STAFF APPRAISAL REPORT

BANGLADESH

THIRD FLOOD CONTROL AND DRAINAGE PROJECT

April 16, 1985

South Asia Projects Department
Irrigation I Division

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Currency Equivalents

US$1 = Taka 26.0
Taka 1 = US$0.038

Weights and Measures

Metric system

Abbreviations Used

BADC - Bangladesh Agricultural Development Corporation
BRDB - Bangladesh Rural Development Board
BWDB - Bangladesh Water Development Board
b. - When preceding a crop means broadcast
DAE - Department of Agricultural Extension
ECNEC - Executive Committee of the National Economic Council
FA - Force Account
FCD III - Third Flood Control and Drainage Project
GOB - Government of Bangladesh
ICB - International Competitive Bidding
IDA - International Development Association
IPC - Imports Program Credit
LCB - Local Competitive Bidding
MOA - Ministry of Agriculture and Forests
MOI - Ministry of Irrigation, Water Development and Flood Control
O&M - Operation and Maintenance
PEC - Project Evaluation Committee
PSA - Project Special Account
PP - Project Proforma
t. - When preceding a crop means transplanted
GLOSSARY

Aman - Rice planted before or during the monsoon and harvested in November or December

Aus - Rice planted during February or March and harvested during June or July

Beel - Low-lying area subject to flooding by rain or river water

Boro - Rice transplanted in December to January and harvested in April to May

District - Administrative unit in the charge of a Deputy Commissioner comprising a number of Upazilas

Khal - Natural channel

Kharif - Summer season (May through October)

Monsoon - Period of rains starting in June and ending in October

Rabi - Winter season (October through May)

Upazila - Smallest administrative unit of the Local Government

FISCAL YEAR (FY)

July 1 - June 30
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BANGLADESH

THIRD FLOOD CONTROL AND DRAINAGE PROJECT

Credit and Project Summary

Borrower : The Government of the People's Republic of Bangladesh

Amount : SDR 50.1 (US$48.0 M equivalent)

Terms : Standard

Project Description: The main objectives of the project are: (a) to protect against crop losses, loss of life and property damage due to floods; (b) to improve the physical environment to allow farmers to adopt improved agricultural practices; and (c) to strengthen the Bangladesh Water Development Board (BWDB). The project would consist of three sub-projects (Cumti Phase I, Naogaon Polder I and Madhumati-Nabaganga), covering an area of 104,500 ha under flood control and drainage (FCD) and 14,350 ha under irrigation. About 115,000 farm families or about 670,000 people would benefit. The project would include: (i) the construction and rehabilitation of embankments, water control structures, drainage channels and irrigation facilities and the upgrading of roads; (ii) support to BWDB to improve the planning, design, and monitoring of FCD projects, and to improve land acquisition and operation and maintenance procedures; and (iii) the preparation of programs for further development of agriculture and fisheries within the project area.

Risks : One possible risk facing the project is implementation delays in processing of land acquisition and preparation of engineering designs. Special arrangements have been incorporated into the project design to minimize this risk. A further possible risk would be the potential decrease in production from natural fisheries within the project area. The project would provide for appropriate design of engineering works to minimize this impact, and for preparation of a follow-up development programme aimed at increasing crop, livestock and fish production in the project areas.
**Project Estimated Costs:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Local Cost (US$ Million Equivalent)</th>
<th>Foreign Cost (US$ Million Equivalent)</th>
<th>Total Cost (US$ Million Equivalent)</th>
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<tr>
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<td>Civil Works</td>
<td>18.6</td>
<td>5.7</td>
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<tr>
<td>Equipment</td>
<td>1.1</td>
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<td>Surveys &amp; Investigations</td>
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<td>3.8</td>
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<td>Studies, Benchmark Surveys &amp; PCR</td>
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<td>0.9</td>
<td>1.4</td>
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<tr>
<td>Engineering &amp; Administration</td>
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<td>-</td>
<td>3.6</td>
</tr>
<tr>
<td>Technical Assistance &amp; Training</td>
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<td>0.3</td>
<td>2.3</td>
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<td><strong>Total Base Costs</strong></td>
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<td><strong>13.6</strong></td>
<td><strong>48.1</strong></td>
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<tr>
<td>Physical Contingencies</td>
<td>1.8</td>
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<td>Price Contingencies</td>
<td>10.4</td>
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<td><strong>Total Costs</strong></td>
<td><strong>46.7</strong></td>
<td><strong>18.3</strong></td>
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1/ Including US$2.3 million in duties and taxes.

**Financing Plan:**

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<th>Source</th>
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<td>GOB</td>
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<tr>
<td>IDA</td>
<td>33.0</td>
<td>15.0</td>
<td>48.0</td>
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<tr>
<td>UNDP</td>
<td>0.6</td>
<td>2.7</td>
<td>3.3</td>
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<tr>
<td>Korean Government</td>
<td>0.1</td>
<td>0.6</td>
<td>0.7</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>46.7</strong></td>
<td><strong>18.3</strong></td>
<td><strong>65.0</strong></td>
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**Estimated Disbursement of IDA Credit:**

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<td>Annual</td>
<td>200</td>
<td>3,300</td>
<td>11,000</td>
<td>12,000</td>
<td>12,000</td>
<td>5,000</td>
<td>2,200</td>
<td>2,300</td>
<td>---------</td>
</tr>
<tr>
<td>Cumulative</td>
<td>200</td>
<td>3,500</td>
<td>14,500</td>
<td>26,500</td>
<td>38,500</td>
<td>43,500</td>
<td>45,700</td>
<td>48,000</td>
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**Rate of Return:** 23%

**Maps:**
- IBRD 18549 - Sub-projects Location Map
- IBRD 18558R - Gumti Phase I Sub-project
- IBRD 18559 - Naogaon Sub-project
- IBRD 18560 - Madhumati-Nabaganga Sub-project
Rationale for IDA Involvement

1.01 Bangladesh suffers from a chronic shortage of foodgrains. The country achieved an annual growth rate in food production of 2.6% over the past ten years compared to a population growth rate of 2.7% and a target annual production growth rate of 7% needed for achieving food self-sufficiency in the 1980s. In addition to the institutional and resource constraints holding back production growth, most increase in production has to come from intensification since available cultivable land is already fully utilized. Intensification, however, is hindered by flood and drainage problems of varying intensities and by limited access to irrigation for the majority of farmers. Of the 9.1 million ha under cultivation during at least part of the year, over two-thirds are subject to water damage due to flooding and poor drainage. The absence of flood control and drainage facilities has been the source of major suffering due to destruction of crops and property. It has also prevented diversification of cropping patterns and a shift to more productive crop varieties, and has delayed increase in cropping intensity and development of irrigation.

1.02 IDA has been supporting flood control and drainage (FCD) type programs in Bangladesh on the basis that they are prerequisites for any investment programs aimed at alleviating hunger and poverty among a major proportion of the country’s farmers. Controlling floods would result in substantial increase in production by simply decreasing the extent of damage to crops, thus at least ensuring farmers their daily food. Under conditions of controlled water flow, intensification of agriculture through investments in improved infrastructure, technology and services becomes a logical subsequent step.

1.03 Presently there are about 3 million ha with drainage and flood control facilities of varying quality. There are also about 4 million additional ha which would likely require such facilities. Based on past experience, resources required to meet the country’s flood control and drainage needs could reach US$2 billion.1/ Given the magnitude of the resources needed, IDA’s financial input will continue to be required regardless of

1/ This estimate is based on US$500 per ha which is the estimate under the present approach of addressing the needs of a defined area at a time.
foreseeable contributions by other agencies and by the Government over the next decade. More importantly, IDA continues to have a critical role to play in assisting Bangladesh with (i) selecting technically and economically viable and socially acceptable approaches to water control; (ii) initiating agricultural development in areas protected from floods and equipped with drainage facilities; and (iii) promoting the development of institutions capable of ensuring that FCD-type investment programs provide the intended services to their clientele.

Project Background

1.04 The Government of Bangladesh (GOB) has requested the International Development Association (IDA) for assistance in financing a flood control and drainage project covering a cultivable area of about 104,500 ha in the Districts of Comilla, Naogaon, Magura and Narail. The proposed project is similar in its objectives and design to several ongoing projects, including two supported by IDA credits (Cr. 864-BD and Cr. 1184-BD). The proposed Third Flood Control and Drainage Project (FCD III) reflects GOB's commitment to promote full use of the productive potential of the country's scarce land resources by controlling floods, improving drainage and increasing access to irrigation. In addition to their direct benefits, these actions are viewed as a means for expanding farmers' access to the benefits from GOB's other agricultural development efforts, particularly those related to the provision of services, such as research, input supply, extension and credit.

1.05 The project was prepared by the Bangladesh Water Development Board (BWDB) assisted by the Netherlands Development Consultants (NEDECO). Funding for feasibility studies was provided under IDA's fourth technical assistance credit. The first group of three sub-projects covering a gross area of about 128,400 ha are included in the proposed FCD III project. Feasibility studies for another two subprojects covering a gross area of about 75,000 ha are scheduled for completion in mid 1985 and are expected to form the basis for a FCD IV project. An IDA appraisal mission comprising Messrs. S. Cafsi, C.P. Cheng, C. Schokman, R. Stevenin, Y. Ali and Ms. S. Lysy visited Bangladesh in July 1984. This report is based on the findings of the appraisal mission. It also gives due consideration to the conclusions of a review of the first and second flood control and drainage projects (Credits 864-BD and 1184-BD) organized in May 1984, in part as a preparation for the appraisal of FCD III.

Agricultural Sector Background

1.06 Agriculture in the economy. The agriculture sector generates over half of Bangladesh's GDP; it employs about three-quarters of the labor force; and it contributes over 80% of export earnings. Agriculture is dominated by the crop sub-sector where over 70% of the agricultural value-added originates, compared to about 15% from livestock, 10% from fisheries and 5% from forestry. The Second Five-Year Plan (SFYP FY81-85) gives high priority to increased foodgrain production as a means of meeting minimum nutritional standards for the country's increasing population. The main thrust of the SFYP with regard to agriculture is to help farmers acquire more control over their production environment through development of irrigation facilities, construction of flood control and drainage works, reduction in market related uncertainties, and widespread use of productivity increasing practices.
1.07 Production environment. Bangladesh is situated in the deltas of three major rivers - Ganges, Brahmaputra and Meghna. The terrain is criss-crossed by some 24,000 km of waterways. Alluvial flood plains occupy about 80% of the total 144,000 sq km land area. During the monsoon season (May/June to October/November), approximately two-thirds of the cultivable land (9.1 M ha) is flooded deeper than 0.3 m for three to five months. Areas along the rivers suffer from overbank flooding, while elsewhere heavy rains and the relatively flat terrain cause extensive drainage congestion. The average annual rainfall varies from about 1,270 mm in the western part of the country to about 5,000 mm in the northeast. Rainfall is characterized by wide seasonal fluctuations, with about 90% occurring in the monsoon period. In spite of an apparent overall abundance of rainfall, serious droughts occur occasionally and soil moisture content is normally insufficient to support cropping without irrigation in the dry season (November-May).

1.08 Nearly all arable land in Bangladesh is under cultivation. Average cropping intensity is about 140%, although it is well accepted that climatic conditions permit a cropping intensity of well over 200%. The most important crop is rice, cultivated on over three-fourths of the cropped area. Jute, the principal export crop, is grown on about 6% of the cropped area. Other crops, in order of importance of acreage, include wheat, pulses, oilseeds, sugarcane, tea, spices and vegetables. Less than 20% of cultivated area is irrigated, compared to an identified water resources potential for irrigating about 50% of the cultivated area using the known potential for surface and groundwater supply. The absence of flood control and drainage facilities on a major part of that area has prevented a shift from the long-stem low-yield rice varieties to the short-stem fertilizer responsive varieties. Moreover, inadequate moisture content in the soils during the dry season has prevented a possible increase in cropping intensity in the absence of irrigation facilities.

1.09 Although average land holding is about 1.4 ha, over 25% of farm families own less than 0.5 ha and over one third of rural households own no land. Mostly as a result of population pressure and the absence of opportunities for horizontal expansion, the proportion of rural households who are landless or functionally landless (owning less than 0.2 ha) has been increasing. This trend, combined with limited non-agricultural employment opportunities has led to an increasing percentage of the rural population below the poverty line (defined as a daily intake of 2,100 calories) from 65% in 1964 to an estimated 75% in 1982. This widespread poverty in rural areas limits investment in required on-farm development and production inputs. In addition, transport infrastructure (roads and water transport facilities) and agricultural services (research, input supply, seed production, marketing, credit and pump maintenance) remain inadequate vis-à-vis existing needs.

1.10 Policy framework. Development efforts in the agricultural sector are aimed primarily at achieving foodgrain self-sufficiency by increasing local foodgrain production. The strategy for realizing this objective is based on policy options favoring increased reliance on private sector initiative, reduction of public subsidies and improved domestic resource mobilization. Government is implementing measures (i) to encourage private ownership of irrigation equipment and private participation in the fielding...
of such equipment; (ii) to reduce subsidies on fertilizer and irrigation equipment with the aim of progressively eliminating them; (iii) to increase the availability of farmers' access to agricultural credit; and (iv) to motivate farmers to increase production in response to favorable prices for foodgrains.

1.11 Major institutions serving agriculture. The Ministry of Agriculture and Forests (MOA) and the Ministry of Irrigation, Water Development and Flood Control (MOI) are the policy-making bodies for all matters pertaining to Agricultural Development in Bangladesh. Two major semi-autonomous agencies are responsible for planning and implementing water-related development programs. The Bangladesh Agricultural Development Corporation (BADC), which is linked to the MOA, is responsible for the development of minor irrigation systems: low-lift pumps, hand tubewells, shallow tubewells, and deep tubewells. The Bangladesh Water Development Board (BWDB), which is linked to MOI, is responsible for planning, implementation, and operation and maintenance of flood control and drainage schemes, and medium and major irrigation systems.

1.12 Several agencies provide agricultural services in support of water development programs. BADC has been the major supplier of farm inputs (fertilizer, seeds, irrigation equipment). Some of these responsibilities are being progressively transferred to the private sector. IDA has supported these privatization efforts in the context of successive imports program credits, agricultural credit projects, and water development projects. The Bangladesh Agriculture Research Council coordinates the research activities of specialized research institutes covering rice (BRRI), jute (BJRI), sugar (SRI), forestry (FrRI), fisheries (FsRI), tea (TRI), livestock (LRC), and other crops and horticulture (BARI). IDA has supported the establishment of BARC under Cr. 828-BD and is supporting the funding of applied research programs under Cr. 1215-BD. The Department of Agriculture Extension of MOA provides extension services supported under IDA Cr. 1215-BD. Institutional lending for agriculture is directed and coordinated by the Bangladesh Bank and channeled through commercial and cooperative financial institutions. Institutional credit has been available to less than 20% of farmers, leaving the others dependent on their own limited resources or on non-institutional forms of lending. The issues affecting the availability of credit and farmers' access to it were addressed in a joint GOB/IDA Review of Agricultural Credit. Operational constraints interfering with adequate and timely flow of credit to farmers are also being addressed under IDA Cr. 1147-BD and the proposed thirteenth Imports Program Credit. The Bangladesh Rural Development Board (BRDB) promotes the growth of farmer cooperatives under the UCCA/KSS system (Upazila Central Cooperative Association and Krishi Samabay Samities). These cooperatives collect thrift deposits, promote group management of minor irrigation equipment and provide credit and inputs to small farmers. Support to BRDB and the UCCA/KSS system was provided under IDA Credits 631-BD and 138-A-BD.

IDA's Role and Lending Strategy

1.13 IDA lending to Bangladesh has emphasized the agricultural sector, reflecting the country's needs and its priorities. Particular emphasis has been placed on water resources development (irrigation, flood control and drainage), on strengthening agricultural services (technology development and
supply, credit and marketing) and on the development of complementary infrastructure facilities in other sectors (transport, power, industry). Increased food production, particularly rice and wheat, has been the target of IDA lending in agriculture. On-going projects supported by IDA in the agricultural sector include a large number addressing constraints to the expansion of irrigation and water control: Barisal Irrigation (Cr. 542-BD), Karnafuli Irrigation (Cr. 605-BD), Muhuri Irrigation (Cr. 725-BD), Drainage and Flood Control I and II (Credits 864-BD and 1184-BD), Hand Tubewells (Cr. 1140-BD), Low Lift Pump (Cr. 990-BD), Deep Tubewells II (Cr. 1287-BD), Agriculture Credit (Cr. 1147-BD), Rural Development I and II (Credits 631-BD and 1384-BD), Small Scale Drainage and Flood Control (Cr. 955-BD) and BWDB Small Schemes (Cr. 1467-BD).

1.14 In addition, IDA staff have participated with Government staff in a number of joint studies. Of special significance was the Land and Water Resources Survey (1972) which led to a change in water resources development strategy in favor of low-cost irrigation and water control schemes. More recent joint studies include assessments of the Water Development Board (1979) and the Minor Irrigation Sector (1982). Finally, IDA is executing agency for the UNDP-financed National Water Plan Project. These studies helped support a series of Imports Program Credits and accompanying policy reforms in agriculture, including such important policy decisions as the move towards privatization of procurement and distribution of irrigation equipment and other farm inputs, the move towards rationalization of Government approaches to foodgrain procurement and farm input pricing, and the move towards creating favorable conditions for improved access to institutional credit. These studies also helped in bringing to the attention of decision-makers in Bangladesh the urgency of policy action on such outstanding issues as funding and organization of the functions of operation and maintenance for completed infrastructural facilities, and the recovery of the cost of operation and maintenance works as well as of the initial capital costs from beneficiaries. These and other issues continue to be part of the substance of the on-going dialogue between IDA and Government.

Lessons from the Past

1.15 Although no Project Performance Audit Reports (PPARs) have been prepared for FCD type projects in Bangladesh, past experience was brought to bear on the design of FCD III through supervision of IDA credits 864-BD and 1184-BD, available PPARs on irrigation projects in Bangladesh, and a review of BWDB's experience in other flood control and drainage improvement schemes in the country. Important lessons reflected in the design of this project include: provision for irrigation development where proven water resources exist; provision for preparation of a comprehensive plan for intensification of crop, livestock and fish production following the completion of flood protection works; provision for upgrading available knowledge on the characteristics of rivers to allow for proper planning of future development activities and for proper assessment of the potential impact of flood control works on a river basin wide basis; taking into consideration the water transport requirements (including country boats) and fish migration patterns in the design of water control structures; and better planning for land acquisition and operation and maintenance-related activities.
II. THE PROJECT

Project Concept

2.01 The project is based on the "simple polder" concept which consists of an embankment constructed around an area with water control structures to permit the discharge of internal runoff when river water level is low and to prevent overbank flooding when river water level is high. This technique is suitable in areas with shallow to moderate flooding, not requiring high embankments or pump drainage. The areas included under this project belong to this category. Other criteria underlying the selection of the project areas are given in Annex 1. In the country context, control of flooding and improved drainage are regarded as: (i) interventions necessary for lowering the crop losses due to the high incidence of floods - this being a means to reducing food shortages in areas covered by the project; and (ii) a prerequisite for making feasible the initiation of other development programs aimed at the intensification of crop, fish and livestock production practices. IDA has considered the international aspects of the project and is satisfied that the project would not be harmful to the interests of other riparians.

2.02 The project is, therefore, conceived as the means for dealing with the immediate need of protecting crops from flood damage, while creating an environment more conducive to intensification of agricultural production. Although the project does not directly provide for such intensification, it does provide for the preparation of programs for making use of the newly improved production environment to increase the production of crops, fish and livestock. The project provides also for strengthening BWDB by complementing programs initiated under other IDA-supported projects. The two functions particularly targeted are design and construction monitoring, along with an attempt at identifying ways for addressing the critical issue of staff motivation and for improving BWDB's operational practices and management procedures.

Project Objective

2.03 The primary objective of the Third Flood Control and Drainage Project is to protect cropped areas, as well as people and their properties from floods, to make further development in agriculture and fisheries possible, and to promote increased food production as a result of (i) reduction in crop losses due to flooding; (ii) making it feasible for an increased number of farmers to shift from broadcast deep water to transplanted shallow water rice cultivation in the aman (monsoon) season with supplementary irrigation when feasible; (iii) increase in the area under boro (dry season) cultivation as a result of a shorter aman season and improved irrigation facilities in part of the project area; and (iv) expansion of the area under improved crop varieties. The project has two other objectives: (i) supporting on-going efforts to strengthen BWDB's institutional capability; and (ii) improving the information basis for planning further development in the project areas. The latter would include updating and expanding existing information on the river basins and on groundwater (for potential development by hand tubewells, shallow tubewells and deep tubewells) in areas where such information is
lacking, and for preparing programs for the intensification of crop, fish and livestock production in these areas.

Project Description

2.04 The project would involve three sub-projects -- Gumti Phase I, Naogaon Polder I, and Madhumati-Nabaganga -- strengthening of BWDB, studies and investigations, and preparation of programs for agriculture and fisheries development. Project works would include construction/improvement of embankments and water control structures, excavation/construction of drainage channels, improvement/construction of irrigation facilities, and upgrading of road networks to facilitate the construction of water control structures and their subsequent operation and maintenance.

2.05 The Gumti Phase I sub-project is located in the Comilla District (IBRD Map 18558R). It is bounded by the Gumti River on the North and East, the Comilla-Daudkandi road on the South and a road connecting the Comilla-Daudkandi road with Gouripur on the West. The project area is within Upazillas of Daudkandi, Muradnagar, Debidwar, and Baucharampur. It covers a gross area of 37,300 ha of which about 29,500 ha are cultivable. The area which slopes in the east-west direction towards the Meghna River is part of the Gumti-Meghna flood plain and is intersected by an irregular network of natural drains (khals), old courses and spill channels of the Gumti River. The micro relief is flat to slightly undulating. From about May to October the eastern section of the project area is flooded to depths up to 0.6 meter and the western end to depths up to 2 meters, due to a combination of overbank spilling of the Gumti River, high water stages of the Meghna River and local rainfall. These floods adversely affect the late growth and harvest of transplanted aus and boro crops and the early aman crop. Cultivation of jute and sugarcane in the river bed restricts water flow and aggravates flooding in the project area. A significant proportion of these crops are cultivated on Government owned land leased out to private cultivators. A small area is under irrigation using the limited supply of the Gumti River during the dry season and groundwater resources. River bank erosion along the Gumti River up to the Meghna flood plain is very severe due to silting up and the meandering of the River channel. Assurances were obtained from Government that cultivation in the Gumti river bed would be controlled by discontinuing the leasing out of public land.

2.06 The Gumti Phase I sub-project provides for controlling floods through an improved drainage system, embankments on both sides of the Gumti River and water control structures. Although the area on the right bank of the Gumti is not covered by the sub-project, embankment on the right side of the river is included to protect the northern part of the Gumti-Titas river basin from possible increased flooding due to the sub-project. Moreover provision is made for a study of the Gumti-Titas river basin, including aerial photography cover, and for the preparation of a Gumti Phase II project aimed at protecting and developing the area of the basin not covered under this project (Annex 2). Provision is also made for improving irrigation facilities on about 3,700 ha and extending irrigation to an additional 10,650 ha using a primary pump station on the Meghna river. Low lift pumps to supply water at the farm level would be provided under existing supply arrangements and their operation would follow procedures established under...
the national Irrigation Management Program (IMP). In order to promote efficient on-farm water use, this sub-project provides for the establishment and operation of On-Farm Demonstration Units for improving water management (Annex 2). Existing navigation routes will not be affected except at the intersection of the Gumti and the Siddheswari Nadi where a navigation lock is incorporated in the Siddheswari regulator. In addition, the sub-project would provide for improvement of the existing road network as required for access to construction sites and subsequent operation and maintenance of the water control structures. The hydrological and morphological study of the Gumti-Titas basin would provide a basis for verifying that works under this sub-project are consistent with further flood control measures and irrigation development in the whole basin, and would provide the necessary data for the preparation of further development programs in the basin.

2.07 The Naogaon Polder I sub-project is located in the Naogaon District (IBRD Map 18559). It is bounded by the Naogaon-Mohadebpur trunk road on the North, the Atrai River on the west and south and the Little Jamuna River on the East. The project area is within the Upazillas of Naogaon, Mohadebpur, Manda, Raniragar and Atrai. It covers a gross area of 46,100 ha of which about 37,000 ha are cultivable. The project area is part of the upper Atrai flood plain and has a gentle slope to the south-eastern direction towards the Brahmaputra River. The land within the area is basically flat (grade of 3 cm per km) with three beels (low area flooded year round) occupying about 10% of the gross area. The project area is annually prone to inundation as a result of impeded drainage and river spills. In a normal year about 32,000 ha (70% of the gross area) is subject to flooding. Approximately 9,000 ha are inundated to depths of 0.60 to 0.90m and about 5,000 ha inclusive of the beel areas are inundated to more than 3m. These floods cause severe damage to aus, boro and aman crops. As in the case of Gumti, cultivation of parts of the river bed aggravates the flooding of the project area. During the dry season, irrigation is mainly by means of shallow and deep tubewells. Surface water resources are limited due to upstream abstraction from the Atrai River. As in the case of Gumti, Government assurances were obtained that cultivation in the Atrai river bed would be controlled by discontinuing the leasing out of public land in the river bed.

2.08 The Naogaon Polder I sub-project would provide for controlling floods through an improved drainage system, embankments along the Atrai and Little Jamuna rivers and water control structures. It would also provide for improving the road system to allow access to construction sites and for operation and maintenance of the facilities built. In addition, provision is made for an aerial photography cover of the area and for the hydrological and morphological study of the Atrai River (Annex 2) to assess the impact of floods on adjacent areas under post-project conditions and provide data for the preparation of a plan for the comprehensive development of the Atrai basin. No investments are planned for the specific purpose of irrigation development. However, provision is made for flushing sluices to be designed for the dual purpose of drainage and irrigation. Their invert levels will be sufficiently low to divert water during the dry season from the Atrai river into khals in the sub-project area. In addition, re-excavated khals, construction of new secondary canals and installation of water control structures would allow storage of water for use during drought periods in the wet season and for limited irrigation of boro and early aus crops. Although there is a potential for expansion of irrigation by means of groundwater
resources, none is recommended as part of this sub-project as Government is in the process of defining rules and procedures for siting shallow and deep tubewells.

2.09 The Madhumati-Nabaganga sub-project is located in the Magura and Narail Districts (IBRD Map 18560). The area is bounded by the Gorai-Madhumati River to the east, the Nabaganga River to the west, the Magura-Kamarkhali highway to the north and the Halifax cut to the south. It falls within the Upazillas of Mohammadpur and Lohagara and covers a gross area of 45,000 ha of which about 38,000 ha are cultivable. The sub-project area is part of the middle deltaic flood plain of the Ganges River and has a gradual slope of 10 cm per km in a south-eastern direction towards the Bay of Bengal. The lowest parts of the basin which occupies about 2,500 ha are permanently submerged and serve as one of the main water sources during the dry season. In most parts of the sub-project area, submergence of agricultural land occurs frequently during the monsoons due to overbank spilling of the Gorai-Madhumati River combined with local rainfall. Flood depths in a normal year (return period of 2 years) is more than 1m in about 10,000 ha including the beel area of 2,500 ha. These floods affect both the aus and the aman crops. At present, there is a limited area irrigated by means of low lift pumps and traditional lifting means. The use of shallow tubewells is restricted because the ground water table is too deep in the north and west and because water bearing formations have low permeability in the middle and south of the area. The use of deep tubewells is limited although some potential for their use may exist in the north; this needs confirmation and a study for determining the reliable yield and optimal siting of wells is provided for under this project (Annex 2). Doubts about the quality of groundwater in the southern area is also a reason for limited development of irrigation.

2.10 The Madhumati-Nabaganga sub-project would provide for the construction of embankments along the Madhumati and Nabaganga rivers, improving and extending the drainage system, and installation of structures to regulate water flow. It would also provide for upgrading the road network to the extent necessary for implementation of sub-project works and for their future operation and maintenance. In addition, provision is made for an aerial photography cover of the area and for the hydrological study of the Gorai River. An evaluation of the potential for irrigation using groundwater resources is also planned. However, no investments are included for the specific purpose of irrigation development. Availability of surface water resources from the Gorai River is uncertain due to inadequate knowledge about the water regime, downstream requirement for navigation, present and proposed abstraction downstream, and the apparently unstable nature of the river which could cause siltation problems at the intake to pump stations. The Nabaganga River has virtually no water during the dry season.

2.11 Guidelines for the studies and investigations provided for under the project are given in Annex 2. The hydrological and morphological studies in all sub-projects and the groundwater study in the Madhumati-Nabaganga sub-project would be based on data collected by BWDB. BWDB would use any suitable and tested river or groundwater simulation models which could be supplied by MPO in a timely manner and without in any way causing delay in the implementation of any project component. Otherwise BWDB and their consultants would develop the necessary models and subsequently would make them
available to MPO in order to avoid duplications. The simulation models are required for studying the rivers concerned to enable an assessment of the hydraulic and morphological changes in the river basins associated with alternative flood control and water development scenarios. BWDB staff would be trained in the calibration and use of such models. Aerial photography would serve for checking the rivers evolution and for preparing contour maps for the detailed design of drainage and irrigation systems. This work would be undertaken by internationally recruited specialists. Provision would be made for a representative of Government to be present while aerial photographs are being taken. The feasibility study for the Gumti Phase II Project would be undertaken under a separate contract, excluding the aerial photography. Water management demonstrations would be conducted by the local agricultural staff following the principles of the on-going National Irrigation Management Program (IMP) introduced under the Rural Development I Project (Cr. 631-BD) to maximize irrigation equipment utilization and minimize cost of operation. Under this program, BRDB, BADC and DAE officers at district and Upazila levels are jointly responsible for supporting UCCA and KSS cooperatives to: (i) adopt improved water management practices; (ii) train managers and chairmen of KSS, UCCA inspectors, village accountants, block leaders, fieldmen, and tubewell operators; (iii) prepare land maps and land registers; (iv) lay out irrigation channels; (v) prepare irrigation budgets; and (vi) obtain production credit.

2.12 Programs for agriculture and fisheries development in the three sub-project areas would be prepared to serve as a basis for mobilizing the necessary complementary resources and services to make optimum use of the newly improved production environment (Annex 2). Since no provision was made under the previous two IDA supported flood controlled drainage projects (Credits 864-BD and 1184-BD) for planning agricultural and fisheries development following completion of the flood control works, FCD III would provide for the preparation of area specific development programs. The preparation of these programs would be initiated soon after FCD III becomes effective since both Credits 864-BD and 1184-BD are at an advanced implementation stage. In the case of fisheries, the preparation of the program would include a study of the impact of flood control measures on natural fisheries, as a means for identifying ways to limit such negative impact. The agriculture and fisheries development programs would be prepared in close cooperation between the Directorate of Planning Schemes I (DPS I), the Ministry of Agriculture and Forests and the Department of Fisheries, and local authorities and the project beneficiaries of the three Flood Control and Drainage Projects supported by IDA. MOI would be responsible for coordination among these agencies. Government assurances were obtained that agricultural and fisheries development programs for areas covered under Credits 864-BD and 1184-BD would be submitted to IDA for discussion no later than July 31, 1987 and those for this project no later than July 31, 1990. Procedures for implementation of those programs, including the possibility of IDA support for follow-up projects, would be agreed between Government and IDA following review of the proposals.

2.13 Strengthening of BWDB (Annex 3). Experience with other flood control and drainage projects has shown that an important reason for delay in project implementation has been limited capabilities within BWDB for design, for planning project implementation, for organizing and monitoring survey activities, and for construction monitoring. Correcting this situation would
require improvement in work procedures (proper scheduling of operations), staff training, improved staff motivation, and enhancing the multi-disciplinary nature of project planning and implementation teams. This project provides for the introduction of measures aimed at (i) giving BWDB an opportunity for attracting, motivating and retaining qualified planning, design and construction monitoring staff; (ii) on-the-job training both in the context of this project and through organized short term training abroad, workshops and seminars; and (iii) providing for technical assistance to BWDB for the specific purpose of implementing this project. The latter is necessary while BWDB staff are being trained and prepared to take over an increasing share of the technical responsibility in the implementation of flood control and drainage projects.

2.14 Provision is made for establishing a Project Management Unit (PMU) under the Chief Engineer Planning to be responsible for overall planning, coordination and monitoring of project implementation (para 4.03). PMU would be given qualified staff (para 2.15). Technical assistance would be provided to assist PMU with the implementation of this project and with developing a capability within BWDB to implement future projects. PMU and its consultants would, thus, assume responsibility for (i) assisting field divisions with planning the implementation of those parts of project works assigned to them; (ii) monitoring engineering surveys, foundation investigations and detailed designs; (iii) overseeing the preparation and processing of tender documents and contracts by field Divisions; (iv) monitoring progress in the construction program; and (v) monitoring the quality of construction works. DPS I would be responsible for organizing and monitoring the preparation of the agriculture and fisheries development plans and for preparation of a feasibility study for the Gumti Phase II Project.

2.15 PMU would consist of a Project Manager, a senior design engineer as Deputy Project Manager, three design engineers, one planning engineer and four design and planning engineers. This team would be supported by three surveyors, two draftsmen and eleven support staff (accountants, secretaries, clerks, drivers). The Project Manager with qualifications satisfactory to IDA would be appointed by BWDB. The senior design engineer, the three design engineers, the planning engineers and the four design and planning engineers would be recruited according to Government procedures regulating employment of Bangladeshi nationals in projects with foreign financial support. The Project Manager and DPS I staff would be expected to ensure direct and frequent contact between headquarters and field staff and would ensure that the works and studies being implemented reflect local realities and needs.

2.16 It is recognized that training and improved work conditions, as staff motivation measures, represent only a limited short term solution to the issues impeding staff motivation in BWDB. Therefore, as an initial step towards identifying a longer term solution, the project would provide for establishing an inter-agency study group to: (i) formally identify and provide a ranking for the reasons underlying the lack of staff motivation in the fields of planning, design and construction monitoring; (ii) review cases (if any) in Bangladesh where such limitations existed and were resolved; and (iii) visit other countries and review their experience, particularly the experience with establishing autonomous planning and design units in such countries as Sri Lanka, Korea and India, among others. The study group would develop proposals amenable to implementation with a minimum of disturbance to
the existing institutional arrangements. Such proposals would be reviewed by Government and IDA. The financial and administrative arrangements for their implementation would be agreed at that time. Government assurances were obtained that the inter-agency study group would be established, terms of reference agreed with IDA and that a report would be submitted to GOB and IDA for discussion no later than December 31, 1986.

2.17 Two senior engineers (6 man-years over a 4 year period) would be provided to PMU as a grant under Korean Government technical assistance. As advisors to PMU, they would help the Project Manager with the identification of training requirements of individual staff members, organization of workshops and seminars, and the preparation and execution of appropriate training programs based on participation in all phases of project implementation and/or planned programs of on-the-job training abroad. They would also assist PMU in supervising project implementation, provide technical support as required, and monitor the quality of construction works.

2.18 For the specific purpose of project implementation, BWDB would be assisted by a local consulting firm (34 man-years of senior technical staff supported by three draftsmen, six surveyors and nine technical assistants over a 6 year period) supported by three expatriate engineers (7.5 man years over a 5 year period) with broad experience in engineering design and construction monitoring. The consultancy services requirements were estimated on the basis of BWDB's assessment of its own needs and a joint analysis of BWDB's existing capability for planning project implementation, for detailed engineering design and for construction monitoring.

2.19 The project manager would be responsible to the Chief Engineer Planning, BWDB. Consultancy services would be financed by UNDP with IDA as executing agency. UNDP would give advance authorization to proceed with the selection of consultants and the award of a technical assistance contract as soon as possible after credit signing. The appointment of the Project Manager and the effectiveness of funding agreements of other financiers would be conditions of credit effectiveness.

2.20 Training in the form of on-the-job training, seminars and workshops would aim at improving BWDB skills in (i) design and construction monitoring, (ii) organization and management (task identification, work loading and estimating, critical path analysis, budgeting, proposal writing, inter-disciplinary cooperation, quality and cost control), and (iii) project implementation (how to organize engineering surveys and investigations, how to organize procurement, how to select among alternative engineering designs, how to request and evaluate proposals from consultants and contractors). BWDB staff from different departments would be given the opportunity to take part in workshops and seminars. In addition, 18 staff members from the design and construction monitoring units would participate in a program of on-the-job training under this project, and/or in a program of on-the-job training abroad. The cost to the project of such participation is recognized and allowance is made for it in designing the project. A training program would be prepared by PMU and their consultants and agreed with IDA by March 31, 1986.

2.21 Beyond the immediate need to strengthen BWDB's capacity for project preparation and implementation, there are broader and longer term
institutional questions which need to be addressed regarding BWDB’s management, internal administration, manpower strength and patterns, operating procedures and its working relationship with other government agencies. Accordingly, the project would provide for a review of the management and administration of BWDB aimed at the consolidation of the findings of previous institutional studies of BWDB into an action plan, supplemented, if necessary, by additional fact finding and analysis (Annex 2). Assurance were obtained that this review would be completed by June 30, 1986, and institutional improvements agreed with IDA would, thereafter, be carried out.

Project Works

2.22 The present status of engineering and detailed design provides an adequate basis for ensuring that cost estimates are reasonably accurate and is expected not to create any hinderance to the timely initiation of first year construction activities. Feasibility studies identified alignment of embankments and location of structures. They also provided bill of quantities for earthworks and corresponding cost estimates based on existing maps. Detailed surveying of longitudinal profiles, geotechnical surveys and final bill of quantities are included in the preconstruction activities which BWDB initiated in December 1984 following the receding of floods. First year construction involves limited sections of embankments which would serve to facilitate access to construction sites and for which acceptable designs are already available. Completion of final designs and preparation of a work program for the first project year would be a condition of credit effectiveness.

2.23 Civil works (Base cost US$24.3 M) would include a combination of the following elements: (i) construction of new embankments and resectioning of existing ones; (ii) excavation of new or rehabilitation of existing drainage channels; (iii) construction of water control structures such as regulators, flushing sluices, cross regulators, and delivery outlets; (iv) construction and improvement of roads, road bridges, culverts and foot bridges; and (v) buildings. Embankments would be adequately compacted and would have a free board high enough to secure them from wave action, subsidence of the crest due to shrinkage and subsoil settlement, and erosion due to human and animal use. Following past practice in Bangladesh, the freeboard will be at least three feet above the design water level which is based on a return period of 20 years. Once the Atrai river studies are completed, a decision would be made as to the need to raise the embankment crest levels in the adjacent Chalan Beel polder (protected under IDA Credit 1184-BD). Adjustments would have to be coordinated basin wide in order not to deteriorate flood conditions in one area or another. Any additional works in the Chalan Beel area would be financed under Credit 1184-BD.

2.24 One major difficulty experienced under other IDA-financed flood control projects was that associated with the enforcement of adequate compaction during the construction of earthfill embankments. Although the specifications described in contract agreements have been quite clear about the method to be adopted to obtain the required degree of compaction, ineffective supervision by BWDB staff resulted in sub-standard work. Embankment heights in the three sub-projects are over 3m for about 50 percent of the total length. High river stages continue for well over 10 days during the monsoon season. Sub-standard embankment construction would be a hazard to
local population and could jeopardize all investments in the project area. Accordingly, provision is made for controlled compaction for the embankment fill and for manually operated pneumatic compactors for backfilling behind structures. To further highlight the necessity of compaction, tender documents would provide for two rates: (i) transport of earth from borrow and placing it in layers of 15 cm (inclusive of stripping of top soil in embankment base and borrow area) and turfing of embankment slopes; and (ii) breaking of earth clods, levelling, watering if needed, and compaction by labor intensive techniques such as medium weight hand tampers or bullock drawn sheep foot rollers. In view of the necessity of ensuring a high standard of construction, each time applications for reimbursement are made against expenditures on construction of embankments, BWDB would be required to certify that compaction was properly done and that embankments constructed meet required standards for safety. Assurances to that effect were obtained from Government.

2.25 Drainage systems are designed on the basis that they would be capable of releasing a runoff of 10 days rainfall with a return period of five years with a submergence duration not exceeding three days and with a submergence period not exceeding six days for a return period of 10 years. The tail water level at drainage structures, which determines the discharge through the vents, was determined from the stage hydrograph for the critical period of each sub-project. The outlet works would be constructed on the dry and would have the standard vent size of 1.50m x 1.80m. The drainage system would generally follow existing khasals, canals and old river courses, resulting in relatively low investment costs. Provision is made for new secondary canals based on the assumption that 1.5 km of canal is needed to drain 200 ha, which represents a sufficient conveyance for the runoff of a storm with a return period of 10 years and discharge within three days. The canals would be unlined and have stable side slopes.

2.26 Irrigation development at Gumti would be based on the siting of the primary pump station at Daudkandi. It would involve a primary pump station equipped with five units of 3 m³/s vertical axial flow pumps, one being a standby, to supply 12 m³/s to the feeder canal. The vertical axial flow pumps would be powered through an existing 33 kw powerline. The feeder canal would run east along the Daudkanji-Comilla trunk road and would be aligned along the existing borrow trench alongside the road. The feeder canal would have two major system crossings besides several road bridges, outlet structures, culverts and foot bridges. Irrigation efficiencies of 75% for the conveyance system and 65% for the field irrigation system were assumed, giving an overall efficiency of about 50%. In order to meet the irrigation water demand, the pump station would have to work a minimum of 17 hours per day during the peak period. Water would be pumped into the feeder canal and from there it would be supplied by gravity into existing drainage channels. Water distribution to the fields would be by low-lift pumps organized under the on-going national Irrigation Management Program.

2.27 Roads to be improved and embankments to be paved were selected on the basis of need for accessibility to construction sites, for use during the operation and maintenance of the project and for use by the extension service for conducting water management demonstrations. Roads and embankment pavement would have a width of 2.4 m of herring bone brick paving, in accordance with established local standards for rural roads.
2.28 Land acquisition (Base cost US$7.2 M) would involve about 2,100 ha or 1.6% of a total gross area of about 128,400 ha. The base cost of land acquisition represents 15% of project base costs. At Gumti the land costs is estimated at Tk 125,000 per ha while land at Naogaon and Madhumati-Nabaganga is estimated at Tk 90,000 and 70,000 per ha respectively. Land acquisition has been a major reason for delay in project implementation. Possession by BWDB of the land required for the first year's construction program would be completed prior to credit effectiveness. In order to facilitate the process, the project would provide the necessary resources (funds, equipment and means of transport) which BWDB would provide to Deputy Commissioners and would ensure that such resources would be used exclusively for undertaking project related land acquisition activities. BWDB would submit land acquisition plans to DCs nine months prior to construction start-up. Government assurances to that effect were obtained during negotiations.

2.29 Operation and Maintenance (Base cost US$2.3 M). The project would provide for the operation and maintenance (O&M) of completed facilities during the five year construction period as well as during two additional years to complete the project. The project would be considered completed when: (i) the necessary measures are taken for ensuring that any deficiencies in design or construction of project facilities would be identified and corrected; (ii) O&M manuals acceptable to IDA are completed, and staff trained in their use; and (iii) potential beneficiaries and local agencies serving farmers are well informed on how project facilities could be taken advantage of in order to improve production practices.

2.30 Operation of the project would involve (i) regular inspections of embankments, major drainage khals and major irrigation canals; and (ii) operation of regulating gates, primary pumps and water control outlets (turnouts). Preventive maintenance would include routine repairs to embankments (such as filling up runnels in slopes, low spots in embankment, returfing) painting of gates, servicing of gates' lifting mechanisms, minor repairs to gates and rubber seals, minor repairs to structures' protection works, removal of man made constriction such as fish fences in major khals and repairs of potholes in roads. Annual maintenance would involve clearing of water hyacinth and desilting of khals, replacement of gates if needed, repairs to regulators, repairs to canal lining, desilting of irrigation canals and repairs to canal structures. Provision would also be made annually for repairs resulting from flood damages, erosion of embankments by meandering rivers and wave actions. O&M duties would be the responsibility of BWDB's field divisions. Preventive maintenance and annual maintenance works could be executed under the field Divisions' supervision through small contracts. Assurances were obtained that Government would allocate the necessary funds to ensure proper operation and maintenance of project facilities. Operation and maintenance costs are estimated at about Tk 180/ha for flood control and drainage works and at Tk 275/ha for the irrigation system at Gumti.

Implementation Schedule (Annex 4)

2.31 The project implementation period would be seven years (FY86 through FY92). The three sub-projects would be implemented in parallel. Construction would begin with embankment works in mid FY86. Project construction
works would be completed in FY 1990. Operation and Maintenance of project facilities would begin as required during the construction period and would continue until the end of FY 1992, with a progressively higher share of the funds coming from BWDB's revenue budget (para. 3.12-f).

III. PROJECT COSTS, FINANCING, PROCUREMENT, DISBURSEMENT AND ACCOUNTS

Project Costs

3.01 Total project costs are estimated at Tk 2,110 million (US$65.0 million) with a foreign exchange component of US$18.3 million or 28% of total costs (Table 3.1). Estimates are based on actual mid-1984 contract prices, adjusted to reflect expected prices in mid-1985. The average cost of land for the three sub-projects is estimated at Tk 96,000 (US$3,310) per ha. Estimates of quantities provided in the feasibility reports were verified with BWDB's field officers during appraisal. Estimates of quantities of earthworks are based on cross sections which are already approved, and on longitudinal profiles derived from available data which require reconfirmation by actual surveys. The latter are part of agreed preconstruction activities. Unit cost estimates for earthwork for embankments assume that bidding documents would specify the requirement for controlled manual compaction and that BWDB would verify that it is done before final payment is made to contractors. Costs of hydraulic structures and bridges were estimated from type designs with foundation conditions to be ascertained during preconstruction surveys and soil investigations. Cost of the irrigation system in the Gumti Phase I sub-project was based on the feasibility study designs which are subject to verification prior to construction. The cost of engineering and administration activities for which BWDB would be responsible is estimated at 15% of the cost of civil works.

3.02 Project costs include US$2.3 million in taxes and duties. Physical contingencies (10% of the base cost of civil works) amount to US$2.5 million or about 5% of project base costs. Price contingencies amounting to US$14.4 million (30% of project base costs) are estimated on the basis of expected rates for local and international inflation as projected by the Bank in January 1985. 1/ Detailed cost tables are given in Annex 9.

1/ Bank estimates of local inflation rates are: 13% for FY86, and 10% thereafter. International rates of inflation are estimated at 6.3% for FY86, 7.8% for FY87 and 8% thereafter.
Table 3.1: PROJECT COST ESTIMATES

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<th>Foreign Exchange Cost</th>
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</table>

Project Financing

3.03 An IDA credit of SDR 50.1 million (about US$48.0 million) is proposed that would cover 77% of total project costs, excluding taxes and duties. UNDP and the Korean Government would finance the Technical Assistance and Training costs amounting to US$4.0 million, or about 6.4% of project costs, net of taxes and duties. Government would finance the balance of project costs US$13.0 million (Tk 380 million equivalent), including taxes and duties through annual budget appropriations in conformity with the project implementation schedule. Table 3.2 summarizes the project financing plan by project component.

Table 3.2: FINANCING PLAN

<table>
<thead>
<tr>
<th></th>
<th>GOB</th>
<th>IDA</th>
<th>UNDP</th>
<th>Korean Government</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Acquisition</td>
<td>8.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.6</td>
</tr>
<tr>
<td>Civil Works</td>
<td>1.8</td>
<td>33.0</td>
<td>-</td>
<td>-</td>
<td>34.8</td>
</tr>
<tr>
<td>Equipment</td>
<td>1.1</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
<td>2.9</td>
</tr>
<tr>
<td>Technical Assistance and Training</td>
<td>-</td>
<td>-</td>
<td>3.3</td>
<td>0.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Surveys and Investigations</td>
<td>0.4</td>
<td>4.0</td>
<td>-</td>
<td>-</td>
<td>4.4</td>
</tr>
<tr>
<td>Studies</td>
<td>0.1</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
<td>1.9</td>
</tr>
<tr>
<td>Engineering and Administration</td>
<td>0.2</td>
<td>4.5</td>
<td>-</td>
<td>-</td>
<td>4.7</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>0.8</td>
<td>2.9</td>
<td>-</td>
<td>-</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>13.0</td>
<td>48.0</td>
<td>3.3</td>
<td>0.7</td>
<td>65.0</td>
</tr>
</tbody>
</table>
3.04 The IDA credit would include US$500,000 for retroactive financing. BWDB initiated the following activities in anticipation of project approval by IDA: preparation of draft Project Proformas; selection and appointment of survey teams; provision of the necessary staff and transport facilities to the Deputy Commissioner's office; undertaking detailed engineering surveys and investigations for about 1/3 of embankments and drainage channels; initiating morphological investigations; and preparation of tender documents. These activities were initiated to allow a timely start-up of construction works and, more importantly, to sustain interest in the project generated at the local level. Government advanced the necessary funds to BWDB and requested that IDA finance retroactively the actual costs incurred. Such costs are estimated at about US$500,000. Government was informed of IDA procedures with regard to retroactive financing.

3.05 Approval of Project Proforma by COB would be a condition of credit effectiveness. In order to avoid delay in project effectiveness, Government would instruct Deputy Commissioners to initiate action on processing land acquisition plans for the first year construction period following receipt of PEC clearance of the draft Project Proforma.

Procurement

3.06 Civil Works (US$34.0 M, including contingencies, but excluding taxes and duties). The works would not be suitable for international bidders because the major portion of the works are relatively small, labor-intensive, geographically scattered in areas with difficult access, and spread over a five-year period. The works would, therefore, be carried out under contracts let through standard local competitive bidding procedures (LCB) which IDA has reviewed in the context of on-going projects in the agricultural sector and found acceptable. Contracts for earthwork would be awarded in reaches, while each major structure would generally have a separate contract. Contracts for structures would generally include construction materials. However, in cases where BWDB is in a better position than contractors to procure and transport materials to construction sites on time, it would supply contractors with construction materials procured under LCB. In this case the contracts for structures would exclude construction materials that would be supplied by BWDB. When contractors are qualified, BWDB would have the option of including in the civil works contracts the fabrication and installation of gates, including embedded parts. If these have not been included, BWDB would award separate contracts under LCB procedures to contractors specialized in this type of work or execute the work on force account basis (FA) utilizing the services of their mechanical engineering unit. For works costing the equivalent of US$150,000 or more, tender documents and bid evaluations would be sent to IDA for review before the contracts are awarded. For all other works, bid evaluation reports together with the contracts would be furnished to IDA before reimbursement is sought. Force account work in respect of earthwork would be permitted but is expected to be limited to O&M activities and would be restricted to amounts under $5,000 equivalent for each individual case. Force account work in respect of fabrication and installation of gates including embedded parts would be limited to $50,000 for each structure. The use of FA in civil works would be limited to an aggregate amount of US$600,000.
3.07 **Surveys and Investigations** (US$4.1 M, including contingencies, but excluding taxes and duties) would be undertaken under FA as well as under contract. BWDB would carry out topographical surveys and foundation investigations either on FA or under contracts awarded under LCB procedures acceptable to IDA. Aerial photography cover (Annex 2) would be awarded according to international competitive bidding (ICB). This contract would cover the three sub-projects (about 150,000 ha) as well as about 100,000 ha on the right Bank of the Gumti (to be covered by Gumti Phase II feasibility study). This component would also provide for consultancy services to prepare a Gumti Phase II project based on the Gumti-Titas basin area outside that covered by the present project (Annex 2). These services would be procured according to principles and procedures described in the "Guidelines for the Use of Consultants by World Bank Borrowers and by the World Bank as Executing Agency" as published by the World Bank in August 1981.

3.08 **Land Acquisition** (US$8.6 M, including contingencies). The staff of BWDB and the Deputy Commissioner would be responsible for the processing. Government would finance land acquisition. Disbursements by IDA would be limited to processing expenditures (about US$0.08 M) included under surveys and investigations, and would be on FA basis. Land acquisition procedures are described in Annex 5.

3.09 **Equipment and Vehicles** (US$1.8 M, including contingencies, but excluding taxes and duties). This includes: (i) primary pumping equipment for irrigation; (ii) construction equipment; (iii) transport vehicles; (iv) furniture and office equipment and supplies; and (v) hydrological and morphological equipment. Spares amounting to approximately 15% of the equipment and vehicles value would be procured with the equipment and vehicles. Generally, these would be procured following ICB procedures consistent with the current edition of the "Guidelines for Procurement under World Bank Loans and IDA Credits". For procurement under ICB, a preference limited to 15% of the CIF price or the prevailing customs duty, whichever is lower, would be extended to local manufacturers in the evaluation of bids. Small off-the-shelf items costing less than US$10,000 for each contract, which are needed urgently, may be procured by prudent shopping after comparing bids from at least three independent suppliers in accordance with procedures acceptable to IDA. Such procurement would not exceed a cumulative total of US$150,000. Tender documents and advertising procedures for all ICB procurements would be reviewed by IDA before issuance by BWDB, and bid evaluations would be reviewed by IDA before contracts are awarded.

3.10 **Studies** (US$1.8 M, including contingencies but excluding taxes and duties). These include the hydrological and morphological studies, the groundwater study (including preparation of river and groundwater simulation models), the benchmark surveys and evaluation studies, the agricultural and fishery development studies, the water management demonstration units, and preparation of the project completion report (para 2.11 and Annex 2). The hydrological and morphological studies would include the installation of recording instruments, topographical surveys and data collection. These would be conducted by BWDB. The groundwater study which would require the installation of test tubewells, the installation of piezometers, data collection, data analysis and interpretation would be carried out by BWDB, assisted by consultants. Procurement of tubewell equipment would be included in the
equipment tender to be floated as described in para. 3.09. Consultants would be selected on the basis of IDA guidelines.

3.11 Technical Assistance and Training (US$4.0 M, including contingencies). This component would be financed through grants from the Korean Government and UNDP. IDA would be the executing agency for the UNDP-financed assistance, which would provide for the appointment of a local consultancy firm with limited international input (para 2.18) with qualifications and experience and on terms and conditions of employment acceptable to IDA in accordance with principles and procedures described in the "Guidelines for the Use of Consultants by World Bank Borrowers and by the World Bank as Executing Agency" as published by the Bank in August 1981.

Table 3.3: PROCUREMENT PROCEDURES (US$ Million)

<table>
<thead>
<tr>
<th>Project Component</th>
<th>ICB</th>
<th>LCB</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Acquisition</td>
<td></td>
<td></td>
<td>8.6</td>
<td>8.6</td>
</tr>
<tr>
<td>Civil Works</td>
<td>33.6</td>
<td>1.2</td>
<td>34.8</td>
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<td></td>
<td>(32.4)</td>
<td>(0.6)</td>
<td>(33.0)</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>1.7</td>
<td>1.2</td>
<td>2.9</td>
<td></td>
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<tr>
<td></td>
<td>(1.7)</td>
<td>(0.1)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>Surveys and Investigations</td>
<td>2.9</td>
<td>0.5</td>
<td>1.0</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td>(0.4)</td>
<td>(0.7)</td>
<td>(4.0)</td>
</tr>
<tr>
<td>Studies, Benchmark Surveys and PCR</td>
<td>0.8</td>
<td>1.1</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.8)</td>
<td>(1.0)</td>
<td>(1.8)</td>
<td></td>
</tr>
<tr>
<td>Engineering and Administration</td>
<td>4.7</td>
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<td>4.7</td>
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<td></td>
<td>(4.5)</td>
<td></td>
<td>(4.5)</td>
<td></td>
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<tr>
<td>Technical Assistance &amp; Training /b</td>
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<td></td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Operation and Maintenance</td>
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<td>3.7</td>
<td></td>
</tr>
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<td></td>
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<td>Total</td>
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<td>36.1</td>
<td>23.5</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>(5.4)</td>
<td>(34.8)</td>
<td>(7.8)</td>
<td>(48.0)</td>
</tr>
</tbody>
</table>

/a Figures in parentheses are the respective amounts to be financed by IDA.
/b UNDP and Government of the Republic of Korea assistance.
Disbursement

3.12 Disbursement from the proposed IDA credit would cover:

(a) 95% of expenditure on civil works, including work done on force account such as fabrication of gates;

(b) 100% of the foreign expenditure on directly imported irrigation primary pumps, construction equipment, transport vehicles, hydrological and morphological equipment, pump sets and miscellaneous equipment;

(c) 100% of the ex-factory price of equipment manufactured within the country or 70% of local expenditures (off-the-shelf);

(d) 100% of foreign expenditures and 95% of local expenditures on surveys and investigation, aerial photography and studies.

(e) 95% of expenditure on engineering and administration during the construction period, which would be based on 15% of the cost of implemented civil works contracts; and

(f) 95% of sub-project O&M costs during the five year construction period 75% in the sixth year and 60% in the seventh year.

3.13 Full documentation would be sent to IDA in support of withdrawal applications except for items (e), (f) above and for force account works and small civil works contracts costing less than the equivalent of $10,000 each. For these items, applications would be supported by statements of expenditures certified by the Chief Engineer and the Project Accountant. The relevant documentation would be retained by BWDB at a central location and made available for review to IDA representatives on request. In addition, this documentation would be subject to audit.

3.14 The proposed allocation of the IDA credit and the schedule of disbursements are given in Annex 6. The disbursement profile reflects the anticipated sequence of sub-project implementation and is based on the assumption that disbursements for work done in a quarter would be completed within the next two quarters. These estimates are consistent with the last disbursement profile for irrigation projects in the South Asia Region which shows a disbursement period of nine years (including retroactive financing period).

Accounts and Audits

3.15 BWDB would maintain adequate records to identify physical progress and financial transactions relating to the project. Individually identifiable accounts would be kept for all expenditures for which credit withdrawals would be made on the basis of statements of expenditure (para. 3.13). Separate project accounts would be prepared annually by BWDB. Auditors acceptable to IDA would audit these accounts and statements of expenditures, where applicable. Audited accounts, together with auditors' comments, would be sent to IDA within nine months of the close of each fiscal year. At present, BWDB's accounts are audited by the Controller and Auditor-General
and by BWDB's Internal Directorate of Audits. These arrangements are satisfactory to IDA.

**Special Account**

3.16 Project works would be carried out by a large number of small contractors whose construction capability depends heavily upon the speed at which they receive progress payments, and by force account. To facilitate payments, to ensure availability of funds and to reduce the number of withdrawal applications submitted to IDA, the Government would open and thereafter maintain a Special Account (Revolving Fund) in U.S. dollars with the Bangladesh Bank in Dhaka. The initial deposit into the Special Account would be US$3.0 million representing estimated four month IDA financed expenditures. The Special Account would be replenished by reimbursements on a monthly basis. The Special Account would be used exclusively for IDA's share of financing.

**IV. PROJECT MANAGEMENT**

4.01 BWDB would be the implementing agency, responsible for surveys, detailed engineering investigations, design, construction, operation and maintenance of completed project facilities. BWDB would also be responsible for implementation of the studies financed under the project and for preparation of a project completion report.

4.02 BWDB was established in 1972 as a semi-autonomous agency with a mandate to plan, construct, operate and maintain major and medium irrigation systems and flood control and drainage schemes. Responsibility for minor irrigation systems was given to BADC. BWDB is under the administrative control of the Ministry of Irrigation, Water Development and Flood Control. It is managed by a Chairman and five board members responsible, respectively, for planning, implementation, operation and maintenance, finance, and administration (Chart 1). BWDB's performance in implementing projects has been improving over time, partly as a result of continued support from IDA for upgrading its capability. Special efforts are being aimed at the operation and maintenance functions in the context of BWDB small schemes project, BWDB systems rehabilitation project (under preparation) and in the on-going O&M sector study. IDA has been investigating with Government ways to strengthen the country's monitoring and evaluation capability at the national level and plans are underway to address BWDB's monitoring and evaluation needs under the fourth Flood Control and Drainage project. This project addresses the planning and design functions.

4.03 BWDB would implement the project through a Project Management Unit (PMU) established under the Chief Engineer Planning and given responsibility for overall planning, coordination and monitoring of project implementation, including: planning project implementation; organizing and monitoring the necessary surveys and engineering investigations; overseeing the preparation of the final design of project facilities; organizing and supervising the hydrological, morphological and groundwater studies (including the preparation of simulation models); monitoring the construction of project facilities; procurement of equipment and consultants; controlling the
quality of project works and verifying their adequacy for intended purposes; arranging for farmers, local government agencies and development agencies serving in the agricultural sector to be thoroughly briefed on modalities for making optimum use of project facilities; preparing manuals for construction monitoring and for operation and maintenance of project facilities; overall financial control; and preparing a project completion report. DPSI would be responsible for organizing and supervising the preparation of agriculture and fisheries development plans (para 2.12) and for the preparation of a feasibility study for the Gumti Phase II Project.

4.04 PMU would be assisted by a local consulting firm with limited expatriate specialist input and by two consultants provided under Korean technical assistance (Annex 3). PMU would be responsible for keeping beneficiaries and local government continuously informed about progress in project implementation. To that end PMU would organize quarterly meetings (or more frequent when necessary) with farmers' representatives, Upazila and District officials, and representatives of concerned development agencies to inform them of progress in project implementation and agree on ways and means to address any issues hindering such progress. Findings of quarterly meetings would be submitted to BWDB's Chairman and Board Members, to concerned Ministries and agencies, as well as to IDA for information and possible follow up actions. Government assurances were obtained during negotiations that the above practice would be followed.

4.05 At the sub-project level, an Executive Engineer, under the supervision of the zonal Chief Engineer and the Superintending Engineer, would be made exclusively responsible for the daily conduct of construction and operation and maintenance activities in each sub-project area; organizing and supervising the surveys and investigations necessary for land acquisition; cooperating with District Land acquisition officers to arrange for verification of land acquisition plans; preparation of tender documents; selection of contractors and award of contracts; supply of construction materials and equipment when needed; construction supervision and quality control; implementation of works under force account; and accounting and detailed financial control. Each executive engineer would be assisted by three sub-divisional engineers, one for construction supervision, one for procurement and contracts, one for the specific purpose of overseeing O&M activities, and one revenue officer for land acquisition activities (Chart 2).

4.06 Given the short construction season in Bangladesh (about six months), efficient project implementation would depend heavily on proper scheduling and timely execution of complementary and interdependent activities. Critical activities are listed below:

(i) staffing and allocation of responsibilities among PMU staff, BWDB field divisions and consultants;

(ii) scheduling of project activities on the basis of consultations between PMU, its consultants, field divisions and local authorities;
(iii) surveys and studies: topography, soil, sub-soil and groundwater investigations, aerial photography, groundwater and river simulation studies, location and alignment of project works including resolution of possible conflicts between project requirements and local private or public interests, agricultural and fisheries studies, Gumti Phase II feasibility study;

(iv) land acquisition: preparation of plans, field verification, placement of funds, transfer of titles and compensation of previous owners;

(v) design of project facilities with due consideration to technical efficiency, cost considerations and suitability for operation and maintenance under local physical conditions, financial arrangements and available skills;

(vi) procurement of materials and services;

(vii) preparation of tender documents, floating of tenders, bid evaluation and award of contracts;

(viii) construction monitoring, quality control, and verifying the suitability of facilities to local needs;

(ix) modification, repair or upgrading of facilities if found defective;

(x) establishing water management demonstration farms;

(xi) operation and maintenance of project facilities;

(xii) training: design, construction monitoring, water charge assessment and collection, administration and management procedures;

(xiii) construction supervision manual; and

(xiv) O&M manual, including procedures for assessing and collecting water charges.

4.07 In order to manage these activities, PMU would require timely information on progress in the implementation of various tasks. Annual work programs prepared for each sub-project would define work targets and allocate the necessary resources to achieve such targets during the year. Monthly, quarterly and annual progress reports would be submitted to the Project Manager who would forward them to BWDB's Chairman and Board Members and to IDA. Those reports would serve as the basis for monitoring progress in project implementation and undertaking corrective actions if and when found necessary. To that end, the Project Manager would be responsible for identifying and highlighting, in writing, any issues in progress reports which PMU could not address within its own administrative jurisdiction, and, in consultation with field staff and/or local officials, he would be responsible for suggesting alternative courses of action. If a problem remained unresolved for three months, the Project Manager would write a special report to BWDB's Chairman, copied to IDA, suggesting ways to avoid a stalemate, and
suggesting measures to be taken, including, if necessary, drastic actions such as rescheduling of project activities and changes in project design. Assurances were obtained that PMU would prepare annual work programs for each sub-project and would keep BWDB management and IDA informed in writing of progress in their implementation, including proposals for addressing outstanding issues.

V. PRODUCTION, MARKETING AND PRICES, FARM INCOME AND COST RECOVERY

Production

5.01 Mainly as a result of controlled flooding, improved drainage on 104,500 ha, and irrigation on 14,350 ha, the project would contribute an annual incremental production of about 100,000 tons of paddy and 13,000 tons of wheat and other crops (Table 5.1). Increased production would be a result of decreased harvest losses during the aus and boro seasons, increased yield in areas where the production environment becomes favorable to a more widespread use of higher yielding varieties, and where supplementary irrigation becomes feasible for aman, boro rice and other rabi crops during the dry season. Except for the Gumti area, the projected future with project production levels would be achieved with existing on-farm irrigation facilities, field services and presently available technological practices.

5.02 Present and predicated future cropping patterns for the three sub-projects are shown in Annex 7. On-farm production parameters are given in the farm budgets in Annex 8. All are dominated by paddy; increased paddy production will be the major benefit of the project. In the Gumti sub-project, where some irrigation equipment is already used, farmers would be able to expand dry season cultivation of boro (HYV) and grow transplanted aman (HYV) with supplemental irrigation. In the Madhumati-Nabaganga sub-project, the major production impact would be expected from the introduction of t. amanu (HYV). The Naogaon Polder I sub-project increased production would result from a notable expansion of t. aman (HYV) with supplemental irrigation using existing tubewells.

5.03 Based on historical observations, reduction in flood losses would be expected to cause an increase in annual production of about 20%. This average loss reflects the fact that in a dry year losses may be negligible, while in a flood year losses may reach 100% over large areas. Production would also rise as a result of shift in cropping patterns and a moderate increase in cropping intensities. Estimates of expected yields are based on field observations under conditions similar to those which would prevail in the project area following construction of project facilities. Present and estimated future crop production levels for the three sub-projects are summarized in Table 5.1 and detailed in Annex 7.
Table 5.1: CROP PRODUCTION  
(Metric Tons)

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th>Future Without Project</th>
<th>Future With Project</th>
<th>Incremental Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(P)</td>
<td>(W)</td>
<td>(W)</td>
<td>(W - W)</td>
</tr>
<tr>
<td><strong>Gumti Phase I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy</td>
<td>96,750</td>
<td>96,750</td>
<td>140,640</td>
<td>43,890</td>
</tr>
<tr>
<td>Wheat</td>
<td>12,000</td>
<td>12,000</td>
<td>16,800</td>
<td>4,800</td>
</tr>
<tr>
<td>Jute</td>
<td>4,480</td>
<td>4,480</td>
<td>5,040</td>
<td>560</td>
</tr>
<tr>
<td><strong>Naogoan Polder I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy</td>
<td>94,760</td>
<td>94,760</td>
<td>140,510</td>
<td>45,750</td>
</tr>
<tr>
<td>Wheat</td>
<td>3,400</td>
<td>3,400</td>
<td>5,500</td>
<td>2,100</td>
</tr>
<tr>
<td>Jute</td>
<td>2,145</td>
<td>2,145</td>
<td>2,310</td>
<td>165</td>
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<td><strong>Madhumati-Nabaganga</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Paddy</td>
<td>43,070</td>
<td>43,070</td>
<td>54,560</td>
<td>11,490</td>
</tr>
<tr>
<td>Wheat</td>
<td>4,200</td>
<td>4,200</td>
<td>4,725</td>
<td>525</td>
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<tr>
<td>Jute</td>
<td>5,100</td>
<td>5,100</td>
<td>7,350</td>
<td>2,250</td>
</tr>
<tr>
<td>Pulses</td>
<td>9,350</td>
<td>9,350</td>
<td>10,800</td>
<td>1,450</td>
</tr>
<tr>
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<td>4,200</td>
<td>4,200</td>
<td>5,200</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>234,580</td>
<td>234,580</td>
<td>335,710</td>
<td>101,130</td>
</tr>
<tr>
<td>Paddy</td>
<td>19,600</td>
<td>19,600</td>
<td>27,025</td>
<td>7,425</td>
</tr>
<tr>
<td>Wheat</td>
<td>11,725</td>
<td>11,725</td>
<td>14,700</td>
<td>2,975</td>
</tr>
<tr>
<td>Pulses</td>
<td>9,350</td>
<td>9,350</td>
<td>10,800</td>
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<tr>
<td>Oilseeds</td>
<td>4,200</td>
<td>4,200</td>
<td>5,200</td>
<td>1,000</td>
</tr>
</tbody>
</table>

**Marketing and Prices**

5.04 Domestic foodgrain production falls about 10% short of total consumption in Bangladesh. Imports of grains have averaged 1.6M tons per year for the past five years (1980-1984). The incremental production of the project is, therefore, not expected to cause any marketing problem. It is very likely that much of the foodgrain production would be absorbed locally, since all three sub-project areas are currently foodgrain deficit areas. The additional production of oilseeds, jute and pulses would also be absorbed without any difficulty, as the amounts involved are relatively small.

5.05 Any surpluses at the sub-project level would be handled by the traditional marketing system. Market prices are largely determined by the supply situation. The IDA-financed Import Program Credits (IPC) IX-XII have supported improvements in the Government's foodgrain procurement and distribution policy. The objective has been to transform the traditional urban-biased public food policy into a set of market-oriented stabilization instruments to promote producer incentives, consumer welfare and food security. The main elements have been: (a) ensuring remunerative output prices to farmers; (b) reducing the direct involvement of the Government in
grain trading and promoting the private grain trade; (c) reducing the large subsidies in public foodgrains sales through the traditional rationing system; (d) reducing the share of subsidized public grain distributed to the relatively better-off urban, industrial and public sectors; (e) increasing the share distributed through channels benefitting the urban and rural poor; and (f) increasing the scope of open-market sales of public foodgrains. While significant progress has been made, some constraints remain and will be addressed as part of IDAs continuing dialogue with GOB.

5.06 In the absence of accurate farm gate prices, current procurement prices are used for paddy and wheat prices in the farm budget analyses. Prices for other crops and farm inputs are based on prevailing market prices.

Farm Income

5.07 Farm income was analyzed for typical farms in the three sub-project areas. Farm sizes used are 0.8 ha for Gumti and 1.2 ha for Naogoan and Madhumati-Nabaganga. Averaging flood and non-flood years, present yields are about 20% below what they would be without flooding, under identical cultural practices. However, it is important to note that in a flood year the crop loss in certain areas can amount to up to 100%. Although, without the project, future flood situation would likely be more severe than at present, the analyses conservatively assumed that future conditions would not be worse. A summary of income estimates is given in Table 5.2 and details are given in Annex 8.

5.08 Incremental income would vary by sub-project and across individual farmers. However, it would rise on the average by about 30-60% compared to the without project situation. Although the overall income distribution would remain essentially unchanged, the project would substantially reduce the overall level of absolute poverty in the areas. Most importantly, controlled flooding and improved drainage as a result of the project, would permit further agricultural development that otherwise would not be feasible.
Table 5.2: ANNUAL NET FARM INCOME  
(Constant FY85 Prices)

<table>
<thead>
<tr>
<th></th>
<th>Present TK</th>
<th>Present US$</th>
<th>Future Without Project TK</th>
<th>Future Without Project US$</th>
<th>Future With Project TK</th>
<th>Future With Project US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gumti Phase I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Family Income</td>
<td>10,040</td>
<td>346</td>
<td>9,940</td>
<td>368</td>
<td>14,950</td>
<td>554</td>
</tr>
<tr>
<td>Average Per Capita Income</td>
<td>1,730</td>
<td>60</td>
<td>1,710</td>
<td>63</td>
<td>2,580</td>
<td>95</td>
</tr>
<tr>
<td>Naogoan Polder I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Family Income</td>
<td>10,920</td>
<td>377</td>
<td>10,920</td>
<td>377</td>
<td>17,260</td>
<td>595</td>
</tr>
<tr>
<td>Average Per Capital Income</td>
<td>1,880</td>
<td>65</td>
<td>1,880</td>
<td>65</td>
<td>2,980</td>
<td>103</td>
</tr>
<tr>
<td>Madhumati-Nabaganga</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Family Income</td>
<td>6,180</td>
<td>213</td>
<td>6,180</td>
<td>213</td>
<td>8,220</td>
<td>283</td>
</tr>
<tr>
<td>Average Per Capital Income</td>
<td>1,070</td>
<td>37</td>
<td>1,070</td>
<td>37</td>
<td>1,420</td>
<td>49</td>
</tr>
</tbody>
</table>

/a Difference between Present and Future without project in Gumti is due to the fact that water charges are not presently collected, but are expected to be in the future.

Cost Recovery

5.09 Cost recovery from the beneficiaries of flood control and drainage works is a complex issue. As in many countries, protection against flooding in Bangladesh is considered to be Government's responsibility, and the accepted view is that beneficiaries should not be directly charged. Moreover, benefits from flood control and drainage work vary from one plot to another, depending upon the topography. In the case of some high land owners, the benefits can actually be questionable. Unless cost recovery is done through a land productivity-based system, it appears very difficult to design an equitable system of direct cost recovery. GOB's current view, which is accepted by IDA, is that cost recovery on drainage and flood control projects is not feasible at this stage.

5.10 A revised Irrigation Water Rate Ordinance went into effect in July 1983, and new water rules were issued in January 1984. Specific water charges for completed gravity irrigation schemes were published in June 1984. These rates were based on estimates of the O&M costs in each project area under consideration. These new rates amount to Tk 125-375 per ha per season depending on crops. Under the new rules, BWDB would be responsible for both the assessment and collection of water charges. Government agreed to initiate the collection of the new water rates in 1985 with a view to recover the cost of O&M by July 1, 1990 (Credit 1467-BD).

5.11 The project provides for irrigation development in the Gumti Phase I sub-project area. Water charges used in the farm budget analysis for Gumti amount to TK 275 ha. This rate was estimated on the basis of full recovery of O&M costs of irrigation facilities. In an attempt to strengthen BWDB's capability to assess O&M cost estimates for irrigation projects and to
develop an institutional capability to collect water charges, the project would provide for undertaking actions in the Gumti area aimed at improving BWDB's methodology for assessing O&M requirements and strengthening its field organization, manpower capability, and procedures for collecting water charges. The results of these actions would be incorporated in the O&M manuals to be prepared by PMU.

VI. BENEFIT AND JUSTIFICATION

Production and Employment

6.01 About 115,000 farm families, the equivalent of 670,000 people, would directly benefit from the project. Their present annual per capita incomes range from Tk 1,000 to Tk 1,900, the equivalent of US$40-65. The project's principal direct benefits would be increased foodgrain production and employment opportunities. Incremental foodgrain production would be 67,000 tons of milled rice and 13,000 tons of wheat and other crops. Direct employment would be permanently increased by about 4.2 million man-days per year of on-farm labor, at the full development stage of the project (project year 10). Two million man-days per year would be required for earth works during project implementation (project years 1 to 5), and 0.2 million man-days per year for O&M after the completion of the project's construction phase (project years 6 to 30). There would also be a substantial increase in secondary employment for marketing, processing and supplying farm inputs.

6.02 At present, there is no scarcity of labor in the project areas. It is very unlikely that foreseeable developments in these areas would result in labor shortage in the future. Due to the age composition of the population, the labor force growth rate in the project areas is estimated at 5.4% or 12,000 workers per annum. 1/ The incremental demand for labor due to the project should help to relieve, but will not eliminate, the high unemployment and underemployment in the project areas.

Economic Analysis

6.03 The economic rates of return (ERR) are estimated at 22% for Gumti, 28% for Naogoan and 16% for Madhumati-Nabaganga. At a discount rate of 12%, the assumed opportunity cost of capital in Bangladesh, the project's discounted benefits would be US$55 million, and the discounted costs US$23 million, leading to an economic net present value of US$32 million. Net present values for each sub-project are shown in Table 6.1. Economic benefits and costs are expressed in constant FY85 prices. The assumptions underlying the economic analysis are as follows:

(a) Project Life: Thirty years, with full development reached in project year 10 (FY95).

1/ Based on information from "Statistical Yearbook of Bangladesh (1981)" and "The Manpower Situation in Contemporary Bangladesh (1982)."
(b) Prices: Farmgate prices for traded goods are projected on the basis of the January, 1985 IBRD commodity price forecasts (Annex 8). Non-traded goods prices are based on domestic financial prices and are assumed not to change in real terms. With the new Chittagong Urea plant under construction, it is expected that Bangladesh will become a net exporter of Urea by the end of the decade. Therefore, the import parity price is used through 1990 and the export parity price for later years. Domestic prices and price components are translated into border prices using a standard conversion factor of 0.8.

(c) Project Costs: Project economic costs are given in Annex 8. All costs are included in the economic analysis with the exclusion of price contingencies, cost of land acquisition, costs of non-project specific studies, and taxes and duties. The O&M costs include those incurred during construction and throughout the useful life of project facilities (estimated at 30 years). Replacement cost of the pumping station in the Cumti sub-project is included as part of O&M costs, with an estimated lifetime of 10,000 hours for each pump. Low lift pumps used in the same area are not financed under the project; however, their investment and O&M costs, estimated on the basis of current charges by co-ops in the project area, are included in the economic analysis as part of on-farm cost. Land acquisition costs are excluded from the economic costs of the project on the basis that the true economic cost of land taken out of cultivation is the production foregone. The latter was subtracted from the project benefits. All costs are converted into FY85 terms using the deflators shown in Annex 8. Local costs are expressed in border prices by applying a standard conversion factor of 0.8.

(d) Project Benefits: Benefits would result from expected reduction of crop losses (which will be realized at the completion of construction or project year 5), minor changes in the cropping pattern (with full development reached in project year 10), and yield increases normally realized under-prevailing cultural practices in conjunction with such changes. An estimated decline in production from natural fisheries of about Tk 1.5 million per sub-project was deducted from project benefits. In addition about 300 ha in the river beds would be taken out of production as a result of the project. Production from that area was excluded from project benefits.
Table 6.1: ECONOMIC RATES OF RETURN AND NET PRESENT VALUE

<table>
<thead>
<tr>
<th>Sub-Project</th>
<th>ERR</th>
<th>NPV (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gumti Phase I</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Naogoan Polder I</td>
<td>28</td>
<td>18</td>
</tr>
<tr>
<td>Madhumati-Nabaganga</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Total Project</td>
<td>23</td>
<td>32</td>
</tr>
</tbody>
</table>

Sensitivity Analysis

6.04 Sensitivity tests indicate that the three sub-projects remain viable under a variety of assumptions regarding costs and benefits. As shown in Table 6.2, with costs up 20% and benefits down 20% or a lag in incremental benefits of two years and a 20% cost increase, the ERRs would remain at or above 12% for all sub-projects. For project to become uneconomical, i.e., generate a real rate of return below the assumed opportunity cost of capital (12%), benefits would have to fall 60% for Cumti, 70% for Naogoan and 45% for Madhumati-Nabaganga; or costs increase 140% for Cumti, 250% for Naogoan and 50% for Madhumati-Nabaganga. Such large changes in the benefit or cost streams are unlikely. Flows of economic benefits and costs are given in Annex 11.

Table 6.2: SENSITIVITY ANALYSIS

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gumti</td>
</tr>
<tr>
<td>(a) Base case</td>
<td>22</td>
</tr>
<tr>
<td>(b) Project costs increase 20%</td>
<td>20</td>
</tr>
<tr>
<td>(c) Project benefits decrease 20%</td>
<td>19</td>
</tr>
<tr>
<td>(d) Costs increase 100%</td>
<td>14</td>
</tr>
<tr>
<td>(e) Benefits decrease 50%</td>
<td>14</td>
</tr>
<tr>
<td>(f) Benefits delayed one year</td>
<td>20</td>
</tr>
<tr>
<td>(g) Benefits delayed two years</td>
<td>18</td>
</tr>
<tr>
<td>(h) Cost increase 20% and benefits</td>
<td>17</td>
</tr>
<tr>
<td>decrease 20%</td>
<td></td>
</tr>
<tr>
<td>(i) Project costs increase 20% and</td>
<td>18</td>
</tr>
<tr>
<td>benefits delayed one year ((b) and (f)</td>
<td></td>
</tr>
<tr>
<td>(j) Project costs increase 20% and</td>
<td>16</td>
</tr>
<tr>
<td>benefits delayed two years ((b) and (g)</td>
<td></td>
</tr>
</tbody>
</table>

Project Risks

6.05 According to supervision reports for ongoing projects and audit reports for completed projects in Bangladesh, project implementation has been hindered by a combination of factors, including:
(a) time overrun resulting from an inadequate allowance made for delays due to: (i) cumbersome administrative procedures and the associated dilution of responsibility and authority; (ii) weak infrastructure (physical and institutional) resulting in worse logistical constraints than foreseen; and (iii) changes in project environment due to unforeseen internal or external developments affecting the parameters on which the project was based; and

(b) ineffective use of technical assistance due to (i) poor definition of its purpose; and (ii) limited country involvement in its design, selection and monitoring.

6.06 Due consideration was given to these factors in the course of appraising this project. Whenever feasible, specific proposals are incorporated in project design to minimize the likelihood that this project would be affected to a similar extent by the above constraints. Some of these constraints are also being addressed under other projects, and as part of the broader policy dialogue with the country. It should be recognized, however, that the above constraints still exist and concerted efforts would have to be made by the implementing agency to minimize their impact on project implementation and to progressively eliminate them.

6.07 With specific reference to flood control and drainage projects, experience in Bangladesh indicates that one risk facing this project would be delays in processing land acquisition, engineering design, and revisions in Project Proformas. The issue of land acquisition was discussed with farmers' representatives and local and central government officials. No local opposition was raised, and all parties involved have agreed to assist in timely preparation and execution of the land acquisition plan. A component of the project is designed to strengthen BWDB's capabilities in planning, design and construction monitoring. BWDB institutional needs are also being strengthened in the context of other projects. It should be recognized, however, that this is a long term process and that BWDB would have to rely partially on the use of consultants. To deal with the issue of frequent revisions of Project Proformas (PP), it was agreed that a draft Project Proforma be prepared prior to negotiations to ensure conformity between PP and SAR. This PP along with the SAR and the legal documents formed the basis of project negotiations. The need for consultations between GOB and IDA prior to changing the PP has been stressed to Government, and was further highlighted during negotiations.

Environmental Impact

6.08 This project faces two possible environmental risks: possible hindrance to the migration of certain species of fish into the project area, and possible shift of floods to areas not yet protected from floods. A fisheries specialist was included in the appraisal team. Measures are introduced in project design to minimize any negative impact on natural fisheries. In addition, the project provides for studies aimed at improving the understanding of the link between flood control and natural fisheries. Investigations are provided for under the project to determine the extent of adverse impact on natural fisheries and devise ways to minimize such impact. Project design has already introduced measures to allow migration of the fish into
polders through properly designed and operated water control structures. Possible losses from natural fisheries would also be ultimately compensated for through fisheries development programs to be prepared under the project. The impact of polders on adjacent areas is also being studied and sufficient flexibility is built into project design to allow corrective action to be undertaken in light of new information. The project provides also for basin-wide assessment of the impact of flood control and drainage programs. Account was also taken during project design of the water transport requirements in the areas being protected from floods.

VII. AGREEMENTS AND RECOMMENDATIONS

7.01 Credit effectiveness would follow (i) appointment of the Project Manager, and effectiveness of funding agreements of other financiers (para. 2.19); (ii) completion of final designs and preparation of a work program for the first project year (para. 2.22); (iii) possession by BWDB of the land required for the first year construction (para. 2.28); and (iv) approval of the Project Proforma by GOB (para. 3.05);

7.02 In addition, the following assurances were obtained during negotiations:

(a) cultivation of jute and sugarcane in river beds would be controlled by discontinuing the leasing out of public lands in river beds to private cultivators (paras. 2.05, 2.07);

(b) agricultural and fisheries development programs for areas covered under Credits 864-BD and 1184-BP would be submitted to IDA for discussion no later than July 31, 1987 and those for this project no later than July 31, 1990 (para. 2.12).

(c) the inter-agency study group to review staff motivation for those involved in planning, design and construction monitoring would be established in accordance with terms of reference agreed with IDA and would submit its report to IDA for discussion, no later than December 31, 1986 (para. 2.16);

(d) a training program would be prepared by PMU and their consultants and agreed with IDA by March 31, 1986 (para. 2.20);

(e) GOB would undertake a consolidation of the findings of previous studies of BWDB's institutional capability, supplemented, if necessary, by additional information gathering and analysis. The study would be completed by June 30, 1986 and a report furnished to IDA for comments. Institutional improvements agreed with IDA would, thereafter, be carried out (para. 2.21);

(f) when submitting bills for reimbursement against embankment works, BWDB would certify that compaction was properly done and that embankments constructed meet required standards for safety (para. 2.24);

(g) BWDB would provide Deputy Commissioners with the resources necessary for verification and approval of land acquisition plans (para. 2.28);
(h) BWDB would submit land acquisition plans to Deputy Commissioners nine
months prior to construction start-up (para. 2.28);

(i) government would allocate the necessary funds in BWDBs annual budget
for operation and maintenance of project facilities (para 2.30);

(j) PMU would organize quarterly meetings with farmers representatives,
Upazila and District officials, and representatives of concerned
development agencies to exchange views on progress in project
implementation and would report its findings to BWDB management and
IDA (para. 4.04); and

(k) PMU would prepare annual work programs for each sub-project and would
keep BWDB management and IDA informed in writing of progress in their
implementation, including proposals for addressing outstanding issues
(para 4.07).

7.03 With the above conditions and assurances, the project would be
suitable for an IDA credit of SDR 50.1 million (US$48 million equivalent) on
standard IDA terms. The Borrower would be the Government of Bangladesh.
ANNEX 1

BANGLADESH

THIRD FLOOD CONTROL AND DRAINAGE PROJECT

Criteria for Selection of Sub-Projects

1. The total irrigation investment per net ha shall not exceed US$620 (at 1980 prices); the per ha drainage and flood control investment shall not exceed US$500 (at 1980 prices) including cost of land acquisition;

2. Each sub-project shall be at least 8,000 ha net;

3. In this early phase of the program, drainage is to be by gravity or tidal outlets;

4. The project will be primarily located in shallow flooded areas. Along 80% of the length of the embankment alignment, the normal flood depth shall not be in excess of 4.5 ft and along the remaining 20% not in excess of 6 ft. Submersible embankments should also be given consideration in areas such as Sylhet;

5. Beneficiaries should indicate support for the project.

6. The embankments shall give protection against 20 years floods, depending on the location, and against 100 years floods if significant loss of life may occur;

7. Due consideration given to the potential effect of proposed improvements on flood conditions in adjacent areas, on navigation and on existing fisheries.

8. Each sub-project shall be self contained even if such a project is a phase of an envisaged bigger project.

9. The construction of project works shall, if possible, be by labor intensive methods and by utilizing as far as possible, indigenous materials, consistent with sound engineering practices; and

10. The economic rate of return shall not be less than 15% for flood control and drainage works and not less than 20% when irrigation development is added.
Guidelines for Studies and Investigations

1. Hydrological and morphological studies at Gumti Phase I and Naogaon Polder I are scheduled to commence in FY84/85 for a period of three years. The hydrological study at Madhumati-Nabaraganga sub-project is scheduled to commence in FY85/86 and be completed at the end of FY86/87. The groundwater study at the Madhumati-Nabaraganga sub-project is scheduled to commence in FY85/86 and be completed at the end of FY86/87. The project would provide for:

(a) installation of the hydrological and groundwater equipment;
(b) carrying out the field measurements processing and publication;
(c) consultancy services for development, calibration and testing of simulation models and for training BWDB staff in their use; and
(d) in Madhumati-Nabaraganga Sub-project for the procurement of deep tubewell equipment.

A. Gumti Phase I: Hydrological and Morphological Study

2. Measurements on the Gumti river, Bari Nadi, Sonai Nadi, Solda Nadi, Bijni and Titas would be undertaken to meet the requirements of mathematical modelling of the Gumti basin. Some measurements would continue to meet BWDB's future needs and would become part of their normal data gathering effort:

(a) bed sampling and determination of grain-size distribution;
(b) water sampling and determination of sediment concentration and grain-size distribution (these samples should be taken regularly, especially during the flood season);
(c) suspended load transport measurements;
(d) bed load transport measurements;
(e) soundings and cross-sections at regular intervals;
(f) survey and inventory of sugarcane crops, tree crops, embankments and structures in the Gumti flood plain which affect the hydraulic roughness;

(g) water surface slope measurements during discharge measurements;

(h) stage-discharge measurements at suitable locations, in particular during floods; and

(i) overland flow and related topography.

3. The study would include the following:

(a) the field measurements described in para 2;

(b) data control, processing and reporting;

(c) development and calibration of a mathematical model of the Gumti and Titas Rivers and the Buri Nadi (including Salda Nadi); and

(d) the numerical simulation of the hydraulic and morphological response of the Gumti River to implementation of flood protection and drainage schemes. This is needed for this project as well as for the feasibility study of the Gumti Phase II Project.

4. Work involved in field measurements would comprise:

(a) the installation of 2 new auto recorders at Salda/Bijni River and Sonai Nadi;

(b) the installation of 11 new staff gauges, 2 at Gumti River, 2 at Buri Nadi, 2 at Titas River, 4 at the auto recorder sites and 1 at existing auto recorder site at Gumti River (Comilla);

(c) the installation of 7 overland gauges in the Gumti-Titas Basin;

(d) hydrographic surveys at about 50 locations along the Gumti River, Buri Nadi, Sonai Nadi, Salda Nadi and Bijni River. The surveys would be conducted at intervals of 3 km along the rivers;

(e) weekly discharge measurements at 12 locations along the rivers;

(f) sediment measurements taken twice a month during the period May to October at 4 locations along Gumti River, 2 locations along the Buri Nadi and 2 locations along the Salda Nadi;
(g) bottom sampling once a year at about 25 locations along Gumti Titas, Buri, Salda, Bijni and Sonai Nadi; and

(h) computation of discharge data, laboratory analysis of sediment, plotting and printing of hydrographic data and compilation of all the data and analysis in book form.

B. Madhumati/Nabaganga

5. Hydrological Study: The study provides for:

(a) upgrading, locating and scheduling installation of the hydrological recording network throughout the Gorai-Madhumati River: 5 gauging stations between Kamarkhali and Patgati;

(b) triangulation and cross-section survey at 5 km intervals along the river including computation and checking;

(c) measuring discharges and water surface slopes at weekly intervals;

(d) water level observations at hourly intervals;

(e) preparation of plans, computation of discharge measurements by computer; processing, checking and plotting of water level data; and

(f) printing of hydrographic data and compilation of data and analysis in book form.

6. Groundwater Study: A regional groundwater model being prepared by a consultant under the South West Rural Development Project would outline the permissible tubewell development based on overall regional conditions. In this regional model the Madhumati-Nabaganga subproject area will be simulated by a few nodes in the grid network. With prevailing local conditions, like lateral attractions from streams, upcoming and/or lateral intrusion of saline groundwater could not be considered accurately in such a regional model. A detailed groundwater model using a relatively dense grid network would be needed to determine the optimal tubewell configuration in the project area.
7. The study would provide for:

(a) mapping of existing tubewells, observation wells and piezometers on topographical maps;

(b) preparation of groundwater contour maps of the phreatic groundwater as well as of the potentiometric surface of the main aquifer. For preparation of the maps, 5 additional double piezometers are needed (one shallow piezometer in the upper clay layer and one deep piezometer in the main aquifer). One of the piezometers should be installed close to the Gorai River, in order to study the lateral inflow or outflow along the periphery and the possible leakage between the aquifer and the river;

(c) preparation of depth to water table maps;

(d) preparation of groundwater fluctuation maps;

(e) preparation of transmissivity maps of the main aquifer. For this study two additional pumping tests (6 days) with 6 to 9 observation wells each would be carried out. The test sites would preferably be selected on the basis of a geo-electrical field survey. The test wells would be developed for irrigation purposes after the tests. Each test is to be repeated 2-3 times;

(f) preparation of hydraulic head differences maps between the upper clay layer and the main aquifer;

(g) preparation of hydraulic resistance map of the upper confining layer;

(h) contour maps of the main aquifer, giving depth and thickness and the impervious base of the aquifer; and

(i) preparation of groundwater quality maps.

C. Naogaon Polder 1: Hydro-Morphological Study

8. During the implementation phase a mathematical model of the Atrai River system would be developed, capable of simulating the hydraulic and morphological processes and its response to river engineering projects. As the ultimate hydrological conditions in the project area depend to a great extent on the future downstream developments, this model should cover the whole of the Atrai River system, between Mohadebpur and its outfall in the Hurasagar (Karatoya) River. The results of this study are
of prime importance for the detailed design of the project, but also for
the planning of other drainage and flood control projects in the Basin.
It would in particular provide information on:

(a) future flood and tail water levels;

(b) embankment design and flood plain management;

(c) morphological changes of the main river channels;

(d) sedimentation of structures;

(e) navigability of the river; and

(f) impact on groundwater table and recharge potential.

9. The field measurements listed below would require mainly the
upgrading and improvement of the existing gauge network:

(a) weekly discharge measurements at 18 existing and 2 new stations
along the Arai-Gur-Camani, Jamuna, Nagor, Bhadai, Baranai-
Fakirni and Baral-Nandakaya Rivers;

(b) daily water level observations at 22 existing and 2 new stations
(5 times daily);

(c) water surface slope measurements during discharge measurements;

(d) sediment measurements at 6 locations at regular intervals (6-8
during the monsoon period and 2-4 during the dry season), compris-
ing suspended load transport and bed load transport measurements
and water sampling;

(e) bottom sampling once a year at approximate 6-8 km intervals;

(f) soundings and cross-sections at 3 km intervals, overland flow
measurement and related topography; and

(g) survey of hydraulic conditions in the flood plain.

10. The study would include the following:

(a) field measurements described in para 9;

(b) data collection, analysis, printing and reporting;
(c) development and calibration of the mathematical model of Atrai-Baranai-Baral Rivers system;

(d) numerical simulation of the hydraulic and morphological response to implementation of river engineering schemes in the Atrai Basin; and

(e) indicate remedial measures against possible adverse effects of basin-wide river development.

11. Upgrading of the existing hydrological network would include:

(a) the installation of 2 new water level and discharge stations along Bhadai and Baranai Rivers;

(b) the installation of 5 auto-recorders at existing stations (Atrai-Gur-Gamani, and Baranai Rivers); and

(c) replacement of 12 shifting type water level gauges by permanent gauges (fixed against structures or bhula poles).

D. Role of BWDB and Consultants in Hydro-Morphological Studies

12. Extensive flood protection works would result in a reduction of the storage of floodwaves, which in turn would cause an increase of peak discharges. Moreover, the flood levels tend to become higher because of the confinement of the flow and increase of backwater levels. The increase of peak levels due to construction of flood protection works in one area of the river basin would result in a higher risk of flooding for another area. The confinement of the flow to the floodway in combination with increased peak discharges would cause increase of flow velocity and subsequently an increase of the sediment transport capacity of the flow; erosion would likely be the result, while sedimentation would occur at other locations. Long term effects would include channel degradation, reduction of the slope of the river bed, local scour, and downstream deposition of sediments, possible change in river geometry and bank instability. One of the important effect on the long term could be lowering of the riverbed. This would have the advantage that, in time, flood stages would be reduced. Basin wide drainage characteristics would be affected as the base level of the river and the groundwater table are lowered; low water levels would also be lowered, and hence water intake structures may lose their function, and foundations of structures as bridges and harbor quaiwalls would be affected. The hydraulic and morphological changes - both short term as well as long term - that are associated with men induced changes in the river on a basin wide scale should be analyzed and their impact assessed.
13. The consultants would develop simulation models that enable a proper quantitative assessment of the hydraulic and morphological changes in the river basin associated with a variety of alternative development strategies. These models shall include a hydrodynamic model and a morphological model. The models shall be general in character allowing application to other river basins in Bangladesh. A data base management system for storage and retrieval of all pertinent hydrological, hydraulic and morphological data of the river and its environment shall be developed and shall serve as a basis for data handling for models. The accuracy of the models shall warrant a sound evaluation of river response to flood protection works without obscuring the significant and fundamental differences. In view of the relatively slow morphological processes and hereto related morphological time scale, the morphological model shall be capable of indicating not only the final condition of the river but also the intermediate conditions prevailing before reaching this final equilibrium state. Since MPO requires this type of simulation model in its planning work, BWDB and its consultants would work in close cooperation with MPO and would exchange information and available knowledge, including tested simulation models and would avoid duplication of efforts, unless such duplications are made necessary in order to implement the project in a timely manner.

14. Data Collection and System Analysis. The consultants shall prepare a basic qualitative description of the physical processes that govern the response to changes in the Atrai and Gumti River basin systems. For the purpose of modeling, the Atrai Basin is defined as the Atrai-Gur-Gumani River system, from about 30 km upstream of Mohadebpur to the confluence with the Karatoya River, including all relevant tributaries and branch channels. The Gumti Basin is limited to the Gumti River between the Indian border and its outfall point in the Meghna River, including the Titas River, the Bijni, the Buri Nadi and its tributaries Solda Nadi and Sonai Nadi. Topographical, hydrological, climatological, hydraulic and fluvial morphological data as well as relevant data on land use and infrastructure shall be collected from existing documents to the extent necessary and practical for evaluation of the environmental impact of alternative development strategies on the entire river basins. The consultant shall review and analyze the collected data, and if deemed necessary, shall specify additional data to be collected, such as discharge measurements, bed material grain size distribution and additional topographical surveys of river levees, flood embankments or other relevant features that are of significance in hydrodynamic modelling. The Bangladesh Water Development Board will make available to the consultants, free of charge, all available data, such as reports (including comments thereon), maps, aerial photographs, climatological and hydrological charts, river channel data, sediment transport data, or any other data that is considered to be essential for the study. In addition, the BWDB will carry out additional data collection as required by the consultant.
15. **Modelling of the River Systems.** The consultant shall initially prepare a basic hydrodynamic model of the specified Atrai and Gumti River basins, based on the presently available data on topography, infrastructure, hydrology, channel geometry and hydraulics. All pertinent and significant features of the river basins shall be included in the schematization for subsequent modeling. The model shall be calibrated for the existing situation using the available data. Calibration and subsequent verification shall continue until the results of the model are of the required accuracy that warrants its useful application in performing impact analysis. For the purpose of impact analysis, a number of river basin development scenarios will be specified by the consultant in close consultation with BWDB and other relevant agencies such as the Ministry of Irrigation (MPO) and Ministry of Port, Shipping and Inland Water Transport.

16. **Transfer of the Model and Training.** The Bangladesh Water Development Board will make available staff selected from the Hydrology Directorate as well as from the Directorate of Planning to cooperate with the team of consultants. During the implementation and development of the model, the consultants shall share their knowledge and experience with this staff, and the subsequent modeling study of the Atrai River basin shall be a joint effort of the consultant and BWDB staff. Consultant shall present recommendations regarding possible additional training for BWDB staff; the type and field of training required shall be indicated. The consultant shall transfer the model and the associated software to the Bangladesh Water Development Board.

17. **Duration of Studies.** The estimated duration of the study would be 18 months. This would require about 20 man-months of internationally recruited specialists for (a) development and calibration of the models, (b) recommendations for application of the model to specific development scenarios, and (c) the preparation of TORs for further work if deemed necessary.

18. **Reporting.** The consultant shall submit the following reports to the Bangladesh Water Development Board:

- quarterly progress reports;
- interim report, to be submitted after six months;
- users manual of the models, to be submitted upon completion of the first phase of the studies (18 months);
- draft final report to be submitted after completion of the second phase of the studies;
one month after reception of the draft final report, the Bangladesh Water Development will give its comments; and

- final report, to be submitted one month after reception of the comments of the Bangladesh Water Development Board.

E. Role of BWDB and Consultants in Groundwater Study

19. The Madhumati Nabaganga Project area is located in the southwest region of Bangladesh in the Magura and Narail Districts. It is situated between the Madhumati River and the Nabaganga River with the Kamarkhali-Magura Road as the northern border and the Halifax cut as the southern border of the project area. The project area is covered with a semi-pervious clay/silt layer. This upper clay/silt layers increase in thickness from the Madhumati River in the east towards the Nabaganga River in the west. The upper clay/silt layer is underlain by good permeable layers of sand and gravel. Regional groundwater balance studies (UNDP 1981 and Howard Humphrey 1984) have indicated that these sand layers (aquifer) offer good prospects for increase of groundwater abstraction. These regional water balance studies are, however, not sufficiently detailed to enable a reliable estimate of the available amount of groundwater in specific sub-areas. A hydrological study is, therefore, provided for with the following objectives:

- to determine the reliable yield from the potential aquifers under the project area.
- to indicate the possible number of tubewells and their distribution over the project area.

The study is estimated to be completed within 18 months. It would require about 5 man-months of internationally recruited specialists.

20. For the purpose of the study, the consultant shall review all data and reports which will be made available by BWDB and the Ministry of Irrigation (MPO). They will further advise and assist in the following field surveys:

- (a) mapping of existing dug wells, shallow and deep tubewells and observation wells;
- (b) indicate, based on the hydro-geological data obtained, the locations where extra piezometers should be installed to complete the data base needed for a reliable estimate of the groundwater yield. A total number of five extra double piezometers, shallow and deep, can be used.
(c) execute a geophysical survey to locate salt/fresh water interface in the south and salt groundwater occurrence in the project area and the thickness of the upper clay layer over the whole project area;

(d) indicate the locations for two pumping tests, prepare drilling contract documents for test boreholes and piezometers boreholes, invitation to tender and award of contract;

(e) supervise drilling, for test boreholes and piezometers borehole, installation of water level recorders and flow recorders;

(f) supervise pumping tests and record all data;

(g) conduct water level measurements in selected boreholes, dugwells, etc. over the whole project area; and

(h) analyze groundwater samples from selected boreholes over the whole project area with special regard to the use for irrigation purposes.

21. The hydro-geological data obtained would be processed with special reference to transmissivities, storage, leakage factors and all other relevant characteristics of the individual boreholes. Further the sub-surface flow from or to the adjacent aquifer shall be assessed. The consultants shall assess the effect of groundwater abstraction on the surface water flows in the Madhumati and Nabaganga Rivers and prepare the following maps:

   (a) contour maps of phreatic groundwater and piezometric surface of the main aquifer;

   (b) groundwater fluctuation;

   (c) hydraulic head difference between the upper clay/silt layer and the main aquifer;

   (d) hydraulic resistance of the upper semipervious layer;

   (e) contour maps of main aquifer (depth and thickness of main aquifer and depth of the impervious base of the main aquifer); and

   (f) groundwater quality.

22. The consultant shall prepare and calibrate a mathematical groundwater model, capable of simulating the groundwater movements in the
project area for specific development scenarios. In particular, the consultant shall determine the safe yield from the main aquifer for irrigation purposes, minimizing the effect of increased groundwater abstraction on surface water flows and penetration of saline/sweet water interface in the south. The consultant shall on basis of the model study determine the number and capacity of deep tubewells in the project area and their distribution over the whole area.

23. The Bangladesh Water Development Board will make available staff selected from the Groundwater Circle as well as from the Directorate of Planning, to cooperate with the team of the consultant. During the implementation and development of the model, the consultants shall share their knowledge and experience with BWDB staff and MPO.

24. The consultant shall submit the following reports to the Bangladesh Water Development Board.

- quarterly progress reports;
- interim report after six months, including the results of the data review, results of geophysical survey and proposal for silting test wells and piezometers before starting with preparation of tender documents for drilling;
- specifications and tender documents for drilling;
- draft final report, one month after reception of the draft final report, the Bangladesh Water Development Board will give its comments; and
- final report to be submitted one month after receipt of comments from BWDB.

F. Aerial Photography

25. Aerial Photography. The three subproject areas and the Cumti Phase II Project area will be covered by aerial photography. The aerial photography will permit (i) checking the rivers evolution; (ii) determining major drainage channels patterns; and (iii) assessing the present land use; and (iv) preparation of contour maps and (v) selection of areas suitable for irrigation development in Cumti Phase II. Aerial photography should be taken with stereoscopic overlap and, most importantly, during the proper season, possibly January-February when the sky is clear, the soil dry and most of the paddy is harvested. Only direct photoprints will be required although an uncorrected photomap may also be useful.
26. **Contour Mapping.** The detailed design for irrigation development requires the preparation of contour maps at scale 1/5,000, for which aerial photographs at a scale of about 1/8,000 or larger are needed. The preparation of contour maps necessitates an accurate ground control work and the processing of the photographs on stereophotogrammetric machines. All prints should be processed to compensate for contrast across the photograph through automatic dodging machine. The ground control work should be carried out immediately after having the aerial photoprints and indeed during the dry season.

27. **Contract for Aerophoto and Stereophotogrammetric Work.** The contract would include two phases: (a) the taking of aerial photographs at scale 1/30,000 over about 250,000 ha total and at scale 1/8000 over about 115,000 ha to be irrigated under the Gumti Phase I sub-project and Gumti Phase II project; and (b) the ground control works, the stereophotogrammetric processing and the preparation of maps. The timing of this contract should be very strict in relation with the season and with the requirement of project preparation for the Gumti Phase II project. The taking and processing of aerial photographs, the ground control work and the stereophotogrammetric processing do not accept second rate equipment or less than perfect methodology. The tender process should thus include careful preselection of prospective international contractors.

G. **Agricultural and Fisheries Development Programs**

28. The preparation of programs for agricultural and fisheries development would require:

(a) a determination of the likely sustainable potential in the area in term of crop, fish and livestock production;

(b) identification of the prerequisites for realizing that sustainable potential: technological practices, institutional needs (marketing, technology development, technology transfer, input supply and services), infrastructure (roads, irrigation, aquaculture), policy measures (eliminating hinderances to the adoption of the optimal mix of crops, to integration of crop/fisheries/livestock activities, and to the promotion of agricultural practices which are compatible with the social and economic objectives selected for each area); and

(c) preparation of an operational time table for bringing about the changes necessary for achieving the production potential in each area. Proposed steps would have to be consistent with (i) the need to protect beneficiaries against the risk inherent in unproven innovations or those perceived to be associated with fast
changes, and (ii) the requirement that complementary changes or actions would have to be carefully coordinated.

29. The programs for agricultural and fisheries development and/or phases thereof suggested for immediate implementation would be subjected to the type of evaluation normally undertaken in the context of a feasibility study. This would include:

(a) review and analysis of available information on agriculture and fisheries in the area, including information on on-going development programs;

(b) define existing cropping practices, extent of use of known improved technological practices and reasons for lack of use, if that is the case;

(c) identify proven technological practices available in the country but not used in the area;

(d) review the existing institutional capability in the area and identify and justify any required improvements;

(e) assess the area's needs as perceived by local people and their representatives (local government);

(f) prepare cost estimates for proposed development programs;

(g) provide an economic and financial analysis of proposed programs along with an assessment of the likely risks;

(h) prepare an implementation plan, including annual work programs; and

(i) prepare proposals for managing the planned development programs.

30. The preparation of fisheries development programs would require an assessment of the production potential of natural fisheries and alternative for developing aquaculture. Investigations would need to be undertaken in order to determine:

(a) Species composition of fish and prawn inside the floodplains in each project area, their relative importance;

(b) water current velocity limitations for fish and prawn to swim through the regulators and other structures, when opened and determination of other requirements for fish migration; and
(c) specific periods of time when movement and migration of fish/prawn into the project areas reach peak level.

31. An alternative for compensating for loss of fish from natural fisheries would be to provide support to aquaculture in ponds and other permanent waters within each sub-project area. To achieve this, investigations are necessary on:

(a) number of ponds, their total water area and extent of culturable area;

(b) determination of the total number of hatchlings and fingerlings of fish needed to stock annually all available culturable waters;

(c) determination of size, capacity and structure of fish hatcheries and rearing stations with recommendation on suitable sites to locate these in each subproject area; and

(d) identification of fish culture potential and desired enhancement programs.

32. The studies would also look into possibilities of reducing potential losses from natural fisheries in the process of providing flood control and drainage facilities. Such loss of fish production can be partially reduced, if the regulators and sluice gates are so designed and operated as to ensure smooth entry of fish and fish fry from rivers into the available waters within each sub-project area by opening them for pre-determined periods of time during fish breeding season (i.e. between May and early August). Again, during the recession of monsoon waters, the regulators and structures may be opened, again for predetermined short periods of time, to allow exits of fish seeking entry into the rivers and khals outside each sub-project area.

H. Feasibility Study for Gumti Phase II Project

33. The area proposed for study is prone to flooding from Gumti, Meghna, Titas, Buri Nadi and Salda Nadi. Along with the Gumti Phase I, this project would provide an opportunity to address the flooding problem in the Gumti basin in a comprehensive manner. The area comprises about 93,000 ha bound to the north and west by Meghna and Titas Rivers to the south by the Gumti River, to the west by the western branch of the Titas River and to the east by the footslopes of the Tripura Hills. There is scope for winter (boro) irrigation through pumping from the Meghna. Water availability in the Meghna is not a constraint for the moment, and is not likely to become one in the foreseeable future. Aerial photography and the simulation model for the Gumti-Titas basin are required for this study,
and should, therefore, be given priority when scheduling project implementa-
tion.

34. The primary objectives of the Gumti Phase II Subproject are:

(a) reduction in crop losses due to flooding and impeded drainage;

(b) increase in the area of transplanted rice cultivation in the aman season as a result of reduced inundation and improved water management;

(c) increase in the area of boro and rabi cultivation as a result of improved irrigation facilities and the reduction of the area under broadcast deep water rice;

(d) expansion of the area under improved rice (and wheat) varieties following the control of floods and improved water management; and

(e) improvement of agricultural, institutional and physical infrastructure necessary to materialize the above objectives.

35. The studies shall include:

(a) review all pertinent available data and identify data requiring collection or updating;

(b) undertake the necessary topographic surveys, hydrological measurements, agro-economic and socio-economic surveys;

(c) assess the extent of benefitted area, the potential impact of the proposed project works on the adjacent areas and the region as a whole and on existing economic activities (fisheries, etc.), possible negative effects in the project area and possible remedial measures;

(d) establish design criteria and planning concepts and preparation of project lay-outs, engineering designs and feasibility level drawings of relevant project components. In this respect due consideration shall be given to:

- the possibility of pump drainage in those areas where gravity drainage is technically and/or economically not feasible;

- the possibility to improve irrigation facilities through pumping water from the Meghna and/or Titas Rivers and to convey it through an improved Khal system;
- the possibility of combining irrigation and drainage pump stations;

- the design height of the embankments and the associated risk of failure;

- the special maintenance requirements of high embankments and the increased damage in case of failure (in particular in those areas where embankments have to be significantly raised as a result of river confinement and where the polder inundation levels will be considerably lowered through pumping);

- the potential for groundwater development and the current abstractions in the project area;

- assess the need for access and service roads, necessary to construct, maintain and operate the embankments, structures and other project facilities.

(e) preparation of cost estimates of project works on the basis of recent contract rates, including annual expenditure schedules in both local and foreign exchange currencies;

(f) preparation of operation and maintenance schedules, including staff, equipment and budget requirements;

(g) preparation of implementation schedules, showing project components in quantitative and monetary terms, equipment and staff requirements and procurement schedules, as well as specifications for engineering and other surveys required for detailed design and implementation;

(h) elaborate on the need and implications of improved water management and propose an organizational structure required to introduce a phased project implementation, institutional infrastructure (e.g. extension, credit, marketing, etc) and farmers organization; and

(i) assessment of project benefits for relevant project alternatives and the evaluation of project economics, including farm budgets, internal rates of return and sensitivity analysis.

36. Preparations for the construction of earthworks (and related structures where required) shall be immediately made following the feasibility study and the selection of the optimal plan. This shall include:
(a) selection of earthworks to be constructed during the first year, in compliance with the proposed overall implementation schedule;

(b) detailed engineering surveys, including:
   - longitudinal profiles;
   - cross-sections, interval between 30 and 60 meter;
   - plane table or grid survey of structure sites at scale 1:200;

(c) detailed design of embankments, roads and drains, including the preparation of provisional land acquisition plans;

(d) preparation of bills of quantities and cost estimates; and

(e) preparation of tender documents for construction.

37. The field surveys required for the feasibility study would include:

(a) **Topographic Survey**

1. Longitudinal profiles of river banks:
   - Buri Nadi 2 x 46 km
   - Salda Nadi 2 x 18 km
   - Ghungrur Nadi 2 x 22 km
   - Bijni Nadi 2 x 23 km
   - Titas upper 2 x 37 km
   - Meghna 25 km
   - Titas lower 38 km
   - Howrah 2 x 10 km
   - Others 2 x 10 km

   **Total** 395 km

2. Longitudinal profile of roads/railway:
   - road Companiganj-Brahmanbaria 30 km
   - road/railway Comilla-Akhaura 46 km
   - road Companiganj-Nabinagar 28 km
   - others 50 km

   **Total** 154 km

3. Cross-sections of rivers (bank to bank, extended up to 300 m in the flood plain) at 3 km intervals:
4. Cross-section roads/railways at 3 km intervals:

- Companyganj-Brahmanbaria 11
- Comilla-Akhaura 16
- Companyganj-Nabinagar 10
- others 15

5. Cross-section in main drains/khals at 5 km intervals = 40

Total number of cross-section = 151

(b) Hydrological Observations

1. Additional water level observations (daily)

- Kuti (Buri/Salda)
- Bangora (Buri/Oder khal)
- Bayek Rly. Bridge (Salda/Bijni)
- Brahmanpara (Chungur)
- Nemfabad Rly. Bridge (Sonai)
- Bathamata (Titas upper)
- Ramkrishnapur (Titas lower)

2. Additional discharge measurements (2-3 times/week)

- Kuti (Buri Branch/Salda Branch)
- Bayek Rly. Bridge 1/ (Salda Branch/Bijni Branch)
- Nemfabad Rly. Bridge 1/ (Sonai)

3. Overland gauges (for approx. location see map)

- 5 no's.

4. Continued operation of existing hydrometric stations:

- No. 109
- No. 110
- No. 111
- No. 113
- No. 114
I. On-Farm Demonstration Units

38. Ten water management demonstration units each covering an area served by a low lift pump (10-20 ha) would be organized on farmers' land following completion of major civil works. The demonstrations would follow the principles under the existing Irrigation Management Program (IMP). The purpose would be to train farmers in the efficient use of water (irrigation and drainage) under varying soil conditions and to meet the requirements of various crops. This component would be coordinated by BWDB staff in close cooperation with agencies of the Ministry of Agriculture in the area and development staff of of the local Government.

J. Study of BWDB's Institutional Capability

39. The review would build on past studies of BWDB. It would assess the consistency of their findings, their relevance and the adequacy of their coverage of the issues involved. It would fill any gaps in information and analysis. It would assess the quality and scope of on-going institution building activities as an aggregate program within BWDB. As a result, the review would provide a set of recommendations along with a timetable and procedures for implementing them.

40. The review would start with a diagnostic analysis of BWDB as a public development institution, with specific emphasis on: BWDB's obligations and responsibilities to the country, its organizational structure and modality of administration and management; the nature of its business; its legal framework; its relation to other development agencies; its sources of funding; the extent of its reliance on contracting; its contracting procedures; internal flow of information; channels of communication and decision taking. BWDB's expected and actual role in project
identification, feasibility studies, project design, project implementation, project operation and maintenance; administrative and management practices in BWDB's headquarters and field offices.

41. On the basis of information acquired in the diagnostic analysis, an evaluation would be made of BWDB's current capacity to effectively assume its responsibilities under its current organization, manpower strength, internal management practices, and the present nature of its work relations with agencies performing services complementary to its own or supplying it with needed services.

42. As a result of this evaluation, recommendations would be made for desirable improvements along with a timetable and procedures for implementing such recommendations with minimum impact on other agencies and national administrative arrangements and practices. The "package" of recommendations would provide a basis for improving BWDB's capability in project preparation, project design, programing construction works, construction management, quality control and operation and maintenance. In particular, such "package" would:

(i) identify tasks for which BWDB should rely on its own implementation capability, tasks for which it could rely partially or totally on contractors and consultancy services, and tasks which would be best transferred (in an orderly manner) to other agencies at the central or local levels, or transferred from other agencies to BWDB;

(ii) compare present staff to staffing requirements implied by the tasks selected for implementation by BWDB, define necessary changes, and propose a program (training and short term interim measures) to overcome any existing qualitative shortcomings;

(iii) define major functional job categories for professional staff (headquarters and field staff) to serve as a basis for specifying manpower requirements, a manpower development plan, and for allocating responsibilities and promoting the concept of accountability;

(iv) prepare a plan for potential redeployment of staff within BWDB or their reassignment to other agencies where a need for their skills is created elsewhere as a result of reallocation of responsibilities between BWDB and other agencies;
(v) assess existing training activities, programs and facilities, both under BWDB's management and other institutions of relevance to water development and propose ways for BWDB to strengthen its staff capability using local training facilities as well as possible opportunities overseas;

(vi) prepare a program for upgrading the internal planning system with particular emphasis on procedures for integrating BWDB's work in that of other development agencies serving the agricultural sector;

(vii) propose guidelines for selection, coordination and control of contractors and consultants during project implementation; and

(viii) provide guidelines for improving budgetary and accounting practices and financial management.

43. The final product would be an action plan acceptable to GOB and IDA which: (i) defines the role of BWDB in relation to national needs which, given the country conditions and goals, could not be met under alternative institutional arrangements, (ii) provides proposals, implementable under country conditions, for improving BWDB's capability to effectively play that role, (iii) provides a realistic timetable for introducing specific measures aimed at strengthening BWDB, or redefining its responsibilities. Administrative and financial arrangements for implementing those recommendations would be agreed between GOB and IDA following discussion of the review findings.

44. The review would be undertaken by a working group consisting of two senior BWDB engineers officially assigned to this review and two organization and management specialists. IDA would assist in reviewing terms of reference, reviewing interim and final reports and providing support as required and feasible during the review.
1. BWDB was established in 1972 as a semi-autonomous agency. It is managed by a Chairman and five Board Members respectively responsible for planning, implementation, operation and maintenance, finance, and administration. BWDB's mandate is to develop water resources and improve water flow for purposes of irrigation, flood and erosion control, town protection, and river training throughout Bangladesh. BWDB has limited capabilities for planning, design, and operation and maintenance. This has been the result of civil service regulations which prevented BWDB from attracting, motivating and, thus, retaining quality planning and design staff. This project provides for a temporary solution to this constraint for the specific purpose of executing project works, while simultaneously, it provides for establishing a forum to search for a more permanent solution.

2. In order to promote timely and effective implementation of the project, provision is made for establishing a Project Management Unit (PMU) under the Chief Engineer Planning. PMU, assisted by consultants, would be responsible for: (i) assisting field Divisions with planning project implementation, (ii) undertaking the engineering surveys, foundation investigation, design, (iii) assisting with the processing of tender documents, bids evaluation and the award of contracts for the construction of project facilities, and procurement (iv) monitoring progress in the construction program on behalf of BWDB's management, and (v) quality control. The Directorate of Planning Schemes I (DPS I) would be responsible for organizing and monitoring the preparation of the agriculture and fisheries development plans and for preparation of a feasibility study for the Gumti Phase II project. PMU and DPS I would be assisted by consultants. In recognition of the extra responsibilities, PMU and DPS I staff would be expected to assume under the project, they would be given a field allowance at a rate commensurate with that paid to local consultants for a maximum of ten days per month. This would encourage direct and frequent contact between headquarters and field staff and would ensure that the works and studies being implemented reflect local realities and needs. PMU and DPS I staff would also have an opportunity to participate in the training program provided for under the project.

3. PMU would consist of a Project Manager, a senior design engineer as a Deputy Project Manager, three design engineers, a planning engineer
and four junior planning and design engineers. This team would be supported by three surveyors, two draftsmen and eleven support staff (accountants, secretaries, clerks and drivers). PHU would also provide the administrative set up for training about 18 BWDB staff in the fields of engineering design, construction monitoring, organization and management (task identification, work loading and estimating, critical path analysis, budgeting, proposal writing, interdisciplinary cooperation, quality and cost control) and planning project implementation (organizing engineering surveys and investigations, organizing procurement, selecting among alternative engineering designs, evaluating proposals from consultants and contractors), and design of water development projects. Training would be in the form of on-the-job training in the context of this project, planned short term training abroad, workshops and seminars.

4. Improved work conditions and training provided would make it easier for BWDB to retain quality design and construction monitoring. It is recognized, however, that this is a short term solution to the issues impeding staff motivation in BWDB. Therefore, as an initial step towards identifying a longer term solution, the project provides for establishing an inter-agency study group to: (i) identify and provide a ranking for the reasons underlying the lack of staff motivation in the fields of planning, design and construction monitoring, (ii) review cases (if any) in Bangladesh where such limitations existed and were resolved, and (iii) review other countries' experience, particularly the experience with establishing autonomous planning and design units in such countries as Sri Lanka, Korea and India, among others. The study group would develop proposals amenable to implementation with a minimum of disturbance to the existing institutional arrangements. Such proposals would be reviewed by Government and IDA. The financial and administrative arrangements for their implementation would be agreed at that time.

5. For purposes of project implementation, BWDB would be assisted by a local consulting firm supported by three expatriate experienced engineers, preferably seconded to the local firm by an international firm of consultants with broad experience in the fields of design and construction monitoring. The following specialists of the local consulting firm would be required for an estimated total period of about 408 man-months of professional staff supported by three draftsmen, six surveyors and nine technical assistants over a period of six years.
(i) one senior irrigation and drainage engineer (team leader) : 60 man-months

(ii) three senior design engineers : 108 man-months

(iii) one programming and construction monitoring specialist : 60 man-months

(iv) three senior construction engineers : 180 man-months

This manpower input would be complemented by 90 man-months of expatriate specialist service over a period of 5 years:

(i) one senior irrigation, flood control and drainage engineer (deputy team leader) : 60 man-months

(ii) one senior design engineer : 15 man-months

(iii) one senior mechanical engineer : 15 man-months

90 man-months

6. In addition the Korean Government indicated its intention to provide about 78 man-months of specialists services over a period of 4 years:

(i) one senior drainage and flood control engineer : 48 man-months

(ii) one senior construction engineer (4 seasons X 6 months) : 24 man-months

72 man-months

The Korean specialists would be attached to PMU as advisors. They would be responsible for ensuring that the four junior engineers in PMU participate in project implementation and receive on-the-job training as required. They would develop a program of on-the-job training for BWDB staff and oversee its implementation. In cooperation with PMU staff, they would supervise the work of local consultants and provide them with the necessary technical support for developing appropriate procedures and for preparing manuals for construction monitoring and for operation and maintenance of project facilities, they would also monitor the quality of project works on behalf of PMU. The main task of the Korean technical assistance would be to prepare PMU to assume primary responsibility for
implementing flood control and drainage projects following the present one.

7. The local consulting firm would keep PMU informed on progress in project implementation, including any problems which may cause delay and alternative ways to address them. In particular, they would submit:

(i) an inception report, two months following the project starting date. This report would include a detailed work plan (nature and sequence of operations and the parties responsible for their implementation), an assessment of the resources required and recommendations for mobilizing such resources, specifications for field surveys and special studies needed (hydrological, morphological, modelling, etc), an evaluation of the pre-construction activities completed and any need for complementary or corrective measures, an estimate of civil works that could be undertaken during the first two construction seasons, and specific instructions for records to be kept in the field and at headquarters;

(ii) brief monthly progress reports on the status of procurement, progress and quality of construction activities and studies, and major findings of field visits;

(iii) detailed quarterly reports on progress in physical implementation of the project, financial status, training, and operation and maintenance of completed facilities;

(iv) annual work program for submission in time for use in the budget preparation process;

(v) operation and maintenance manual for each sub-project;

(vi) construction monitoring manual for BWDB; and

(vii) project completion report.

8. The local consulting firm and its expatriate specialists would be responsible, in cooperation with PMU staff, for (i) planning project implementation, (ii) organizing and supervising the necessary engineering surveys and undertaking design works, and (iii) monitoring construction activities (timing and appropriateness for intended end use).

9. BWDB would provide PMU and their consultants with the following items and services when required:
### BANGLADESH
### THIRD FLOOD CONTROL AND DRAINAGE PROJECT
### Implementation Schedule

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* Actual construction period extends from early January (after AMAN harvest) to June (monsoon season)
(i) available information of relevance to the project: statistical data, contour maps, Mouza maps, aerial photograph, feasibility studies and other relevant reports, hydrological data, records of river stages and morphology plans, rainfall data, groundwater studies conducted by BADC, MPO, and BWDB;

(ii) standard design manuals and type plans for hydraulic and other civil engineering structures and buildings as required;

(iii) professional staff as specified in para 3;

(iv) transport facilities, design equipment, and office supplies if such items are not included in the consultancy services contracts; and

(v) office accommodation and housing for consultants hired under bilateral arrangement.
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1/ Tk 40,000/month including overhead costs, transport, housing, travel, office space, equipment, support services, insurance and other related incidental costs. These consultants will be assisted by three draftsmen, six surveyors and nine technical assistants.

2/ Tk 250,000/month including overhead costs, transport, housing, travel, office space, equipment, support services, insurance and other related incidental costs.

3/ Tk 200,000/month including overhead costs, international travel and insurance. BWDB assumes the cost of transport, housing, office space, in-country travel, equipment, support services, insurance and other related incidental costs. These are provided for under the engineering and administration cost category.
**Land Acquisition Procedures**

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<td>8. Preliminary Estimate Made by Deputy Commissioner</td>
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BANGLADESH
THIRD FLOOD CONTROL AND DRAINAGE PROJECT

Proposed Credit Allocation

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Total: 48.0  74
### Estimated Schedule of Disbursement

(Bangladesh Third Flood Control and Drainage Project)

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### Cropping Area, Yield and Production

**Crop** | **P** | **W** | **N**  
--- | --- | --- | ---  
--- | ha | ha/ha | m.t. | ha | ha/ha | m.t. | ha | ha/ha | m.t.  
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---  
**I. Gumti Phase I** (29,500 ha) (29,500 ha) (28,700 ha)  
B. Aman | 2,000 | 1,350 | 2,700 | 2,000 | 1,350 | 2,700 | 1,200 | 1,900 | 2,280  
T. Aman (L) | 7,900 | 1,700 | 13,430 | 7,900 | 1,700 | 13,430 | 1,800 | 2,400 | 4,320  
T. Aman (HTV) | 4,000 | 2,500 | 11,600 | 4,000 | 2,500 | 11,600 | 4,200 | 3,800 | 13,960  
B. Aman | 3,700 | 1,900 | 7,700 | 3,700 | 1,900 | 7,700 | 2,000 | 2,000 | 5,000  
T. Aman (L) | 9,000 | 2,220 | 19,990 | 9,000 | 2,220 | 19,990 | 2,450 | 11,015  
T. Aman (HTV) | 6,000 | 2,700 | 16,200 | 6,000 | 2,700 | 16,200 | 11,000 | 3,000 | 33,000  
B. Aman + Aman | 7,500 | 2,100 | 15,750 | 7,500 | 2,100 | 15,750 | 5,700 | 2,300 | 13,110  
Boro | 3,200 | 3,200 | 10,240 | 3,200 | 3,200 | 10,240 | 12,000 | 4,400 | 52,600  
Wheat | 6,000 | 2,000 | 12,000 | 6,000 | 2,000 | 12,000 | 7,000 | 2,400 | 16,800  
Jute | 8,800 | 1,600 | 4,480 | 8,800 | 1,600 | 4,480 | 2,800 | 1,800 | 5,040  
Total | 52,100 | 52,100 | 54,000  
**Cropping Intensity X** | 177 | 177 | 189  

**II. Haogoa Phase I** (36,900 ha) (36,900 ha) (36,300 ha)  
B. Aman | 9,700 | 1,000 | 9,700 | 9,700 | 1,000 | 9,700 | 10,500 | 1,200 | 12,600  
T. Aman (HTV) | 400 | 2,900 | 1,160 | 400 | 2,900 | 1,160 | 800 | 3,800 | 3,040  
B. Aman | 2,150 | 1,200 | 2,580 | 2,150 | 1,200 | 2,580 | 1,350 | 1,400 | 2,170  
T. Aman (L) | 15,000 | 1,300 | 23,400 | 15,000 | 1,300 | 23,400 | 11,500 | 1,500 | 17,250  
T. Aman (HTV) | 1,100 | 3,200 | 3,520 | 1,100 | 3,200 | 3,520 | 7,500 | 3,500 | 26,250  
Boro | 37,000 | 3,200 | 54,400 | 37,000 | 3,200 | 54,400 | 18,000 | 4,400 | 79,200  
Wheat | 1,700 | 2,000 | 3,400 | 1,700 | 2,000 | 3,400 | 2,300 | 2,200 | 4,500  
Jute | 1,650 | 1,300 | 2,145 | 1,650 | 1,300 | 2,145 | 1,650 | 1,400 | 2,310  
Total | 51,700 | 51,700 | 54,000  
**Cropping Intensity X** | 140 | 140 | 149  

**III. Mahomati-Netrangana** (39,000 ha) (39,000 ha) (37,200 ha)  
B. Aman | 8,500 | 1,000 | 8,500 | 8,500 | 1,000 | 8,500 | 11,600 | 1,200 | 13,920  
B. Aman | 10,500 | 1,200 | 12,600 | 10,500 | 1,200 | 12,600 | 8,000 | 1,450 | 11,660  
T. Aman (L) | 900 | 1,500 | 1,170 | 900 | 1,500 | 1,170 | 3,900 | 1,600 | 6,520  
T. Aman (HTV) | - | - | - | - | - | - | - | - | -  
B. Aman + Aman | 12,000 | 1,600 | 19,200 | 12,000 | 1,600 | 19,200 | 4,600 | 1,800 | 8,200  
Wheat | 3,000 | 1,100 | 3,300 | 3,000 | 1,100 | 3,300 | 3,500 | 1,300 | 4,850  
Jute | 3,500 | 1,200 | 4,200 | 3,500 | 1,200 | 4,200 | 3,500 | 1,350 | 4,725  
Pulses | 8,500 | 400 | 3,400 | 8,500 | 400 | 3,400 | 9,000 | 500 | 4,500  
Oilseeds | 7,000 | 400 | 2,800 | 7,000 | 400 | 2,800 | 8,000 | 500 | 4,000  
Total | 53,900 | 53,900 | 55,700  
**Cropping Intensity X** | 142 | 142 | 150
## Inflation and Exchange Rates

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<th>FX86</th>
<th>FX87</th>
<th>FX88</th>
<th>FX89</th>
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The World Bank
ASADA, January 31, 1985
2/11/85
### Economic Price of Paddy

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</table>

Thai 5% Broken, FOB Bangkok 1/  
- Const 1984 US$ per MT (CY basis) 255 224 227 249 274 301 330 329 328 326 323 320 318  
- Const FY85 US$ per MT (FY basis) 241 221 227 239 263 289 317 330 328 326 323 320 318  
- Exchange Rate (Tk per US$) 29.0 29.0 29.0 29.0 29.0 29.0 29.0 29.0 29.0 29.0 29.0 29.0  
- Const FY85 Tk per MT 6900 6572 6940 7621 8368 9188 9582 9512 9441 9372 9303  
- CIF Chittagong 6202 5913 6246 6859 7531 8270 8624 8560 8497 8435 8372  
- Plus: Handling and Transport between Port and Market 3/  
  - Market Price 7432 7665 7396 8069 8681 9420 9774 9710 9647 9585 9522  
  - Less: Processing Cost 4/  
  - Ex-Mill Price of Rice 6852 6405 6016 7429 8101 8810 9194 9130 9067 9005 8942  
  - Equivalent Price of Paddy 0.67 4591 4345 4567 4977 5428 5923 6300 6117 6050 5923 5801  
  - Less: Handling and Transport between Mill and Farmgate 5/  
  - Farmgate Price, Tk per MT 4481 4235 4457 4867 5318 5813 6050 6007 5965 5923 5801  
  - Farmgate Price, Tk per Kg 4.48 4.23 4.46 4.87 5.32 5.81 6.05 6.01 5.97 5.92 5.88  

2/ Based on FY74-FY84 relationship between import unit prices and reference quality prices.  
3/ Based on RB II Project SAR(4348-DB). Non-traded cost components have been adjusted by SCF of 0.8.  
4/ Net of value of by-products, adjusted by SCF of 0.8.  
5/ Average distance assumed to be 10 miles. Adjusted by SCF of 0.8.

01/13/95

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**Table 8**
### Economic Price of Wheat

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<td>148</td>
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<td>147</td>
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<td>Cost 1984 USD per MT (FYt basis)</td>
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<td>148</td>
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<td>4261</td>
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<td>4721</td>
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2/ Based on FY76-FY84 relationship between import unit prices and reference quality price.
3/ Based on RD II Project SAR(4340-BH). Non-traded cost components have been adjusted by SCF of 0.8.
4/ Average distance assumed to be 16 miles. Adjusted by SCF of 0.8.

01/10/95
## Bangladesh

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### Third Flood Control and Drainage

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### Economic Price of Jute

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<td>14119</td>
<td>8740</td>
<td>8392</td>
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Table 9.10

1/ World Bank, EPWCB, January 1995.

2/ Based on FY76-FY84 relationship between export unit prices and reference quality prices.

3/ Based on DMD Small Schemes Project SAR (1985-88). Non-traded cost components have been adjusted by SCF of 0.0.

01/10/85
### Economic Price of Oilseds

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1/ World Bank, EPICD, January 1985.
2/ Based on FY76-FY84 relationship between export unit prices and reference quality prices.
3/ Based on MODD Small Schemes Project SAR(8015-HO). Non-traded cost components have been adjusted by SCF of 0.9.
4/ Cake recovery rate 0.66. Adjusted by SCF of 0.8.
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1/ World Bank, EPDCO, January 1985.
2/ Based on FY7-FY84 relationship between import unit prices and reference quality prices.
3/ Based on Swadho Smial Schemes Project S814815-90. Non-traded cost components have been adjusted by SCF of 0.8.
4/ It is assumed that by 1991 Bangladesh will become a net exporter of Urea.
5/ Based on BADC costs between primary distribution point and Upzila sales center, plus handling and transport costs to faragate

Adjusted by SCF of 0.8.
### Bangladesh

#### Third Flood Control and Drainage

**Economic Price of NP**

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2/ Based on FY76-FY80 relationship between import unit prices and reference quality prices.

3/ Based on both Small Schemes Project SAR14015-00. Non-traded costs components have been adjusted by SCF of 0.8.

4/ Based on DARC costs between primary distribution point and Upzilla sales center, plus handling and transport costs to faragate.

Adjusted by SCF of 0.8.

01/10/85

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- Page 74 of [Source](#)
### Bangladesh

**Third Flood Control and Drainage**

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**Economic Price of TSP**

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2/ Based on FY76-FY84 relationship between import unit prices and reference quality prices.
3/ Based on Rdwb Small Schemes Project SAR(1815-80). Non-traded cost components have been adjusted by SCF of 0.9.
4/ Based on RMRC costs between primary distribution point and Upzila sales center, plus handling and transport costs to faragate. Adjusted by SCF of 0.9.

01/10/85
## BANGLADESH

Third Flood Control and Drainage Project

### Economic Benefits and Costs - Qumti Subproject

(Tk Million)

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1/ O&M costs include the replacement cost of the pump.

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BANGLADESH

Third Flood Control and Drainage Project

Economic Benefits and Costs - Medhumati-Webassanga Subproject
(Tk Million)

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02/11/85
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### Third Flood Control and Drainage Project

#### Farm Budget - Dongtan Irrigation

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**1/ New Labor in 30% of the total labor requirement.**
**2/ New labor is 80% of the total labor requirement.**
**3/ Normal annual average family size is 6.0**

**Average Monthly Family Size = 6.0**
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**Note**: Equipment used includes earth work (2,000,000) and annual operation (2,000,000) (see details in report).
### Bangladesh

**THIRD FLOOD CONTROL AND DRAINAGE PROJECT**

**Table J. GUNI PHASE I SUBPROJECT**

**Detailed Cost Table**

(1K '000)

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### 1. RECURRENT COSTS

#### A. Operation & Maintenance

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**Sub-Total Structures**

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**Sub-Total Operation & Maintenance**

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**Total RECURRENT COSTS**

March 29, 1985 10:13
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**Notes:**
- Unit: 1000 $.
- Excludes costs associated with the construction of the dam.
- Costs are rounded to the nearest 1000 $.

**Source:**
Table A. Investment-Summary Report (1953)
### Table 6: CABALENGA-HAGANANZA SUBPROJECT
#### Detailed Cost Table

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#### 1. RECURRENT COSTS

**A. Operation & Maintenance**

1. **Earthworks**

   - Embankment Repair
     - Cost
     - Total

   - Road Maintenance
     - Cost
     - Total

   - Secondary Drainage Canal
     - Cost
     - Total

   - Revetments
     - Cost
     - Total

   - Road Pavement
     - Cost
     - Total

   **Sub-Total Earthworks**

2. **Structures**

   - Major Regulators
     - Cost
     - Total

   - Floor Dorings
     - Cost
     - Total

   - Culverts
     - Cost
     - Total

   - Bridges
     - Cost
     - Total

   - Foulaways
     - Cost
     - Total

   - Cross Regulators
     - Cost
     - Total

   - Buildings
     - Cost
     - Total

   **Sub-Total Structures**

3. **Supervision Incl. Transport**

   - Cost
   - Total

   **Sub-Total Operation & Maintenance**

**Total RECURRENT COSTS**

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March 29, 1985 10:37

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**Appendix**
### Table 9. MAGDAON POLER 1 SUBPROJECT  
#### Detailed Cost Table  

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#### Base Costs

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#### Sub-Total Earthworks

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#### Sub-Total Structures

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#### Sub-Total Supervision Incl. Transport

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### Notes

- March 29, 1995 10:16
### Bangladesh

#### Third Floor Control and Drainage Project

**Summary Accounts by Year**

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<th>Totals Including Contingencies (US$ '000)</th>
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<td></td>
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<tr>
<td>B. CIVIL WORKS</td>
<td></td>
<td></td>
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<tr>
<td>1. DRAINAGE AND FLOOD CONTROL</td>
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<td>5. EQUIPMENT</td>
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<td>6. SURVEYS AND INVESTIGATION</td>
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<td>8. ENGINEER. &amp; ADV.</td>
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**II. RECURRENT COSTS**

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| A. OPERATION & MAINTENANCE |        |        |        |        |       |       |       |       |        |        |        |        |        |        |       |       |       |        |        |
| Total RECURRENT COSTS |        |        |        |        |       |       |       |       |        |        |        |        |        |        |       |       |       |        |        |
| Total PROJECT COSTS   |        |        |        |        |       |       |       |       |        |        |        |        |        |        |       |       |       |        |        |

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March 29, 1985 10:14
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<th>05/06</th>
<th>06/07</th>
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<th>10/11</th>
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March 29, 1985 10145
## BASE COSTS

### A. LAND ACQUISITION
- Base Cost: $7,147.6
- Physical Continuities: $7,147.6
- Price Continuities: $7,147.6
- Total Incl. Cont.: $7,147.6

### B. CIVIL WORKS

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<th>Item</th>
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### 11. RECURRENT COSTS

#### A. OPERATION & MAINTENANCE
- Base Cost: $267.6
- Physical Continuities: $267.6
- Price Continuities: $267.6
- Total Incl. Cont.: $267.6

**Total RECURRENT COSTS:** $267.6

**Total:** $13,630.1

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March 27, 1985 10:150
## BANGLADESH
### THIRD FLOOD CONTROL AND DRAINAGE PROJECT
### BREAKDOWN OF SUMMARY ACCOUNTS
### (Taka '000)

### I. INVESTMENT COSTS

#### A. LAND ACQUISITION

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<th>Physical Continuance</th>
<th>Price Continuance</th>
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<td>207,280.0</td>
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#### B. CIVIL WORKS

1. DRAINAGE AND FLOOD CONTROL

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#### CIVIL WORKS

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### II. RECURRENT COSTS

#### A. OPERATION & MAINTENANCE

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#### TOTAL RECURRENT COSTS

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### TOTAL INVESTMENT COSTS

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### TOTAL RECURRENT COSTS

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### TOTAL INCOME COSTS

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March 29, 1985 10132
### Table 14

#### THIRD FLOOD CONTROL AND DRAINAGE PROJECT

**Summary Account by Project Component (TK '000)**

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<td>Physical Contingencies</td>
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<td>24,259.3</td>
<td>20,979.6</td>
<td>70,440.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Price Contingencies</td>
<td>257,762.5</td>
<td>203,573.1</td>
<td>188,882.9</td>
<td>650,221.4</td>
<td>5.1</td>
<td>33,477.8</td>
</tr>
<tr>
<td>Total PROJECT COSTS</td>
<td>863,855.9</td>
<td>655,323.5</td>
<td>596,344.7</td>
<td>2,115,524.1</td>
<td>4.9</td>
<td>103,937.7</td>
</tr>
<tr>
<td>Taxes</td>
<td>37,977.0</td>
<td>21,824.8</td>
<td>15,545.8</td>
<td>75,347.5</td>
<td>3.4</td>
<td>2,544.5</td>
</tr>
<tr>
<td>Foreign Exchange</td>
<td>249,029.2</td>
<td>192,886.9</td>
<td>147,337.3</td>
<td>592,253.3</td>
<td>4.3</td>
<td>25,387.7</td>
</tr>
</tbody>
</table>

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BANGLADESH

THIRD FLOOD CONTROL AND DRAINAGE PROJECT

Polder Concept and Agricultural Development

Polder Concept

1. Depending on the topography and available financial resources, different technical solutions to achieve a degree of flood control and drainage may be considered:

   Embankment along the river banks to prevent overspilling;

   Simple Polders: Construction of a surrounding embankment, with sluice structures (regulators) to permit the discharge of the internal runoff as long as the outside river level is low enough;

   Tidal Drainage Polders: Construction of same embankment, with sluice structures to permit tidal drainage. This is only possible in low lying areas, close to the sea where the tidal range is sufficient to permit discharge of internal runoff at low tide; and

   Pump Drained Polders: Construction of same embankment with sluice structures, supplemented by pumping units to help discharge the internal runoff when the river level outside gets too high for gravity outflow.

2. To the above categories of flood protection, correspond various solutions for irrigation:

   - in the case of embankments and "simple" polders, irrigation may be provided through (i) LLPs operating along the embankment if there is a sufficient perennial flow in the outside creeks or rivers, or (ii) by allowing the outside water to enter the drainage channels through the regulators if the topography and river level at low stage flow so permit or (iii) by using DTWs or STWs, if the groundwater conditions are favorable. Supplementary irrigation during dry spells of the monsoon season can be arranged by opening flushing gates to let the outside water in. Check structures at convenient locations within the polder area would be needed to retain water for irrigation purposes.
- the tidal drainage polders may also benefit of tidal irrigation, if the tidal range during the dry season and the topography are adequate. Generally, tidal irrigation needs to be supplemented by LLPs. In low-lying tidal areas, aquifer conditions are generally poor and preclude the use of tubewells.

- the polders with drainage pumps can generally be equipped with reversible pumps to provide irrigation during the dry season. This is the costliest solution, both with regard to initial investment costs and the ensuing operating costs. This alternative may, nevertheless, present the only choice in deep-flooded areas where the topography makes gravity drainage impossible.

3. The proposed project consists of one subproject of the 'flood protection embankment' type (Cuati Phase I) and of two subprojects of the 'simple polder' category (Naogaon Polder I and Madhumati-Wabaganga). This approach to flood protection, although incomplete, permits to (i) serve as large an area as possible with available funds and does not require high recurrent costs for operation and maintenance, (ii) provide basic flood protection to as many people as possible, (iii) create conditions and motivation for gradual agricultural development by eliminating the major risk of crop failure and (iv) provide partial flood protection which may be upgraded by 'pump drainage' when and if economic conditions would warrant it at a later stage.

4. The degree of flood protection of the 'simple polder' system is limited by the interplay of two conflicting factors:

- the (outside) river level range (between low and high stage) is about 15 to 20 feet. The rivers start rising in May, cause damaging inundation from mid-July, reach the peak level usually mid-August and recede below inundation level in October;

- the (inside) monsoon rainfall may total about 50 inches for the months of June to September, while the evapotranspiration for the same period is only about 22 inches. The resulting runoff gets impounded inside the polder, causing the internal water level to rise and flood the low lying areas. The extent of damaging inundation depends largely on the topography of the area. The feasibility of the 'simple polder' concept hinges on the existence of a deep low lying portion of the polder area sufficient to temporarily impound the runoff from the monsoon rainfall.
5. For the three subprojects, the hydrograph analysis has been made and the results are shown in the form of the flood routing curves attached to this Annex. The analysis of the inundation conditions after the project is completed indicates that (i) flood depth and duration are reduced, (ii) the rise of water level is retarded, slowed, and the peak is reached later in the cultivation season.

6. Increased crop production in a polder or an embankment protected area would mainly come from (i) reduction of crop losses due to late arrival of flood and reduced flood level, (ii) shift from broadcasted deep water to transplanted shallow water rice cultivation, (iii) substitution of low yielding varieties, and (iv) increased cultivation of dry season crops in case irrigation is provided.

7. Based on flood depth, the present land use in Bangladesh has been classified into the following four groups:

<table>
<thead>
<tr>
<th>Land Class</th>
<th>Flood Depth, m</th>
<th>Cropping Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Highland</td>
<td>Above flood level or less than 0.3 m temporary submersion</td>
<td>Rainy Season: Broadcast Aus + Rabi Crops 1/ Transplant Aus + Rabi Crops Jute + Rabi Crops B. Aus + T. Aman+ Rabi Crops Sugarcane</td>
</tr>
<tr>
<td>(2) Medium Highland</td>
<td>0.3 - 1</td>
<td>T. Aman + Rabi Crops T. Aman + Boro Rice Jute + Rabi Crops B. Aus + Rabi Crops Mixed B. Aus/Aman+ Rabi Crops Sugarcane</td>
</tr>
<tr>
<td>(3) Medium Lowland</td>
<td>1 - 2</td>
<td>B. Aman + Rabi Crops Mixed B. Aus/Aman+ Rabi Crops Boro Rice</td>
</tr>
<tr>
<td>(4) Lowland</td>
<td>Over 2</td>
<td>B. Aman Rabi Crops Boro Rice</td>
</tr>
</tbody>
</table>

1/ Pulses, oilseeds, vegetables and wheat are the major rabi crops. Their cultivation is dependent upon the presence of enough residual soil moisture and/or irrigation.

8. Following the completion of a polder or embankment protected scheme, the cropping pattern would be modified according to different soil
types, availability of irrigation water and reduction in level and duration of floods. Possible major cropping pattern changes in each land group within a protected area include:

1. **Lowland area.** Low yield, long stem and long growth period b. aman would be substituted by improved b. aus or mixed b. aus and aman. Boro rice and wheat could be expanded if irrigation is available in dry season.

2. **Medium lowland area.** T. aus and t. aman would replace b. aman in rainy season. Boro rice and wheat could be grown in dry season if irrigation is available.

3. **Medium highland area.** Mixed b. aus and aman would decrease and be substituted by either t. aus or t. aman and b. aus followed by t. aman. In addition to other rabi crops, boro rice and wheat could also be dry season crops when irrigation can be supplied.

4. **Highland area.** Cropping patterns would remain the same as pre-protection stage but reliable irrigation would be needed to achieve higher potential yields.

9. The success of a well designed and constructed polder project would mainly depend on sound operation and maintenance of the polder facilities and on the farmers’ awareness of and adaptability to the new environment. Farmers in different parts of a polder area would face different problems. Generally speaking, the reduced flood level in lower lying areas would necessitate substantial changes in cropping patterns and farming techniques for the farmers who have traditionally cultivated deep water and broadcast rice and may be less familiar with shallow water transplanted rice. They may also be short in knowledge on the use of water for irrigation of dry season crops. In higher land areas, farmers could get less water on their fields during the monsoon season because of the polder facilities and would have to depend on reliable supplementary irrigation for their crops. All farmers would have to improve their farming techniques to increase yields and cropping intensities. Thus, an agricultural and a well planned fisheries development program would need to be prepared for implementation following completion of project facilities.

10. In order to facilitate the transition of the polder areas, the project provides for (i) aerial photography and mapping of the lands to help with project implementation and provide a basis for defining suitable cropping patterns, demonstrations to test the need and utility of field bunding, the use of adequate on-farm irrigation channels, and possible alternatives to remedy animal power shortage.
Agriculture in the Cumti Phase I Subproject area

11. The subproject area is located in the Comilla District and to the west of Comilla town. It is bounded by the Cumti river on the north and east, the Daudkandi-Comilla road on the south and the Couripur-Homna feeder road on the west. It has a gross area of approximately 37,300 ha of which about 29,500 ha are cultivable. It is a part of the Megna-Cumti flood plain and is intersected by a network of natural drains (khals), old river courses and spill channels of the Cumti river. It has a population of 315,000 with a density of 960 inhabitants per square kilometer, making it one of the most densely populated areas in Bangladesh. The total number of farming families is around 44,000; the average farm size is 0.8 ha; however, thirty percent of the farm household cultivates only 0.4 ha or less which puts them below subsistence level. The current annual cropping intensity in the subproject area, 177%, is among the highest of the nation. The better cultural practices generally adopted by farmers in Comilla area lead to a higher yields when excessive flood and drought do not occur.

12. Crop production is usually affected by floods and drought spells. Floods are a combination of (1) flash flood from the Cumti river in early monsoon period, May and June; (2) overbank flow from the Meghna-Cumti rivers during periods of high Meghna stage in late monsoon season; and (3) impeded drainage during periods of high Meghna stage. Flood depth and duration are variable in time and location, but generally increase towards the low lying area in the west. In an average year about 26,000 ha (70% of the subproject area) is inundated to a depth of more than 0.3 m and the maximum depth in the lowest area could reach around 3.0 m.

13. Cropping pattern is governed by the flood situation in monsoon season and the availability of irrigation in dry season. In the subproject area, b.aus, mixed b.aus and ama t. aus, t. aman and jute dominate in monsoon season. Wheat and boro rice are the major dry season crops, but, their present acreages are restricted given the inadequate supply of irrigation water due to low river flow in the dry season and limited underground water development. Only about 3,700 ha is irrigated under manual lifting, low-lift pumps and tubewells at present.

14. The extent of flood damage to crop production depends on the depth, duration and time of occurrence of floods and the kind of crop grown. Heavy crop losses usually occur from early flood in May and June which submerges the maturing t. aus and boro rice plants and makes the harvest impossible. The subsequent flood would affect the normal growth of b. aus and aman crops. Annual loss due to floods are estimated by BWDB from about 5% to complete loss of crop with an average of about 20%.
15. The provision of flood control and drainage works and additional irrigation in the subproject area would result in the following improvements in the future: (1) reduction of flooded arable land area from about 26,000 ha to about 18,000 ha; (2) delayed arrival of floods; and (3) increase in the irrigated area from about 3,700 ha to over 13,000 ha. These changes, in turn, would have the following impact on crop production: (1) a decrease in the acreage of broadcasted rice; (2) acreage of high yielding t. aman expands from its present 6,000 ha. to 11,000 ha; and (3) boro rice acreage almost quadruples through the increased supply of irrigation water.

16. Ten water management demonstration units each covering an area served by a low lit pump (10-20 ha) would be organized on farmers' land following completion of major civil works. The demonstrations would follow the principles under the existing Irrigation Management Program (IMP). The purpose would be to train farmers in the efficient use of water (irrigation and drainage) under varying soil conditions and to meet the requirements of various crops.

Agriculture in the Naogaon Polder I Subproject area

17. The subproject area is in the Naogaon District. It is bounded by the Little Jamuna river to the east, the Atrai river to the west and south and the Naogaon-Mohadebpur road to the north. It covers a gross area of 46,100 ha of which about 37,000 ha is cultivable. The total population is around 324,000 people, including, 31,000 farm families. The average farm size is about 1.2 ha, but 45% of households cultivate 0.8 ha or less. Among the latter group, 24% cultivate 0.4 ha or less putting them below the subsistence level.

18. The flooding problem in the subproject area is due to a combination of: (1) inflow of river water through the khals; (2) overbank spill from the main rivers at high flood stage; (3) drainage congestion from the north. In a normal year, about 32,000 ha or 70% of the gross area is subject to flooding. Approximately 9,000 ha, is inundated to a depth of 0.6 - 0.9 m. and about 3,000 ha, including three beel areas, is under a depth of more than 3.0 m. During the dry season, about 2,000 shallow tubewells and 30 deep tubewells are serving in the subproject area.

19. Current cropping intensity is about 140%. In monsoon season, b.aus, b.aman and t. local aman are the major crops. In dry season, boro rice is the leading crop, next to wheat, pulses and oilseeds. Early flood usually causes severe damage to the maturing boro and t. aus crops and also affect sowing or transplanting of aman crop.

20. The project flood control and drainage improvement works would reduce flood levels and delay flood occurrence time, thus minimizing boro
and aus losses and allowing more land to be cultivated into improved t.aman. In addition, the re-excavation of khals, construction of new secondary canals and installation of water control structures would make it possible to maintain water at a level which allow irrigation of aman crop when dry spells occur during monsoon season or for limited irrigation of boro and aus crops in dry season.

Agriculture in the Madhumati-Nabaganga Subproject area

21. The subproject area is located in both Magura and Narail Districts. It is bounded by the Madhumati river to the east and the Nabaganga river to the west. It has a gross area of 45,000 ha of which about 38,000 ha are cultivable. The current population is about 230,000, including 39,000 farming families. About 50% of farm families cultivate less than 1.2 ha. About 15% of those cultivate less than 0.3 ha.

22. Annual flooding in the subproject area originates from: (1) inflow of river water through the khals in early monsoon season, May–July; (2) overbank spill from river during high river stage in late monsoon, July–September; and (3) rainfall run-off accumulated in the low lying areas due to drainage congestion. About 20,000 ha. or 45% of the total area is flooded in a normal year to a depth of more than 0.3 m, of which about 10,000 ha is flooded to over 1.0 m. Groundwater irrigation through shallow or deep tubewells is limited due to watertable depth in northern and central parts, high percolation rate of the soil and water salinity content in the southern area. Surface water irrigation is also constrained by the limited river flow in the dry season and the saline water intrusion. Rainfed pattern characterizes agricultural production in the sub-project area.

23. Present cropping intensity is about 142%. In monsoon season, rice cultivation is dominated by b. aus, b. aman, and mixed b. aus and aman. Low yields inherent in the varieties are exacerbated by floods in early growth stage (aus) and prevailing dry spells in late stage (aman). Complete crop loss happens frequently in areas where floods come or recede early. In dry season, pulses and oilseeds are the main crops; wheat is limited due to lack of irrigation water supply.

24. Construction of embankment and installation of control structures along the main rivers in the subproject area would delay the arrival and reduce the depth of floods. They would also maintain water level in late monsoon season to permit supplementary irrigation. These changes would have the following impact on crop production: (1) expansion of b. aus, (2) reduction of mixed b. aus and aman; and (3) increase of t. aman. In addition, crop yields would be increased as farmers would use more inputs and adopt available farming techniques under improved cultural conditions.
BANGLADESH

THIRD FLOOD CONTROL AND DRAINAGE PROJECT

Related Documents in Project File

Drainage Analysis Charts
Project Description
BWDB Organization Chart
Procurement Schedule
Feasibility Studies
BANGLADESH
THIRD FLOOD CONTROL AND DRAINAGE PROJECT
Organization of the Bangladesh Water Development Board

Chairman

Member Planning
- Chief Engineer Monitoring & Evaluation
- Chief Engineer Planning
- Chief Engineer Hydrology
- Chief Engineer Water Investigation
- Chief Engineer River Research

Member Implementation
- Chief Engineer Food for Work
- Chief Engineer Project 1
- Chief Engineer Project 2
- Chief Engineer Project 3
- Chief Engineer Project 4

Member Operation & Maintenance
- Chief Engineer North-West Zone
- Chief Engineer South-West Zone
- Chief Engineer South-East Zone

Member Finance
- Controller of Finance & Accounts
- Director Store
- Director Purchases

Member Administration
- Director Land & Water Use
- Director Land & Revenue

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BANGLADESH
THIRD FLOOD CONTROL AND DRAINAGE PROJECT
Project Headquarters Organization

BWDB Chairman

Member Planning

Chief Engineer
Planning I

TA Project
Preparation

Director
DPS I

Project Manager
PMU

TA Project
Implementation

Project Field Organization

Zonal
Chief Engineer

Superintending
Engineer

Executive
Engineer

Revenue Officer
Land Acquisition

Subdivisional
Engineer
Procurement
& Contracts

Subdivisional
Engineer
Construction
Supervision

Subdivisional
Engineer
O&M

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THIRD FLOOD CONTROL AND DRAINAGE PROJECT

1. GUMTI PHASE I
2. NAOGAON POLDER I
3. MADHUMATI - NABAGANGA
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BANGLADESH
THIRD FLOOD CONTROL AND DRAINAGE PROJECT
GUMTI PHASE 1 SUB-PROJECT

PROPOSED PROJECT:
- Embankments
- Main Drainage Khols
- Regulator Lock
- Road Improvement

EXISTING:
- Metalled Roads
- Partly Metalled Roads
- Bridges
- Khols
- New Drainage Khols
- New Irrigation Khols
- Embankments
- West Irrigation Area (Pump Station Daudkandi)
- Drainage Regulator
- Pump Station
- West Irrigation Area
- Contours
THIRD FLOOD CONTROL AND DRAINAGE PROJECT
NAOOGAON POLDER SUB-PROJECT
PROPOSED PROJECT:

- Resectioning/Raising Existing Low Embankments
- New Embankments or Resectioning/Raising Existing Tracks
- New Drainage Canals
- Drains to be Re-excavated
- Flushing Sluices
- Regulators
- Water Control Structures
- Road Improvements

EXISTING:

- Metalled Road
- Partly Metalled/Unpaved Roads
- Rivers
- Khals
- Beels
- Retired Embankments
- Contours
PROPOSED PROJECT:
- Embankments
- Regulators
- Road Improvements

EXISTING:
- Partly Metalled Roads
- Unmetalled Roads
- Railways
- Towns
- Rivers
- Main Drainage Khals
- Khals
- Beals
- Paved Embankments
- Embankments
- Regulators
- Contours

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FEBRUARY 1985