shows the division of the entire Project into the 2 phases and the classification of Phase-I under the stage plan currently in progress in view of easy understanding.



Note: <1 The figure is the area given in the request. As the result of this study, the area of Block A-1 has been modified to 3,000 ha.

2.3.3 N-N Demonstration Unit

The N-N Demonstration Unit of some 1,300 ha was developed under the N-N Terminal Irrigation Facilities Construction Project with the grant aid cooperation (840 million yen) of the Government of Japan in fiscal year 1981 as a model area for the N-N Irrigation Project. The work commenced in April, 1982 and was completed in March, 1984. The outline of the constructed facilities and the benefited area is as follows.

Gross Area	1,300 ha
Net Irrigable Area	1,000 ha
Flood Embankment	6.6 km
Pumping Station	φ700 mm x 3 pumps
Main Irrigation Canal	7.8 km
Secondary Irrigation Canal	7.8 km
Main Drainage Canal	8.6 km
Secondary Drainage Canal	15.6 km
Number of Farming Households	520
Subject Population	2,600
Farmers Without Own Land	50

The construction of tertiary and field canals is in progress by the Bangladesh Government and farmers' organizations and their completion by 1989 is anticipated by the BWDB which is responsible for the implementation of the Project and the subsequent maintenance of these facilities.

Although the Project intends the construction and improvement of the terminal facilities, the agricultural productivity in the subject area has already improved, showing remarkable effects, including an increase of the income of the benefited farmers by 3 or even 4 times. The success of this Demonstration Unit has in fact led to the request for the implementation of this Project (Block A-1). However, such problems as the incompleteness of some terminal facilities and the lack of timely irrigation during the dry season due to

that the pumping facilities and the intake canal have been set up at higher level and the side slopes of intake canal are not stable, still remain unsolved. In fact, the entire area of the Demonstration Unit was flooded due to the collapse of the flood embankment by unusually heavy rainfall one month before the commencement of this study and all the crops were destroyed (see Appendix 4).

The operation and maintenance of the terminal facilities is carried out by the following staff of the BWDB and the annual operation and maintenance budget for 3 years between 1984/85 and 1986/87, including the personnel cost, was TK 10.94 million.

Civil Engineering Section

Sub-Divisional Engineer	1	(Responsible for all areas in N-N Project)
Sub-Assistant Engineers	2	- do -
Work Assistants	4	- do -

Mechanical Section

Sub-Divisional Engineer	1	(Concurrently serving the D-N-D Project)
Sub-Assistant Engineer	1	- do -
Foreman	1	- do -
Operators	5	(Full-Time)
Electrician	1	- do -
Mechanic	1	- do -

In regard to water management and farming, 8 farmers' organizations (Krishak Shamabay Samity: K.S.S) have been organized to promote modern agriculture. Rice cultivation has consequently improved from the single cropping of the low productivity B-Aman variety prior to the Project implementation to the double cropping of the high yield, high quality T-Aman, Boro and Broush varieties.

2.3.4 Similar Projects

4 projects, similar to this Project in that they intend flood control, irrigation and water drainage, have been selected and are outlined in Table 2-3-1

Table 2-3-1 Details of Similar Project

1. Name of Project	D-N-D	Meghna · Dhonagoda	Pabna R.D. (Phase-1)	North Rugganj	
2. Location (District)	Dhaka	Chandpur	Pabna, Serajgonj, etc.	Rugganj	
3. Completion Time	1968	June, 1986	to be completed in June, 1989	to be completed in 1988	
4. Gross Area /Net Irrigable Area	5,870ha/4,820ha	18,800ha/14,200ha	185,000ha/21,860ha	2,270ha/2,270ha	
5. Population (Density)	--	260,000 persons (Estimated in 1977) (3,580 persons/mile ²)	1,552,519 (1983) (2,170 persons/mile ²)	--	
6. Fund	IDA	ADB	ADB, IFAD	CHINA	
7.	Total Project Cost	233.27 Lakh TK	11,330 Lakh TK	27,292 Lakh TK	2,445 Lakh TK
	Local	226.53 Lakh TK	9,419 Lakh TK	22,548 Lakh TK	1,389 Lakh TK
	Foreign	6.74 Lakh TK	1,911 Lakh TK	4,743 Lakh TK	1,055 Lakh TK
8. Land Utilizing Ratio (Pre/Post)	100% / 148%	151% / 185%	121% / 201%	--	
9. I.R.R.		24.36%	19.41%	--	
10. Flood Embankment	Approx. 40 km (Existing Road)	64 km	161 km	18 km	
11. Pumping Station	1 place 4 units Total 600 cusec	2 places 6 units = 1,530 cusec 4 units = 1,020 cusec	2 places 6 units = 2,530 cusec 4 units = 1,250 cusec	1 place	
12. Irrigation Canal	M : 25.6km S : 51.2km T : 16.0km	M+S : 96km T : 121km } 217km	M : 39km S : 93km T : 135km } 267km	38.5km	
13. Drainage Canal	M : 22.4km S : 35.2km	125 km	M : 51km S+T : 77km } 128km	15.5km	
14. Land Acquisition Area		1,440 ha	2,800 ha	133.6 ha	

Remark: M : Main Canal S : Secondary Canal T : Tertiary Canal

2.4 Process and Contents of the Request

2.4.1 Process of the Request

In 1976, the Government of Bangladesh requested the Government of Japan to conduct a feasibility study for an irrigation and flood control project for some 45,000 ha in the Narayanganj - Narsingdi area which is located at the centre of the country and near Dhaka, the capital. Commissioned by the Government of Japan, the Japan International Cooperation Agency (JICA) conducted the Feasibility Study between 1977 and 1978 and found the project to be technically feasible and economically viable. The N-N Terminal Irrigation Facilities Construction project for some 1,300 ha (net irrigation area is 1,000 ha) along the D-N Road in the Rupganj area at the centre of the subject area was subsequently initiated with the grant aid cooperation of the Government of Japan in fiscal year 1981. The actual construction work commenced in April, 1982 and was completed as the Demonstration Unit in March, 1984, proving highly beneficial for the local inhabitants.

The success of the Demonstration Unit further strengthened the Bangladesh Government's confidence in the feasibility of the entire N-N Irrigation Project and provided a strong incentive for the early implementation of the main project. The Government of Bangladesh consequently commenced the self-supported construction of a flood embankment, starting in the area designated as the Phase-I area by the Feasibility Study. However, the future of this construction effort became uncertain due to financial constraints and the Government of Bangladesh subsequently submitted a request to the Government of Japan for the provision of grant aid cooperation for the project implementation in Block A-1 in the Phase I area.

In response to this request, the Government of Japan commissioned JICA to send the Preliminary Study Team to Bangladesh in June, 1987 in order to confirm the contents of the request. As only the construction items in the original request were confirmed during

this visit, the entire contents of the request were again examined and reconfirmed by the Basic Design Study Team as described in 2.4.2. The description "construction equipment" in the original request has now been changed to "operation and maintenance equipment" and the concrete contents (vehicle, equipment and boat) are given.

2.4.2 Contents of the Request

The contents of the Bangladesh Government's request for the Project, confirmed during the Basic Design Study, are given below and it is agreed that the actual quantities will be reviewed and finally decided during the course of the domestic work in Japan.

- | | |
|--|-------|
| (1) Project Area | |
| Block A-1 of Area A of N-N Irrigation Project Phase I | |
| (2) Flood Embankment | 4 km |
| (3) Pumping Station (for both irrigation and drainage) | 1 |
| (4) Drainage Facilities | |
| Main Canal | 12 km |
| Secondary Canal | 20 km |
| Tertiary Canal | 30 km |
| Regulator | 1 |
| Siphons | 2 |
| Pipe Sluices | 4 |
| (5) Irrigation Facilities | |
| Main Canal | 15 km |
| Secondary Canal | 30 km |
| Tertiary Canal | 45 km |
| Regulators (main canal to secondary canal) | 10 |
| Regulators (secondary canal to field canal) | 80 |
| Turnouts (tertiary canal to field canal) | 200 |
| Aqueducts | 4 |
| Escapes | 2 |

Check Structures	2
Dredging of Intake Canal	1 km
(6) Bridges and Culverts	
Bridges	16
Culverts	25
(7) Surveying and Soil Investigation	1 item
(8) Maintenance Equipment	
Vehicles	1 item
Machine	1 item
Speed Boat	1 item
(9) Engineering Service	1 item

2.4.3 Necessity of the Project

Although Bangladesh is mainly an agricultural country with a large majority of the people depending on agriculture, it has not yet achieved a self-sufficient supply of food due to frequent flooding and drought. Therefore, flooding and drought must be overcome to achieve the necessary self-sufficient food supply. Water resources development, which plays an extremely important role in the achievement of this objective, has been given top priority in the Third Five Year Plan currently in progress.

This Project intends to overcome these natural problems by the new construction of flood control, drainage and irrigation facilities, as well as the consolidation of existing facilities, to largely increase the agricultural productivity which, in turn, will contribute to the achievement of a self-sufficiency of food.

The Project is prepared based on the results of the Feasibility Study conducted as part of the Japanese grant aid cooperation for the entire N-N Irrigation Project. As the Project will be implemented based on a flood control plan with embankment, drainage plan and irrigation plan, the technical suitability and economic effectiveness of which have already been proven in the Demonstration

Unit, it can be expected that the Project will result in similar or even better effects than those in the Demonstration Unit. In addition, it will largely contribute to an increase of the agricultural productivity and agricultural income. Furthermore, both demonstration and spread effects can be anticipated.

In view of the above effects and benefits, coupled with the importance of assisting the self-help efforts of the Government of Bangladesh, the implementation of the Project appears to be highly necessary.

CHAPTER 3 - PROJECT AREA

3.1 Outline of the Project Area

As shown on the location map previously given, the Project area is located almost at the centre of Bangladesh, some 20 km east of Dhaka.

The Block A-1 area, consisting of 3,000 ha, is located at the southwestern end of the N-N Irrigation Project area and is bordered by the Lakhya River to the west, Dhaka-Narsingdi (D-N) Road to the east, Golakandail-Kanchan Road to the north and Rupsi Road to the south.

The area belongs to Rupganji Upazila of the Narayanganj District, Dhaka Division, Dhaka Region and consists of 5 Unions with 32 Mouzas of Rupganji Upazila. The land utilization of the Project area (3,000 ha) is as follows.

Farming Land	<u>2,380 ha</u>
Net Irrigable Area	2,230 ha
Land Used for Project- Related Facilities, Pumping Station and Farm Roads, etc.	150 ha
Non-Farming Land	<u>620 ha</u>
Public Land, Housing and Orchards and Factories, etc.	590 ha
Drainage Canals and ponds	30 ha

3.2 Social and Economic Conditions

(1) Social Conditions

Table 3-2-1 shows the area, number of households and population by Mouza in the Project area while the area, number of households and population by Union are given below.

Union	Area(ha)	No. of Households	Population (persons)
Tarabo	895	2,068	13,055
Murapara	816	3,200	18,827
Bulta	901	2,611	16,268
Colakandail	313	120	745
Kanchan	175	473	3,245
Total	3,000	8,472	52,140

Farming Households were estimated to be some 50% of the total number of households, i.e. 4,240 households with a population of 26,000. Such estimation was also made through field interviews and from "Dhaka District Statistics (1983)".

The areas, number of households and population of those Upazilas included in the A-1, A-2 and A-3 Blocks are as follows.

Upazila	Area(ha)	No. of Households	Population (persons)
(A-1)			
Rupganj	3,000	8,472	52,140
(A-2)			
Rupganj	3,923	9,686	28,529
Araihazar	1,140	2,309	12,569
Palash	88	366	2,051
Narsingdi	2,419	5,864	33,239
Sub-Total	7,570	18,225	76,388
(A-3)			
Palash	2,193	6,038	36,830
Narsingdi	1,899	4,421	24,798
Sub-Total	4,092	10,459	61,628
Total	14,662	37,156	190,156

(2) Economic Structure

While agriculture dominates the Project area, the jute industry has a long history and there are 2 jute factories in Murapara, the central area of the Project area, and 5 factories in Kanchan. Most raw materials and products are transported by river. There is also a spinning factory in Murapara.

Traditional handloom weaving is popular in the Project area and some 40% of the farming households are engaged in it as a home industry.

With the implementation of various development projects in recent years, the demand for bricks has been rapidly increasing and several brickyards are located in the Project area along the D-N Road.

Table 3-2-1 Mouzas Characteristics and Their Geo-codes

Mouza Name	Area	Family	Population	Remark
	Ac	Nos.	Persons	
TARABO (8)	2,209	2,068	13,055	
Barpa	214	165	998	50% of Total
Debai	203	96	513	
Gandharbapur	274	635	4,388	
Karagop	528	72	575	
Khadan	145	115	701	50% of Total
Noagaon	383	166	963	
Ultar Rupsi	427	705	4,221	40% of Total
Ariaba	55	114	693	
MURAPARA (13)	2,014	3,200	18,827	
Baniadi	269	369	2,234	
Brahmangaon	1,048	1,744	10,148	90% of Total
Chhota Baniadi	28	42	273	
Lakshya Jatrabari	39	94	581	
Mangai Khali	43	149	975	
Mirkuti	21	38	239	
Mirkutichhao	41	80	510	
Murapara	75	275	1,499	
Narasingal	150	64	377	
Parain	137	100	598	
Poraba	115	72	426	
Sariatganj	40	124	651	
Shibganj	8	49	316	
BULTA (8)	1,977	2,611	16,268	
Atlaspur	99	240	1,400	50% of Total
Berokdighirpar	221	110	643	"
Bhaela	282	546	3,657	
Bulta	387	342	2,400	50% of Total
Masimabad	142	158	1,030	
Mithaba	269	409	2,386	90% of Total (Only Area)
Panchaikhan	170	296	1,745	
Paragaon	407	510	3,007	
GOLAKANDAIL (1)	773	120	745	
Amlada	743	120	745	
KANCHAN (2)	433	473	3,245	
Kanchan	349	422	2,953	50% of Total
Noagaon	84	51	292	
Total (32)	Ac 7,406 (3,000ha)	Nos. 8,472	Persons 52,140	

Small Atlas of Bangladesh
Mauzas and Mahallah of Dhaka
District Sep. 1985

3.3 Natural Conditions

3.3.1 Topography and Geology

The Project area and the surrounding areas are part of the flood plains comprising some 87% of the national land of Bangladesh. In particular, the land along the east bank of Lakhya River is entirely part of the flood plain formed by Lakhya River and, therefore, has an elevation as low as 3 - 6m (PWD) in most places.

The topography of the Project area shows the existence of slightly elevated land (natural embankment) of 4.7 - 6.0m along the river with the elevation gradually decreasing towards the east and south-east. There are many small meandering rivers, generally running towards the southeast and joining the downstream of Lakhya River outside the Project area.

The fact that a series of slightly elevated areas which are higher than the natural embankment form a dotted line in the centre of the Project area indicates the previous existence of river channels. Of these slightly elevated areas, those with an elevation of 5 m or higher are seldom flooded during the rainy season and are used for the location of villages. The following table shows the ratio of area by the respective elevation range in Block A-1.

Area by Elevation Range in Block A-1

Elevation (m) PWD	Aggregate Area (ha)	Aggregate %
Less than 2.9 m	140	5
Less than 3.5 m	1,480	50
Less than 4.1 m	2,540	85
Less than 4.7 m	2,850	95
Less than 6.1 m	3,000	100

As the water level during the study period was around 4.6 - 5.7 m, more than 95% of the Project area was flooded.

The geology of the Project area is characterized by alluvium consisting of clay, silt and sand which are typical deposits in a flood plain. According to the available data on wells, etc., the upper layer (20 - 30m in depth) of the Project area and the surrounding areas consist of silt or clay beneath which there is a dominant sand layer.

Boring tests (5 locations) and soil tests were conducted at the planned pumping station site and at the planned embankment sites (at embankments already constructed by the BWDB and existing roads) during this study. In addition, the available data and materials from previous surveys on the Project area and the surrounding areas were collected. These tests, data and materials are summarized as follows (see Appendix 3-2 for details).

(1) Boring Log

Fig. 3-3-1 shows the boring log for the boring tests conducted at 5 locations.

(2) Foundation for Pumping Station

The existence of a sand layer capable of supporting the pumping station structures was confirmed 26 m below the surface at the planned pumping station site.

(3) Banking Material

The density of the embankment constructed by the BWDB during the last dry season is some 10% lower than that of the existing roads and, therefore, it has an inferior strength to the roads.

No. 1 (Baniadi) Pumping Station No. 2 (Murapara) No. 3 (Gandharubapur) No. 4 (Utter Rupsi) No. 5 (Mashinbad)

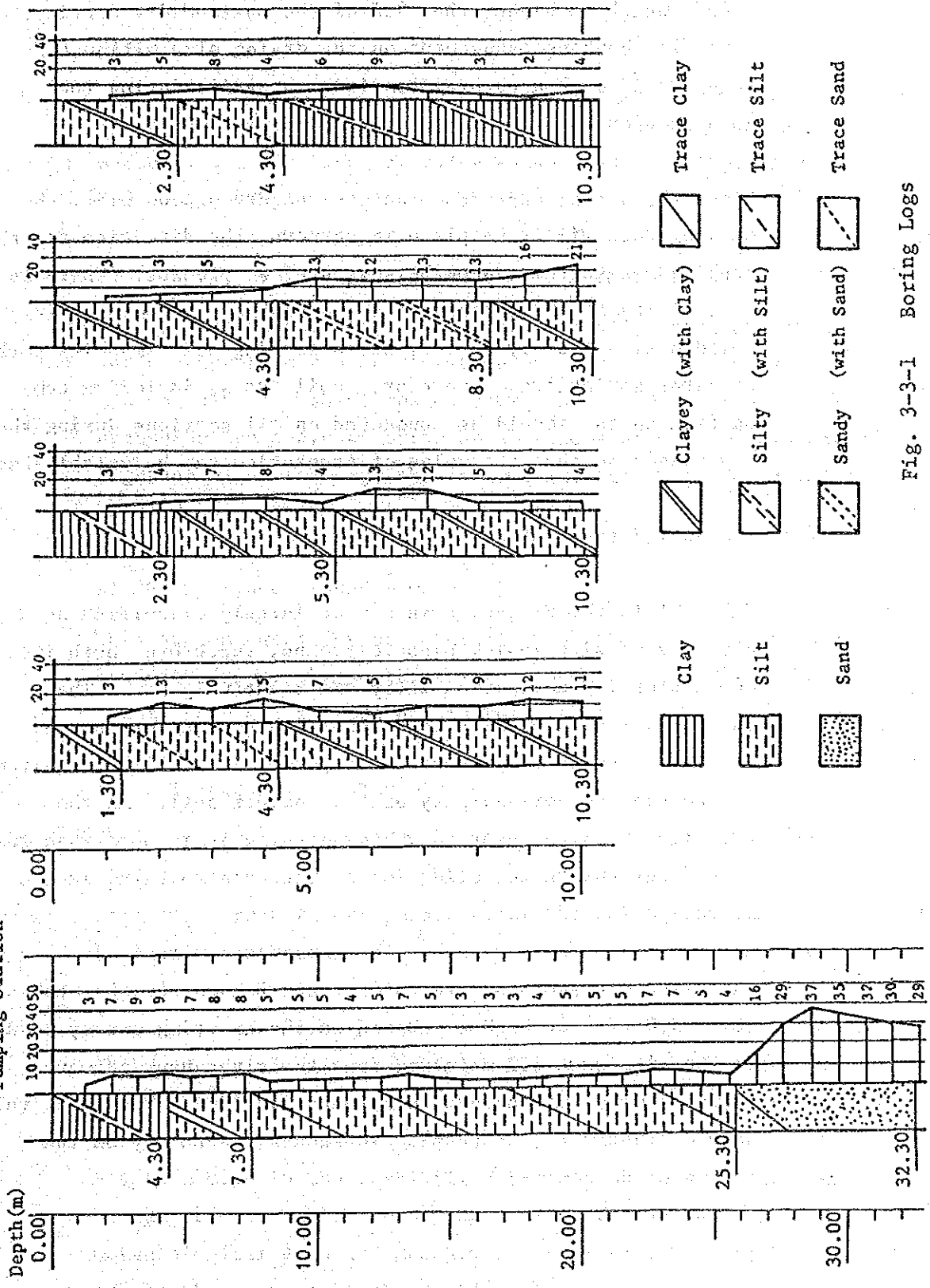


Fig. 3-3-1 Boring Logs

According to the test results, the natural water content is 29 - 45%, which is higher than 90% of the maximum dry density. As a result, banking management on the drying side will be required if such a natural condition prevails during the construction work.

Since the natural water content in the dry season where the banking work will take place is unknown, the direction for the banking management cannot be suggested at present. There is a possibility of the surface of the embankment becoming fairly solid during the dry season, necessitating soil smashing work or water sprinkling. Therefore, soil tests, including compaction tests, should be conducted on all sections during the dry season so that the rules of compaction can be established.

(4) Foundation for Banking

The soil in the Project area can be largely classified as clayey silt with medium plasticity and, therefore, both its compactibility and permeability are relatively low. The on-the-spot permeability test results also suggest that no special measures to prevent water permeation will be required due to the low permeability of the subject soil. As the stratigraphical pressure of this clayey silt is more than 20m, settlement due to consolidation is expected to take place over a long period of time.

The value obtained for the soil strength suggests that cohesion (C) = 3.0 t/m² or higher. Based on the existing survey results at the site some 100 m inland from the river bank, however, the value of C is estimated to be around 1.4 t/m². The lower value should, therefore, be adopted to secure the safety of the entire embankment.

3.3.2 Climate and Hydrology

(1) Climate

The Project area belongs to a typical monsoon zone and has 3 seasons, i.e. dry season, rainy season and transitional season between the dry season and the rainy season.

1) Transitional period to Rainy Season (March - May).

This period is characterized by dramatically changing weather and a shift from the northeastern monsoon to the southwestern monsoon with the rainy season commencing in May. Tropical low pressures and cyclones often attack the area during this period together with storms which are sometimes accompanied by large hailstones.

2) Rainy Season (June - October)

This season has a lot of rainfall, high temperatures and high humidity due to the southwestern monsoon. Some 70% of the annual rainfall is recorded in this season.

3) Dry Season (December - March)

The southwestern monsoon weakens in November, while the northeastern monsoon prevails in the dry season and there is little rainfall. Both the temperature and humidity are low and there is mainly continuous fair weather. Only less than 5% of the annual rainfall is recorded in this season.

There are 5 rainfall observation stations in the Project area and its vicinity, including the rainfall observation station in Dhaka. The weather data of the observation station in Dhaka has been used in the Feasibility Study and the previous Basic Design Study. Tables 3-3-1 and 3-3-2 give the general meteorological data and monthly rainfall for the past 20 years of the Dhaka rainfall observation station respectively.

Table 3-3-1 Meteorological Data in Dhaka
(1975~1985 Average)

MONTH	※ ¹ RAINFALL (mm)	TEMPERATURE °C			HUMIDITY (%)		SUN- SHINE HR	WIND		
		MAX	MEAN	MIN	※ ² MAX	MEAN		WIND SPEED (km/day)	DAY TIME WIND SPEED (m/sec)	DAY: NIGHT WIND RATIO
JAN	4.9	25.2	18.8	12.4	90.0	69.2	8.1	34.3	0.5	1.4
FEB	15.4	27.6	21.2	15.1	87.0	64.1	8.5	48.5	0.7	1.4
MAR	78.4	32.3	26.3	20.5	85.0	63.1	8.4	109.9	1.5	1.4
APR	150.3	33.4	27.7	23.7	90.0	72.3	8.3	185.5	2.4	1.3
MAY	316.4	32.4	27.9	24.2	93.0	79.7	7.5	147.1	1.9	1.3
JUN	364.6	31.6	28.4	25.9	94.0	85.8	5.1	160.0	1.8	1.2
JUL	378.2	31.0	28.3	26.1	94.0	86.9	4.7	146.7	1.8	1.2
AUG	332.6	31.3	28.4	26.3	94.0	85.4	6.1	140.2	1.7	1.2
SEP	283.0	31.5	28.5	25.8	94.0	85.2	5.9	76.4	0.9	1.1
OCT	157.9	31.4	26.9	23.8	94.0	79.6	7.8	41.6	0.6	1.2
NOV	29.3	29.5	24.1	19.0	91.0	73.0	8.3	25.4	0.4	1.3
DEC	11.0	26.2	19.8	13.6	90.0	72.0	8.2	23.8	0.3	1.2
ANNUAL	2122.0	30.3	25.5	21.4	91.3	76.4	7.2	95.0	1.2	1.3

※¹ 1967~86 AVERAGE ※² 1967~80 AVERAGE

Table 3-3-2 Monthly Rainfall (in mm)

MONTH YEAR	Station Dhaka												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1967	17.3	0.8	167.6	72.4	160.5	240.8	361.4	493.8	277.9	73.2	0.5	0.3	1866.4
1968	0.0	0.5	120.4	77.5	212.1	493.5	481.8	254.5	126.5	68.6	54.4	0.0	1890.0
1969	0.0	1.3	66.0	86.1	94.5	249.2	302.8	532.1	200.7	102.6	32.5	0.0	1667.8
1970	15.2	7.6	37.3	44.7	201.4	291.3	499.1	253.2	198.6	478.8	31.2	0.0	2058.7
1971	2.5	27.4	—	—	378.2	313.2	552.7	546.6	317.5	118.4	83.3	0.0	—
1972	0.0	11.9	12.4	247.9	338.3	352.6	158.2	376.7	111.3	105.7	0.0	0.0	1715.0
1973	0.0	20.8	55.6	128.0	609.6	412.2	286.8	255.8	349.5	126.7	66.5	86.1	2397.8
1974	3.8	0.0	99.6	160.3	236.5	281.9	705.1	339.1	225.8	155.7	1.5	0.0	2209.3
1975	0.8	29.0	13.0	111.3	270.8	270.0	572.0	204.7	339.3	202.4	37.8	0.0	2051.1
1976	0.0	7.4	116.1	33.5	334.0	625.3	328.4	386.6	164.6	113.3	8.1	0.0	2117.3
1977	0.0	66.1	73.7	296.3	593.1	300.8	263.2	89.6	121.0	301.7	34.8	25.9	2166.2
1978	0.0	10.4	21.6	171.2	521.2	564.3	336.7	452.0	185.3	74.3	0.0	0.0	2337.0
1979	3.0	18.6	36.8	60.9	78.7	255.5	365.0	437.0	383.0	146.0	5.0	51.0	1840.5
1980	0.0	31.0	51.0	143.0	411.0	330.0	394.0	234.0	289.6	299.0	0.0	0.0	2182.6
1981	8.0	34.0	94.0	274.0	188.0	154.0	235.0	197.0	320.0	82.0	9.0	35.0	1630.0
1982	0.0	15.0	81.0	104.0	154.0	514.0	136.0	346.0	258.0	84.0	51.0	0.0	1743.0
1983	18.0	25.0	219.0	318.0	348.0	299.0	179.0	434.0	322.0	253.0	0.0	18.0	2433.0
1984	13.0	1.0	7.0	124.0	707.0	697.0	694.0	311.0	477.0	57.0	0.0	0.0	3028.0
1985	8.0	1.0	195.0	176.0	300.0	399.0	262.0	338.0	306.0	79.0	0.0	1.0	2065.0
1986	6.0	0.0	23.0	231.0	191.0	308.0	450.0	171.0	687.0	237.0	172.0	3.0	2479.0
MEAN	4.9	15.4	78.4	150.5	316.4	364.6	378.2	332.6	283.0	157.9	29.3	11.0	2122.2

(2) Hydrology

The Project area is located along the left bank of Lakhya River and is, therefore, directly affected by the water level fluctuations of the river. The Demra Gauging Post is located in the Project Area and, therefore, its data has been used in this study.

The peak water level of Lakhya River occurs approximately one month after the peak rainfall in the area and the highest level extends from late July to early September. In comparison, the lowest water level is generally observed between late December and early April. Between November and the end of May, the water level in the area is affected by tides. The mean maximum water level and the maximum water level in the period between 1976 and 1986 were 5.79 m PWD and 6.60 m PWD respectively while the mean minimum water level and the minimum water level in the same period were 0.80 m PWD and 0.58 m PWD respectively. Existing data gives 2,000 m³/sec to be the mean maximum discharge, however, there are no records on the drought discharge due to the above-mentioned influence of tides. The river Lakhya at Demra, in dry season, is subject to the back flows from the three major river - the Ganges, the Jamuna and the Meghna. According to the results of assessment of water availability, which is given in the "National Water Plan" issued by the Master Plan Organization (MPO) in December, 1986, by 2005 AD, the water demand to be withdrawn from the Lakhya river at Demra for irrigation including the N-N irrigation (19.6 m³/sec) and municipal supply is 33 m³/sec in total, and this water demand can rely satisfactorily on the back water flows.

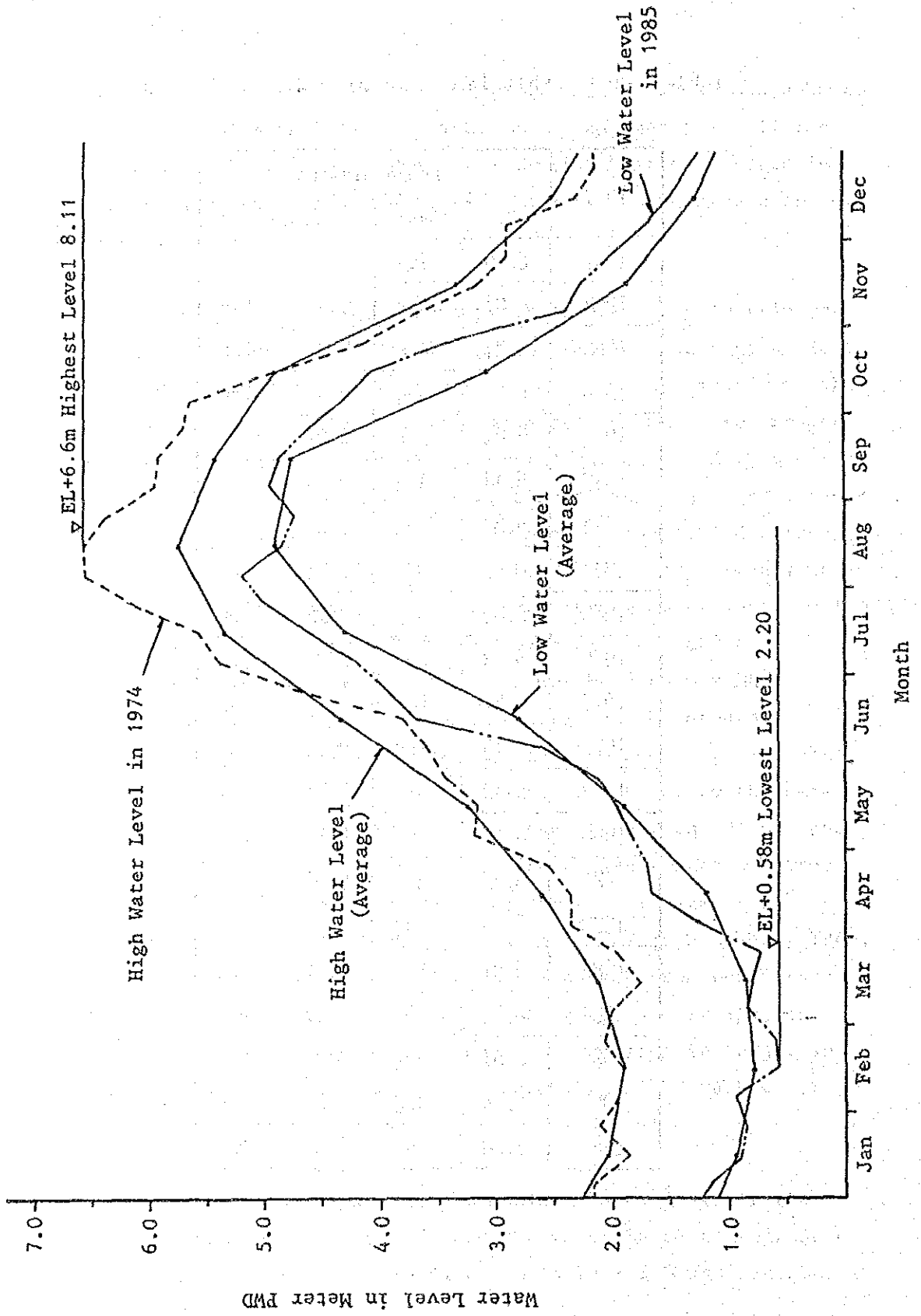
The maximum water level and the minimum water level in the period between 1967 and 1986 and the water level hydrograph of the Demra Gauging Post are given in Table 3-3-3 and Fig. 3-3-2 respectively.

Table 3-3-3 Shitalakhya River H.W.L. and L.W.L.

(m PWD)

Year	DEMRA Station			
	H.W.L. (Max)		L.W.L. (Min)	
1967	5.46	Jun		
1968	6.07	Aug	0.91	Feb
1969	5.87	Aug	0.87	Feb
1970	6.13	Aug	0.87	Feb
1971	6.08	Aug	0.91	Mar
1972	5.44	Aug	0.85	Feb
1973	5.88	Aug	0.85	Jan
1974	6.60	Aug	0.88	Feb
1975	5.60	Aug	0.88	Feb
1976	5.53	Jul	0.85	Feb
1977	5.81	Sep	0.73	Jan
1978	5.43	Aug	0.72	Mar
1979	5.49	Aug	0.75	Mar
1980	6.16	Aug	0.82	Feb
1981	5.65	Aug	0.91	Mar
1982	5.35	Aug	0.79	Mar
1983	5.81	Sep	0.71	Feb
1984	6.04	Aug	0.48	Feb
1985	5.57	Aug	0.83	Feb
1986	5.14	Aug	0.58	Feb
1987	6.38	Aug	0.81	Mar

Fig. 3-3-2 Water Level Hydrograph Demra (Lakhya River) (1974-86)



3.4 Agriculture, irrigation and Drainage

(1) Outline of Agriculture

There are 4,240 farming households in the Project area, which is roughly 50% of the total number of households, and a farming population of 26,070. 70% of the farmers are independent farmers with their own land while most of the remaining 30% are independent farmers who also work as tenant farmers. The number of tenant farmers without their own land is, therefore, very small.

The farming area per farming household is some 0.56 ha and this small landholding size per household is the result of progressive divided succession, in turn caused by religious customs in the area and limited employment opportunities outside the agricultural sector (see Table 3-4-1).

(2) Soil

The Project area was formed by the flooding of the old Brahmaputra and Lakhya Rivers and it has alluvial clayey soil consisting of non-calcareous, dark grey clay and silt. The soil in the Project area can be largely classified into the 3 types shown in Fig. 3-4-1. The permeability is generally very low and the soil is saturated for a long period of time. The soil moisture, however, reduces remarkably in dry season. Once the soil has dried, however, it becomes extremely hard.

(3) Land Utilization

As the water level in the rainy season reaches 5.0 - 5.5m (PWD) every year and as the depth of the flooding water is 1.5 - 2.5m, most of the arable land in the Project area is submerged during the rainy season. In comparison, the water level of Lakhya River is less than 2m in the dry season and natural

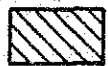
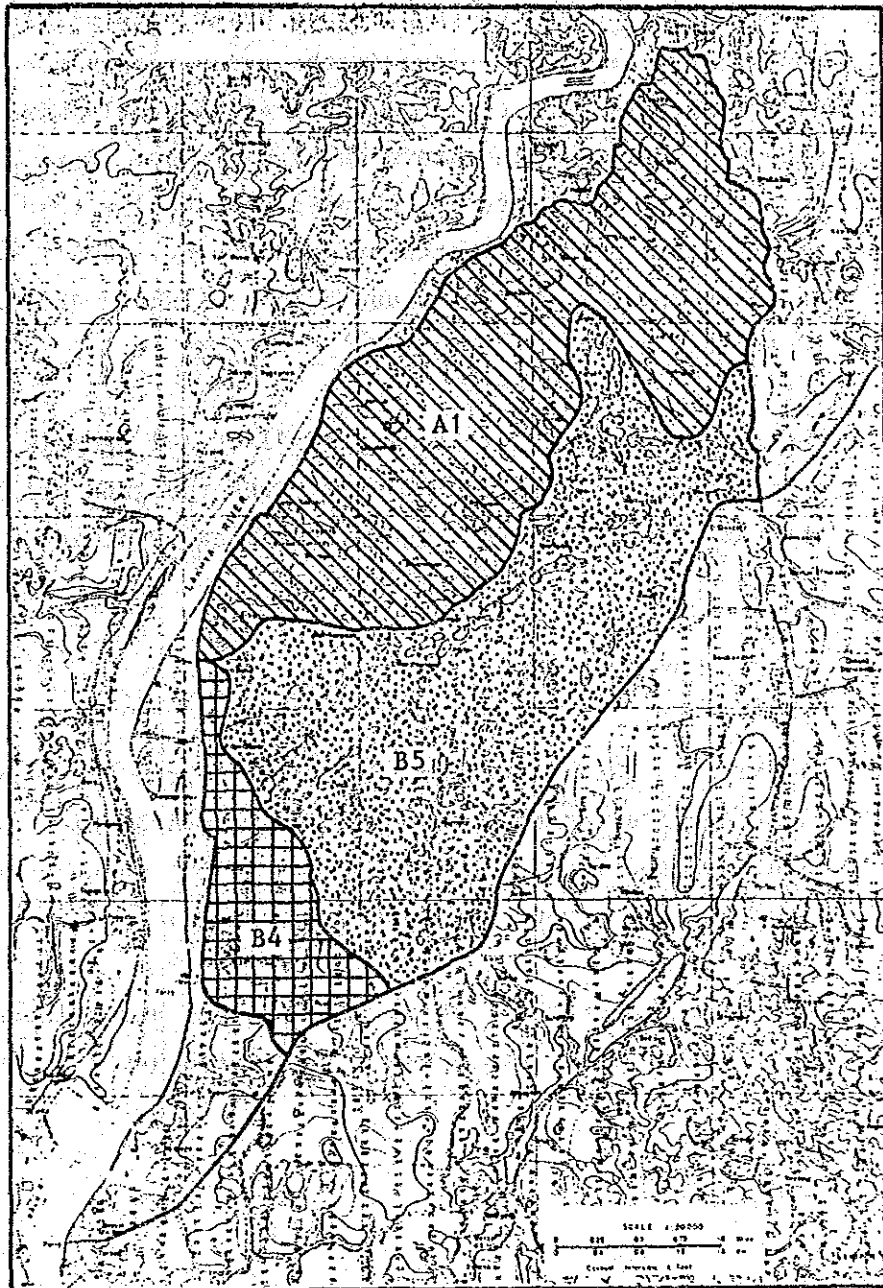
Table 3-4-1 Number and Area of Farm Holdings by Size, Class (1983-84)

(Unit: 1,000)

Region	Small (0.05 ~ 2.49Ac)		Medium (2.5 ~ 7.49Ac)		Large (7.5 ~ 0.60Ac)		Total	
	No	Area Average	No	Area Average	No	Area Average	No	Area Average
Dhaka Dist. (Former)	613	551 ^{Ac} 0.8	146	580 ^{Ac} 3.9	18	206 ^{Ac} 11.4	777 ^{Ac} 1337	1.7 ^{Ac}
Bangladesh	7066	6573	2483	10226	496	5879	10045	22678
		0.9	4.1		11.8			2.2

Source: Yearbook 1986

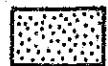
Fig. 3-4-1 Soils Generalized



A1 Mainly deep, friable, moderately well drained, red and yellow clay loams, with dark grey heavy clays in valleys.



B4 Mainly yellowish silty clay loams on ridges and dark grey clays in basins



B5 Mainly dark grey clays road

intake from the river is impossible.

Agriculture faces many constraints under such severe natural conditions. While planting in the rainy season consists of the direct seeding of floating Aman rice and partly mixed with Aus rice, and jute is also grown on high ground. Boro rice is grown in the dry season by pumping or manually transporting the river water, standing water or groundwater. Small quantities of wheat, pulses, potatoes and edible oilseeds are also grown in the dry season.

The present cropping intensity of Block A-1 area is approximately 110%. Table 3-4-2 gives the land utilization rates of Bangladesh as a whole, the Dhaka District and Rupganj Upzila.

(4) Cultivated Crops

As the crop calendar shows (Fig. 3-4-2), the directly seeding floating rice (B-Aman) and mixed Aus and Aman rice account for about 50% and 7% of the crops grown in the rainy season. Jute grown on high ground accounts for some 3%.

Boro rice (about 50%), wheat (2%), pulses and oilseeds and potatoes (some 4%) are grown in irrigated areas in the dry season.

(5) Irrigation and Drainage

Irrigation is currently practiced on a small scale in various parts of the Project area using water from the natural drainage canals and natural ponds on the scattered lowland areas or using groundwater. There are 6 small intakes along Lakhya River and low head pumps are installed in these locations during the dry season to pump river water to farming fields via irrigation canals (either concrete or excavated without timbering).

Table 3-4-2 Land Utilization (1983-84)

	Bangladesh		Dhaka District (Former)		Rupganj Upazila	
	Acreage(Ac)	%	Acreage(Ac)	%	Acreage(Ac)	%
Total area	35,700,121	100.0	1,844,480	100.0	65,280	1.0
Not available for cultivation	7,156,355	20.0	425,413	23.1	18,403	28.2
Forest	5,204,723	14.6	58,619	3.2		
Culturable waste	825,219	2.3	14,517	0.8		
Current fallow	1,136,381	3.2	90,000	4.8	2,349	3.6
Net area Cropped	21,377,443	59.9 (100.0)	1,255,931	68.1 (100.0)	44,528	68.2 (100.0)
Single cropped	11,526,003	(53.9)	791,931	(63.1)	27,781	(62.4)
Double cropped	8,339,506	(39.0)	400,000	(31.8)	14,542	(32.6)
Tripple cropped	1,511,934	(7.1)	64,000	(5.1)	2,205	(5.0)
Total cropped area	32,740,817	(153.1)	1,783,931	(142.0)	63,480	(142.6)

Source : The Yearbook of Agricultural statistic of Bangladesh 1984-85

Fig. 3-4-2 Existing Cropping Pattern

Item	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(1) Mixd Aus/Aman	170ha							Mixd Aus/Aman					
(2) Wheat + Jute	50						Jute						
(3) Oilseeds + Jute	25						Jute						
(4) Potato + B.Aman	15								B.Aman				
(5) Pulses + B.Aman	50								B.Aman				
(6) B.Aman	780								B.Aman				
(7) HYV Boro + B.Aman	90								B.Aman				
(8) HYV Boro	270												
(9) B.Aman	175												
(10) HYV Boro	345												
(11) L.Boro	410												

Cultivated Area = 2,380 ha Cropped Area = 2,610 ha

Intensity of Cropping = 110 %

The intake of water from the natural ponds is conducted by hand (using doons or swing baskets) or by low head pumps while the groundwater is pumped up from wells.

While the irrigated area is supposed to be some 50% of the Project Area, only Lakhya River and deep wells can be considered stable water sources in the dry season. The number of pumps by type is as follows.

<u>Type</u>	<u>Pumping Capacity</u>	<u>Number</u>
1. Low Head Pump	2 cusec	36
2. Shallow Well Pump	0.75 cusec	7
3. Deep Well Pump	2 cusec	33

Drainage is conducted entirely through natural drainage canals. Of the natural drainage canals flowing into Lakhya River, 3 have regulators to prevent the flooding of Lakhya River affecting the canals.

3.5 Social Infrastructure

All households in the Project area are supplied with power and groundwater is utilized for drinking water. The main public institutions and factories, etc. are covered by the telephone network, showing a good communication network standard.

Transport to the Project area from Dhaka is assured by the asphalt paved Dhaka - Narsingdi (D-N) Road. The Bulta - Murapara Road which runs across almost the centre of the Project area is paved with bricks while the Gokalkandail - Kanchan Road which is the north circular road of the Project area is unpaved.

Of the 9km stretch of road along Lakhya River, only 2.5 km is paved with bricks and the remainder is unpaved. While the roads in the Project area are just serviceable for vehicle traffic, only the Bulta - Murapara Road can be used in the rainy season and consequently, materials are frequently transported by river.

There is a good provision of other social infrastructural facilities, such as educational facilities, etc.

