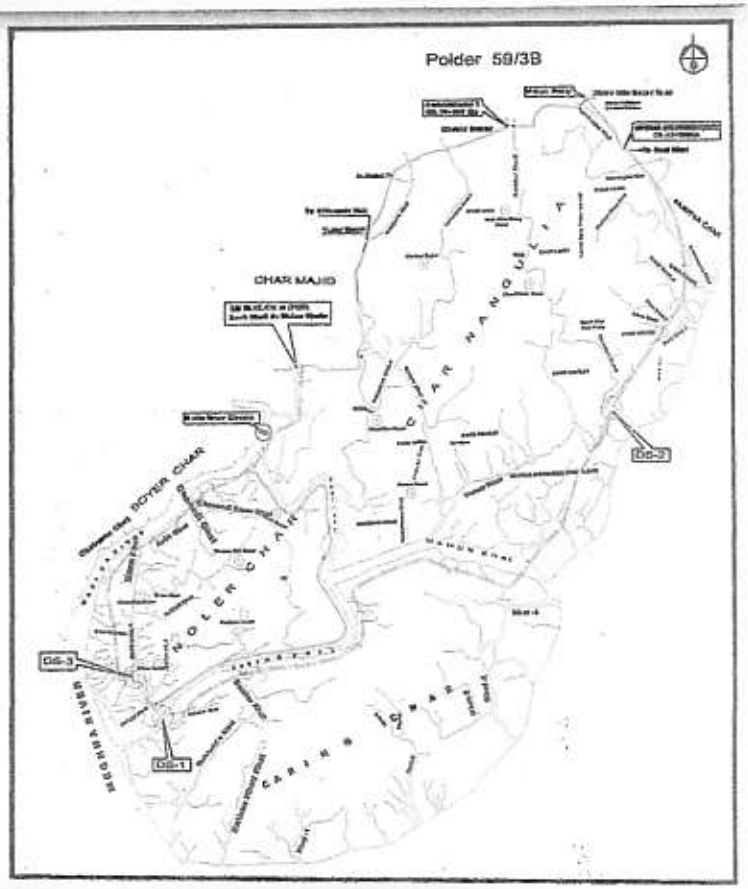
Koen de Wilde

Ministry of Water Resources
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Report on

Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char



Main Report
Final

Appendice 2A

August 2007

Development Design Consultants Ltd.
In association with
House of Consultants Ltd.

DEVELOPMENT DESIGN CONSULTANTS LIMITED

Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char (under CDSP-III)

Project Office: DDC Centre
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Memo No. DDC/WRE/CDSP-III/25/2007 Dated : 15-08-2007

To
The Team Leader
CDSP-III,
BWDB Compound, Sonapur,
Maizdee Court, Noakhali.

Subject : **Submission of Final Report**

Dear Sir,

In accordance with the requirement of the Terms and Reference (Section 4.4) of the Consulting Services for Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char (under CDSP-III) we are pleased to submit the Final Report of the study in 5 sets for favour of your kind disposal. The Report consists of two Volumes – The Main Report and The Annexure.

It is stated here that the Draft Report was submitted to you on 14.05.07 and comments on which received from you on different dates. A Technical session on the Study was held on 25.06.07 in the BWDB Conference Room where the study results were presented and discussed.

Based on the discussions and decisions of the technical session and comments received on the draft, this Report on Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char has been finalized.

Thanking you and assuring you our best services.

Yours sincerely,

(Md. Lutfur Rahman)
Team Leader/
Water Management Engineer

Enclosure : 1. Final Report – 5 sets of 2 Volumes each.

CC to : 1. The Project Director, CDSP-III/Director, PMU-ESPP, BWDB, Dhaka.
2. The Coordinator/Chief Technical Advisor, CDSP-III, Dhaka

Highlights

Studies Conducted

Char Nangulia Development Plan – Part-A

Noler Char Development Plan - Part-B

Preliminary Development Plan of Caring Char – Part-C

External Drainage System Study – Part-D

Polder Options of Char Nangulia & Noler Char

Option-1: 2 Polders, Mamur Khal and Caring Khal Open

Option-2: 1 Polder 2 Drainage Units, Mamur Khal closed

Option-3: 1 Polder 1 Drainage Unit, Mamur Khal and Caring Khal closed.

Option-4: 1 Polder, 2 Units, Mamur Khal and Caring Khal closed

Selected Option : Option -4

Salient Features of Part - A & Part - B

Features	Part-A	Part – B
Project Area	8994 ha	2691 ha
Cultivate/Cultivable Area	6964 ha	2011 ha
Existing Households	8500 Nos.	4690 Nos.
Embankment	29.0 km	23.75 km
Drainage Sluice	2 Nos.	1 No.
Drainage Khals	63.78 km	26.40 km
Rural Roads	37.77 km	17.45 km
Multipurpose Cyclone Shelter	17 Nos.	10 Nos.
Plan Cost	Tk. 694.103 M	Tk. 314.735 M
Increased Yearly Crop Production	13487 Mt.	2455 Mt.

Salient Features of Part-C

Project Area	6852 ha
Grazing/Leski Area	3795 ha
Cultivated/ Cultivable Area	1788 ha
Existing Homesteads	533 Nos

Land level yet to be matured.
Feasibility study for empoldering to be delayed by 5-7 years

Slient Features of Part-D

2nd Cross-Dam on Hatiya River will be located at D/S of outfall of Char Majid out of the three location options.

Hatiya River avoided as drainage outfall channel due to its susceptibility to silting up in the long run.

EXECUTIVE SUMMARY
General

G-1 : This report named " Report on Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char" gives study on CDSP-Type Development Plans of Char Nangulia and Noler Char which are empolderable in respect of land levels and local peoples demand, Preliminary Development Plan of Caring Char – comparatively a newer char yet to be matured in land levels and External Drainage System Study.

G-2 : The study has been conducted from October, 06 with a study period of 6 months under a consultancy contract between Development Design Consultants Ltd. and Associates and ARCADIS Euroconsult BV, the TA Consultant of CDSP-III under the project implementation program of the Government of Bangladesh with the Technical Assistance of the Government of the Netherlands.

G-3 : The Report has been prepared in 4 Parts and presented in two volumes: Main Report and Annexure. The Main Report contains : Executive Summary, Part A : Char Nangulia Development Plan, Part B : Noler Char Development Plan, Part C : Preliminary Development Plan of Caring Char and Part D : External Drainage System Study. The Annexure contains Figures in Enclosure-1, Tables in Enclosure-2 and others in Enclosure-3.

G-4 : Part A and Part B studies dealt with 4 study components as per TOR out of 10 required for the full Feasibility Study; the 4 components are : a. Topography, Water Management and Land Suitability; b. Agriculture and Livestock, c. Internal Infrastructure and d. Environmental Impacts. Part C : Preliminary plan study deals Topography and Water Management as per TOR out of 4 required.

G-5 : The study area is in Southern Noakhali at south-most extension of main land by newly accreted chars in Subarno Char and Hatiya Upazilas and falls within BTM co-ordinates of about 482,000-503,000 Northings and 612,000-630,000 Eastings. Morphological development in the area is very complex with much more land accretion comparing to erosion. New char land is still forming on the south of the study area. Location of the study area is given in Fig. G5.

G-6 : Char Nangulia and Noler Char being side by side separated by Mamur khal and possessing almost same hydro-morphology have been considered together for empoldering options with required peripheral embankment, sluices and improved drainage network. The options are :

1. Two-Polders Option with separate Char Nangulia Polder and Noler Char Polder

2. One-Polder 2 Drainage Units Option with Char Nangulia - Noler Char Polder having two drainage units for the two chars

3. One-Polder 1 Drainage Unit Option with Char Nangulia - Noler Char Polder having 1 drainage unit for the two chars and

4. One Polder 2 units Option avoiding Hatiya River as drainage outfall channel.

All the four options have strong individual positive points.

Option 1 keeps Mamur khal open which will continue its tidal flow and along with Char Majid and Char Nangulia drainage discharges is expected to contribute in maintaining channel section of Hatiya River, but has the risk of its silting up in the long run.

Option 2 will have drainage efficiency due to drainage distribution for the two chars but, closed Mamur khal is likely to create rapid siltation in Hatiya River.

Option 3 has only one sluice at south-most location to discharge to Lower Meghna River, but drainage efficiency will be less due to accumulation of water near the drainage sluice area for comparatively lower land levels of Noler Char.

Option 4 has drainage efficiency with separate drainage units and avoids Hatiya River as drainage outfall channel and uses Lower Meghna River and Hatiya Channel as drainage outfalls. Any siltation in Hatiya River will not impact drainage of the study area.

Fig: G5

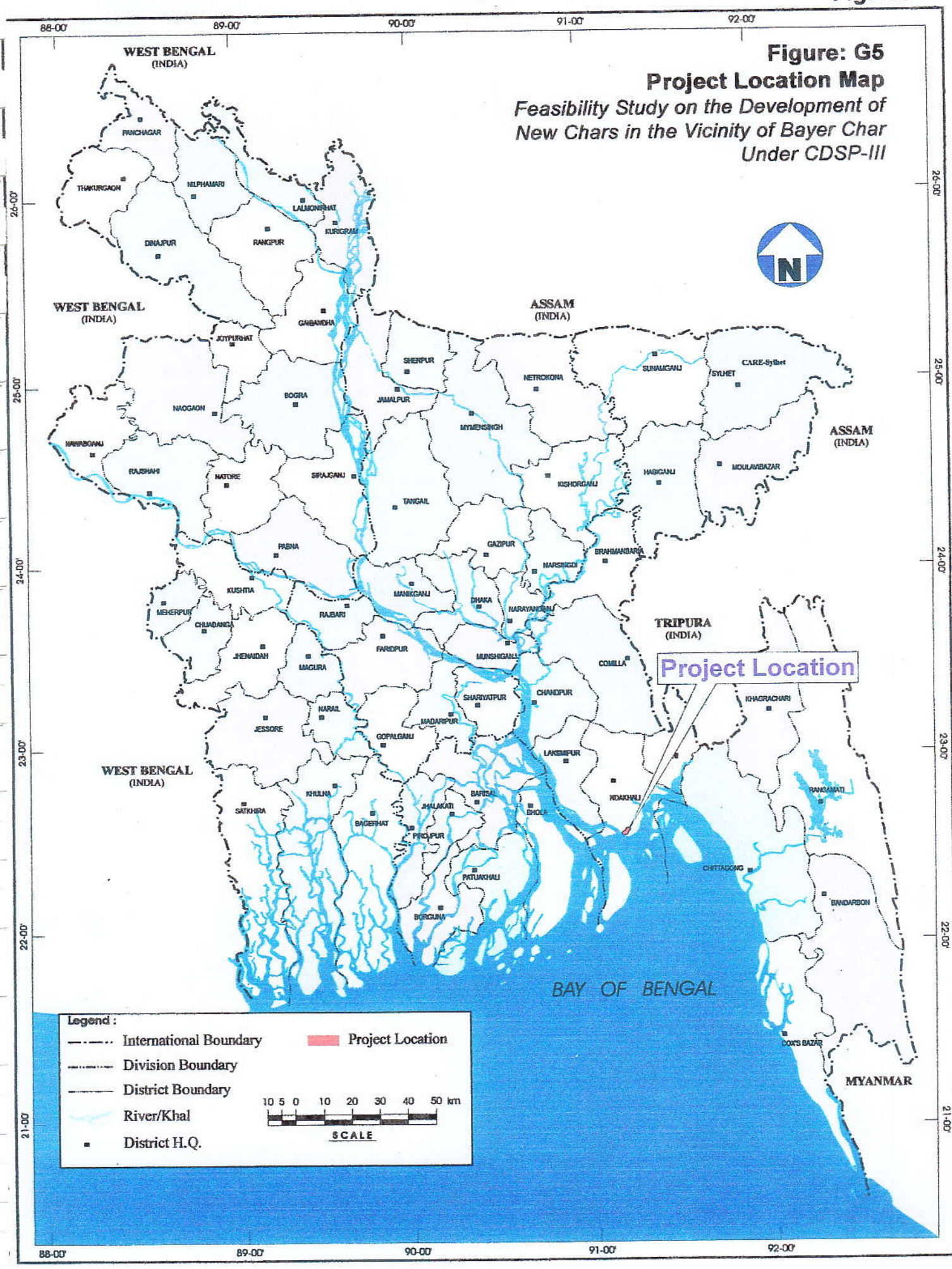
Figure: G5
Project Location Map
Feasibility Study on the Development of New Chars in the Vicinity of Bayer Char Under CDSP-III
WEST BENGAL (INDIA)
ASSAM (INDIA)
TRIPURA (INDIA)
MYANMAR
BAY OF BENGAL
Project Location
PANCHAGAR
THAKURGAON
NILPHAMARI
LALMONIRHAT
KURIGRAM
DINAJPUR
RANGPUR
GAIBANDHA
JOYPURHAT
SHERPUR
NETROKONA
SUNAMGANJ
SYLHET
CARE-Sylhet
NAOGAON
BOGRA
JAMALPUR
MYMENSINGH
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
TANGAIL
KISHORGANJ
HABIGANJ
MOULAVIBAZAR
PABNA
GAZIPUR
BRAHMANBARIA
NARSINGDI
KUSHTIA
MANIKGANJ
DHAKA
NARAYANGANJ
MEHERPUR
CHUADANGA
RAJBARI
FARIDPUR
MUNSHIGANJ
COMILLA
JHENAIDAH
MAGURA
CHANDPUR
KHAGRACHARI
NARAIL
SHARIYATPUR
JESSORE
MADARIPUR
GOPALGANJ
LAKSHMIPUR
KHULNA
BARISAL
NOAKHALI
RANGAMATI
SATKHIRA
JHALAKATI
BAGERHAT
BHOLA
PIROJPUR
CHITTAGONG
PATUAKHALI
BANDARBON
BORGUNA
COX'S BAZAR
Legend :
International Boundary
Division Boundary
District Boundary
River/Khal
District H.Q.
Project Location
10 5 0 10 20 30 40 50 km
SCALE
88-00'
89-00'
90-00'
91-00'
92-00'
26-00'
25-00'
24-00'
23-00'
22-00'
21-00'

Comparing the positive and negative points of the four Options, Option 4 is the most favourable one.

G-7 : The selected Option is the Option 4. Development Plans of Char Nangulia and Noler Char have been prepared accordingly.

G-8 : Estimated development plan costs of the two chars using 2006-07 rates are : Char Nangulia Tk. 694.103 million and Noler Char Tk. 314.735 million. Preliminary development plan cost for Caring Char is Tk. 25.172 million. Total estimated cost is Tk. 1034.010 million.

G-9 : Major environmental impact on the two development plans will be transforming tidal inundation/flood affected and water logged area to inundation/flood free and drainage improved area with gradual flushing out and leaching of soil salinity to give a secured environment for T. Aman production and reduced soil salinity to allow Rabi crop cultivation.

Part - A : Char Nangulia Development Plan

A1 Char Nangulia Development Plan area falls in Subarno Char and Hatiya Upazilas of Noakhali District. The plan is to prevent tidal inundation/flood, improve drainage and reduce soil salinity for the purpose of increased agricultural production.

A-2 Topographic surveys at 100m grid have been conducted for preparation of the plan. Land elevations of the area varies mainly between 2.75m and 4.75 mPWD with maximum area of about 88% between elevations 3.00m and 4.50 mPWD.The plan area is about 8994 ha with 6964 ha (77%) of present cultivable land. Area-elevation and present land use are given below:

Char Nangulia

Area Elevation	
Elevation mPWD	Area (ha)
<2.75	395
2.75 - 3.00	191
3.00 - 3.25	350
3.25 - 3.50	1357
3.50 - 3.75	2616
375 - 4.00	1483
4.00 - 4.25	1242
4.25 - 4.50	842
4.50 - 4.75	314
>4.75	204
Total :	8994

Present Land Use	
Land Use	Area (ha)
Project Area	8994 ha
Cultivated/Cultivable Areas	6964 ha
Grazing/Fallow Lands	782 ha
Forest Areas	54 ha
Fishery Areas	381 ha
Khals	202 ha
Homesteads and Ashrayan Kendros	492 ha
Ponds/Ditches	75 ha
Roads	15 ha
Bazars, Schools, Mosques, Playgrounds	29 ha

A-3 Major interventions for preventing tidal inundation/flood and drainage improvement and for internal development are : Drainage sluices, Embankment, Re-excavation and excavation of khals, Rural Roads and Cyclone Shelters etc. Detailed list of infrastructures are given below :

. Water Management Infrastructures

- Drainage Sluice DS-1, 10V – 1.5m x 1.8m - 1 No.
- Drainage Sluice DS-2, 5V - 1.5m x 1.8m - 1 No.
- Embankment, Sea Dyke - 25.50 km
- Embankment, Interior Dyke - 3.50 km
- Closures on khals - 8 Nos.
- Re-excavation of khals - 63.78 km
- Borrowpit/Peripheral link channel - 14.83 km

Internal Infrastructures

•	Rural Roads (Type R-2)	-	37.77 km
•	Bridge 20m span	-	3 Nos.
•	Bridge 15m span	-	3 Nos.
•	Bridge 10m span	-	2 Nos.
•	Culvert Box 1 vent 4m x 3m	-	1 No.
•	Culvert Pipe 0.60m dia	-	8 Nos.
•	Multi-purpose Cyclone Shelter	-	17 Nos.
•	Community Ponds	-	43 Nos.
•	Deep Tube well	-	607 Nos.
•	Latrine	-	9350 Nos.
•	Public Toilets	-	11 Nos.
•	Pond Sand Filter Schemes	-	30 Nos.
•	Rain Water Harvesting Schemes	-	60 Nos.

Design criteria and standards followed were of BWDB for water management infrastructures and of LGED for internal infrastructure.

A-4 Civil works estimated costs using 2006-07 schedule of rates are : Water Management Infrastructure Tk. 431.166 million and Internal Infrastructure Tk. 262.437 million, Total Tk. 693.603 million. In addition, Tk. 0.5 million has been provided for land acquisition. Total cost is Tk. 694.103 million.

A-5 Total cropping intensities of Char Nangulia is expected to increase from present 140% to 155% in 5th year of project condition and to 170% in the 10th year.

Production benefit from increased crop per year is expected to be 6424 metric tons from 5th year and 13487 metric tons from 10th year.

Part - B : Development Plan of Noler Char

B - 1 Noler Char Development Plan area falls in Hatiya Upazila of Noakhali District. The plan is to prevent tidal inundation/flood, improve drainage and reduce soil salinity for the purpose of increased agricultural production.

B-2 Topographic surveys at 100m grid have been conducted for preparation of the plan. Land elevations of the area varies mainly between 2.00m and 4.00 mPWD with maximum area of about 88% between elevations 2.25m and 3.75 mPWD. The plan area is about 2691 ha with 2011 ha (75%) of present cultivable land. Area-elevation and present land use are given below :

NOLER CHAR

Area Elevation	
Elevation mPWD	Area (ha)
<2.00	182
2.00 - 2.25	78
2.25 – 2.50	130
250 – 2.75	176
2.75 – 3.00	516
.300 - 3.25	703
3.25 - 3.50	503
3.50 – 3.75	341
>3.75	62
Total :	**2691**

Present Land Use	
Land Use	Area (ha)
Project Area	2691 ha
Cultivated/Cultivable Areas	2011 ha
Fallow Lands	278 ha
Fish Ponds	3 ha
Khals	87 ha
Homesteads	170 ha
Ponds/Ditches	100 ha
Roads	9 ha
Bazars, Schools, Mosques, Playgrounds	33 ha

B - 3 Major interventions for preventing tidal inundation/flood and drainage improvement and for internal development are : Drainage sluices, Embankment, Re-excavation and excavation of khals, Rural Roads and Cyclone Shelters. Detailed list of infrastructures are given below :

Water Management Infrastructures

•	Drainage Sluice DS-1, 7V – 1.5m x 1.8m	-	1 No.
•	Embankment, Sea Dyke	-	6.00 km
•	Embankment, Interior Dyke	-	4.50 km
•	Dwarf Embankment	-	13.25 km
•	Closures on khals	-	5 Nos.
•	Re-excavation of khals	-	26.40 km
•	Borrowpit/Peripheral link channel	-	22.50 km

Internal Infrastructures

•	Rural Roads (Type R-2)	-	17.45 km
•	Bridge 15m span	-	1 No.
•	Culvert Box 1 vent 4m x 3m	-	1 No.
•	Culvert Pipe 0.60m dia	-	8 Nos.
•	Multi-purpose Cyclone Shelter	-	10 Nos.
•	Community Ponds	-	24 Nos.
•	Deep Tube-well	-	313 Nos.
•	Latrine	-	5159 Nos.
•	Public Toilets	-	12 Nos.
•	Pond Sand Filter Schemes	-	16 Nos.
•	Rain Water Harvesting Schemes	-	32 Nos.

Design criteria and standards followed were of BWDB for water management infrastructures and of LGED for internal infrastructure.

B - 4 Civil works estimated costs using 2006-07 schedule of rates are : Water Management Infrastructure Tk. 175.725 million and Internal Infrastructure Tk. 139.010 million, Total Tk. 314.735 million.

B - 5 Total cropping intensities of Noler Char is expected to increase from present 150% to 165% in 5th year and 180% in the 10th year in project condition.

Production benefit from increased crop per year is expected to be 444 metric tons from 5th year and 2455 metric tons from 10th year of project condition.

Part-C : Preliminary Development Plan of Caring Char

C-1 Caring Char Preliminary Development Plan Area is the south-most extension of the mainland of South Noakhali in Hatiya Upazila and is in developing stage in respect of land elevation.

C-2 It has an area of about 6852 ha divided in to 4 Drainage Units and named as Eastern, Southern, Western and Northern Drainage Units.

Topographic surveys have been conducted at 500m grid. Land level varies between 1.502m and 4.426 mPWD. Maximum land area is within 2.00m and 4.00 mPWD covering about 77% of the Char. Present land Use gives that maximum area is grazing land (more than 55%) and cultivated land 26%. There are 533 homesteads and two small Bazars. Area-elevation and present land use is given below :

CARING CHAR

Area Elevation	
Elevation mPWD	Area (ha)
<2.00	634
2.00 - 2.50	1052
2.50 – 3.00	1463
3.00 – 3.50	1438
3.50 – 4.00	1371
>4.00	894
Total :	6852

Present Land Use	
Land Use	Area (ha)
Project Area	6852 ha
Cultivable Areas	1788 ha
Grazing/Leski Areas	3795 ha
Forest Area	584 ha
Khals	605 ha
Homesteads, Bazars, Religious Places	80 ha

C-3 Empoldering land level is a critical issue for the char. Majority area of the char lies between 2.00m and 4.00 mPWD. Compared with Char Nangulia (between 3.00m and 4.50 mPWD) and Noler Char (between 2.50m and 4.00 mPWD) empoldering and development plan study of Caring Char may be delayed by 5 to 7 years.

C-4 Immediate measures to be taken up for the present habitations in respect of Internal Infrastructures are : Cyclone shelters 2 Nos., Rural Roads 10 km, Community ponds 5 nos., Latrines 586 nos., Deep Tube-wells 38 nos. and provision for some social afforestation with total base year cost of Tk. 25.172 million.

Part - D : External Drainage System Study

D - 1 Hatiya River is the main external drainage channel in the study area discharging its outflow to Lower Meghna River. Drainage diversions of its upper catchments already planned to drain to Meghna River towards west by two cross-dams on Hatiya River.

D - 2 Ist cross-dam diverts drainage of upper catchments through Jarirdona khal and 2nd cross-dam at Streamer Ghat (Ferry Ghat) plans to divert mid-catchment comprising Char Maradona and Char Majid Polder through Boyer Char.

D - 3 The present study needed to assess suitable location of the 2nd Cross Dam among the three alternatives – at the Ferry Ghat, D/S of Char Majid outfall and D/S of mouth of Mamur khal or further down stream.

D - 4 The 2nd Cross Dam on Hatiya River has been decided to be located at D/S of Char Majid drainage outfall for diversion of drainage of areas including Char Majid. Char Maradona and area south of Char Majid. Hatiya River has not been proposed as a drainage outfall channel for Char Nangulia and Noler Char for its susceptibility to silting up. Instead, their drainage discharges for them have been planned direct to Lower Meghna River.

D-5 After the planned diversions are implemented Hatiya River channel section will keep on adjusting itself naturally to its reduced flow condition and ultimately will be silted up.

Abbreviations

AEZ	-	Agro-ecological Zone
BADC	-	Bangladesh Agricultural Development Corporation
BARI	-	Bangladesh Agriculture Research Institute
BBS	-	Bangladesh Bureau of Statistics
BIWTA	-	Bangladesh Inland Water Transport Authority
BM	-	Bench Mark
BRAC	-	Bangladesh Rural Advancement Committee
BRRI	-	Bangladesh Rice Research Institute
BWDB	-	Bangladesh Water Development Board
CDSP	-	Char Development and Settlement Project
CEGIS	-	Centre for Environmental and Geographical Information Services
CEP	-	Coastal Embankment Project
CERP	-	Coastal Embankment Rehabilitation Project
CI	-	Cropping Intensity
DAE	-	Department of Agricultural Extension
DANIDA	-	Danish International Development Agency
DC	-	Deputy Commissioner
DDC	-	Development,Design Consultants Ltd.
DLS	-	Department of Livestock
DOE	-	Department of Environment
DPHE	-	Department of Public Health Engineering
DTW	-	Deep Tube-well
DS	-	Drainage Sluice
EIA	-	Environmental Impact Assessment
EIAM	-	Environmental Impact Assessment Matrix
EMP	-	Environmental Management Plan
ESPP	-	Estuarine Survey Pilot Project
FAP	-	Flood Action Plan
FCD	-	Flood Control and Drainage
FGD	-	Focus Group Discussion
FMD	-	Flood Management and Drainage
FPCO	-	Flood Plan Coordination Organization

FS	-	Feasibility Study
PWO	-	Future Without Project
FWP	-	Future With Projects
GDP	-	Gross Per Capita Development
GOB	-	Government of Bangladesh
HCL	-	House of Consultants Ltd.
hh	-	Households
HYV	-	High Yield Variety
IAM	-	Impact Assessment Matrix
ICZM	-	Integrated Coastal Zone Management
IEC's	-	Important Environmental Components
IEE	-	Initial Environmental Examination
IPM	-	Integrated Pest Management
IRR	-	Internal Rate of Return
IUCN	-	International Union for Conservation of Nature
IWM	-	Institute of Water Modelling
Km	-	Kilometer
KSS	-	Krishak Samabaya Samity
LCS	-	Landless Contracting Society
LGED	-	Local Government Engineering Department
LRP	-	Land Reclamation Project
MCA	-	Multi-criteria Analysis
MES	-	Meghna Estuary Study
M	-	Million
MOA	-	Ministry of Agriculture
MCSP	-	Multipurpose Cyclone Shelter Programme
MOL	-	Ministry of Land
MOWR	-	Ministry of Water Resources
Mt	-	Metric ton
NCA	-	Net Cultivated Area
NGO	-	Non Government Organization
O&M	-	Operation and Maintenance
PLDP	-	Participatory Livestock Development Project
PMU	-	Project Management Unit
PT	-	Plane Table

PWD	-	Public Works Department
RL	-	Reduced Level
RRA	-	Rapid Rural Appraisal
SIA	-	Social Impact Assessment
SOB	-	Survey of Bangladesh
SPARRSO	-	Space Research and Remote Sensing Organization
SRDI	-	Soil Resources Development Institute
SWMC	-	Surface Water Modeling Centre
TOR	-	Terms of Reference
TBM	-	Temporary Bench Mark
UP	-	Union Parishad
WARPO	-	Water Resources Planning Organization
WL	-	Water Level
XEN	-	Executive Engineer

GLOSSARY

Aman	-	Rice produced during the Kharif II season
Aus	-	Rice produced during the Kharif-1 season
B Aman/ T. Aman	-	Broadcast/Transplanted Aman
Boro	-	Rice produced during the Rabi season
Bundh	-	Earthen closure/embankment
Char	-	Newly formed land in estuary/river
Katcha	-	Temporary/earthen
Khal	-	Natural or man made earthen channel
Kharif II	-	Late summer (July through October) crop season
Kharif I	-	Early summer (March through June) crop season
Rabi	-	November through March, crop season
Monsoon	-	Period of rains starting in June and ending in October
Leski	-	Local term for a sloping char area that goes under water during normal tide

PART – A

CHAR NANGULIA DEVELOPMENT PLAN

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CHAR NANGULIA DEVELOPMENT PLAN

CHAPTER-1: INTRODUCTION

1.1 Background

Char Nangulia is a fairly stable and developed new char at the south-ward extension of accreted char lands in Southern Noakhali in the vicinity of Boyer Char. The char reached at empolderable land level and as such needs to be developed to provide, mainly protection to the agricultural land from saline tidal inundation/flood and to provide drainage improvement.

Land Reclamation Project (1978-1991) of the Government of Bangladesh developed Char Baggardona as a pilot rural development project in addition to survey and study of Meghna Estuary with Dutch Technical Assistance. As a continuation, Char Development and Settlement Project (CDSP) came in 1994, also with Dutch Technical Assistance for implementation of Baggardona-II, Char Batir Teck, Char Majid, Char Maradona, Muhuri Char and Boyer Char under CDSP-I & II with BWDB, LGED, DAE, Ministry of Land, DPHE and Department of Forest as Executing Agencies, BWDB being the Lead Agency. BRAC, a leading NGO is also associated with the programme. CDSP deals with empoldering new Char areas for the purpose of settlement of land to the landless and through them increase of agricultural production in the lands to be saved from tidal/saline inundation with improved land drainage. CDSP also provides development of rural road communications, cluster villages, water supply and sanitation, cyclone shelters and mangrove forest belts and social forests.

Present Plan preparation (Part A – Char Nangulia Development Plan) is a part of "Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char under CDSP-III", conducted under a consultancy contract for 6 months from October, 06 between Development Design Consultants Ltd. and associates and ARCADIS Euroconsult Ltd., the TA consultant of CDSP-III.

The Support of the Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char covers the following:

- Part of the Feasibility Study of Char Nangulia and Noler Char for the preparation of comprehensive development plans for the two Chars. Of the 10 components of the feasibility study (Art. 3.1 of ToR) the present study covers 4 components: Topography, Water Management and Land Suitability; Agriculture and Livestock; Internal Infrastructure; and Environmental Impacts. Study results are in: Part A – Char Nangulia Development Plan and Part B – Noler Char Development Plan.

- Part of the Feasibility Study for the Preliminary Development Plan for Caring Char. Of the 4 components: the present study covers only 1 component: Topography and Water Management (Art. 3.2 of ToR). Part C – Preliminary Development Plan of Caring Char gives the study results.

- External Drainage System Study to create adequate drainage conditions for drainage units (polders). Part D gives the study results.

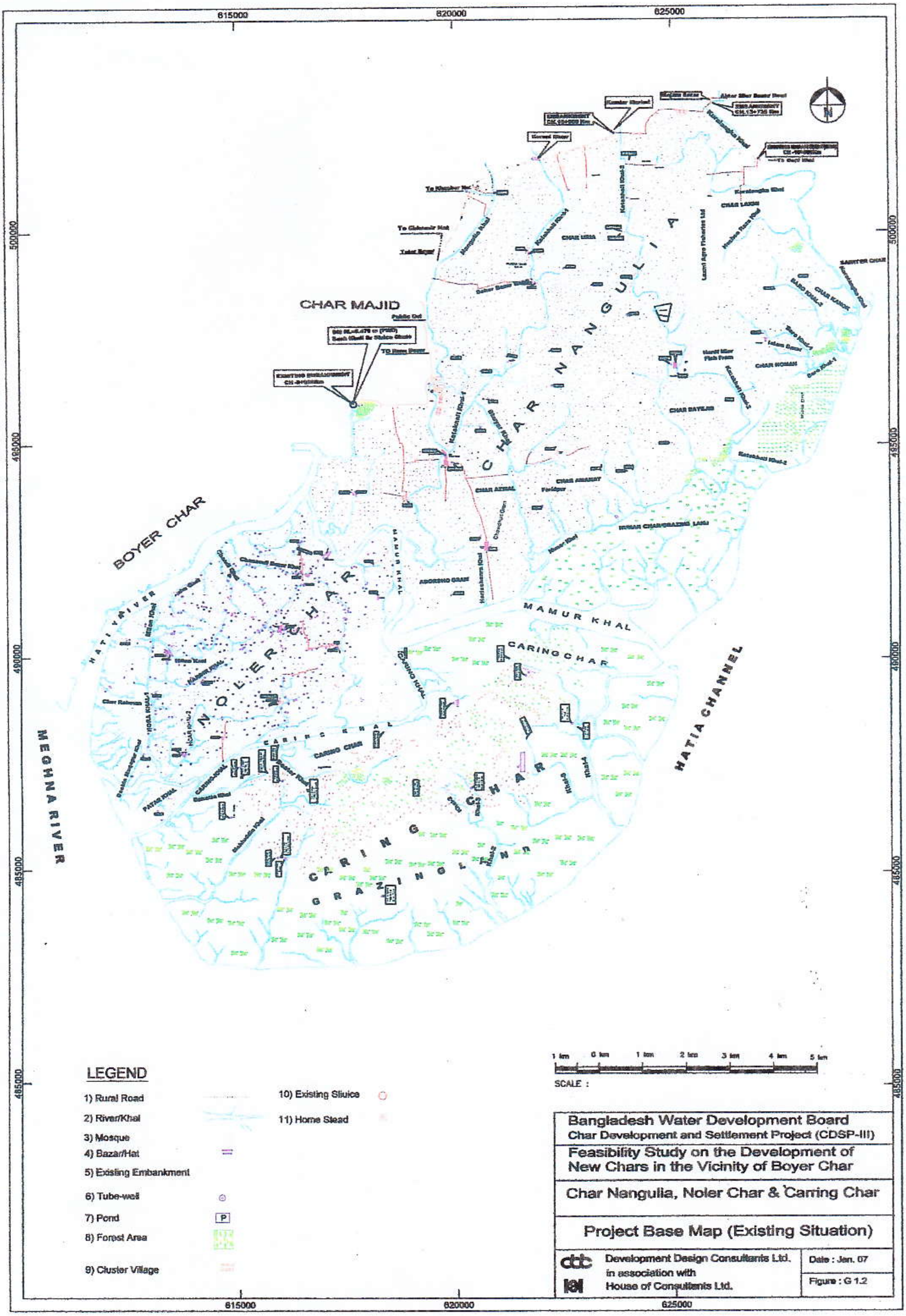
1.2 Plan Area

The Plan area falls in Subarno Char and Hatiya Upazilas of Noakhali District. The Unions are Char Bata in Subarno Char and Chanandi in Hatiya Upazila.

It has a total land area of 8994 ha. Agriculture of the area is affected by saline tidal inundation/flood, drainage congestion and soil salinity. The area is criss-crossed by numerous tidal channels and creeks. But, main drainage khals receive rainfall runoff also of area beyond northern boundary. The plan area is shown in Fig. G 1.2.

1.3 Objective of the Plan

The main objective of the Development Plan is to provide protection of the area from saline tidal inundation/flood and land settlement to landless farmers and CDSP type rural development. The physical interventions will include peripheral embankment with drainage sluice, rural road including bridge/culverts, multipurpose Cyclone Shelter and sanitary and water supply facilities.



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490000
485000
CHAR MAJID
BOYER CHAR
MEGHNA RIVER
HATIA RIVER
HATIA CHANNEL
MAMUR KHAL
CARING CHAR
CHAR NANGULIA
NOLER CHAR
CARING GRAZING LAND
CHAR AZIMAL
CHAR BAYEJID
CHAR NOMAN
SANTER CHAR
CARING KHAL
CARING CHAR
LEGEND
1) Rural Road
2) River/Khal
3) Mosque
4) Bazar/Hat
5) Existing Embankment
6) Tube-well
7) Pond
P
8) Forest Area
9) Cluster Village
10) Existing Sluice
11) Home Stead
SCALE :
1 km
0 km
1 km
2 km
3 km
4 km
5 km
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)
Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char
Char Nangulia, Noler Char & Carring Char
Project Base Map (Existing Situation)
ddc
Development Design Consultants Ltd.
in association with
House of Consultants Ltd.
Date : Jan. 07
Figure : G 1.2

CHAPTER – 2: SUEVEY AND INVESTIGATION

2.1 Engineering Surveys

Engineering Surveys include Bench Mark Survey, Topographical Survey, River and Khal Survey and Embankment and Road Survey.

2.1.1 Bench Mark Survey

Bench Mark (BM) values have been carried to the permanent objects within the project area from the nearest available permanent Bench Mark (PWD).

One permanent BM has been set up by CDSP / BWDB at the Bashkhali sluice site in Char Majid Polder having a value of 5.479(m PWD). Existing BM at Char Majid 8-vent sluice and TBMs at study area are presented in Map Fig. G. 2.1.1 (Enclosure-1, Annexure Volume).

2.1.2 Topographical Survey

BM set up by CDSP at the Bashkhali sluice in Char Majid Polder was connected by GPS measurement, with an accuracy below 5-10 cm per 100 km (both horizontally and vertically) to get the horizontal co-ordinates for accurate positioning in the study area and are used as control points for carrying out Survey for producing correct topographical maps.

Detail Survey was carried out in the areas of Char Nangulia. The existing features such as rivers/khals, river banks, ponds, roads, houses and mangrove areas and location of existing Tube-wells etc. have been taken by offset methods.

100m X 100m size grid surveys have been carried out in Char Nangulia. Land levels related to PWD levels at each grid have been taken, and also where abrupt changes of land profile have been found.

Topographical map of Char Nangulia is presented in Fig. A 2.1.2 (Enclosure- 1, Annexure Volume) respectively.

2.1.3 Embankment/Road Survey

Longitudinal and cross-section surveys were carried out for the existing roads and embankment bordering Char Nangulia. The proposed flood embankment along with the proposed internal road network system empoldering Char Nangulia were also surveyed,

For the long section, spot levels along the centre line of the alignment of proposed embankment/road have been taken at 100m intervals or closer, depending on ground profile. Levels at closer intervals have been taken to represent the actual profile of depressions, raised grounds and khals crossing the embankment/road alignment.

For proposed embankment/road, cross-sections have been taken at 100 m intervals or closer, depending on ground profile and extending over 10m or more and at 10m apart or closer at abrupt changes depending upon field condition with spot levels. Three cross-sections have been taken for a khal crossing the embankment/road alignment, one along the deepest level of khal and the other two along the banks of the khal.

In case of existing embankment/road, spot levels at centerline, two edges of the crest, toes on either side and ground extending 30m on either side of toe at 10m apart or closer depending on ground conditions have been taken. Additional spot levels, where required, were taken on slopes of the embankment and road to complete the full section. The list of Embankment and Road surveyed is given in Table A 2.1.3.

Table A 2.1.3 : List of Embankment and Roads Surveyed:

Sl. No.	Description of Embankment/Road	Length (Km)
	Embankment	
1	Proposed embankment sea dyke cum feeder road from Hemayetpur Bazar to confluence point of Mamur khal and Caring Khal.	18.00
2	Proposed embankment from confluence point of Mamur khal and Caring khal to outfall of point Mamur khal to Hatiya River (interior dyke)	5.23
3	Proposed embankment from outfall of Mamur khal to Bashkhali sluice of Char Majid polder (interior dyke)	3.30
4	Existing Embankment of polder Char Majid from Bashkhali sluice to Polder 59/3B (Kazir Dokan)	5.55
5	Existing Embankment of Polder 59/3B from Kazir Dokan to Kamlar Market in Char Lakmi.	5.46
6	Existing Embankment of Polder 59/3B from Mayjam Bazar to Hamayetpur Bazar	1.77
	Road	
1	Existing Road from Kamalar Market Char Lakmi to Moyjam Market	2.74
	Proposed Road :	
2	Purba Char Majid to proposed embankment (via Bhumihin Bazar, Janata Bazar)	5.05
3	Kamlar Market (Polder 59/3B) to Mamur khal via Chaloman Bazar, Chankhola Police Camp, Syedpur Jame Mosque	10.72
4	Kerani Bazar (Polder 59/3B) to Bellal Bazar via Abu Taher Miar Bazar	4.80
5	Char Majid embankment (Haji Para) to Chankhola Police Camp via Bellal Bazar	5.67
6	Bhumihin Bazar to Syedpur Jame Mosque via Kaladur Bazar, Hemayetpur Primary School	5.63
7	Darbesh Bazar to Bhumihin Bazar	2.40
8	Bashkhali Sluice Site to Islam Bazar via Darbesh Bazar.	3.50

2.1.4 River and Khal Survey

Longitudinal and cross-section surveys were conducted for existing drainage channels/khals and rivers.

For longitudinal profile, the spot levels of the existing river or channel beds and banks have been taken at 500m interval in the case of main channel or river and 100m intervals in the case of branch or small channels. The survey started from the outfall of the channel proceeding towards upstream.

The cross-section of existing channels has been taken at 500m and 100m intervals or closer depending on ground conditions in the main and branch channels. All cross-sections were made perpendicular to the longitudinal alignment of the channel at point of survey. The cross-section covered the full width of the channel and extended up to 30m on either bank side.

The list of rivers and drainage channels/khals surveyed are given in Table A 2.1.4

Table A 2.1.4 : List of Drainage Channels/khals Surveyed

Sl. No.	Description of Khals	Length (km)
1	Nangulia khal	12.80
2	Katakhali khal-1	8.850
3	Katakhali khal-2	11.800
4	Boro khal-1	3.00
5	Boro khal-2	3.35
6	Nunar khal	5.90
7	Hasan Raja khal	3.00
8	Bhuiyar khal	5.675
9	Mamur khal	13.70
10	Caring khal	9.12

2.1.5 Presentation of Survey Data

Field survey data have been processed by using the computer packages. The survey data have been presented as below:

- Longitudinal profiles of proposed embankment in Char Nangulia and existing embankment at Char Majid are plotted to the scale of 1:200 vertically and 1:25,000 horizontally. The design levels have also been drawn on it.

- Existing rivers, channels and khals, profiles of bed along with design bed were drawn.

- The profiles also show the locations of all the existing roads, khals and structures and the names of all proposed structures with the individual chainages in km.

- Cross-sections were plotted to the scales of 1:200 vertically and 1:500 horizontally.

Survey results are presented in Annexure Volume, Enclosure- 1. (Embankment - Fig. A 5.2.1, Fig. A 5.2.1a, Drainage Khal - Fig. A 5.2.3/1-9, Fig. D 2.2b, D 2.2b/1, D 2.2c and D 2.2c/1

2.2 Agriculture Survey

Char Nangulia has a project area of 8994 ha and net cultivated area is 6961 ha and an estimated 8500 households (hh). Crop production (Agriculture) in Char Nangulia mainly suffers from drainage congestion, tidal inundation/flooding and salinity. So, the task of the study is to solve the drainage congestion and abnormal flooding and desalination of the South Western part.

2.2.1 Objectives

The major objectives of agricultural component mentioned in the TOR are as follows;

- to determine land types, soil characteristics, land suitability and land use under pre and post Project situation.

- to identify major crops, area under each crop, yield, cropping intensity and production at pre and post Project condition;

- to analyze land tenure system and socio-economic conditions of the farmers;

- to estimate crop damage due to flooding, water-logging and salinity;
- to assess the present support services (extension credit and market);
- to develop/suggest intervention to remove the constraints including field-age and demonstration.

2.2.2 Scope

The study analyzed the land suitability and land use for crop production under pre and post Project situation. The report covers farm size, land tenural system, present crops grown, cropping intensity, area, yield, input use and costs of inputs and output prices, constraints of crop production, crop damages due to flooding, water-logging, salinity and socio-economic conditions of farmers, availability of support services such as extension, credit and marketing facilities. The report also covers farmers food security and employment situation.

The future projections of increasing cropping intensity, yield and productivity are based on the analysis of the present situations in the adjacent areas and on the assumption that the major constraints of crop production will be removed and support services are improved and strengthened.

2.2.3 Method and Approach

In order to collect relevant information on landuse, socio-economic condition of farmers and constraints of production, primary data was collected from household sample survey and group discussion with farmers using a structured format and a cheek list. Group discussion was conducted using a cheek list by the Consultant to estimate farmers perception on crop damages due to salinity, flooding and water-logging. The household sample survey was conducted by an enumerator following a practical briefing by the Consultant how to elicit farmers opinions and fill up the questionnaire.

Household Survey. Households were not stratified as landless, marginal, small, medium and large farmers as it was reported that each household has about 1.5 acre (0.61 ha) land in Char Nangulia. More than one percent households (1.21%) were selected randomly from the different wards of Union Parishad. First, the enumerator explained to the farmers the purpose of the survey and the household heads and other members became interested to provide information. The questionnaire was lengthy and it took about two hours to complete one questionnaire. The discussion was held in or around the households or in market places. Each Ward of an Union Parishad has several Samaj/Villages. From each village of a Ward, households samples were selected randomly proportionate to the number of the total household of the Ward with the help of village leaders.

Information on family size, farm size, land tenurial system, food availability for the family per year, season wise land use, sources and share of annual income, cultivation resources, labour availability, employment of family member, credit, extension and homestead agro-forestry were collected through the household survey.

Group Discussion/Meeting. Five group discussions having 5-8 farmers per discussion were held in Char Nangulia to collect information on the farmers perceptions on season wise area affected and extent of crop damage due to salinity and abnormal tidal flooding. From such group discussion proportionate areas under different seasons, crops, yield, cost of production for each crop, inputs rates, prices and farm gate prices of the farm outputs were also collected.

Farm Walks/Transect Walks. Farm walks or Transect were used to determine land, soil types, observe crops, agro-forest trees, and talk to farmers in the fields or village road. These helped farmers to talk informally on land, soil types, their field problems and tidal flooding. Farmers reported three land types such as high land, medium land and low lands with corresponding soil types of Duas (loam), Kada duas (clay loam) and Kadamati (clay or silty clay). Farmers also reported that salinity increases starting from high land to lowland.

Household survey, group discussion and farm walks helped clarify some information, cross checking and validation of information.

2.2.4 Land and Soil Types

The land and soil types of Char Nangulia are briefly described below :

Land Types. The study area Char Nangulia falls within the AEZ 18, the Young Meghna Estuarine flood plain. The flood plain lands are classified by MPO and FAO on the basis of flood regime, i.e. the depth and duration of flooding. During Group Discussion and Farm Walks information on depth of flooding was collected. A part of the land types (34%) in Char Nangulia fall within medium high land (F1) class which is flooded between 30-90 cm depth during the peak monsoon. However, most lands close to the canals, the homestead areas, markets, roads and other infrastructures are built by raising land which is above normal flood level (>30cm is classified as (Fo), which constitute 59% of the area. Some area fall within medium low land (F2) is flooded between 90-180 cm depth of water. And the F3 (low land) which is flooded>180cm is only 1 percent area.

The present land types of the Char Nangulia area were estimated by Topo survey for 1:10 year return period for monsoon season are 59% , 34%, 6% and 1%) as Fo, F1, F2 and F3 respectively (Table 2.2.1). With project condition land types improve with reduced flood depth.

Table : 2.2.1 Land types of the Project Area (ha) in Char Nangulia

Land Type	Present Condition			With Project		Remarks
	Flooding depth (cm)	Area (ha)	(%)	Area (ha)	(%)	
Fo (High Land	0-30	5296	59	8143	90	Homesteads and Infrastructures
F1 (Medium High Land)	30-90	3070	34	545	6	
F2 (Medium Low Land)	90-180	508	6	249	3	
F3 (Low Land)	> 180	120	1	57	1	Khals and Fisheries
Total		8994	100	8994	100	

Source : Topo Survey

Soil Types and Salinity. The detail soil survey and soil analysis of Boyer Char are available. Char Nangulia is adjacent to Boyer Char. Land topography and soil types as determined by visual examination of Char Nangulia are very close to

Boyer Char. Examination of canals and recently excavated ponds, showed no distinct soil horizon developed. Horizons are undifferentiated and less compacted.

Table 2.2.2 : Soil Characteristics of Char Nangulia

Land Types	Flooding depth (cm)	Texture	Salinity	Drainage Classes
Fo (Highland)	0-30	Loam	Slightly Saline	Moderate
F1 (Medium Highland)	30-90	Clay Loam	Moderately Saline	Poor
F2 (Medium Lowland)	90-180	Clay	Strongly Saline	Poor

Source : Farm Walks and Group Discussion

Table 2.2.3 : Soil Salinity Level in Boyer Char

Salinity Class	Salinity Level (Ece:dS/m	% in Boyer Char (2001)	% in Boyer Char (2006, June)
Non-saline (So)	<2.0	0	0.5
Very slightly saline (S1)	2-4	1.25	2.3
Slightly saline (S2)	4-8	11.25	8.5
Moderately saline (S3)	8-12	40.0	
Strongly saline (S4)	12-15	32.5	23.6
Extremely saline (S5)	>15	15.0	65.1

Source : SRDI, CDSP (2001 and 2006) and DDC.

Soils of (Fo) lands are loam to silty loam, slightly saline, crops in three seasons (Aus, Aman and Rabi) can be grown and the land and soils are intensively cropped. Soils of F1 lands are silty clay loam to clay loam, moderately saline, two crops (T. Aman during Kharif-II and Rabi season) are grown. Soils of F2 lands are silty clay to clay usually strongly saline and single T. Aman crop is grown during the Kharif-II season.

2.2.5 Land Suitability and Land use

Land suitability is determined considering the ecological requirements and limitation of crops under specified production system such as rainfed, irrigated, traclifional or modern management. Land suitability has to be assessed considering agroclimatical and individual soils for each crop in each growing

season. Combining the agroclimatical and soil suitability, land suitability classes for each crop has to be made. Five suitability classes linked to the attainable yields are as follows (FAO/UNDP, 1988).

Very suitable (VS)	:	80% percent or more of maximum attainable yield (MAT),
Suitable (S)	:	60-80 percent MAT
Moderately suitable (MS)	:	40-60 percent (MAT)
Marginally suitable (mS)	:	20-40 percent (MAT)
Not suitable (NS)	:	Less than 20% of (MAT)

However, research/experimental results on attainable yields for different crops under specific land and soil conditions are not available. So, it will not be possible to classify the lands of Char Nangulia for different crops under the above classes.

The agricultural potentials of the flood plain soils are determined by hydrology and soil properties. The common soil types in Char Nangulia are silty loam to clay loam; low in organic matter, nitrogen and phosphorus and have poor structural stability. However, there is annual silt deposition from tidal flood which enrich the soil to some extent.

In Char Nangulia crop production is limited due to salinity in dry Rabi/Aus season. In the dry season, soil salinity increases by capillary rise from slightly to strongly saline ground water. Aus rice in Kharif-1 season is affected at germination and seedling stages in March-April when salinity reaches its peak level. However, from May onward, salinity starts decreasing due to rain and problem for Aus rice is reduced. During T. Aman season (July-December) there is little problem due to salinity but tidal inundation damages the crop. Rabi crops are restricted by salinity at all stages of its growth in the dry season.

Water-logging is seriously affecting crop production and degrading the environment. Aus rice is less affected compared to T. Aman and Rabi crops by water-logging. Higher water depth at transplanting and tillering stages affects the growth and yield of T. Aman. After the harvest of T. Aman, Rabi crop cultivation starts, Rabi crop planting is delayed upto January as lands remain wet and not

suitable for Rabi crop seeding and planting. So, intervention to remove tidal inundation/floods, drainage congestion and salinity are needed to make soil suitable for crop production.

Land use. Present land use for specific crops and cropping patterns is determined by dry/Rabi season salinity, soil moisture condition, monsoon rain, tidal flood and water-logging.

Char Nangulia has project area of 8994 ha and 77% net cultivated area (NCA), 45% single, 40% double and 5% triple crops area. Land use are shown in Table 2.2.4. Current fellow/cultural waste has been considered to be 10% of NCA.

Table 2.2.4 Present, Land use for Crop Production in Char Nangulia

Sl. No.	Name of the Char	Total Project Area (ha)	Area under Settlement, Water bodies, Infrastructure, etc. (ha)	Net Cultivated Area (ha) and %	Single Crop Area (ha) & %	Double Crop Area (ha) & %	Triple Crop Area (ha) & %
1	2	3	4	5	6	7	8
1	Char Nangulia	8994	2034 (22.61%)	6961 (77.39%)	3132 45%	2784 40%	348 5%

Source : Household Survey and Topo Survey

2.2.6 Farmers Perception on Crop Damages

Land suitability classification for each crop in different seasons are not available. Research/experimental data for different crops under specific land and soil conditions are also not available. Though some sporadic information on crop losses due to insect pests, dieses and post-harvest losses for rice are available. But no information on crop losses due to salinity, water-logging and tidal flooding in the Coastal Char lands of Bangladesh are available.

The Agricultural Expert met the farmers with the complaint that their crops are damaged due to salinity, water-logging and the tidal flood. The Agricultural Expert tried to assess the area affected, severity of damages due to salinity water-logging and the tidal flood in different seasons for different crops. For this purpose, a check list was used to collect information season wise crop area affected and severity of damages for Aus, Aman and Rabi crops. Group

discussion having 5-8 farmers in three places in Char Nangulia were conducted. In each places farmers were asked to estimate the total area affected, extent of severity of damage for Aus, Aman and Rabi crops due to salinity, water-logging and the tidal flooding. The average information from three places are shown in Table 2.2.5.

Table 2.2.5 : Farmers Perception on Crop Damage in Three seasons in Char Nang ulia

Season	Area affected (%)	Severity of Damage (%)	Damage Index (%)	Remarks
Aus/Kharif-I	53	60	32	
T.Aman/Kharif-II	20	10	2	
Rabi	26	25	6.5	

Source : Group Discussion

2.3 Livestock Survey

There is no reliable data on the livestock population, per capita availability and their contribution to household economy, soil fertility, employment and use for agricultural operations. A sample survey was undertaken to better understand the current management practices and the constraints in the production system and the scope of livestock sub-sector for future development in the context of marginal and small holder farming system. A comprehensive survey was undertaken in Char Nangulia in November 2006 to January 2007. A pre-tested questionnaire containing both structured and semi structured questions were used and the responses from the surveyed households were recorded. The data collected were compiled and analyzed. Additional information was collected from the Hatiya and Subarna Char Thana Livestock Office and Noakhali District Livestock Office of the Department of Livestock Services and others providing input services in the area.

2.4 Environmental Survey

Environmental survey on the Char Nangulia and Noler Char Development Study was conducted to –

- study the existing environmental situation of the project/study area,

- identify important Environmental Components (IECs) needing attention,

- help in assessing the impacts of development works/interventions in river hydraulics, morphology and water management etc. on environment and

- identify major impacts on existing environment and first identification of possible mitigation measure for the project area, utilizing experiences of CDSP activities.

The survey has been carried out according to guidelines set by GOB and Guidelines for Environmental Impact Assessment of CDSP Activities exploring the existing biodiversity.

Group Discussion has also been undertaken. The survey and the group discussions helped in carrying out an Initial Environmental Examination (IEEs).

CHAPTER- 3: PRESENT SITUATION IN THE PLAN AREA

3.1 Location

Char Nangulia is located on the southern side of Polder 59/3B and Char Majid Polder. It is bounded on the southern side by Mamur khal, western side by Char Majid, Banshkhali khal and Hatiya River and Hatiya Channel on the East. The plan area falls within the BTM co-ordinates of about 490,000 - 503,000 Northings and 617,000 - 630,000 Eastings. Fig. G 1.2.

3.2 Physical Condition

The area is a fairly raised char land at southward extension by accreted land of Southern Noakhali. It gets saline tidal inundation through the tidal channels and creeks. Agriculture is impeded due to tidal inundation, drainage congestion and soil salinity. The area needs empoldering.

3.2.1 Topography

The plan area is on an average about 11 km long north-south and 8 km wide east-west. Land level has a gentle slope north-south with higher levels on northern part. Average land elevation is about 3.7m (PWD). Maximum land of the area is within the elevation of 3.00m and 4.50m(PWD) covering about 88% of the Char Area. Area elevation relation is as below :

Elevation (mPWD)	Area(ha)
<2.75	395
2.75 - 3.00	191
3.00 - 3.25	350
3.25 - 3.50	1357
3.50 - 3.75	2616
375 - 4.00	1483
4.00 - 4.25	1242
4.25 - 4.50	842
4.50 - 4.75	314
>4.75	204
Total :	8994

3.2.2 Climate

The climate of Bangladesh is tropical, with a hot, humid summer (March to June), a rainy monsoon (June to September) with predominantly south-easternly monsoon wind. The climate characteristics of the study area such as temperature, relative humidity, sunshine hour and wind speed are based on Maijdee station. Maximum temperature stays between 34.0C to 35.3C during March-June period with the highest temperature experienced in the month of April and May. There is a significant fluctuation of minimum temperature varying between 9.5C to 23.0C. The lowest temperature is experienced in the month of January.

The range of average relative humidity is 73% to 88%. Humidity is the highest during June to October. The average wind speed varies between 1.5 m/s to 2.6 m/s with the highest speed occurring in the months of April, June, July and August. The sunshine hours vary from 3.0 hr/day to 8.2 hr/day with the minimum sunshine hour 3.0 hr. occurring in the month of July and the maximum sunshine hour 8.2 hr. in December.

The study area is often subject to severe cyclonic storm and vulnerable to tidal surges of the Bay of Bengal. Several major cyclones and tidal bores have crossed the area in the past. The peak cyclone risk times are September/October and April, the worst years being 1970, 1985 and 1991.

3.2.3 Soil

The area belongs to AEZ 18 Young Maghna Estuary Flood Plain and in Sub-region 18f – Saline : Noakhali, Hatiya and Meghna Estuary Char Land. General soil type is calcareous alluvium seasonally saline silty loam.

3.2.4 Hydro-morphology

The hydraulic and morphological conditions in the estuarine river and channels are quite complex and very dynamic in nature. The tides, river discharges, waves and storm surges are mainly responsible for the morphological development of channels in and around Char Nangulia. Major peripheral channels, Hatiya River and Mamur – Caring khal and downstream part of the main internal channel Nangulia – Katakhali khal gets morphological change in the form of gradual narrowing of section and raising the bed level due to siltation. The present condition of channels can be seen in the long section and cross-sections given in Enclosure-1, Annexure.

3.2.4.1 Rainfall Analysis

Considering the different catchments area, data of the rainfall gauge station Ramgati (Station Id 375) from 1961 to 2002 have been used to determine the drainage requirement. A 5-day duration rainfall with 10-years recurrence interval is taken as the design rainfall for computation of drainage modulus. Results of 5-day duration rainfall of different return periods, which present the results of the frequency analysis of 5-days accumulated rainfall of the project area in monsoon periods, are presented in the Table 3.2.4.1

Table 3.2.4.1 Frequency Analysis of 5-day Accumulated Rainfall (Monsoon)

Return Period / Station	2.33 Year Rainfall (mm)	10 Year Rainfall (mm)	20 Year Rainfall (mm)	25 Year Rainfall (mm)
Ramgati	340.65	591.61	699.67	733.94

3.2.4.2 Wind

The wind regime along the Bay of Bengal shows a typically seasonal variation between the dry season (November-March) and the monsoon season (June-September). During the dry season the prevailing winds are calm and offshore. The prevailing winds during the monsoon season are from the South-Southeast direction, with an average velocity of about 8-12m/s. During severe storms and cyclones, very high wind velocities can occur. The highest wind speed, reported during the April 1991 cyclone (CERP - II, 2000), is 62.5 m/s, corresponding to 225 km/h. Most cyclones occur during April-May and September-November, which are the transitional periods between the dry season and the monsoon season.

3.2.4.3 Tides

Tides in the sea results from the gravitational pull of the moon, the sun and the planets and from local meteorological disturbances. Two tides will occur during each rotation of the earth, and that the spring tide will occur when the forces due to the sun and the moon appears to be in opposition to each other. Tidal rise and fall of the water surface at the entrance of an estuary causes surface gradients which results in the propagation of a gravity wave into the estuary. The rate of propagation depends primarily on the depth of water and, in consequence, on the tidal range at the mouth.

The tidal wave travels more slowly as the depth decreases and, consequently, the wave form becomes distorted as it travels inland.

The water level variation is dominated by a semi-diurnal tide with a considerable variation from neap to spring tides. In the entire coastal area the variation of amplitude from neap to spring is from 0.6 to1.4 times the average amplitude (FAP-4).

According to the classification of tides proposed by Devies (1964) the tidal range in the study area can be classified as follows:

- South Bhola – Hatiya North : Meso-tidal – tidal range 2-4 m
- East Hatiya – sandwip :Macro-tidal – tidal range > 4 m

The study area is un-protected and completely subject to tidal movement of the coastal waters. Coastal water at this location are mainly saline i.e. about eight months a year.

The maximum high-tide water level is about 6.5 m above PWD during cyclone surges. The maximum current velocities vary from 0.1-4.0 m/s in the tidal channels to about 0.2 – 0.5 m/s in the shallow areas on the mudflats and chars. During spring tide the flow velocities are normally higher than during neap conditions (MES II, June 2001).

The high water levels at spring tide outside the Char Majid Polder are 3.5m PWD and at neap tide 2 to 2.75m PWD (Polder Design and Development, Technical Report No. 13, 2004) during monsoon season. In dry season, water levels outside the Char Majid Polder are about 1.5m lower, as compared to the monsoon.

3.2.4.4 Waves

Under the prevailing S – SE winds (with an average wind speed of about 8 m /s), the average significant wave height varies between 0.6 – 1.5 m in the near shore zone to 0.1 – 0.6 m in the landward part of the project area. In the dry season the waves are generally less than 0.6 m with peak periods of 3 – 4 seconds. During the monsoon season wave heights exceed 2 m with periods greater than 6 seconds.(MES 11, June, 2001).

Higher waves may occur mainly in the pre and post monsoon periods during cyclones. In a study carried out under Second Coastal Embankment Rehabilitation Project (CERP-11, 2000), the following estimates are given for the offshore wave heights (Table G 3.2.4.4).

Table G 3.2.4.4 : Offshore Significant Wave Height and Wave Periods

Return Period (Years)	2.5	5	10	20	50	100
Offshore Significant Wave Height Hs(m)	6.9	7.6	8.2	8.8	9.6	10.2
Offshore Significant Wave Period Ts(m)	11.1	11.7	12.2	12.5	13.1	13.6

3.2.5 Cyclonic Storm Surges

The coastal areas of Bangladesh are occasionally struck by severe tropical cyclones which generally originate in the form of a low pressure depression out at sea. They move northwards with well-defined circular wind fields which rotate in an anti-clockwise direction.

Flooding of coastal areas and off-shore Island by storm surge during a cyclone causes loss of lives and damages to properties. Available data on cyclonic storm surge height is very scanty. The displacement of water surface during a cyclonic storm surge also depends on tide. The displacement of water surface is the largest when the cyclonic storm surge reaches the coast during the time of spring tides. Such coincidence occurred during cyclones of November 12, 1970, December 10, 1981 and April 29, 1991.

The Multi-purpose Cyclone Shelter Programme (MCSP, 1993) has made a very thorough analysis of various aspects of the generation of cyclones surges and its penetration in-land. The yearly maximum wind speed (anywhere in the Bay of Bengal) was analyzed statistically revealing a relationship between return period and wind speed in presented in Table G 3.2.5 (a).

Table G 3.2.5(a) : Cyclone Wind Speeds (source MCSP, 1993)

Return Period (years)	5	10	20	25	50	100
Wind Speed (km/h)	165	195	223	233	261	289

The storm surge height in the Meghna delta entrance is generally larger due to shoaling condition. Storm surge heights have been computed using a mathematical model in MCSP(1993). Estimated surge heights at the Chittagong to Noakhali sea

coast for 20 years, 50 years and 100 years return periods with 90% confidence limits is presented below in Table G 3.2.5 (b).

Table G 3.2.5(b) : Estimated Surge Heights at Chittagong to Noakhali Coast with 90% Confidence Limits

Region	Surge Height (m)		
	20 years Return Period	50 Years Return Period	100 Years Return Period
Chittagong to Noakhali Coast	4.8 ± 1.0	6.5 ± 1.4	7.8 ± 1.8

The design surge height corresponding to given return period has been used for design of proposed infrastructure.

3.2.6 Salinity

Salinity intrusion is caused by the inflow of sea water during cyclones and lunar high tides and is the major constraint to agriculture development in the study area. The construction of embankments with adequate drainage facilities and adequate water management can reduce this problem. Serious crop damage occurs when standing crops are flooded by saline water.

Salinity data from LRP and MES indicate an enormous seasonal effect due to the influence of huge fresh water discharge from the lower Meghna River on the horizontal distribution of salinity in the estuary. During monsoon (June-September), nearly the whole estuary is filled with fresh water (salinity lower than 2 ppt (part per thousand).

Salinity level of water within the unprotected project area varies with the seasons; maximum values are reached in the pre-monsoon (April, May) and vary between 20-30m S/cm (12-19 ppt) (CDSP-II, Technical Report No. 13, May, 2004).

As per classification by MES, the land in this area is surrounded too long, more than three months, by saline water intrusion. No irrigation of any importance is possible in this case. Soil salinity levels in the area fluctuates considerably within a year. During the monsoon (July – October) soils of the project area are slightly saline but remain below 5 to 10 d S/m. After the monsoon, from November onwards, soil salinity levels increase and reach a peak in March and April. High post and pre-monsoon soil salinity levels prevent settlers from cultivating crops in the Rabi and pre-kharif seasons (MES, FAP 5B, 1998).

With the construction of polders, Aus rice and Rabi crops can be grown without irrigation and improved yields of Aman rice can be ensured if soil salinity is sufficiently reduced.

3.2.7 Drainage

The general drainage pattern of the area is towards the south-west, while the land of the area slopes to the South. The topographic map in Fig. A 2.1.2 shows the main drains. Hatiya River, flowing south-west of the project area is the main drainage outfall channel connected with the existing Mamur khal receiving drainage of the project area through internal khals. Significant area also drains to Hatiya Channel through Katakhali Khal-2. Major internal drainage khals are – Nangulia khal, Katakhali khal-1, Bhuyer khal, Katakhali khal –2, Kuralanka khal and Nunar khal. Drainage problems are mainly caused by siltation of the drainage channels due to rapid morphological changes. Silt deposition in tributary khals is a contributing factor.

Areas located along north periphery of the project area, the catchments area of Char Clarke and part of Char Lakshmi is also included in the project for drainage (Fig. A 3.2.7). The area drains into the Hatiya River through a network of khals passing through the project area. The main khals carrying water from beyond the boundary of the project are Munshir khal and Katakhali khal.

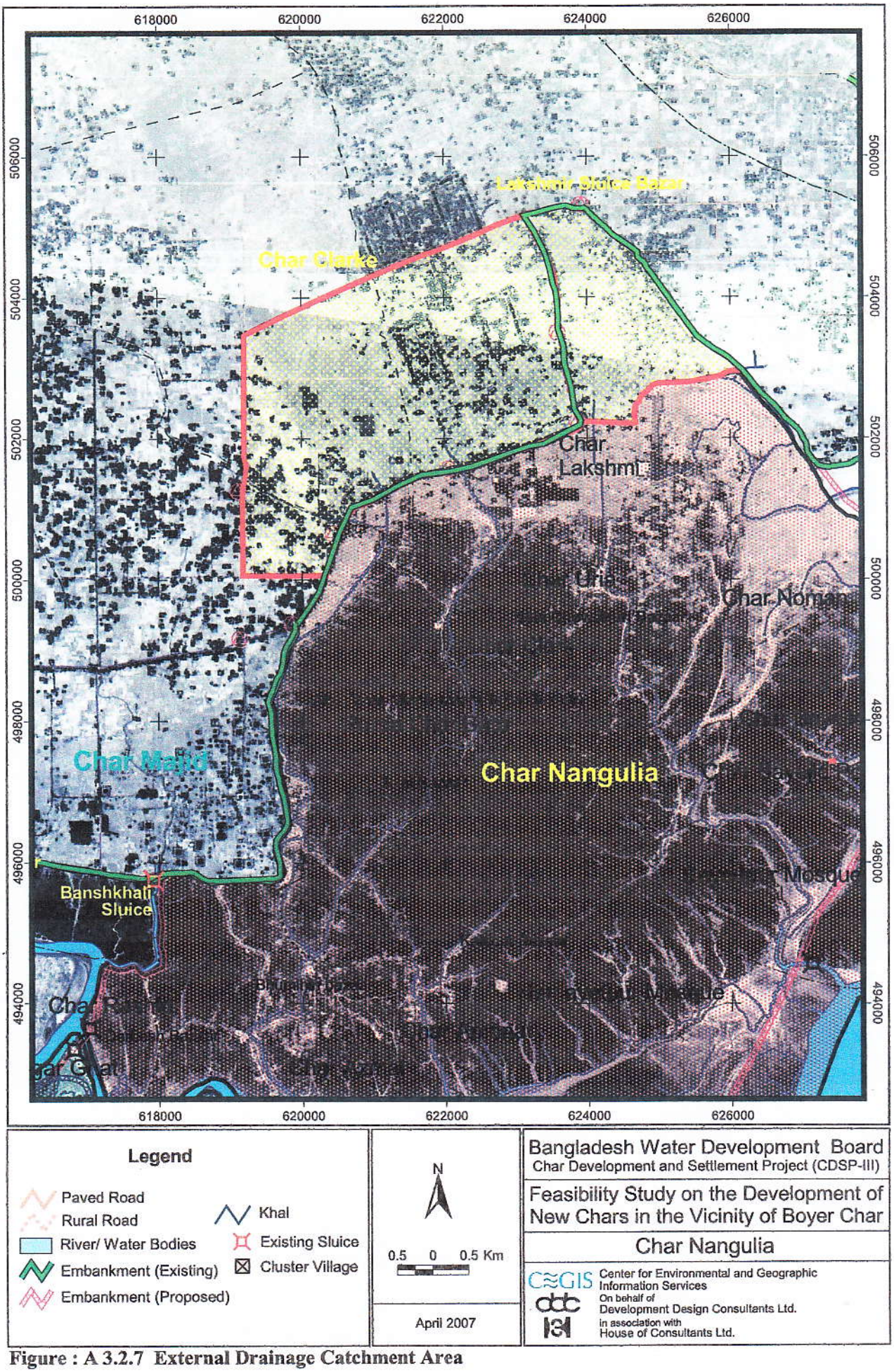


Figure : A 3.2.7 External Drainage Catchment Area

3.2.8 Present Land Use

Char Nangulia

Char Nangulia has a present land area of about 8994 ha as found from the survey. Land under productive use are mainly in agriculture with about 77% cultivable but mostly mono cropped area with less productivity. Fallow land which can be brought under agriculture is about 8.7% of the area. Existing homestead and Ashrayan Kendro (Cluster Village) covers about 5.4% and fishery area 4.2%. There are 4365 homesteads, 2 Ashrayan Kendros, 11 Bazars, 26 Mosques and 11 Primary Schools. Present household number as given by TA team is 8500. Present land use as per field survey is presented below :

Char Nangulia

Project Area	...	8994 ha
Cultivated/Cultivable Areas	...	6964 ha
Grazing/Fallow Lands	...	782 ha
Forest Areas	...	54 ha
Fishery Areas	...	381 ha
Khals	...	202 ha
Homesteads and Ashrayan Kendros	...	492 ha
Ponds/Ditches	...	75 ha
Roads	...	15 ha
Bazars, Schools, Mosques, Playgrounds	...	29 ha

3.3 Existing Infrastructure

3.3.1 Physical Infrastructure

Char Nangulia appears to be well developed naturally but not empoldered. It is bordered in the north by embankment of Polder 59/3B; in the west by embankment of Char Majid Polder, Banshkhali khal and Hatiya River; south by Mamur khal and east by Hatiya Channel.

In Char Majid embankment there is a public cut, 14 metre in length. The cut was made last year (2006) to solve partially the drainage problem of northern area of Char Nangulia by diverting excess water through Char Majid. Similar cut was also made in the year 2005.

In the portion of embankment of Polder 59/3B border in the north, there are four gaps at the crossing of Nangulia khal, Munshir khal, Katakhali-I khal (where there is a pipe culvert) and Katakhali-II khal, Bridges have to be provided in those places for easy communication.

There is a box culvert (size 7.3m x 4.5m) and one drainage sluice (3-vents) in CEP embankment at km 13.50 and km 13.73 respectively away from Bashkhali sluice of Char Majid Polder.

There is no cyclone shelter in Char Nangulia. The whole polder area is vulnerable to cyclone disaster.

There exist only two cluster villages in the Char Nangulia area and eleven markets inside with four markets at the periphery.

In the eastern side there existed Forest which protected the area from cyclone. The forest was dense a few years back. But in the near past those forest area were cleared to make the land cultivable. Now the area is exposed to sea and needs protection by putting embankment.

In Polder 59/3B embankment for a length of 9,95km (from km 5.55 to km 15.50) makes common boundary with Char Nangulia Polder. Within this portion of embankment there exist one 3-vent sluice, one 7.3m x 4.5m culvert and four openings of different size.

In Char Majid polder embankment for a length of 5.5km (from km 0.00 to km 5.5) borders Char Nangulia Polder. Within this portion of embankment there is no structure. Inventory of embankments and the detail of existing structures on the embankment of Polder 59/3B within the study area and Bashkhali Sluice of Char Majid Polder are shown in Table A 3.3.1.

Table A 3.3.1 : Inventory of Gaps and Drainage Sluices on the Existing Embankment

Gaps

Polder	Name of khal	Remarks
59/3B	Nangulia khal	16m Gap in embankment.
	Munshir khal	24m Gap in embankment
	Katakhali khal - I	Depression in embankment with a pipe culvert
	Katakhali khal-II	8m Gap in embankment.
Char Majid	Public Cut	About 14m Gap in embankment, public cut in 2006. Embankment was cut by public to drain excess rain water from Char Nangulia through Char Majid.

Sluice

Polder	Name of Khal	No. of Vents	Sill Level m/PWD	Gate Type	Year of Completion	Remarks
59/35	Bashkhali	7.3m x 4.5m (Box Culvert) DS 3-vents				Moderate condition Moderate condition
Char Majid	Bashkhali khal	DS 8-vents (1.52m x1.83m)	1.00	Flap	1998	Good condition

3.3.1 Communication

There is no road network within the proposed polder area except a few footpaths connecting bazaars, mosques and peripheral embankments of CEP and Char Majid. The bordering embankments act as peripheral road, paved partly, mostly unpaved.

These embankment roads are linked with Feeder Road of RHD (linking Steamer Ghat to Sonapur) and connects the study area with Sonapur-Maijdee (District Headquarter).

The internal footpaths (Road) are in very bad condition and accessibility in the monsoon period is problematic. Most of these footpaths are inundated during high tide twice a day in the monsoon period.

Within the proposed polder area there is no Jeep-able road. Motorcycles and Bi-cycles can ply within the area in dry period.

3.3.2 Pond

In Char Nangulia about 1.1% of Char area is occupied by ponds and ditches. In every house there is a small pond/ditch to collect rain water for domestic use of house owner and also for cattle use. Ponds and ditches become dry during the pre-monsoon period and filled-up in rainy season. In comparatively low lying areas those are inundated by high tide. Small saline water fishes take shelter in those ponds and are caught by owner just after wet season before ponds are dried up.

3.3.3 Tube-wells & Toilets

There are 37 Deep Tube-Wells (DTW) in the Char Nangulia Polder area. The tube-wells are the main source of drinking water supply. Tube-wells are inadequate. Previously people were to use polluted pond/ditch water and to go far for collecting drinking water. DTW is the safe drinking water supply in the area. Drinking water crisis is mainly due to high salinity in surface and in ground water of shallow depth. Arsenic pollution within shallow depth of ground water is also problem in Noakhali Coastal Area. DPHE has conducted Arsenic tests on samples collected from DTW & STW in different Coastal areas in Noakhali Sadar Upazila. The Arsenic Test Results show arsenic content is nil in the samples of DTWs whereas Arsenic Content is beyond tolerance limit (limit 0.05mg/litre, Bangladesh Standard) in 1/3 samples of Shallow tube-wells. Therefore, STW for drinking water supply should be avoided in the Char area.

Sanitation facilities in Char Nangulia is almost nil. Most of households are using kucha latrines. Very limited households are using single pit latrine supplied by NGO's.

3.4 Present Agriculture

3.4.1 Agricultural Seasons

There are three rainfall patterns associated with cropping seasons for non rice crops. Close to these three non-rice seasons, there are three distinct rice season having some overlapping periods and with its definite seasonal characteristics. The seasons and their limits, rainy season and crop growing periods are shown below.

Crop/Rice Season	Rainy Season	Time Period
Kharif-1/	Pre-Monsoon	April-June
Aus Rice	Pre-Monsoon	Mid March-July
Kharif-II/	Monsoon	July-October
T. Aman Rice	Monsoon	July-December
Rabi/	Post Monsoon	November-March
Boro Rice	Dry Season	December-May

3.4.2 Farm Size, Family Size and Land Tenure System in Char Nangulia

Farm Size. Farm size classification in Bangladesh is landless (0-0.2 ha), marginal (0.2 – 0.4 ha), small (0.41-1.0 ha), medium (1.01 – 3.0 ha) and large >3.0 ha. During group discussion in Char Nangulia, farmers reported that each farm family was provided with 0.60 ha i.e. 1.5 acre of land. Household survey showed the average land holdings is 0.73 ha consisting of the homestead 0.083 ha, pond area 0.097 ha and the cultivated land 0.55 ha. However, the range of cultivated land holding is 0.064-1.9 ha and the homestead and pond area range is 0.0-0.32 ha each, Annex-3, Table 3.1.

Annex-3, Table 3.1 : Average Land holdings of the Sample Farmers in Char Nangulia

Purpose of Land Use	Area in (ha)	Range (ha)	No. of Responses	%
Homestead	0.083	0.032-0.32	103	100
Pond (if any)	0.097	0.0-0.32	102	99
Cultivable Land	0.55	0.064-1.9	103	100
Fallow Land (if any)		0.19-0.42	2	2
Orchard	Included with the homestead and pond area			
Agro-forest	Included with the homestead and pond area			
Total (ha)	0.73			

Source : Household Survey

Family Size. The household survey showed the average family size is 6.38 persons with a range of 2-14 persons. However, the average number of agricultural farm workers is 1.83 with a range of 1-5 per family, Annex-3, Table 3.2.

Annex-3. Table 3.2 : Information on Households Member in Char Nangulia

	Total number	Average	Range
Total number of Member	657	6.38	2-14
No. of Agricultural labourer	189	1.83	1-5
No. of hh surveyed N = 103			

Source : Household Survey

Land tenure System. Household survey showed that 100% of the farm family possess land while 1% lease out land, 0% take lease and 21% cultivate land on share cropping. The share-cropping arrangement is on the 50% basis (Annex-3, Table 3.4).

Annex-3, Table 3.4 : Land Tenure System

Nature of ownership	No. of Response	(%)	Remarks
Own land	103	100	
Lease out	1	1	
Lease in	0		
Share-cropping	22	21	50% share basis

Source : Household Survey

3.4.3 Socio-economic Profiles of the Farm Family in Char Nangulia

Besides the socio-economic conditions described in the above section; some additional socio-economic conditions such as cultivation resources, sources and share of annual income, food security, farm employment and labour availability are described below :

Cultivation Resources. Household survey showed that only 24% farm family have bullock, plough and ladder for own land preparation from where 19% lease out bullock, ladder and plow. None of the farmers has power-tiller and sprayer. Surprisingly 76% of land preparation is done by Power-tiller (Table 3.4.2), hired from the machinery businessmen of neighboring settled areas.

Table 3.4.2 : Cultivation Assets of Farmers in Char Nangulia

Assets	Farmers		Lending (%)	Borrowing (%)
	No.	%		
Bull/Bullock	25	24	19	-
Plough	25	24	19	-
Ladder	25	24	19	-
Power Tiller	-	-	-	76
Sprayer	-	-	-	-
Weeder/Sickle	-	-	-	-

Source : Household Survey, N=103

Food Security. Only 16.5% of the farm family have 12 months food available and 9.7% of the family have 3 months food and 55 and 18% of family have 6 and 9 months food available per year (Table 3.4.3).

Table 3.4.3 : Availability of Food for the Family Per Year

No. of months food is available	No. of Responses	%
3	10	9.7
6	57	55.33
9	19	18.44
12	17	16.5
Total :	103	

Source : Household Survey

Employment of the Farm Family Member and Source of Income. Household survey showed that only 36% of the households have full employment in the farm while rest 64% has partly employment. Unemployment rate is 20%, i.e. on an average they become unemployed for 2.4 months in a year (Table 3.4.4)

Table 3.4.4 : Employment of Family Members of the Farmers

Nature of Employment	Responses	%	Unemployment Rate (%)	Av. Agricultural Labours in the Family
Fully Employed	37	36		
Partly Employed	66	64	20.48	
Total :	103	100	2.4 months/yr	1.83 (1-5)

Source : Household Survey

The major sources of farmer incomes are crops, small trading and labour selling. Hundred per cent of farmers earn average 43.5% of their income from the crops while 41 and 64 percent farmers earn 53 and 42 percent of their income from small trading and labour selling respectively. Ninety nine and 100 percent farmers reported that they earn 5.0 and 4.5 percent income respectively from fishery and livestock.

Table 3.4.5 : Farmers Sources and Share of Annual Income in Char Nangulia

Sources	Av. Share (%) & Range	Responses (%)
Crops	43.5 (15-90)	100
Fishery	5.0 (2-8)	99
Livestock	4.5 (2-15)	100
Small Trading	53 (30-90)	41
Labour Selling	42 (10-60)	64
Handicrafts	-	-

Source : Household Survey

Labour Availability for Agricultural Operations. The survey showed that 87% of the households have their own labourer for agricultural operation while rest 13% have to hire labourer from the local source. No migrated labour used is reported, rather during lean period, labour migrate to other areas for their employment (Table 3.4.9).

Table 3.4.9 : Labour Sources for Agricultural Operations in Char Nangulia

Source	No. of response	%
Own Labourer	89	87
Hired Labour	Local = 14	13
	Migrant = 0	100

Source : Household Survey

3.4.4 Present Cropping Pattern and Cropping Intensity

A farmer's decision to select a crop and cropping pattern is location specific, demand driven, depends on the availability of resources and support services. Food security is the prime concern to a farmer. Once food is secured economics and environment determine his choice of crops. Char Nangulia is dominated by T. Aman crop (90%) during Kharif-II season followed by Rabi season crop (40%) and Aus/Kharif-I (10%). Table 3.4.1. Shows the present cropping pattern, NCA and (%) and cropping intensity as calculated from NCA (100%) and cropped area in Char Nangulia.

Table 3.4.1 : Present Cropping Pattern, Cropping Intensity in Char Nangulia

Name of the Char	Cropping Pattern	Net Area (NCA) and %	Cropped Area (ha)	Cropping Intensity(CI)
Char Nangulia	**Single Crop**			
	Fallow–GM. -T. Aman 0 - 0 - 45	3132(45%)	3134	45
	Double Crop			
	Fallow-Aus-T. Aman 0 - 5 - 5	348 (5%)	696	10
	Rabi-GM-T. Aman 35 - 0 - 35	2437 (35%)	4874	70
	Tripple Crop			
	Rabi-Aus-T. Aman 5 - 5 - 5	348 (5%)	1044	15
Total :	40 - 10 - 90	6265(90%)	9748	140

Source : Study Estimation

The future cropping pattern will remain more or less the same with the replacement of single crop area by double crops and increase of triple crop area. The major crops grown in Char Nangulia are shown below.

Boro/Rabi Season :

Pulses – Most common is khesari with little cow pea and Mungbean.
Oilseeds – Groundnut, Mustard and Linseed (Tishi)
Spices - Chillis, Onion, Garlic
Boro rice – Both local and HYV is absent

Aus/Kharif-1:

Aus – Local rice varieties are Saita, Boilam and HYV rices China IRRI (Purbachi), BR-1 (Chandina) and BR-27

Kharif-II /T. aman :

Local rice varieties are Rajasail, Kajolsail, Gigaj and HYV rice is BR-23 and BR-II.

3.4.5 Homestead Agriculture

The average homestead area including ponds in Char Nangulia is 0.18 ha with a range of 0.032-0.32 ha. Homestead agriculture includes agro-forest and vegetables or kitchen garden. Survey showed that use of homestead is important to raise the income, nutritional status of the family and environmental protection. Older households have more trees and vegetable crops than the new settlers. Almost every household have some kind of homestead crops.

The common homestead crops observed are Banana (37%), Koroi (71%), Coconut (22%), Mango (37%), Mehogany (6%) and Bambo (15%) in the sample household (Annex-3, Table 3.3). Homestead agriculture through proper planning, managements and following the models developed by BARI could contribute to raise income, nutrition and environmental protection of the households and the char lands.

3.4.6 Present Level of Input Use and Management

The present use of inputs (such as fertilizers) in Char Nangulia is not optimum. Urea, TSP, some pesticides and power tiller is used in T. aman season. But very little fertilizer is used for pulses and oilseed crops except groundnut. For the common spice crops Urea and TSP are used. Sulphur and Zinc are not found to be used. Majority of the farmers used their own saved seeds and some get the seeds from local markets

and from the neighbors/relatives. The farmers lack cash for investment on inputs. A major part of the farmers are share croppers (21%) who are not much interested for investment on land (Annex-1).

Char Nangulia is newly settled, resource poor and lack all kinds of support services including basic necessities of life like drinking water and health services. Among the inputs, locally produced seeds are used. Besides, human labour is used in different operations of crop production. Power tiller (76%) and animal power is used for land preparation (Table 3.4.2).

3.4.7 Present Support Services (Extension, Credit and Marketing)

Support services such as extension services, credit and the marketing facilities to transfer new and modern technologies to the farmers, availability and access to production inputs such as quality seeds, fertilizers and the pesticides were examined in Char Nangulia. The extension services either from the GOB agencies such as DAE, DLS and DOF and the NGO's are almost absent in Char Nangulia. To increase production, income and employment opportunities of the farm household, support services need to be strengthened and improved.

Extension Services. The tasks of the extension services providers in GOB/NGO's and the private sectors are to train the farmers on modern and new technologies in the areas of crops, fisheries, livestock, homestead and agro-forestry and the income generating activities (IGA). The principles of the extension services and technology transfer is to assess the farmers needs and the resources of the farmers through involving the farmers, working in groups rather than individuals and targeting all farmers including women. The sources of extension services from any source at Char Nangulia is absent (Table 3.4.6).

Table 3.4.6 : Source of Support Services in Char Nangulia

Source of Services	Responses	
	No.	%
GOB (DAE/DLS/DFS)	0	0
NGO	0	0
Others (Seed/Fertilizer/Pesticide Dealers)	0	0
Total :		

Source : Household Survey

Credit Support. Credit support for farmers is very important to adopt modern technologies in the field of crops, livestock, fisheries and small trading. The farmers in Char Nangulia are resource poor and do not have necessary agricultural assets and cash money. Majority of households (75%) reported that they need credit. The source of credit is the money lender (74%), bank (1%) and through the mortgage of the land (2%). No credit from relative and the NGO's. The interest rate of the money lenders is 160% i.e. 6 mds of paddy per Tk. 1000 for one season (Table 3.4.7.).

Table 3.4.7 : Source and Interest Rate for Credit in Char Nangulia

Credit needs, Yes = 75%, No = 25%

Source	Responses		Interest Rate (%)
	No.	%	
Bank	01	1.3	8
NGO	0	0	0
Money Lander	74	96	160%, 6 mds. of paddy per Tk. 1000
Relative	-	-	
Others (Mortgage)	2	2.6	Lease out land
Total : N = 103	77	100	

Source : Household Survey

Marketing Facilities. Household survey showed that the farmers have local marketing facilities for all their inputs such as seeds, fertilizers, pesticides and their produces. They do not need outside markets (Table 3.4.8).

Table 3.4.8 : Responses on the Marketing Facilities of Agricultural Inputs and Outputs in Char Nangulia

Commodity	Local Market		Other Market	
	No.	%	No.	%
Rice	103	100	0	0
Pulses/Oilseed/Vegetables	103	100	0	0
Seeds/Fertilizer/Pesticides	103	100	0	0
Total : N = 103				

Source : Household Survey

3.5 Livestock

Livestock sector accounts for about 3.2 percent of GDP, and about 11 percent of agricultural GDP. The contribution of livestock of agricultural GDP is increasing over the years, providing about 20 percent employment of rural work force. In Bangladesh farming system crop production and livestock are closely linked. In addition to providing part of draft power for crop production and rural transport the animals are major source of high quality protein in the diet. In the estuarine environment where tidal inundation, salinity and land erosion and accretion is a continuous phenomenon, vulnerability of farmers to natural disasters is prevalent, livestock production led to a strong element of risk aversion in farming systems and large animals are considered as an important hedge against risk. The large farmers often own large herds of buffalo orcow and put the animals in the natural grass pasture to grab the accreting land. Livestock and Poultry raising represent a reliable source of cash income for small farmers in the area.

3.5.1 Livestock Situation in the Project Area

Although the livestock sector is dominated by large animals, more farmers especially the women and children are involved in small animal and poultry production. At the farm level, a small farmer operating about one-acre land typically owns (two heads of cattle, two goats and about ten poultry). Goat population is assumed to have increased significantly over the past few years of settlement despite recorded reports of mortality both in adult and young stock. For the poor settlers in the new land all animals are important assets and are generally better able to acquire and manage small ruminants and poultry; as these are cheaper to purchase and easy to feed and can be reared using very little land and other resource. Under care of women and children small ruminants and small flocks of poultry are kept under scavenging system, supplemented with feeds made up of household wastes are significantly contributing in raising women's income and home nutrition especially of the children. Government considers livestock as a highly viable sector for employment generation for the rural landless, marginal households and the unemployed youths and to have direct impact on poverty alleviation and accordingly have given priority in the Sixth Five Year Plan 2002 - 07.

Table 3.5.1.1 : Livestock Population.

Type of Livestock	Respondent households (%) Current holding (for >2yrs M/F)	Num-ber	Changes in stock in last 12 months						Income from sale (BDT)		
			No Bought	Purchase cost(BDT)	No sold	No born	Mora-lity	Net change	Animal	Milk	Eggs
Cattle >2Years	34(33.01%)	71	13	73,000	12	12	2	11	84,500		
Cows number		43	10	53,000	10	10	2	8	70,500	15,000	
Bullocks number		28	3	20,000	2	2		3	14,000		
Buffalo >2Years	12(11.65%)	17	3	62,000	3	2		2	50,000	8,850	
Male number		4		14,000	1			-1	30,000		
Female number		13	3	48,000	2	2		3	20,000		
Goat/Sheep >year	33(32.03%)	196	3	15,700	56	40	28	-41	15,700		
Does number											
Bucks/Rams											
Chicken>6months (Pre-Layers)	101(98.05%)	825	60	5,800	222	60			18,040		
Hens		720	45	4,350	142	60			11,540		14,200
Cocks		105	15	1,450	80				6,500		
Ducks>6 months(Pre-Layers)	95(92.33%)	579	35	2,500	338	15			27,400		9,900
Males number		95	10	715	88				7,100		
Females		484	25	1,785	250	15			20,300		
Pigeon											
Other											

In the proposed Char Nangulia project area out of existing 8,500 households (HH) 103 HH were surveyed, 34 households (33.01%) recorded 71 cattle above 2 years, among them 43 cows and 28 bullocks indicate the preference for keeping females overthe males and 12 (11.65%) households recorded 17 buffalo above 2 years, 13 female and 4 male. This again indicates to the preference for keeping more females than males. Dependence on animal draft power is reducing with the gradual introduction of power tillers. 33 Households (32.03%) have 196 goats above 1 year, the survey recorded no sheep. 101 households (98.05%) rear 825 chicken above 6 months (720 hen and 105 cocks) in the backyard and 95 households (92.23%) rear 579 ducks above 6 month age (484 female and 95 male). It is seen that during last 12 months number of cattle increased by 11 and buffalo by 2 but goat decreased by 41 of which mortality was 40. More deaths of goat recorded than normal for some unidentified diseases. Number of chicken and ducks sold out more than born. (Refer Table 3.5.1.1). Per capita availability of 0.171 (0.138 cattle and 0.033 buffalo), 0.38 goat and 2.72 (1.6 chicken and 1.12 ducks) as against national average of 0.26 cattle, 0.18 goat and sheep and 0.91 chicken and ducks as recorded in 1996 Agriculture and Livestock Census. Which indicates local farmers dependence on livestock and further opportunities to increase both large and small ruminant production with seasonal facilities for free grazing in fallow land and mostly single cropped land that remain open for grazing during January to July and in the adjoining coastal forests during monsoon. The per capita availability of cattle

is less than national average the goat production can also be increased with extension of technical services and micro credit facilities.

Table 3.5.1.2 : Estimated Livestock Population in Char Nangulia

Livestock Population in 2007

Households	Buffalo	Cattle	Goat	Sheep	Chicken	Ducks
8500	1402	5865	16149	-	68000	47600

The estimated livestock population of the Char Nangulia project village is given in Table-5.3.1.2.

Natural Feeds and Fodder :

The most common natural grass that grows with natural accretion of landmass is Uri grass (Oryza coarctata) and comes first. the farmers usually cut and carry them from the mud flat when the soil is soft and cannot bear the trampling by cattle. With further consolidation buffaloes are brought in by large farmers and grazed. If the land goes to the Forest Department (FD), the FD starts plantation with keora (Sonneratia oapetala) under the cover of Urigrass and do not allow grazing for three yearstill the planted materials are above the reachof the animals. However, the forest employees usually do not restrict cut and carry system unless the collectors do harm to the plantation. After 3 to 5 years the growth of the urigrass subsides with the decline of salinity and replaced by Dhubgrass/Durbagrass (Cynodon dactylon) which grows with monsoon rain and the animals are grazed freely during monsoon and post monsoon months. The animals while in the forest also graze on other creepers, leaves of keora trees and any other palatable material availableto the animals. During June with the start of monsoon rain a mixed grazing and stall feeding system is practiced. During October-February dry months and main Aman growing season the animals are tethered and grazed in rice crop failure plots and other fallow lands.

Table 5.3.1.3 : Feeds and Fodder Situation in the project village

Types of Livestock	Source of Grazing		Feed Sources			Source of Supply			Remarks
	Rainy Season July-September	Dry Season March-May	Cut and carry (for fattening)	Grown (Including under sown) (Tk)	Purchased (Total cost, Tk)	Private	DLS	NGO (Name)	
Cattle/ Buffalo	Tethered and stall fed	Open field	Limited	120,000	18,000	Private	-	-	No formulated concentrate is available
Goat/ Sheep	Tethered	Open field	Very limited	20,000	-	Private	-	-	"
Chicken	Scavenge	Scavenge	-	21,000	1,020	Private	-	-	"
Duck			-	15,000	700	Private	-	-	"
Pigeon									

In Char Nangulia the settlers opined that they usually do not calculate the value of natural fodder and crop by-products and spend very little cash to buy feed ingredients from the market.

Breed and breed characteristics of livestock species

Cattle: The predominant indigenous (deshi) animal is a small nondescript Bos indicus type, the mature body weight is between 125 - 200 kg. The slow growing, shy breeding animals average age at first calving is 45 months and have lactation period of about 7 months, the prolonged intercalving period is about 38 months. No improved breed have so far been introduced in the area. The priority purpose of cattle was for draft power, particularly for cultivation of land but the scenario is fast changing with the introduction of power tillers in the area .

In the emplodered area with the increasing cropping intensity and the greater need for timeliness in land cultivation, the demand for draft power is increasing; to meet the demand cows are being harnessed to the plough. Small local breeds of cattle are preferred because they are adequate for local farm, easily housed with the limited homestead space and easily managed by women and children.

Under these circumstances milk, meat and hides are largely by products of the draft herd. However, inspite the high price of milk the average daily yield of milk is little over one litre per cow. Also the traditional grazing areas are going under the plough to produce rice which under the existing price structure are financially less attractive but with such a poor agricultural economy, survival is the prime motivating force.

Excluding the landless, the bulk of the estuarine households farm between one and two acre of land, much of it on a share cropping basis. To hire draft power for cultivation will cost between Tk (1500 to 2000) per acre per season but timeliness is so critical that hiring is a risky business. From this it can be seen that ownership of a few draft cattle is highly desirable, although they constitute a very high capital investment. To minimize the size of individual herd, whilst at the same time ensuring theircontinuity, systems of exchange exist between villagers. Recent introduction of power tillers and their easy availability on rent have greatly reduced dependency on draft animal, the surveyed households indicate preference for milk and meat animals. So far no initiative to introduce milk or meat breeds have been under taken by any public or private agency.

Buffalo: In the estuarine environment buffaloes are a preferred species as they are better adopted to plough the mud flats, consumecoarser roughage that grows in the newly accreting chars and in the forests. They can tolerate more salinity than cows and are more resistant to disease. In the new estuarine chars the buffaloes are kept in large herd of 50 to 250 under care of herdsmen. The buffaloes found in the coastal region are Indian water buffalo type, mature body weight is 350450 kg and are seasonal breeders and come in heat in post monsoon months with the increased availability of fodder in the chars and calve in spring. The average milk yield about 2.5 to 3 kg per day and lactation period is 7 to 8 months.

Buffalo milk contains more fat and solid not fat (SNF) than cow's milk and are preferred by local people for making ghee (Clarified butter) and curd. There is scarcity of quality stud buffalo bulls and no improved breeding and management have been initiated in the area.

Goat: The major breed of goat is the Black Bengal. The breed is famous for its high prolificacy, tender meat and skin quality. The Black Bengal goat is well adopted to hot humid climate and produces twins and triplets and have the potential of being developed as "Broiler goat". The average live weight of adult goat is 16 to 18 Kg. goats are reared by marginal and landless households and children and women take care and considered an important activity in the existing integrated small holder farming system. The marginal households prefer goat rearing for it requires small capital investment, simple housing, easy management, graze on fallow lands after crop harvest, selectively browse on weeds in weed infested and planted rice crop during mid stage or are tethered along the road sides, embankments. The goat can survive on tree leaves of number of species frequently seen in the estuarine villages. The goats mature at an early age short gestation period and generation interval. Goat meat fetches

higher price than beef and the milk is easily digestible by children and the old. The kids are reared as households pets.

Marginal households with limited access to feed large ruminants but have the opportunity to obtain green grass and palatable leaves round the year and have idle manpower to look after may be promoted to take up goat rearing to augment the flow of side line income. Women groups mainly destitute and embankment/roadside plantation caretakers may be given preference to take up this activity. There is acute shortage of quality breeding bucks in the area, through project intervention this can be addressed benefiting the destitute women to earn an income by selling the services of the bucks.

Sheep: Sheep found in the coastal area are coarse wool type, small in size about 10-12 kg adult live weight and well adapted to the saline environment. In some coastal households they are preferred to goat for their selective browsing on the leftovers of cattle and buffalo and considered less menacing than goat. However, in the surveyed households no sheep was found. Preliminary information indicates that no effort was made to promote sheep in the area.

Chicken: In the project area most of the households rear chicken. Generally they live a scavenging existence, and seldom receive much supplementary feeding. The local "deshi" types is poor egg producer and lays 40-50 eggs in a year with a behavior of pronounced brooding. No impact of cockerel exchange programme with improved breed like Rhode Island Red or White Leghorn under taken by the Livestock Department. The indigenous deshi birds are small in body size of about 1-1.5 Kg and well adapted under scavenging condition and probably more resistant to prevalent common diseases and are better able to protect from predators. Commercial farms with improved breeds are non existent probably because of poor preventive coverage, non-availability of day old chicks, formulated feed and proper marketing network. The local birds are ideal for reproduction by natural brooding. However, in a semi scavenging model with artificial hatching and balanced feeding have shown to increase income of small holder poultry rearers in other parts of the country. No similar projects have been initiated in the study area.

Duck: Like chicken duck raising is widely practiced by the housewives in the area especially in the village areas, having large member of ditches that favours natural growth of fresh water snails and duck weeds. The area is ideal for duck raising on commercial basis but their number is not much because of shortage of natural feed during the dry months. The fresh water snails do not survive during the post winter salinity and this increase the cost of supplementary feeding. However, a few (Khaki Campbell) was seen in the project area foraging in the depressed part, the rearers reported less egg production due to natural feed scarcity. The flock size is reduced through sale of surplus duck at the end of monsoon season.

The ducks are preferred by housewives living around the fresh water pools, as they produce 100-150 eggs per year, more meat and are resistant to many diseases that affects the chicken.

Pigeon: Although the project village appears to have good opportunity to rear pigeon but it is seldom practiced. Simple project intervention to introduce and management practices like supplementary feeding and disease control expected to bring significant economic benefit to the women beneficiaries.

3.5.2 Constraints in Animal Production System

Seasonal shortage of fodder is the main constraint in animal production system in the project area specially when the crop lands are under rice cultivation and the animals are restricted to homesteads and in the villages. The poor farmers have little access to forest under growths for grazing and the distant accreting lands.

Table 3.5.2.4 : Common Animal Diseases of Estuarine Area

Type of Animal	Type of disease		
	Bacterial	Viral	Parasitic
Cattle	Anthrax, Black Quarter, Haemorrhagic septicemia	Foot and Mouth Disease (FMD)	Paramphistomaides, Fascioliasis, Nematodes
Goat	Entero-toxaemia, Pluereo pneumonia (PPR), Anthrax	Goat pox	Fascioliasis, Haemonchosis, Trematodes
Sheep	Entero toxaemia	Sheep pox	Fascioliasis, Haemonchosis, Trematodes
Chicken	Fowl cholera, fowl typhoid	New Castle Disease Fowl pox	Ascaris, Coccidiosis
Duck	Duck Cholera	Duck plague	Coccidiosis
Pigeon		Pigeon pox	Coocidiosis

Source: Department of Livestock Services, Personal Commuoation

Animal disease is another major constraint encountered by the farmers. The estuary receives all the washings of the upstream including the infected carcasses and the environment favours quick spread of disease organisms and causing high mortality in large and small ruminants. Among the infectious diseases Foot and Mouth Diseases is common which renders the work animals unfit for work in the ploughing season and also is responsible for many calf deaths, infertility and loss of milk production. According to Livestock Department field officials other bacterial diseases like anthrax, black quarter, haemorrhagic septicemia, enterotoxaemia and viral disease like goat pox, sheep pox etc. are occasionally seen in pockets. Newcastle disease, coccidiosis, fowl pox, fowl cholera, duck plague, duck cholera are seen in poultry and take heavy toll every year.

Parasitic infestation is common and the burden is high which largely affects animal productivity in terms of milk and meat production, delayed maturity and prolonged inter calving period, parasitic diarrhoea and poor utilization of scarce feed resources.

The ignorance of the farmers on the preventive and curative facilities that are now available in the townships is not utilized in the locality. The above facilities could easily be made available if the farmers are organized and oriented with the government and growing private veterinary service delivery system.

Table 3.5.2.5 : Constraints in Livestock Rearing (Ranking in order of Importance)

Types of Livestock	Lack of Fodder (Season)	Lack of Water (Season)	Mortality/ Disease (Including predation)	Market Access	Cost of Feed	Lack of Access to Extension Services	Others Micro-credit	Remarks
Cattle/ Buffalo	Monsoon	Dry	Dry and Pre winter	Monsoon	Dry	Round the year	Not available	
Goat/ Sheep	Monsoon	Dry		Monsoon	Dry	"	"	
Chicken			Pre winter			"		
Ducks		Dry	Pre winter			"		

However, the market access is not a problem as reported by the respondents. It appears that the cattle traders frequently visit the area and buy the surplus stock, milk is sold locally and the peddlers collect the eggs and chicken regularly from the household and the adjacent market places. The farmgate price offered by the middlemen are often satisfactory to the households. During monsoon the traders visit less frequently and aggregation of animal, poultry, eggs and milk is difficult

due to bad road condition. The farmers get little less price to more aggregating cost and increased transport cost to distant markets. The farmers requested for provision of liberal micro credit facilities to small holder livestock raisers.

Mitigation of Constraints:

Table 3.5.2.6 : Technical Input Services

Type of Livestock	Vaccination		De-worming	Source of Service			Breeding Services	
	No of dose used	*Type	No. of dose used	Private (Tk)	DLS (Tk)	NGO (Tk)	Natural Cost (BDT)	Artificial Insemination (Cost) (BDT)
Cattle/ Buffalo	500	FMD, BQ	200	700	-	-	-	-
Goat/ Sheep	900	HS,PPR	-	900	-	-	-	-
Chicken/ Ducks	285	RDV,Duck Plague	-	285	-	-	-	No cock exchange

- FMD-Foot and Mouth Disease, BQ-Black Quarter, HS-Haemorragic septicemia, PPR-Pluro pneumonia, RDV-Ranikhet / Newcastle disease vaccine.

The above Table 3.5.2.6 explains the dark picture of almost non availability of technical input services from both public and private service providers. A few quacks on demand provide some inputs and the quality and quantity is far from satisfactory. No livestock development can be envisaged without bridging this wide gap. Project intervention need to address this on top priority basis.

Over the past three decades the public and private service delivery have improved considerably in the main land especially in and around the Upazila Livestock Development Center. In absence of government services the NGOs and other private services has reduced the wide gap. Vaccination and deworming boluses and feed ingredients are available at the door step of farmers. In designing project intervention similar experience of other projects may be taken to expand quality input service delivery in the project area.

Development options:

Seasonal shortage of fodder can be largely mitigated through introduction of leguminous fodder crops like salt tolerant varieties of kheshari and cowpea in the farming system in the dry season. Establishment of multipurpose trees in the village plantation schemes which can be used as protein leaf bank and also meet the fuel wood requirement of the households. The marginal farmers who are shy to use the under utilized forest under growths can be promoted to use the resource through group approach. The other feeds and fodder improvement can

be achieved through popularizing urea treatment of straw and feeding urea molasses mineral blocks which have shown promising results in the north and central region of the country. Salt free drinking water facilities for buffaloe/cattle can easily be made by simple rain water collection devices and their proper maintenance during the dry season.

Introduction of routine preventive vaccination against common prevalent diseases would reduce mortality and deworming would increase livestock growth and farmer's profitability, facilities of other inputs like improved bulls and bucks can be introduced to increase genetic potential and productivity of the animals.

Small scale solar powered cool chain facilities can be introduced through the NGOs promoted Rural Livestock Extension Workers to preserve vaccines, drugs and semen. Semen preservation in liquid nitrogen and its extension to the project area is feasible, this will solve the key constraint of genetic improvement of cattle .

In the chicken and duck development similar approach to ADB financed and DLS and NGOs implemented Participatory Livestock Development Project (PLDP) with suitable improved breeds of chicken and duck may be adopted for organized promotion of day old chick rearing, formulated feed supply and improvement of chicken and egg marketing network. However, it is assumed that introduction of cross bred like Sonali may not sustain in the long run. The learning from PLDP success or failure need to be considered prior to adventure of any intervention in poultry sub-sector.

Simple rural hygienic milk processing can be introduced by installation of diesel/wind power operated milk chilling vats and can be integrated with national milk marketing network though the NGOs, or Dairy Co-operatives. Quality and high value milk products like Ghee, Cheese, Yoghurt etc can be produced and marketed to distant markets. The secondary markets have good demand for quality processed products and the market is rapidly expanding.

Farming System Development Options

Livestock are well integrated into the existing farming system of the estuarine region. The strategies attempting to increase animal performance must take into account both the complementary and competitive relationships between crops,

trees and livestock in these systems. Farmers make few crop decisions without considering the demands for feed for their livestock.

In the estuarine area the small farmers operate with a very small resource base. This means that they have to be more dependent on the positive interactions resulting from crops livestock relationship and are in a less flexible position to adopt innovations. Negative interactions like free ranging of chicken and damage to home garden or free ranging of goats and cattle and damage to young field crops resulting in conflicts among neighbors are often inevitable and need careful considerations for planning changes in the system. However, the profitable use of accreting landmass and its natural vegetation is made through raising livestock till the salinity declines and are suitable for other higher value crop production. In the study village many of the respondents reported failure of rice crop due to water logging and increased salinity. These households can benefit from investing in livestock till the drainage congestion is removed.

It is expected that the new settlers would be served by NGOs and would include in their line of activities beneficiaries group formation, awareness building, savings mobilization and utilization of credit facilities. The NGOs are also likely to include home gardening, crop, livestock and fisheries development through group approach.

In the livestock sub-sector main activity of the NGOs would be to develop man power through organizing farmers training with cooperation of Livestock Department in specific line of activities and creation of a cadre of Livestock Field Workers and Women Poultry Workers who would undertake extension activities at the grassroots level on participatory approach and on self help basis. The farmers would be motivated to bear the inputs cost and service charge of the workers. DLS with cooperation of NGOs and participation of farmers all the inputs like vaccines, drugs, feed, and day old chicks, artificial insemination would be channeled through these workers.

Through project intervention the productivity of the existing herd of cattle, buffalo, sheep goat chicken and ducks are expected to be improved and reduce the preventable mortality and morbidity. Gradual introduction of more productive animals with the increased inputs availability and farmers skills to rear the improved stock will be a practical proposition in near future. The effect of project intervention on livestock is given in the Table 3.5.2.7.

Table 3.5.2.7 : Mortality in Animal due to disease under village conditio

Type of animal	Mortality without Treatment (%)	Mortality with Preventive Care (%)
Adult cattle ***	5	3
Calf	13	8
Adult Buffalo	4	2
Calf	12	6
Goat*	8	3
Kid	24	14
Sheep	8	3
Lamb	24	14
Chicken	20	10
Chicken up to 8 week **	50	20
Duck	10	5
Ducklings up to 8 week	40	10

Source: * Production of Bengal Goat with limited amount of supplementation and anthelimentic drugs in selected regions of Bangladesh, SS Kibria.

** Semi-Scavenging model for rural poultry, holding, hans Askov Jensen.

*** DLS and personal experience

3.5.3 Livestock Production and Population Growth Rate

Although no specific study was carried out in the project mauzas to determine the real growth rate but through farmers and field staff interview of the Livestock Department and study consultant's observation estimated the annual growth rate of different types of animal in the project area over the next 5 - 7 years is given in Table 3.5.3.8.

Table 3.5.3.8 : Livestock Production and Population Growth

Type of Animal	* Growth Rate in 5 years (1983-84 to 1988-89) (%)	Annual Growth (%)	** Cyclone Shelter preparatory study (%)	Estimated Growth Rate Char Nangulia (%)
Cattle	- 1.7	-0.34	3.70%	2.8%
Buffalo	36.6	7.32	-	15%
Goat	39	7.8	1.50%	5.3%
Sheep	24	4.8	-	-
Chicken	26	5.2	21.1%	7.2%
Duck	13	2.6		5.0%

* BBS 1994 Survey on Livestock and Poultry in Bangladesh

** Cyclone Shelter Preparatory Study 1996 Supporting Volume 4 Livestock

Livestock and poultry survey of Bangladesh conducted in 1988 - 89 by BBS has estimated overall decrease of Bovines population by 1.03% of which cattle population decreased by 1.7% but the buffalo population increased by 36%. and the Goat population increased by 39% and sheep 24% respectively. The

chicken population increased by 26% and ducks increased by 13% respectively over the census conducted in 1983-84 covering 5 years. The annual growth rate of the livestock sub-sector in 1994-95 was 9.5 percent which was one of the highest in the economy [1]. The production of milk, meat and eggs increase by an annual compound growth rate of 1.3 percent, 3.2 percent and 6.5 percent respectively between 1990 - 91 to 1990 - 95[1].

Table 3.5.3.9 : Estimatesof growth in livestock population in Cyclone Prone area

			Zone			
			West	Central	East	Overall
Average number per household	1983/4 (census)	Bovines	2.43	1.52	1.54	1.70
		Ovines	0.84	0.78	0.79	0.80
		Poultry	7.72	7.61	8.09	7.79
	Fifth Five - year plan 1997-2001	Bovines	2.29	1.76	1.91	1.91
		Ovines	1.06	1.12	1.00	1.00
		Poultry	13.66	18.22	19.13	19.13
Increase in number per household(Avg. change per year)		Bovines	-1.10%	0.80%	1.25%	0.70%
		Ovines	0.10%	23.20%	-0.70%	1.30%
		Poultry	16.50%	21.60%	18.50%	19.60%
Increase in nr. of household			3.50%	2.00%	2.20%	2.20%
Increase in total number (Avg. change per year)		Bovines	2.30%	2.80%	3.70%	2.90%
		Ovines	3.60%	5.30%	1.50%	3.50%
		Poultry	20.50%	24.10%	21.10%	22.20%

Source: Cyclone Shelter Preparatory Study Stage 1
Feasibility phase draft final report supporting volume 4 Livestock
Sener Ingenieria Y Sistemas Sa, Spain, 1996.

Similarly Cyclone Shelter Preparatory Study conducted a survey in 1996 in the cyclone prone coastal area and found 2.3 to 3.7% growth in bovines, 1.5 to 5.3% in ovine and 20.5 to 24.1% growth in poultry per year over the 1996 period. The above study covered wider coastal zone from east to the west. However, the east zone, which is largely identical with the project area have similarity with estimated growth rates except the poultry. The Cyclone Shelter Study included many small scale commercial poultry farms (Broiler and layer) operating in the main land along the Chittagong Highway and none of the organized farms exists in the study area. The poultry growth rate is assumed close to the findings of BBS survey, the growth rate is given in Table 3.5.3.8, and the Cyclone Shelter Preparatory Study findings is given in Table 3.5.3.9 .

It was noted that the buffaloes are in better health than cows as the buffaloes can consume coarser roughage and tolerate more salinity. During monsoon and post monsoon the cattle are reared in house and are stallfed. The farmers seldom spend money on improved feeding and the animals have to subsist only on rice straw and scraps of grasses in the embankment, pond dykes, village roads and bunds which is not enough for minimum maintenance. The animals loose weight and are easily attacked by disease. The situation further deteoriates if there is draught and delayed monsoon.

The small and marginal farmers do not send their cattle or buffalo in the forest for fear of theft or loss and their dependence on animal draft power for cultivation and other agricultural operations.

Table 3.5.3.10 : Estimated Livestock Population in Char Nangulia with increase of settlement (10% over present hhs)

Livestock Population in 2007 – 2012

Households	Buffalo	Cattle	Goat	Sheep	Chicken	Ducks
9350	1542	6451	17763	-	74800	52360

Table 3.5.3.11 : Estimated growth of livestock population in Char Nangulia with project

Type of Livestock	Expected Growth Rate	PY-0 2008	PY-1 2009	PY-2 2010	PY-3 2011	PY-4 2012	PY-5 2013	PY-6 2014	PY-7 2015	PY-8 2016	PY-9 2017	PY-10 2018	PY-11 20119	PY-12 2020
Cattle	2.8%	6451	6631	6812	7006	7199	7405	7612	7825	7825	7825	7825	7825	7825
Buffalo	1.5%	1542	1563	1588	1611	1660	1685	1685	1685	1685	1685	1685	1685	1685
Goat	5.3%	17763	18704	19681	20729	21830	22985	24211	25489	25489	25489	25489	25489	25489
Sheep														
Poultry	7.2%	74800	80186	85945	92078	98736	105842	113472	121624	212114	130451	139801	139801	39801
Duck	5.0%	52360	54978	57700	60580	63617	66811	66811	66811	66811	66811	66811	66811	66811

Note:

The consultants estimate of growth potential of cattle will continue for seven years and then the herd size will stabilize based on the total carrying capacity of available land. The growth of buffalo population will continue for five years and will stabilize based on carrying capacity and cultivation of high value crops and reduced availability of coarse roughage and reduced dependence of draft power. The goat population is likely to increase for seven years for increased interest of women in goat production and high profitability and fecundity. The poultry growth is expected to continue till tenth year for easy management and introduction of simple technology. The duck population will increase for five years and then stabilise for reduced area for free grazing and reduced availability of natural feed.

With project the main benefit will be increase in sideline income of the beneficiaries and expected to be above the national average of per smallholder households. The unemployed youths and the housewives will find more employment facilities remaining in the village. The livestock product consumers in the adjoining townships, rural growth centers and including Noakhali, Feni and Chittagong will get continuous supply of wholesome livestock products at a more competitive price.

CHAPTER- 4 : WATER MANAGEMENT OPTIONS

4.1 General

Char Nangulia and Noler Char, the two chars for development plans have been considered together for empoldering options. Char Majid drainage has been taken into account for preparation of the options.

The existing physical situation, environment, major constraints and problems of the study area, public demand and impact on adjacent projects have been carefully identified and studied for formulation of a comprehensive and balanced Development Plan.

Hazard due to saline tidal inundation/flood and drainage congestion are the main causes of problems to agriculture and of sufferings of the people living in the unprotected areas.

Considering the complex and dynamic situation and existing environment of the study area channels the consultants carried out detailed hydro-morphological investigations in the Hatiya river system. The consultants carried out detailed topographical survey in Char Nangulia, Noler Char, Caring Char, river surveys, land use survey, drainage studies etc. to prepare a balanced water management plan for the proposed study area. Mamur khal and Caring khal are the two hydro-morphologically important channels connected with and influencing Hatiya River hydro-dynamics. Lower Meghna River on the South-west and Hatiya Channel on the East are the two ultimate drainage outfall channels of the study area.

The average ground level of Char Nangulia is about 3.70 mPWD while the average ground level of Noler Char is lower and about 3.00 mPWD.

Knowledge was gained from local communities especially from those using local land and water resources through direct communication and field visits. Their views were considered on drainage congestion, tidal inundation/flood, saline water intrusion etc. in the study area. Based on this knowledge gained, need assessments of the project have been done.

The consultants investigated into possible options for solution of the related water management problems in the study area taking into considerations the external drainage situartion and dynamic morphological conditions of the tidal channels.

4.2 The Options

After thorough examination of the existing physical situation, environmental status, major constraints and problems of the area, public demand and status of the adjacent projects the consultants investigated the following possible options for formulation of a comprehensive and balanced water management plan for the project area.

- No intervention,
- Two polders (Char Nangulia and Noler Char Polders),
- One polder (Char Nangulia – Noler Char Polder), 2 Drainage Units,
- One polder, 1 Drainage Unit, avoiding Hatiya River for drainage,
- One Polder, 2 Units, avoiding Hatiya River for drainage.

To arrive at a comprehensive and optimum solution of the drainage problem and flooding situation, drainage simulation model and GIS model developed by CEGIS were used and application runs of the models for different design events were carried out. The interventional options are presented in Figures G 4.2a, G 4.2b, G 4.2c and G 4.2d.

No Intervention Option

This option allows the present situation to prevail i.e. keeping the area as it is without water management interventions. If no Water Management interventions are taken up in the unprotected study area, regular saline water intrusion and tidal flooding and drainage congestion will remain as constraints to the optimum utilization of land, water and other natural resources. However, the diminishing development of land elevation will continue. The economic activities of the area will continue at present slower rate.

Figure : G 4.2a Water Management option - 1

Legend

- Bazar/ Hat
- Azim Ghat
- Mosque
- Police Station
- Cluster Village
- Existing Sluice
- Proposed Sluice
- Paved Road
- Rural Road
- River/ Water Bodies
- Mangrove Forest
- Embankment (Existing)
- Embankment (Proposed)
- Khal

N

1 0 1 Km

January 2007

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia, Noler Char & Caring Char

CEGIS Center for Environmental and Geographic Information Services
On behalf of
Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Figure : G 4.2b Water Management option - 2

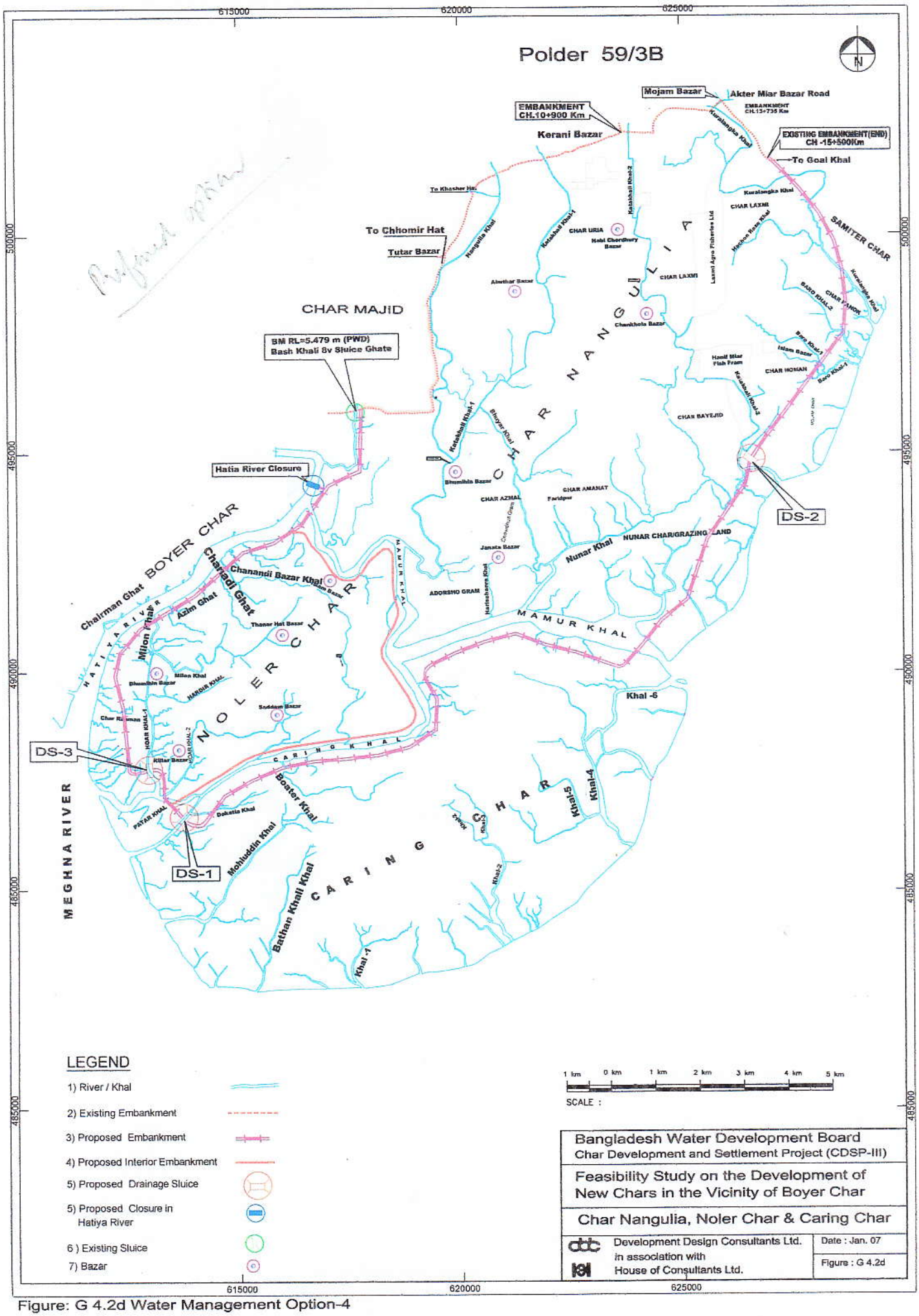


Figure: G 4.2d Water Management Option-4

Under this option, the existing situation in respect of drainage congestion will deteriorate, salinity will remain unchanged and most of the study area will remain flooded during high tidal flood.

Therefore, structural intervention for improvement of water management of the project area is essential and hence the option will not be discussed further.

Option-1 :

This option keeps Mamur khal and Caring khal open with the construction of (a) peripheral embankment for Char Nangulia Polder and a sluice at south-west corner of the polder discharging to Hatiya River and another sluice on eastern side to drain to Hatiya channel; and (b) peripheral embankment for Noler Char polder and a sluice near Milon khal outfall of this polder discharging to Hatiya River (Fig G 4.2a). The option will have the planed Cross-dam on Hatiya River at Ferry Ghat.

Option-2 :

This one-polder option is based on 2 drainage units 2 sluices approach. It will have one peripheral embankment around Char Nangulia and Noler Char area keeping Caring khal outside with 2 closures on Mamur khal one each near its confluences with Hatiya River and Caring khal and one sluice each for Char Nangulia and Noler Char drainage units both discharging to Hatiya River (Fig G 4.2b). Cross-dam on Hatiya River will be as planned at Ferry Ghat.

Option-3 :

This option will also have one combined polder with continuous peripheral embankment as of Option 2 but keeping Caring khal and eastern part of Mamur khal inside with one big sluice near the south-west end discharging to the Lower Meghna nearer to the out fall of Hatiya River (Fig. G 4.2c). It avoids Hatiya River as drainage outfall channel. Closure on Hatiya River may be at D/S of Char Majid out fall.

Option-4 :

The Option has been developed after the Technical Session on the study held on 25-06-07 in the Conference Room of BWDB, Dhaka (Proceedings given in Annexure Volume, Enclosure-3). It is a modified Option 3 with Noler Char as a separate drainage unit with a low height dyke on the other side of Caring khal and follow Mamur khal. Major Char Nangulia drainage will be effected through Mamur-Caring khals leading to a drainage sluice on Caring khal near to its outfall discharging to the Lower Meghna and another drainage sluice, like Option 1, will be on Khatakhali khal-2 to discharge to Hatiya Channel. Noler Char unit will have only one drainage sluice on Hoar khal to discharge also to the Lower Meghna. Option Map is given in Fig. G 4.2d. Closure on Hatiya River shall be at D/S of Char Majid outfall.

4.3 Discussion on Options

The four interventional options as already stated have been considered for Char Nangulia and Noler Char together taking into accounts the present hydro-morphological conditions of the major tidal channels of the study area - Hatiya River, Mamur and Caring khals, flow through them and tidal situation of the area. Option 1 keeps Mamur khal and Caring khal open with two polders and keeps Hatiya River as a drainage outfall channel; Option-2 closes Mamur khal, both sides with one polder and two drainage units and also uses Hatiya River as drainage outfall channel; Option-3 closes both Mamur khal and Caring khal with one polder and one drainage unit, and avoids Hatiya River as drainage outfall channel; and Option 4, actually a modified Option 3, also avoids Hatiya River as drainage outfall channel but having two separate units. The options and the points in favour and against are discussed to facilitate decision in favour of a specific option to prepare the development plans for the two chars accordingly.

4.3.1 Details of Option-1 :

There will be two separate polders – Char Nangulia and Noler Char Polders with individual peripheral embankment and drainage sluices keeping Mamur khal open as boundary external channel between them. With this option the cross dam on Hatiya River will be, as already planned, at Ferry Ghat to divert first drainage of Char Moradona through Boyer Char leaving Char Majid drainage as it is to drain to Hatiya

River since there is no problem of drainage in Char Majid. If required, Char Majid drainage may be diverted in future. This arrangement along with Char Nangulia drainage discharge and tidal discharge of the open Mamur khal is expected to help in channel maintenance of the Hatiya River for drainage.

Char Nangulia Polder will have the drainage sluice DS1 at the south west corner to discharge to Hatiya River and another sluice DS-2 on eastern side at Katakhali khal-2 outfall to discharge to Hatiya Channel. Mamur khal has been avoided as drainage outfall channel of Char Nangulia sluice due to its susceptibility to comparatively faster siltation. The silted up internal drainage channels Nangulia khal, Katakhali khal-1, Katakhali Khal-2, Bhuiyar khal and others will be re-excavated. Borrow pit channel for construction of embankment will be inside the polder to act as peripheral main drainage channel having required culvert/bridges at road crossings. Cross drainage inside will be affected through culverts on the internal roads.

Noler Char Polder will have the drainage sluice DS1 at the Milon khal outfall also discharging to Hatiya River. Here also borrow pit channel of embankment will act as peripheral drainage channel. Required culvert/bridges will be provided at road crossings of the drainage channels.

Positive Points of Option-1

1. Mamur khal and Caring khal are open to allow to continue natural tidal flow condition which will help maintain Hatiya River as out fall drainage channel of the area to discharge to Meghna River.

2. The two sluices in Char Nangulia will distribute drainage westward to Hatiya River and eastward to Hatiya Channel.

3. Construction of two large closures on Mamur khal as needed for one polder option will be avoided.

4. Nangulia drainage sluice (DS-1) discharging to Hatiya River will contribute to maintain Hatiya River channel.

5. Until diverted, Char Majid drainage will add to out-flow discharge of Hatiya River and help maintain the channel for drainage.

6. Peripheral embankments along Mamur khal will create facility to have east -west road communication of the polders.

Negative Points

1. Comparatively lesser siltation impact of Hatiya River than other Options.
2. Embankment length will be about 5.5 Km more.

4.3.2 Details of Option-2 :

The option will have a combined polder, **Nangulia-Noler Char Polder** with Char Nangulia and Noler Char Drainage Units. There will be one peripheral embankment for the two chars with two closures on Mamur khal, one near its outfall and the other at D/S of confluence with Caring khal. The polder will have two sluices, one for drainage of Char Nangulia Unit and the other for Noler Char Unit. A guide bund (dyke) on the southern bank of Mamur khal will separate the two drainage units. Eastern side embankment alignment will follow keeping eastern portion of Mamur khal and Caring khal out side the polder. Cross-dam on Hatiya will be as planned at Ferry Ghat with drainage diversion first of Char Maradona only leaving Char Majid Drainage as it is.

Positive Points of Option-2

1. Char Nangulia drainage sluice (DS-1) discharging to Hatiya River will contribute to maintain Hatiya River channel.

2. Until diverted, Char Majid drainage discharge will add to out-flow discharge of Hatiya River and help maintain the channel for drainage.

3. Closed Mamur khal is likely to be converted to a sweet water reservoir in futue.

4. Total embankment length is about 5.5Km less.

Negative Points

1. Closing of Mamur khal may likely to have uncertain morphological impacts including comparatively rapid siltation of Hatiya river leading to its dis-functioning as drainage outfall channel relatively early.

2. Two closures on Mamur khal.

4.3.3 Details of Option-3 :

This option will have a combined polder, **Char Nangulia-Noler Char Polder** avoiding Hatiya River as outfall drainage channel but one drainage unit. It will have one large drainage sluice on Caring khal at the southern end and discharge to Lower Meghna. Alignment of eastern side embankment will follow keeping eastern part of Mamur khal and Caring khal inside the polder which will be the main drainage channel leading to the drainage sluice. Cross-dam on Hatiya River may be at D/S of Char Majid out-fall to divert drainage of Char Majid, Char Maradona and also the area south of Char Majid through Boyer Char. This location of closure on Hatiya River will reduce embankment length of Boyer Char at Ferry Ghat end.

Positive Points of Option-3

1. One large polder with one sluice discharging to Lower Meghna River.
2. Likely siltation of Hatiya River will not affect drainage of the area.
3. The drainage sluice being nearer to the outfall River (Lower Meghna) there will be less problem of D/S siltation.
4. Closed Mamur khal and Caring khal may be used as sweet water reservoir in future.
5. Planned Boyer Char embankment length will be reduced by 1.5 km at Ferry Ghat end.

Negative Points

1. There will be no drainage distribution, char-wise. Accumulation of run off near the drainage sluice is likely to create temporary inundation near the sluice area due to lower land level in Noler Char.

2. Closing of Mamur khal may likely to have uncertain morphological impacts including rapid siltation of Hatiya river.

3. Two closures on Mamur khal and one on Caring khal.

4.3.4 Details of Option- 4 :

This option will also have a combined polder, **Char Nangulia-Noler Char Polder** but both the chars as separate units avoiding Baggardona/Hatiya River as drainage outfall channel. **Char Nangulia** will have the main drainage sluice (DS-1) nearer to the outfall end of Caring khal to discharge to the Lower Meghna. Like Option-3 alignment of eastern side embankment will follow keeping eastern part of Mamur khal and Caring khal inside the polder. Mamur khal - Caring khal will be the main drainage channel for Char Nangulia drainage leading to the Drainage sluice DS-1 (10V-1.5m x 01.8m). There will be another drainage sluice DS-2 (5V-1.5m x 1.8m) for Char Nangulia at eastern side on Katakhali khal-2 to discharge to Hatiya Channel. **Noler Char** will have one drainage DS-3 (7V x 1.5m x 1.8m) located at southern end of Hoar khal to discharge to the Lower Meghna river. Location of the proposed DS-1 and DS-3 will be at a minimum set-back distance of 1 km from the present coast line to provide safe distance against possible erosion and coast line migration at the outfalls of the sluices. The proposed Second Baggardona/Hatiya river Cross-dam will be at D/S of Char Majid out-fall instead of earlier one planned at Ferry Ghat. The river closure will be about 200m.

Positive Points

1. Hatiya River, susceptible to silting up in the long run, has been avoided as drainage outfall channel of Char Nangulia and Noler Char.
2. Noler Char being a separate drainage unit there will be no drainage accumulation.
3. Likely siltation of Hatiya River will not affect drainage of the area.
4. The drainage sluices being nearer to the outfall river Lower Meghna there will be less D/S siltation problem.
5. Planned Boyer Char embankment length will be reduced by about 1.5 km.
6. Closed Mamur khal and Caring khal are likely to act as sweet water reservoir.

Negative Points

1. Closing of Mamur khal and Caring khal may likely to have uncertain morphological impacts including rapid siltation of Hatiya river.

2. Two closures on Mamur khal and one on Caring khal.

4.4 Options Comparison

It is seen that all the four Options have individual points in favour for consideration. Positive and negative points of the Options have been discussed earlier. Comparison are made taking into account only the key positive and negative points.

Option 1 and Option 2, if compared first give that Option 1 has open Mamur khal an d its tidal flow in addition to the drainage discharges of Char Majid, until diverted, and of Char Nangulia and is likely to impact favourably the channel maintenance of Hatiya River; and Option 2 will have less embankment length (by about 5.5 km) and scope of using closed Mamur khal as a sweet water reservoir. Considering anticipated more siltation impact of Hatiya River in Option 2 due to absence of Mamur khal flow, Option 1 is assessed to be favourable.

Option 3 has the strong positive point that it has only one drainage sluice discharging to Lower Meghna River but has a strong negative point that it creates drainage accumulation in Noler Char area. Comparing Option 1 and Option 3, Option 1 is considered favourable. The three Options (Options1, 2 & 3) were presented (Option 4 was not developed by then) in the Workshop held on 23.04.07 at Sonapur and Option 1 was accepted (Proceedings given in Annexure, Enclosure-3).

Option 4, developed after the technical session on the draft study report held on 25.06.07 (Proceedings given in Annexure, Enclosure-3), is a modified Option 3 with Noler Char as a separate drainage unit which eliminates the strong negative point of drainage accumulation in Noler Char. Like Option 3 it avoids Hatiya River but uses Lower Meghna River and Hatiya Channel as drainage outfalls of the sluices. If Option 1 and Option 4 are compared Option 1 has the risk of silting up of Hatiya River, the drainage outfall channel in the long run. So, Option 4 is favourable and considered as the selected option.

Although Option 4 was found to be the most viable option for the project area, the project model on flood depth was simulated for a number of scenarios.

The scenarios are :

- Existing condition for average, 5 & 10 year return periods, monsoon and post monsoon (Fig. in Enclosure-1, Annexure).
- Option-1 for 10 year return period, monsoon (Fig. A 4.4/1)
- Option -2 for 10 year return period, monsoon (Fig. A 4.4/13)
- Option - 3 for 10 year return period, monsoon (Fig. 4.4/14)
- Option-4 for average year, 5 year and 10 year return periods for monsoon and post monsoon (Fig. A 4.4/15-20, Enclosure-1, Annexure).

From the simulation results it is found that the flooding situation at existing condition of Char Nangulia (10-year return period) give that 41% area is under F1 and below. But flooding condition for Option 1, Option 2 and Option 4 give about 11%, 9% and 9% areas are under F1 and below respectively. Considering other aspects, particularly avoiding Hatiya River and using Lower Meghna as drainage outfall Option 4 has been considered to be the best Option (Fig. A 4.4/1, A 4.4/2, A 4.4/13, 4.4/14 & A 4.4/15). Accordingly, Char Nangulia Development Plan has been prepared following Option 4.

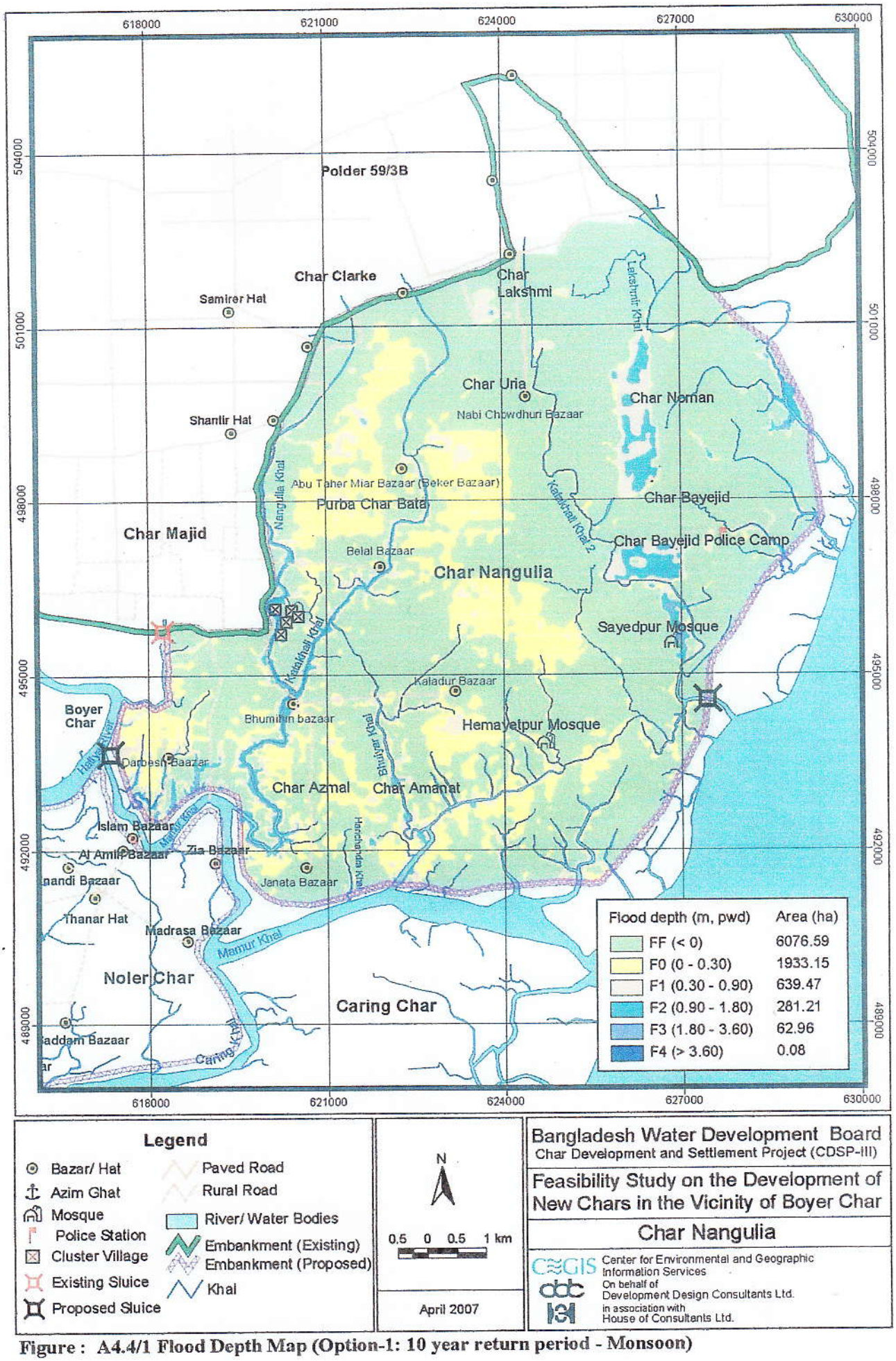
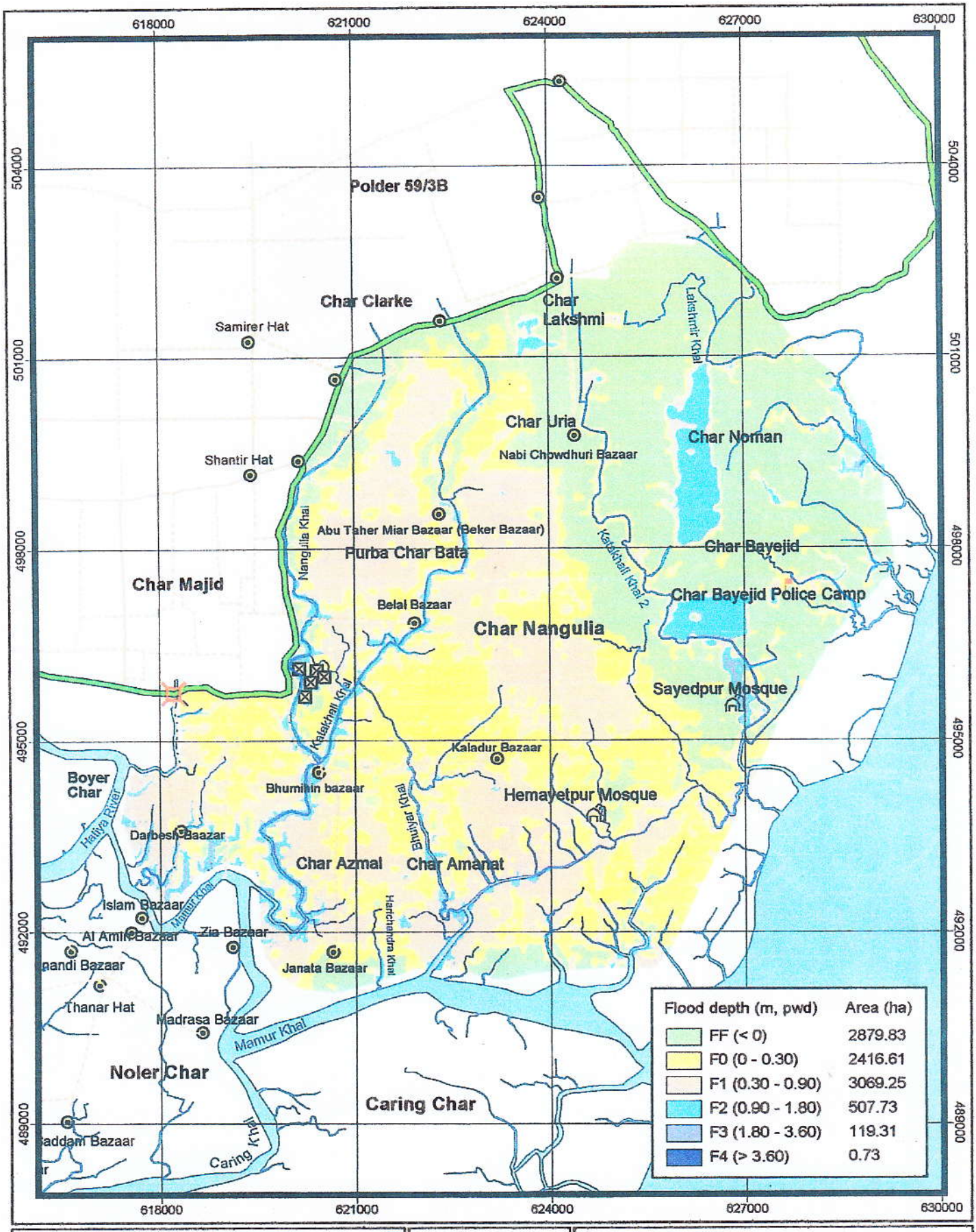


Figure : A4.4/1 Flood Depth Map (Option-1: 10 year return period - Monsoon)



Legend

- Bazar/ Hat
- Azim Ghat
- Mosque
- Police Station
- Existing Sluice
- Cluster Village
- Paved Road
- Rural Road
- River/ Water Bodies
- Embankment (Existing)
- Khal

N

0.5 0 0.5 1 km

April 2007

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia

Center for Environmental and Geographic Information Services
On behalf of
Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Figure : A4.4/2 Flood Depth Map (Existing Condition: 10 year return period - Monsoon)

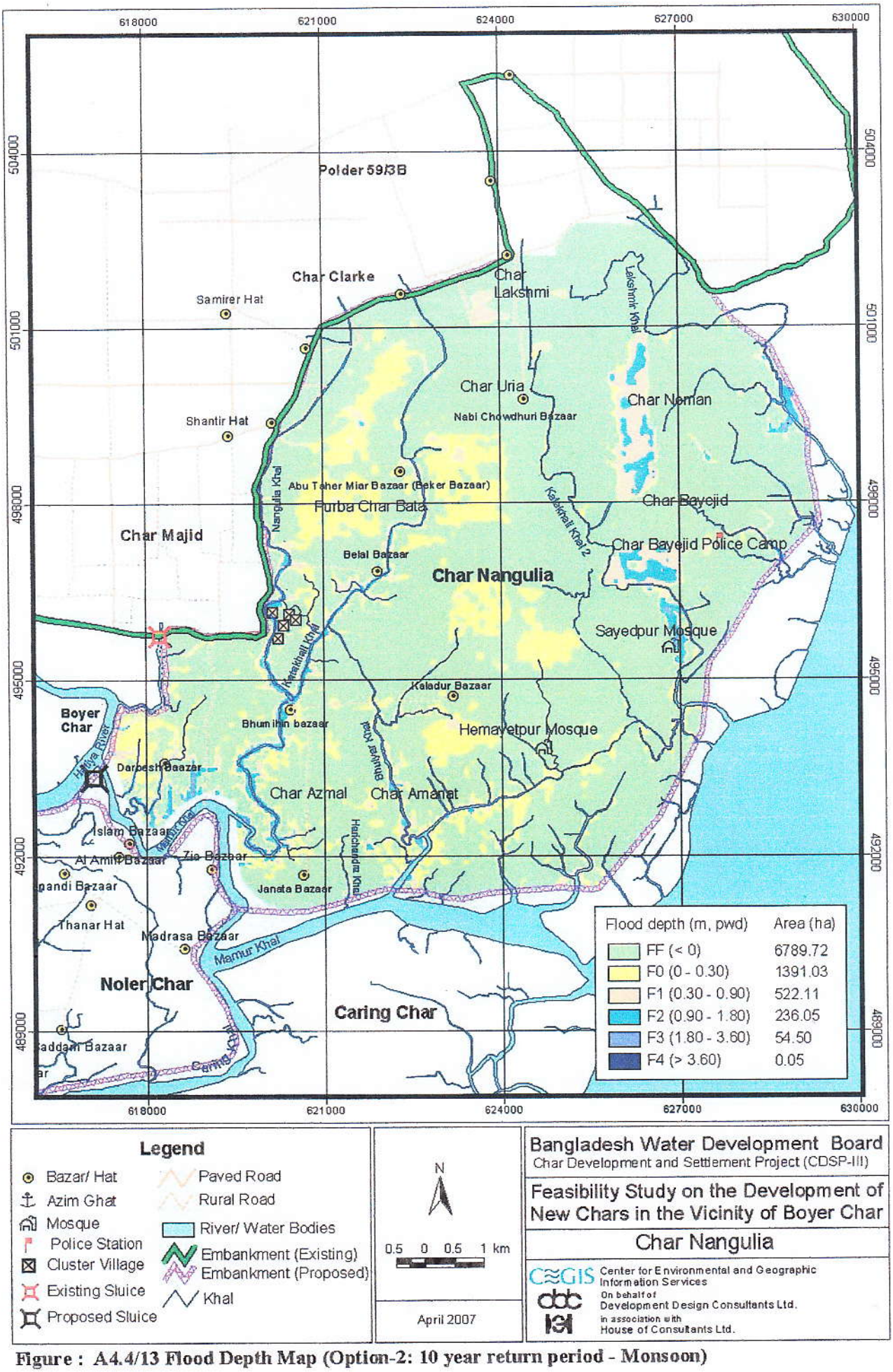
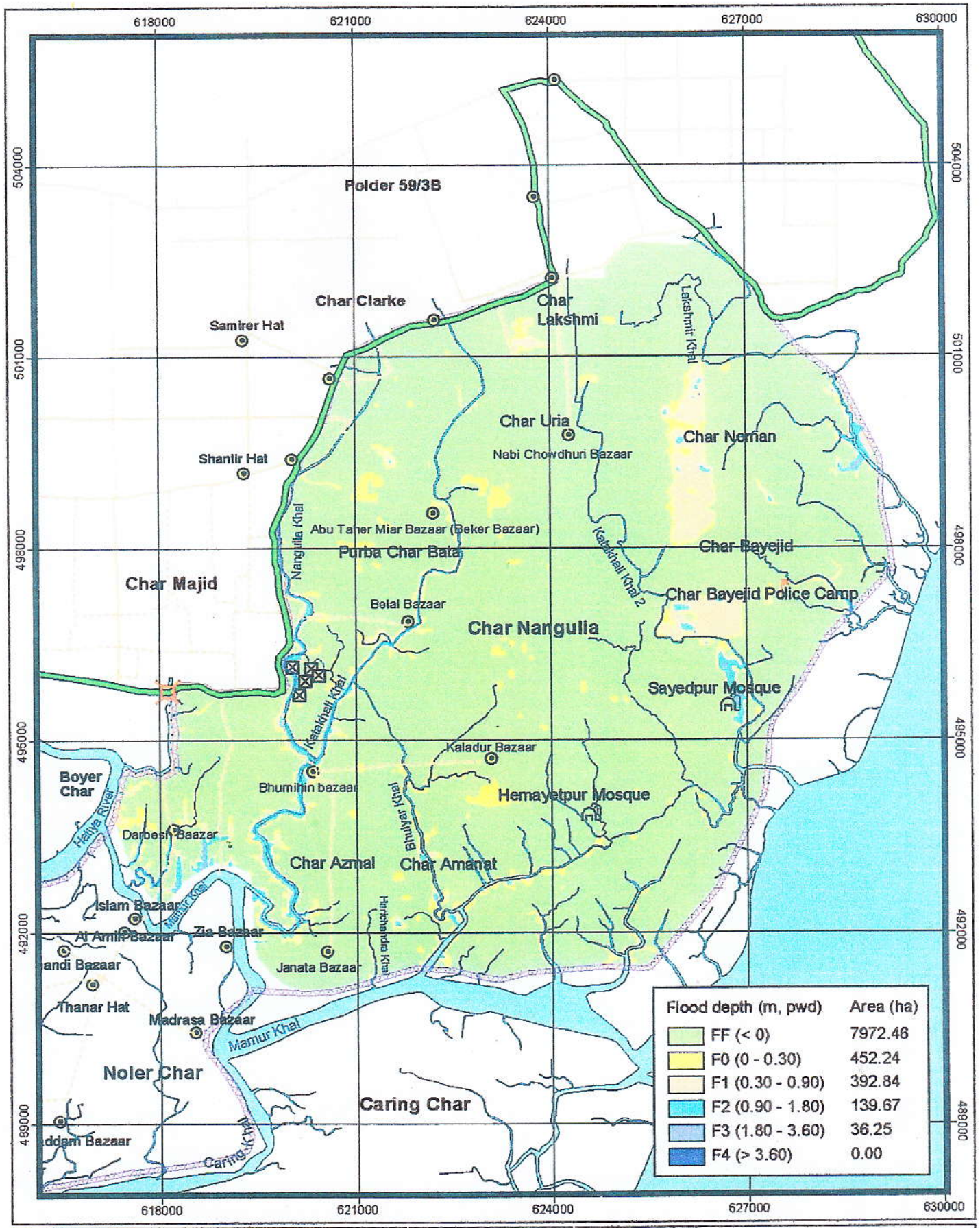


Figure : A4.4/13 Flood Depth Map (Option-2: 10 year return period - Monsoon)



Legend

- Bazar/ Hat
- Azim Ghat
- Mosque
- Police Station
- Existing Sluice
- Cluster Village
- Paved Road
- Rural Road
- River/ Water Bodies
- Embankment (Existing)
- Embankment (Proposed)
- Khal

N

0.5 0 0.5 1 km

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Figure : 4.4/14 Flood Depth Map (Option-3: 10 year return period - Monsoon)

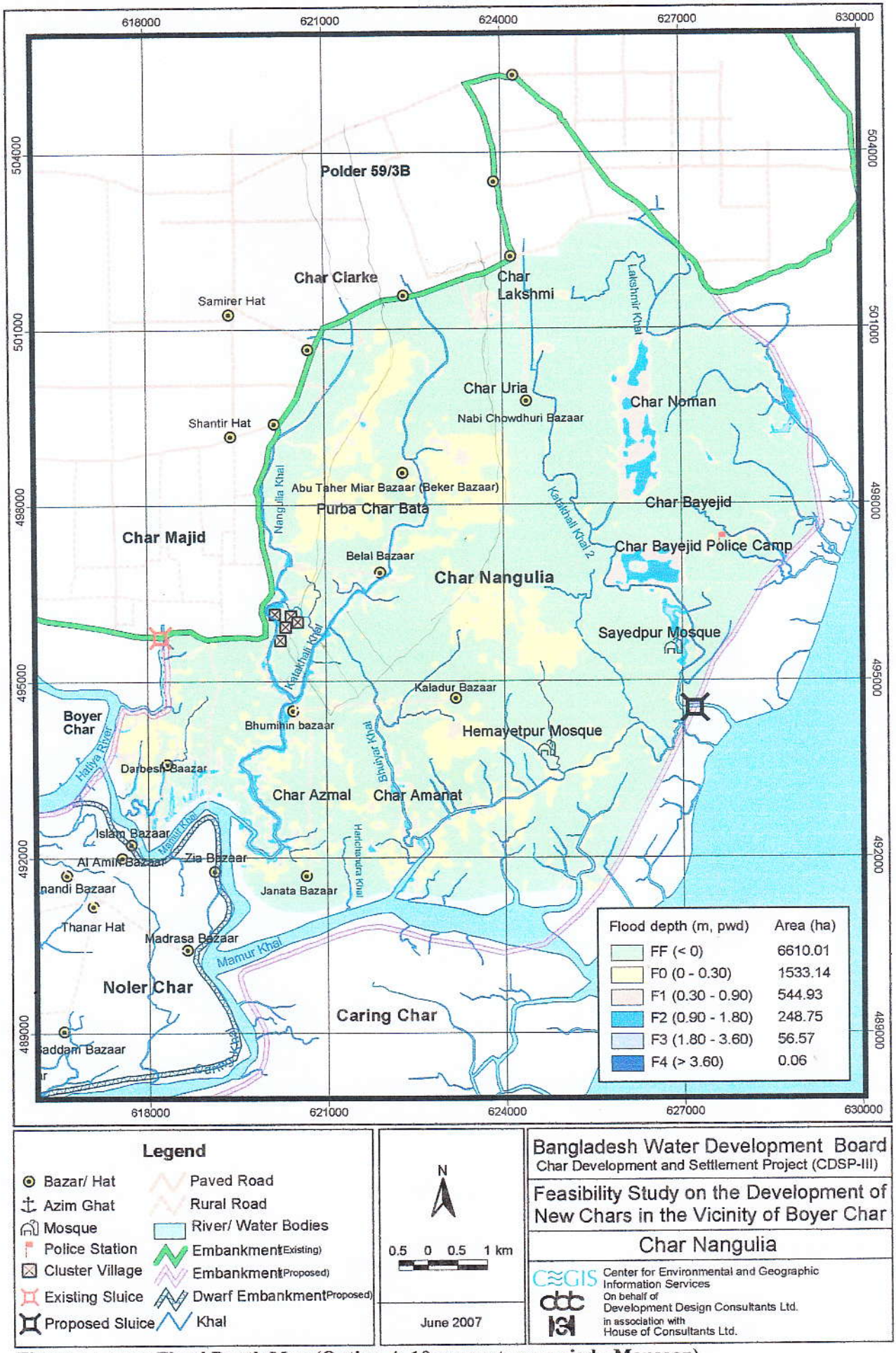


Figure : A 4.4/15 Flood Depth Map (Option-4: 10 year return period - Monsoon)

CHAPTER - 5 : PROPOSED DEVELOPMENT PLAN

5.1 General

In the newly accreted area development plan of new polder establishes the main pattern of physical infra-structures and the plan is determined by considering overall regional physical infra-structure of the nearby existing developed area and future requirement. The development plans are prepared for -

i) Water Management
ii) Communication
iii) Internal infrastructures

Proposed interventions Map is given in Figure G 5.1

Water Management

Special care has been taken so that new empolderments do not in any way hamper the drainage of existing polders and or any unprotected land. The new system will integrate well with the existing drainage system of the area. Incorporation of fresh water source (surface/ground) has been considered for drinking. Further, future development has been left open.

Communication

Communication within the planned polders, between different polders and between new land and old land has been taken into account in the development plan and planned physical infrastructures. The transport of inputs into and outputs from the area, access of population to regional services and cyclone shelters has been considered during polder planning.

Internal Infrastructure

Internal Infrastructure like cluster village, rural roads with bridge/culvert, multipurpose cyclone shelters, ponds, tube-wells and latrine have been considered.

Long terms developments are also taken into consideration. There exists a long traditional reclamation and development activities of newly accreted land for agriculture in this area. The ongoing traditional land reclamation in Noakhali coast has been taken into account in the land development planning of the new polders.

5.2 Proposed Water Management Infrastructures

Embankment and Sluice

Embankments and Sluices along with drainage systems constitute essential structures necessary for achieving development of water management and agricultural production. Designs have been made following BWDB Standards and Practices

5.2.1 Embankment Cum Feeder Road

General

Design crest level is determined by providing free board over the design flood level. A rational determination of free board requires a determination of the height and action of waves. The height of waves generated by winds of the surface of a large body of water depends on the wind velocity, the duration of wind, the fetch length, and depth of water and the width of the water surface. After reaching and getting contact with the face of the embankment, the waves run-up move towards up in inclined planes and dissipate energy.

Level of Protection

The level of protection is defined through the selection of hydraulic design conditions. These conditions are chosen on the basis of an optimization of the embankment design taking into account both technical and economical criteria. The design criteria are divided into monsoon conditions and the event of cyclone conditions as follows :

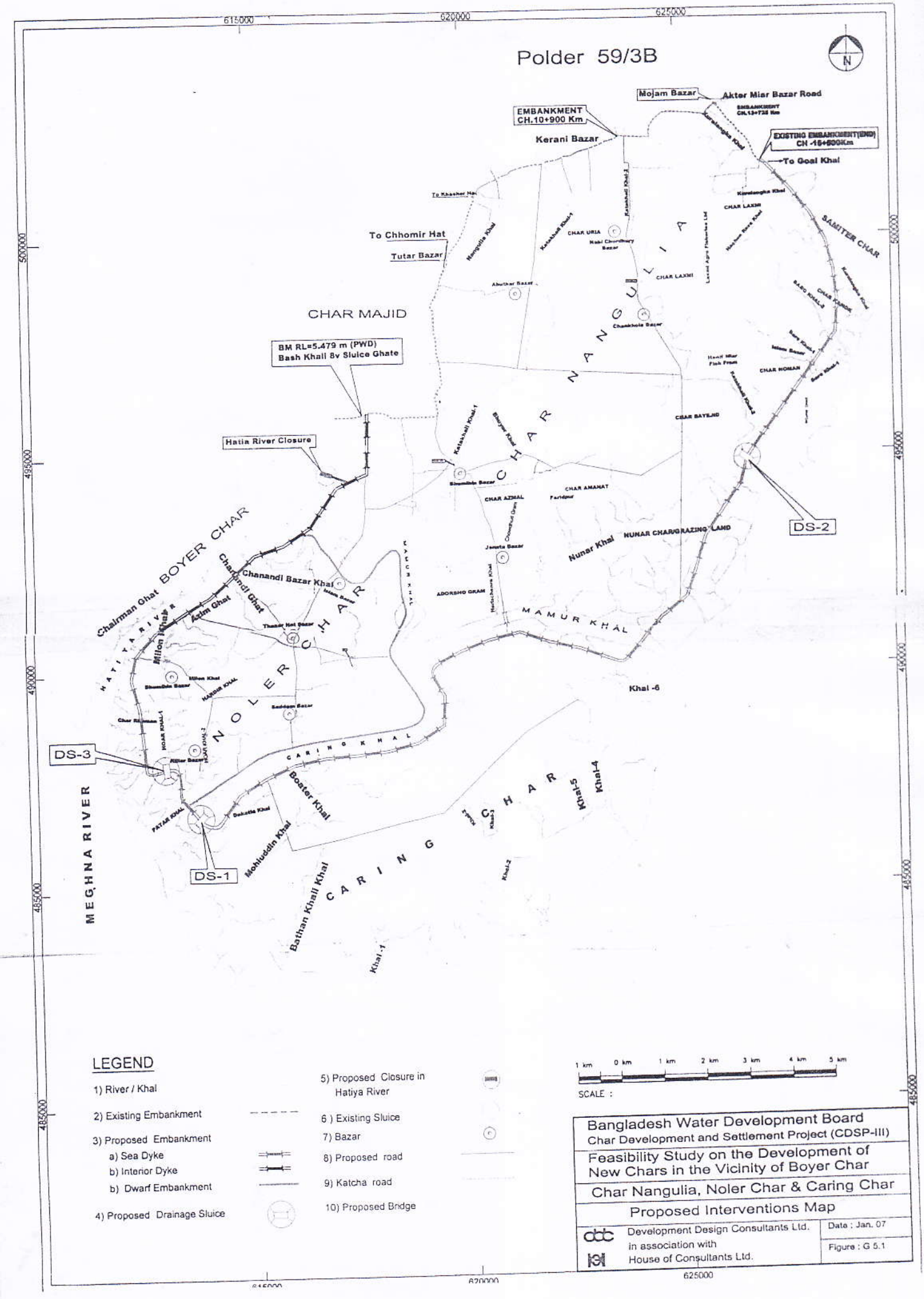
- For monsoon design condition the return period has been set to 5 years. No overtopping should occur at the significant wave height in this situation (only 13% of the waves should overtop).

- The return periods of cyclonic design conditions has been set to :

  - 20 years, where flooding due to wave overtopping of the sea/major river facing embankment should not result in average water depth in the polder exceeding 1.0m, and crest should not be lower than the still water level of cyclonic storm surge.

- Climate induced sea level rise :

  - 5mm – 10 mm rise per year as scenario for next 5-30 years.


Polder 59/3B
615000
620000
625000
500000
495000
490000
485000
Mojam Bazar
Akter Miar Bazar Road
EMBANKMENT CH.10+900 Km
Kerani Bazar
EXISTING EMBANKMENT(END) CH.15+600Km
To Goal Khal
To Chhomir Hat
Tutar Bazar
CHAR MAJID
BM RL=5.479 m (PWD)
Bash Khali Sv Sluice Ghate
Hatia River Closure
CHAR NANGULIA
CHAR LAXMI
CHAR URIA
SAMITTER CHAR
CHAR NOMAN
CHAR BAYEJID
CHAR AZIMAL
CHAR AMANAT
Nunar Khal
NUNAR CHAR/GRAZING LAND
DS-2
BOYER CHAR
Chairman Ghat
Chanandi Bazar Khal
Azim Ghat
HATIYA RIVER
NOLER CHAR
MAMUR KHAL
ADORSHO GRAM
Khal -6
DS-3
CARING KHAL
Boater Khal
Mohiuddin Khal
Bathan Khali Khal
CARING CHAR
Khal-4
Khal-1
DS-1
MEGHNA RIVER
LEGEND
1) River / Khal
2) Existing Embankment
3) Proposed Embankment
a) Sea Dyke
b) Interior Dyke
b) Dwarf Embankment
4) Proposed Drainage Sluice
5) Proposed Closure in Hatiya River
6) Existing Sluice
7) Bazar
8) Proposed road
9) Katcha road
10) Proposed Bridge
1 km 0 km 1 km 2 km 3 km 4 km 5 km
SCALE :
Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)
Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char
Char Nangulia, Noler Char & Caring Char
Proposed Interventions Map
Development Design Consultants Ltd.
in association with
House of Consultants Ltd.
Date : Jan. 07
Figure : G 5.1

Design Crest Levels and Slopes

Reduction of construction costs can be obtained by reducing the cross sectional area of the embankment either by lowering the crest levels and/or by applying steeper slopes.

Lower crests will for identical seaward slope lead to move frequent overtopping and hence to increase erosion damages to the crest and the inner slope. Too low crests will result in overtopping, which leads to considerable erosion to the inner slope.

Steeper seaward slopes will result in high velocities in the wave run-up and the slope will be subjected to wave erosion even during moderate monsoon conditions. For identical crest level the frequency and the amount of overtopping of the embankment will be increased.

Steeper inner slopes will be subjected to increased scour in overtopping situations and the geo-technical stability is not acceptable for steep countryside slopes.

For a given overtopping criteria, it can be demonstrated that a flat slope is more cost effective than a steep slope.

The crest levels arrived at for the CERP, Phase 2 embankment in May 1993 are listed below for comparison of the proposed polder in table.

Polder	Crest Level m(PWD)	Sea side slope
59/2, Ramgati	7.00	1:7
59/3B, Sudharam	7.60	1:7/1:5
59/3C, Companiganj	7.60	1:7/1:5
72, Sandip	7.0	1:7
73/1B, Hatiya	6.30	1:7

Considering the existing crest level of the embankment near Ramgati and adjoining polders (Boyer Char and Char Majid), it is recommend that crest level will be 7.00m (PWD), the sea side slope 1:7, country side slope 1:3 and crest wi dth will be 7.30m for the proposed see dykes. Crest width of interior dyke will be 7.3m with riverside and country side slopes as 1:5 and 1:2 respectively.

Crest Width

The crest width of 7.3m is recommend as the embankment will be used as Feeder Road.

The proposed cross-section and longitudinal sections of the alignment of embankments of Char Nangulia is shown in Fig. A 5.2.1 and Fig. A 5.2.1a respectively (Enclosure-1 of Annexure).

For selection of alignment of the embankments, ground level, accretion and erosion of river bank, rate of coast line migration and protection of embankment from wave action by existing forest have duly been taken into consideration. Borrow pit will be provided inside so that it will perform the function of link channel for drainage leading to the respective drainage sluices.

The proposed embankment will protect the polder area against saline inundation during high tide and cyclonic storm surges. It will also protect human lives, cattles, crops and properties from damage due to cyclonic storm surge and flooding.

Closure

Three closures are proposed at the offtake and outfall of Mamur Khal and one near the outfall of Caring khal for construction of proposed embankment cum feeder road. There will be other smaller closure on the khal crossing the proposed embankment.

5.2.2 Drainage Sluice

General

Drainage Sluices in tidal area are designed to drain the polder area up to design level. A tidal drainage sluice with suitable invert level and a flap gate at the river side is the most appropriate structure. To control the drainage flow and to maintain certain water level inside the polder, the drainage sluice is to be equipped with a vertical lift gate at the countryside where necessary.

Rainfall and Run-off

The drainage run-off is equal to the quantity of rainfall in the catchment reduced by evapo-transpiration, surface storage and infiltration into the ground. To estimate the drainage modulus of the drainage basin the method described in "Design Manual for Polders in South-West Bangladesh, Part 4, VOL. IX" with the assistance of Delta Development Project, Bangladesh-Netherlands Joint Programme under BWDB has been used.

To determine the drainage requirement rainfall frequencies have been worked out from the rainfall gauge station 375, Ramgati which is very close to proposed project site. A 5-day duration rainfall with 10-years recurrence interval is taken as the design rainfall for computation of drainage modulus. The same criteria were used in CERP, Phase 2 sluices planning and design in May 1993. It may be mentioned that the same criteria were also in CDSP-II. Results of frequency analysis is presented in Table G 5.2.2 (Enclosure-2, Annexure).

Water Level

Sluice size is calculated, based on the average design drainage discharge. During stages of design drainage discharge the polder water level may be assumed to be halfway in between the design drainage level (d.d.l) and maximum storage level (m.s.l). In monsoon period the design drainage level corresponds to the required water level in the rice fields.

The design drainage discharge through the sluice is to calculated at average tide condition of the river water. Average tide is defined as the average tidal amplitude ranging from M.H.W to M.L.W. at average river level for the considered time of the year.

Water level variations of the study area are mainly governed by tide as well as river discharge. Water level data for the stations 321, Hatiya and Banshkhali Sluice have been collected and analyzed as these are the nearest stations. A co-relation has been used to determine the design water level in project site Table G 5.2.2b (Enclosure 2, Annexure).

Drainage Routing

Drainage routing is carried out using 1 in 10 years 5 days rainfall amounts for the period of June-July following the criteria of 5% inundation of the incremental area in addition that can not be drained by gravity to greater depth than 0.30m for a period of 3 days. A co-related average year high water level and low water level during monsoon is considered as tail water level. Standard hydrological techniques are used in this analysis with the assistance of a number of computer programs. A computer simulation model is developed for design of drainage sluices in the coastal area by CERP, Phase 2 Engineers. Number of vents and invert levels of sluices are determined from several alternatives by the above Routing Program. Dimension of sluices at two different locations in Char Nangulia is covered in the Option-4.

Char Nangulia and Noler Char lie in very active zone in southern Noakhali of Meghna Estuary. The outfall of Mamur khal which drains maximum area of Char Nangulia and a portion of Noler Char area along with tidal flows coming from the east falls in Hatiya River 8 km upstream of its (Hatiya River) outfall to Meghna River (Hatiya Channel). On the other side Caring khal which drains part of the area of Noler Char and Char Rahman and part of Caring Char falls in Hatiya Channel. Char Rahman at the southern end near the outfall of Hatiya River, is being eroded which is also presently restraining the coastline forward movement towards south-west and lengthening of drainage path improving outfall condition of Hatiya River. For draining efficiently Char Nangulia and its adjoining northern areas one sluice DS-1 (10-Vant - 1.50 m x 1.80 m) is proposed near the outfall of Caring khal to drain towards Lower Meghna River and another sluice DS-2 (5-Vent - 1.5m x 1.8m) at the outfall of Katakhali khal-2 to drain towards Hatiya Channel. Plan and section of DS1 & DS2 are presented in Figure A 5.2.2/1 and A 5.2.2/2 réspectively. Mamur khal will be closed and will act as a drainage channel draining the drainage runoff of Char Nangulia into the Caring khal leading to DS-1 sluice. Results of simulation of flood routing through sluices are presented in Table A 5.2.2a (Enclosure-2, Annexure).

The secification of drainage sluice are :

DS-1

Vent Size	:	10 Vent-1.5m x 1.8m
Sill Level	:	1.00 m PWD
Allowable Submergence	:	0.3m
Time o Drain out by access		
Water	:	72-96 (max.) hours

Figure : G 4.2c Water Management option - 3

DS-2

Vent Size	:	5 Vent-1.5m x 1.8m
Sill Level	:	0.00 mPWD
Allowable Submergence	:	0.3m
Time o Drain out by access Water	:	72-96 (max.) hours

5.2.3 Drainage Channel

Drainage channels have been designed considering the design procedures followed in "Design Manual for Polders in South-West Bangladesh, Part 4, VOL IX " with the assistance of Delta Development Project, Bangladesh-Netherlands Joint Program under BWDB.The criteria followed for the drainage channels in the polders with some remarks are given below :

- the catchment area for individual channel has been delineated and measured with the assistance of computer;
- the same drainage modulus for sluices design has been considered for both the polders;
- the longitudinal slopes for the channels is considered0.0001 - 0.0005m/m;
- the design bed width of the channel shall be such that top width of design section remains within the existing top width of channel;
- the water level in the drainage channel at sluice point is the average of the high and low water level;
- the Manning's equation with roughness co-efficient of 0.035 and channel side slope 1:1.5 have been used to design the capacity of channels;
- the drainage time is taken 18 hours for all channels;
- the permissible velocity of flow should be within 0.90m/sec.

The design sections of the drainage channels/khals for Char Nangulia Polder is furnished in Fig. A 5.2.3/1 to A 5.2.3/9 (Enclosure-1, Annexure). List of existing khals to be re-excavated are given in Table : A 5.2.3.

Table A 5.2.3 : List of Existing Khals proposed for re-excavation

Char Nangulia

Sl. No.	Description of Khals	Length (km)
1	Nangulia khal	12.80
2	Katakhali khal-1	8.85
3	Bhuiyer khal	5.68
4	Katakhali khal-2	11.80
5	Nunar khal	5.90
6	Hasan Raja khal	3.00
7	Kuralanka khal	9.40
8	Boro khal-1	3.00
9	Boro khal-2	3.35
	Sub-Total:	**63.78**
10	Borrowpit khal-I (Eastern side)	12.0
11	Borrowpit khal-II(Western side)	2.83
	Total :	90.31

5.3 Proposed Internal Infrastructure

The following internal infrastructures (Table A 5.3) have been identified and assessed for Char Nangulia. Estimated numbers of household related infrastructures have been determined using number of households considering surveyed project area. Standard Design and Practices of LGED have been used.

Table A 5.3 Details of Internal Infrastructure of Char Nangulia

Sl. No.	Infrasturcture	Length /No.	Unit
1.0	Rural Roads (Type R-2)	37.77	km
2.0	Bridge	-	-
	2.1 20m span	3	each
	2.2 15m span	3	each
	2.3 10m span	2	each
3.0	Culvert		
	3.1. 1- Box Culver(1-vent - 4m x 3m)	1	Each
	3.2 Pipe Culvert (0.6m dia)	8	Each
4.0	Multipurpose Cyclone Shelter	17	Each
5.0	Community Ponds	43	Nos
6.0	Deep Tube-well	607	Nos
7.0	Latrines	9350	Nos
8.0	Public Toilets	11	Nos.
9.0	Pond sand Filter Scheme	30	Nos
10.0	Rain water Harvesting Schme	60	Nos.
11.0	* Market	11	Nos.
12.0	* Secondary School	2	Nos.
13.0	* Graveyard	8	Nos.

* Considered for provision of land for future development

5.3.1 Rural Roads

Rural roads will connect the cluster villages, farms, markets etc. with the feeder roads and embankment. The proposed rural roads are R2 type of LGED Standard (Fig. G 5.3.1). Its specification will be –

Crest width	-	3.7m
Side slope	-	2 :1
Crest level	-	4.5m PWD

Long Section is provided in Figure A 5.3.1 and Cross-Section in Figure G 5.3.1 (Annexure, Enclosure-2)

Table A 5.3.1 : List of Roads Proposed for Development of Char Nangulia

Sl. No.	Description of Roads	Length (km)
1	Purba Char Majid – Bhumihin Bazar and Janata Bazar – Mamur khal	5.05
2	Kamlar Market – Chholeman Bazar and Chhonkhola Police Camp - Sayedpur-1 Jame Mosque-Mamur khal	10.72
3	Kerani Bazar – Belal Bazar (via Abu Taher Miar Bazar)	4.80
4	Bhumihin Bazar-Kaladur Bazar-Hemayetpur- Sayedpur Mosque	5.63
5	Belal Bazar Road – Chankhola Police Camp	5.67
6.	Darbesh Bazar – Bhumihin Bazar	2.40
7	Bashkhali Sluice – Islam Bazar	3.50
	Total :	37.77

The existing footpaths will be utilized in the proposed rural roads planning.

5.3.2 Bridge & Culvert

To minimize road crossing with existing channels new road alignment are selected parallel to the existing channels. Thus the number of bridge and culvert are kept minimum. Type design of Bridge and culverts are given in Fig. G 5.3.2/1-5 (Enclosure-1, Annexure). Location of Bridge/box culverts have been shown in the Map (Figure G 4.4). For cross drainage provision of pipe culverts have been kept and to be located at appropriate places.

5.3.3 Cluster Village

People are not interested to live in cluster village as expressed during field visit and meetings. They prefer to live in independent houses as they are living now.

5.3.4 Multi-purpose Cyclone Shelter

Emergency shelters have been provided to give high degree of security and safety for the people against tidal bore and cyclone. The cyclone shelters can also be used for other purposes like educational institution, place of social gathering etc. Total number has been determined considering one Cyclone Shelter for each 500 household. Shelter sites are selected in densely populated areas preferably near important market places and other locations. The market places selected on discussions with beneficiaries are (1) Janata Bazar, (2) Bhumihin Bazar, (3) Darbesh Bazar, (4) Kaladur Bazar, (5) Syedpur Jame Mosque, (6) Chankhola Police Camp, (7) Belal Bazar, (8) Abu Taher Miah Bazar in Char Nangulia. Other locations are to be selected. A typical plan of multi-purpose cyclone shelter is presented in Figure G 5.3.4 (Enclosure-1, Annexure).

5.3.5 Tube-Well

One deep tube-well of average 400m depth for 15 families and one deep tube-well for each cyclone shelter, for each market (included with public toilets) and each mosque have been provided as per public demand during field visits and meetings. Provisions for rain water harvesting schemes and pond sand filter schemes have been kept for locations where Deep Tube-wells are not feasible, about 10% and 5% of Tube-wells respectively.

5.3.6 Latrine/Public Toilets

One single pit Latrine is provided for each present family and for increased families during project period, 10% increase considered. Provision of public toilet is made for each large Bazar.

5.3.7 Ponds

Community ponds have been provided for each 200 households.

5.4 Cost of Civil Works

5.4.1 Cost Estimate of Water Management Infrastructures

For the proposed project (Option-1) assessments of the following water management infrastructures have been made :

- Sea dyke cum Feeder Road
- Interior dyke
- Drainage Sluices
- Drainage channels
- Borrow pit cum drainage channel.

A summarized proposed water management infrastructures are presented in Table A 5.4.1a.

Table A 5.4.1a : Proposed Water Management Infrastructures in Char Nangulia

Sl. No.	Project Infrastructures	Unit	Quantity
1.0	Drainage Sluices		
	1.1 DS-1 (10- Vent 1.50m x 1.80m)	No	1
	1.2 DS-2 (5- Vent 1.50m x 1.80m)	No	1
2.0	Embankment		
	2.1 Sea Dyke	km	25.5
	2.2 Interior Dyke	km	3.5
3.0	Closure of khals	Km	7.53
	3.1 Major khal (Mamur khal and Caring khal)	Nos	3
	3.2 Other khals	Nos	5
4.0	Re-excavation of khal/D. Channel (63.78 km)	Cum	915.066
5.0	Borrow Pit/Peripheral Link	km	14.83
6.0	Land Acquisition	ha	5.00
7.0	Land requirement for Infrastructures	ha	323

For the proposed water management infrastructures i.e. sea dyke, interior dyke, drainage sluices and drainage channels the unit rates have been based on standard schedule of rates of Feni O & M Circle, BWDB, 2006 and adjusted to 2009 cost.

Physical contingencies have been considered in the estimate by 10% of the total construction cost. Cost of land acquisition for only 5 ha has been considered as all the infrastructures will be constructed on Government Khas land, except the area where new embankment will link with old embankment.

A summarized cost estimate of proposed water management infrastructures is presented in Table A 5.4.1b for Char Nangulia for year 2006-2007 and the expected escalated cost @ 10% increase per year is considered. Accordingly expected cost for the year 2009 is indicated in last column of the table.

Table A 5.4.1b : Cost Estimate of Water Management Infrastructures of Char Nangulia

Sl. No.	Project Infrastructures	Length/ No./Cum	Unit	Rate (Tk)	Amount as per schedule of 2006-07 (Tk. '000)	Expected escalated amount for the year 2009 (Tk. '000)
1.0	Drainage Sluices					
	1.1 DS-1 (10-Vent – 1.5m x 1.8m)	1	Each	7,50,00,000	75,000	99,825
	1.2 DS-2 (5 Vent-1.5m x 1.8m)	1	Each	4,50,00,000	45,000	59,895
2.0	Embankment					
	2.1 Sea Dyke	25.50	Km	69,87,800	1,78,189	2,37,170
	2.2 Interior Dyke	3.50	Km	55,75,865	19,516	25,976
3.0	Closures of khals					
	3.1 Major khals (Mamur khal and Caring khals)	3	LS		33,852	45,057
	3.2 Other khals	5	LS		5,633	7,498
4.0	Re-excavation of Khal/ Drainage Channel(63.78 km)	9,15,066	Cum	38.01	34,779	46,291
5.0	Land Acquisition**	5	ha	1,00,000	500	666
				Total :	**3,92,469**	**5,22,378**

* Earth from borrow pit cum link channel will be used in construction of embankment.
** Cost of land acquisition will be born by GOB.

5.4.2 Cost Estimate of Internal Infrastructures

For the project development in Char Nangulia the following internal infrastructures have been proposed.

- Rural roads
- Bridge/culverts
- Multipurpose Cyclone shelters
- Community ponds
- Deep tube-wells and Rain Water Harvesting Schemes/Ponds and Filter Schemes
- Latrines/Public Toilets.

For Char Nangulia the proposed internal infrastructures such as rural roads, bridge/culverts, multipurpose cyclone shelters etc. the unit rates of LGED standard schedule of rate for the year 2006 of Noakhali Region have been used and Physical contingence have been considered in the estimate by 10% of the total construction cost. A summarized cost estimate of proposed internal infrastructures is presented in Table A 5.4.2 for Char Nangulia.

Table A 5.4.2 : Cost Estimate of Internal Infrastructure of Char Nangulia

Sl. No.	Project Infrastructure	Length/ No	Unit	Rate (Tk)	Amount as per schedule of 2006-07 (Tk. '000)	Expected escalated amount for the year 2009 (Tk. '000)
1.0	Rural Roads (Type R-2)	37.77	Km	5,30,000	20,018	26,644
2.0	Bridge (Girder bridge)					
	2.1 20m span	3	No.	36,16,000	10,848	14,439
	2.2 15m span	3	No.	27,00,000	8,100	10,781
	2.3 10m span	2	No.	18,00,000	3,600	4,792
3.0	3.1 Box Culvert, (1- Vent 4m x 3m)	1	No.	10,00,000	1,000	1,331
	3.2 Pipe culvert (0.6m dia)	8	Nos.	1,00,000	800	1,065
4.0	Multipurpose Cyclone Shelter	17	Nos.	64,66,000	1,09,922	1,46,306
5.0	Community Pond	43	Each	3,00,000	12,900	17,170
6.0	DTW	607	Each	60,000	36,420	48,475
7.0	Latrine	9,350	Each	2,000	18,700	24,890
8.0	Public Toilet	11	Each	6,01,030	6,611	8,799
9.0	Pond Sand Filter Schemes	30	Each	1,79,944	5,398	7,185
10.0	Rain Water Harvesting Schemes	60	Each	71,030	4,262	5,672
				Total :	2,38,579	3,17,549

5.4.3 O & M Cost

Routine O & M cost has been assumed 1% of initial capital cost of the project. Item-wise yearly O & M cost has been considered as a percentage of initial capital cost as follows :

O & M cost of Drainage Channel	2%
O & M cost of Embankment	4%
O & M cost of Structure	2%

Cost of the emergency maintenance for restoration of Natural damage due to cyclone and tidal surge is estimated to be 4% of the initial capital cost of major infrastructures.

Item-wise estimated Yearly O & M costs are given in Tables A 5.4.3a and A 5.4.3b for water management and internal infrastructures respectively on 2009 year costs.

Table A 5.4.3a : Yearly O & M Cost Estimate of Water Management Infrastructures of Char Nangulia

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 cost	Estimated Cost (Tk. '000)
1.0	Drainage Sluices					
	1.1 DS-1 (10-Vent-1.5mx 1.8m)	1	No.	99,825	2	1,997
	1.2 DS-2 (5 Vent-1.5m x 1.8m)	1	No.	59,895	2	1,198
2.0	Embankment					
	2.1 Sea Dyke	25.5	Km	2,37,170	4	9,487
	2.2 Interior Dyke	3.50	Km	25,976	4	1,039
3.0	Closures of khals	-	-			
	3.1 Major khals (Mamur khal and Caring khal)	3	LS	45,057	4	1,802
	3.2 Other khals	5	LS	7,498	4	300
4.0	Re-excavation of Khal/ Drainage Channel (63.78 km)	915,066	Cum	46,291	2	926
			Total:	5,22,378		16,749

Table A 5.4.3b : Yearly O & M Cost Estimate of Internal Infrastructure of Char Nangulia

Sl. No.	Item of works	Quantity	Unit	Item Cost at 2009 year (Tk. '000)	Yearly O & M	
					% on 2009 cost	Estimated Cost (Tk. '000)
1.0	Rural Roads (Type R-2)	37.77	Km	26,644	2	533
2.0	Bridge (20m Girder bridge	-	-	-	-	-
	2.1 20m span	3	No.	14,439	2	289
	2.2 15m span	3	No.	10,781	2	216
	2.3 10m span	2	No.	4,792	2	96
3.0	3.2 Box Culvert, (1- Vent 4m x 3m)	1	No.	1,331	2	27
	3.2 Pipe culvert (0.6m dia)	8	No.	1,065	2	21
4.0	Multipurpose Cyclone Shelter	17	No.	1,46,306	2	2,926
5.0	Community Pond	43	No.	17,170	2	343
6.0	DTW	607	No.	48,475	2	970
7.0	Latrine	9350	No.	24,890	2	498
8.0	Public Toilet	11	No.	8,799	2	176
9.0	Pond sand Filter Schemes	30	No.	7,185	2	146
10.0	Rain water Harvesting Schemes	60	No.	5,672	2	113
				3,17,549		6,354

Yearly O & M cost comes as Tk. 16.749 million for Water management infrastructures and Tk. 6.354 million for Internal infrastructure with a total of Tk. 23.103 million.

CHAPTER 6 : DEVELOPMENT BENEFITS

6.1 General

The project will create ample scope of agricultural development through the proposed solution to the major problems of saline inundation/flood by constructing protection embankment and drainage congestion by re-excavation of khals with drainage sluices.

6.2 Agriculture with Project

A comprehensive solution of problem of salinity, water-logging and abnormal tidal flooding through the proposed interventions and providing land settlement and support services in Char Nangulia will bring positive impact on crop production and livelihood of the farmers of the char. The cropping intensity, yield, production and employment opportunity will be increased.

6.2.1 Rationale of Future Crop Production in Char Nangulia

Based on the review of other feasibility study reports on the coastal Char land, field surveys, discussion with farmers, extension agencies, environmental and socio-economic consideration of the study areas, future projections are planned under the options of the feasibility study. The planned cropping intensity will be close to the national cropping intensity, yields will be also increased and crop damages due to salinity, water-logging and tidal flood will be reduced.

6.2.2 Projected Cropping Intensity and Crop Diversity

The present cropping intensity in Char Nangulia is 140%. This is rather low compared to the national average of about 180%. The future cropping intensity of Char Nangulia is expected to increase to 155% in the 5th year and 170% in the 10th year of empoldering. In the 10th year, the cropping intensity is expected to be stabilized. The increase of area i.e. intensity is expected in the Rabi and Kharif-1/Aus season. In the Kharif-II/T. Aman season, the area or intensity is shown to

be 90% at present and in future projection, the intensity will remain the same (Table-6.1). However, the area under HYV/T. Aman will increase to 30% from the present 5% only. Similarly, HYV area in the Aus season is expected increase to 14% from the present 2%. The intensity or area in Rabi season is expected to increase to 60% from the present 40%. It is expected that high value winter vegetable such as tomato, cauliflower, cabbage etc. will get its way in the production (Table 6.2). Present and With Project crop area information is given in Fig. G 6.2.2a and Fig. G 6.2.2b.

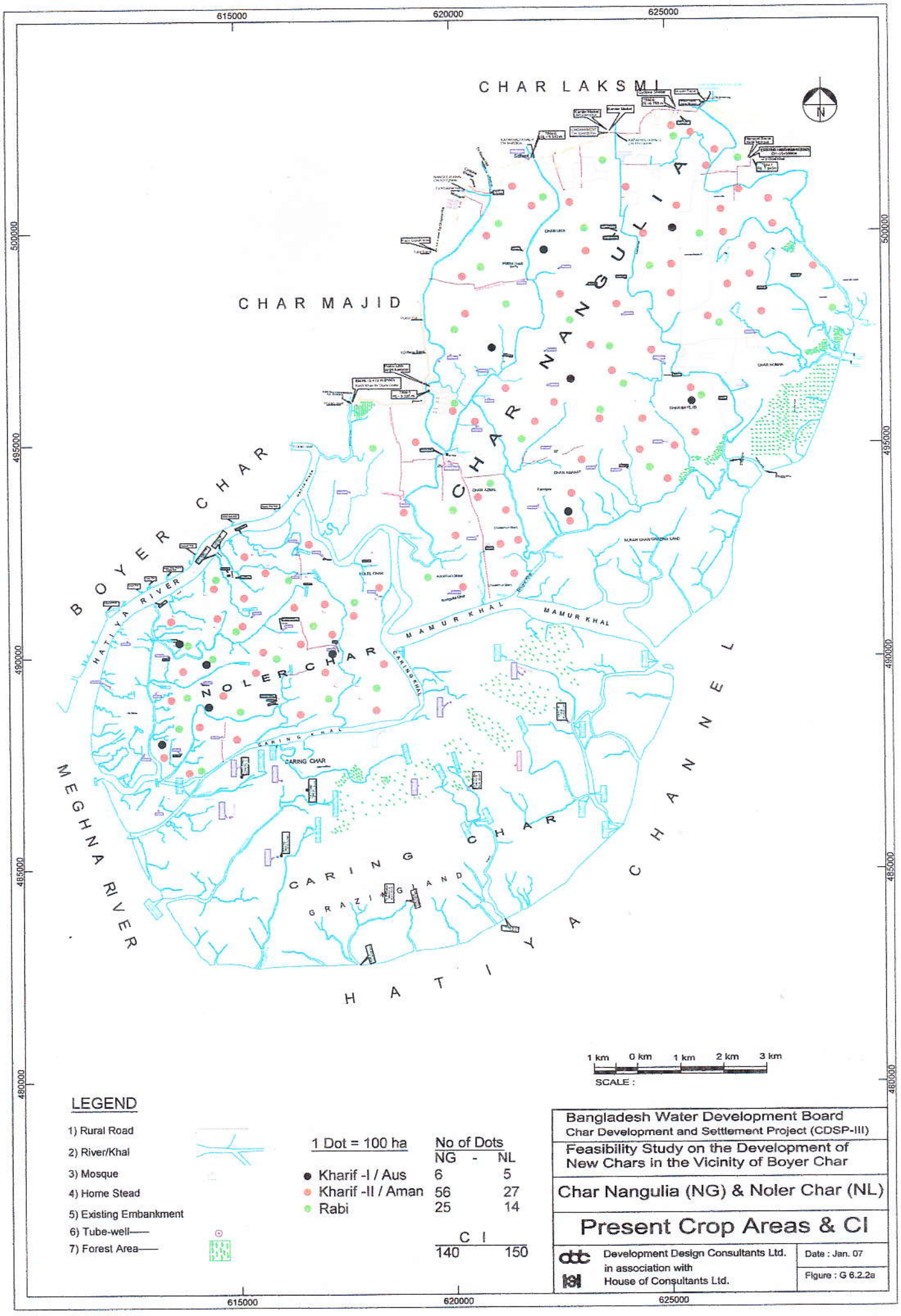
Table 6.1 : Present and Projected Cropping Intensities (%) in Char Nangulia

Name of the Char	Year after empoldering	Rabi/ Boro	Aus/Kharif-1		T. aman/ Kharif-II		Total Intensity%
			HYV	Local	HYV	Local	
Char Nangulia	Base Situation (Present)	40	2	8	5	85	140
	5th year of empoldering	50	8	7	15	75	155
	10th year of empoldering	60	14	6	30	60	170

Source : Study Estimation-2007

6.2.3 Projected Yield and Production

Present yield rates for the major crops are low due to salinity and water-logging except rice. With the removal of salinity and drainage congestion, crops yields are expected to rise. The anticipated production of different crops at full development stage are expected to be achieved after 10 years of project implementation. Projected area, yield and production of different crops with project situation are shown in Table6.2 and Annex-4. Future projection of crop yields was assessed in the light of average yield reported by BBS, yield obtained by CDSP's demonstrations, yield obtained by BRRI, BARI in their on farm research trials. Projected yield will be easily achievable if recommended level of inputs such as quality seeds, fertilizers etc. are used and proper management of crops are provided.



LEGEND

1) Rural Road
2) River/Khal
3) Mosque
4) Home Stead
5) Existing Embankment
6) Tube-well
7) Forest Area

1 Dot = 100 ha

	No of Dots NG	NL
Kharif -I / Aus	6	5
Kharif -II / Aman	56	27
Rabi	25	14
C I	140	150

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

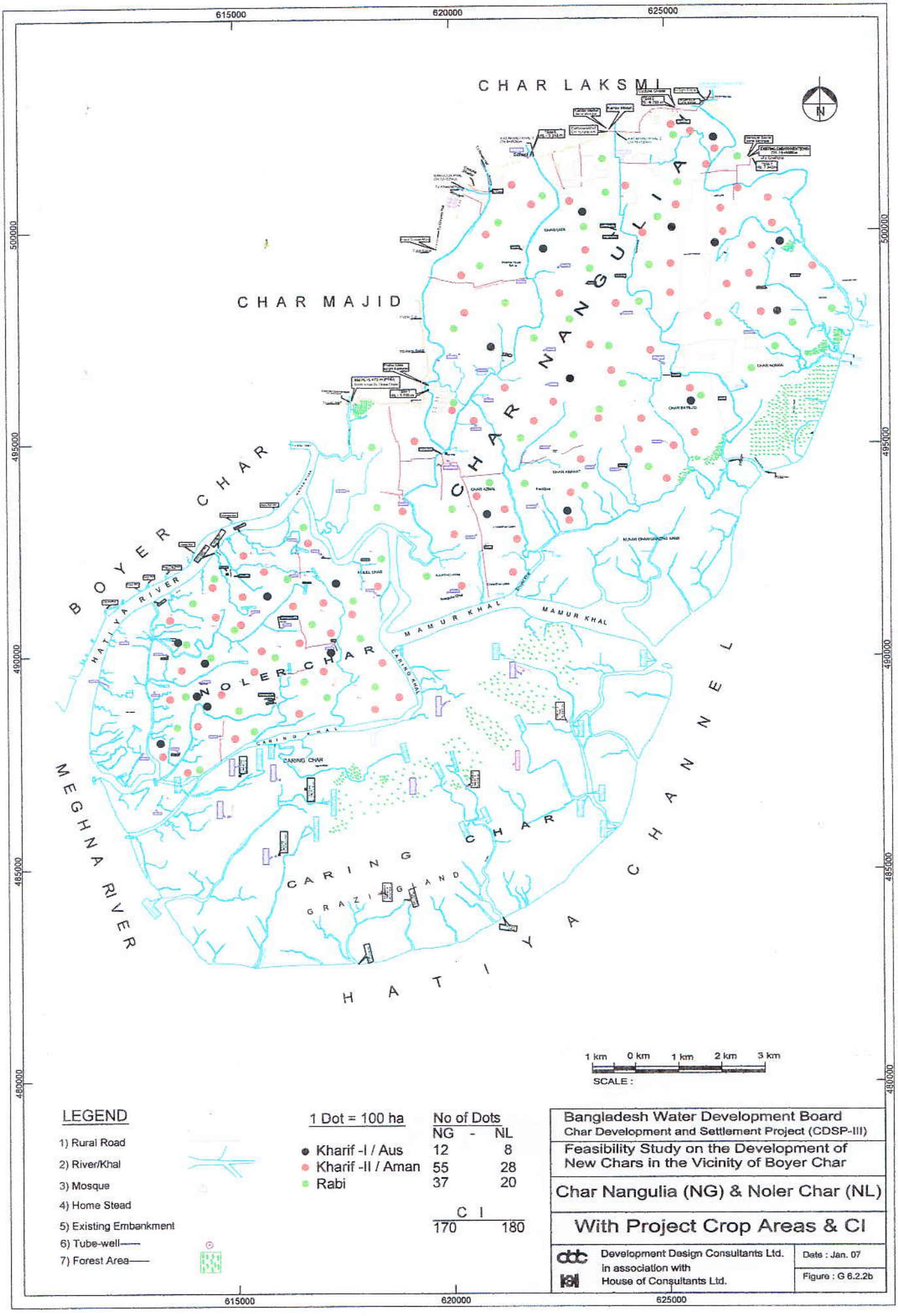
Char Nangulia (NG) & Noler Char (NL)

Present Crop Areas & CI

Development Design Consultants Ltd.
in association with
House of Consultants Ltd.

Date : Jan. 07

Figure : G 6.2.2a



LEGEND

1) Rural Road
2) River/Khal
3) Mosque
4) Home Stead
5) Existing Embankment
6) Tube-well
7) Forest Area

1 Dot = 100 ha

	No of Dots NG	NL
Kharif -I / Aus	12	8
Kharif -II / Aman	55	28
Rabi	37	20
C I	170	180

Bangladesh Water Development Board
Char Development and Settlement Project (CDSP-III)

Feasibility Study on the Development of New Chars in the Vicinity of Boyer Char

Char Nangulia (NG) & Noler Char (NL)

With Project Crop Areas & CI

ddc Development Design Consultants Ltd. in association with House of Consultants Ltd.

Date : Jan. 07

Figure : G 6.2.2b

Table 6.2 : Present and with Project Area (ha), Yield (T/ha), and production (tons) of different Crops In Char Nangulia

		Present			5th year			10th year		
Crops	Crops Name	Area (ha)	Yield (T/ha)	Production (ton)	Area (ha)	Yield (T/ha)	Production (tons)	Area (ha)	Yield (Tk/t)	Production (ton)
	1	2	3	4	5	6		7	8	9
Rice	Aus Local (8%)	501	1.25	626	431 (7%)	1.5	646	369 (6%)	1.6	590
	Aus (HYV) (2%)	125	2.25	281	492 (8%)	2.5	1230	861 14%)	2.7	2325
	T. Aman Local (85%)	5328	2.0	10656	4614 (75%)	2.5	11535	3691 (60%)	3.0	11073
	T. Aman HYV(5%)	313	3.0	939	923 (15%)	3.5	3230	1846 (30%)	4.0	7384
	Rice Total :	**6267**	-	**12502**	6460	-	16641	**6767**	-	**21372**
	Rabi Crops (40%)	-	-	-	Rabi (50%)	-	-	Rabi (60%)	-	-
Pulses	Khesari (40%)	1003	0.8	802	1077 (35%)	1.0	1077	1107 (30%)	1.2	1328
Oil Seeds 26%	Ground Nut(4%)	100	1.5	150	154 (5%)	1.6	246	185 (5%)	1.8	333
	Mustard (7%)	175	0.6	105	215 (7%)	0.7	150	295 (8%)	0.8	236
	Linseed (7%)	175	0.5	88	215 (7%)	0.6	129	296 (8%)	0.7	207
	Oil Seeds Total:	**450**	-	**343**	584	-	525	**776**	-	**776**
Spices 24%	Chillies (Dried) (19%)	251	0.7	176	308 (10%)	0.8	246	443 (12%)	0.9	399
	Garlic (7%)	175	0.6	105	215 (7%)	0.8	172	295 (8%)	1.0	295
	Onion (8%)	200	0.75	150	246 (8%)	1.0	246	295 (8%)	1.2	354
	Spices Total :	**625**	-	**431**	769	-	664	**1033**	-	**1048**
Tubers	S. Potato (10%)	251	8.0	2008	308 (10%)	9.0	2772	369 (10%)	10.0	3690
Vege-tables 3%	S. Vegetables(2%)	52	3.0	156	123 (4%)	3.5	430	148 (4%)	4.0	592
	W. Vegetables(5%)	125	5.0	625	215 (7%)	5.5	1182	258 (7%)	6.0	1548
	Rabi Crops Total :	**2507**	-	**4365**	3076	-	6650	**3691**	-	**8982**
Grand Total :		**8775**	-	**16867**	**9536 (8.6%)**	-	**23291 (38%)**	**10458 (19%)**	-	**30354 (80%)**
By Products	Rice Straw (Aman only)			**11595**		-	**14765**			**18457**
	NCA = 6964 ha,		CI = 140%	90% of NCA =6268 ha	NCA= 6836 ha	CI 155%	90% of NCA =6152 ha	NCA= 6836 ha	CI = 170 %	90% of NCA =6152 ha

Source : Household Survey, Group Discussion and Study Calculation

Note : Area for each crop is calculated from the net cultivated area (NCA) and the Cropping Intensity under the base situation, 5th and 10th year of empoldering (Table 6.1).

Example : Present Aus Local Area is 8%, 90% NCA = 6268 ha x 8% = 501 ha.

Again for present Rabi Crops, 90% NCA 6268 ha x 40%, Rabi Crops = 2507 ha.

For Khesari , 2507 ha x 40% Kheshari = 1002 ha. Similarly Area with the project situation is calculated from 90% NCA = 6152 ha x Area %.

Rice Straw : Grain straw Ratio for local rice is 1:2 and HYV rice 1:1

6.2.4 Homestead Agro-forestry

Char Nangulia was partly a forested land. Erosion victims from Hatiya and other neighboring areas deforested it and settled there. The area is vulnerable to cyclones and tidal surges. In order to maintain a natural balance and partially protect the areas from the cyclones and tidal surges, planned homestead agro-forestry is essential.

The agro-forestry system has productive and service functions. The productive functions are provision of fruit trees, timber, fuel wood, fodder and service functions are environmental protection partial protection from cyclone, tidal surges and shelter. The system may have multi-level arrangement of different planted species, specially in three layers for optimum use of land, air and light. The area is already growing different plant species but not well planned. CDSP may enter into arrangement with DOF, DAE and NGO for social and homestead agro-forestry services in the coastal char lands.

6.2.5 Support Services

To achieve the projected cropping intensity of 170% at the end of 10 years of poldering in Char Nangulia and increase of yield per unit area, support services need to be improved and strengthened. It will be important to reorient extension and technology delivery system and to train the extension/development staff to effectively handle the delivery of Knowledge Intensive Technology (KIT). A new mechanism should be established to strengthen research-extension-farmers linkages to deliver information, Knowledge and Technology packages based on participatory approaches. This calls for effective collaboration among CDSP, GOB extension agencies, NGO's and the private sectors.

Appropriate trainings will be vital in future to equip both the farmers and the extension agents with adequate information, Knowledge and Technology to tackle the need based production problems of the farmers in the new chars of the coastal areas. At present extension services are almost absent in the new chars.

Extension Services. At present extension services from GOB agencies, NGO's and Private Sector is absent. It was observed during group discussion by the Consultant that farmers are growing China IRRI (Purbachi) and Chandina (BR-1) in Aus season and BR-22 in the T. Aman season. These HYV are not suitable for the coastal char lands. Farmers also reported that they face problems with these varieties. Recommended HYV rice varieties for the coastal area are BR-27 in Aus and BR-40 in the T. Aman season are also grown in limited scale. These happened due to lack of information and knowledge and lack of any extension service.

The CDSP has collaborative arrangements with GOB agency such as DAE for transfer of technologies and research organization such as BRRI, BARI and SRDI for new technologies and BADC for input supply. This arrangement should be made effective in Char Nangulia to achieve the projected targets in the crop sector.

Credit. Majority of the farmers reported that they need credit but no institutional credit is at present available. To adopt modern technologies and management, credit support is very important. At present, majority of credit requirement is met from the moneylenders with high interest rate. In order to achieve the project targets institutional credit should be made available to the farmers.

Marketing Facilities. Char Nangulia is inaccessible by any means of transport which makes the agricultural inputs scarce in the local bazaar/markets. Yet the farmers do not consider the scarcity of inputs a problem for their agriculture. They can easily sale their produces in the local market also.

6.2.6 Production Benefit

Cropping Intensity and Land Use. Total Project Area of Char Nangulia is 8994 ha of which 6964 ha (77%) is the Net Cultivated Area (NCA). A summary situation of total cropped area (ha) production (tons) and changes (%) are shown below in Table 6.2.6.

Table 6.2.6: Total Crop Areas (ha), production (ton) and Changes of Areas and Production in Base, 5th and 10th year in Char Nangulia

Year after empoldering	Total Cropped area (ha)	% (-+)	Total production (tons)	%	Cropping Intensity (CI) (%)	Remarks
Base Year	8775	-	16,867	-	140	
5th year	9536	8.6	23,291	38	155	
10th year	10,458	19%	30,354	80	170	

In the 5th year, though total areas is increased by 8.6% there is 38% increase of total production due to favorable situation with the project and higher yield of different crops. In the 10th year, there is 19% increase of crop areas and production increased by 80%. Total production of crops has been estimated to increase per year by 13487 tons from present 16867 tons to 30354 tons from the 10th year.

6.3 Other Benefits

In addition to the increased crop production and employment benefit there will be other direct extended and indirect benefits of the project.

Following benefits can be mentioned:-

- land security to landless through settlement,
- greater security of life against cyclone and tidal bores,

- increase of value of land and property due to prevention of tidal inundation and improvement of drainage and reduction of salinity of both water and soil.
- Increase in side line income from livestock.
- Improvement of road communication
- Scope for plantation on embankment and road slopes, and creation of mangrove forest outside embankment.
- Scope for culture fishery.

CHAPTER - 7 : PLAN COSTS

7.1 General

Estimated cost of physical interventions has been prepared based on the current schedule of rates of BWDB and LGED. The Schedule of Rates of 2006-07 of Feni Operation and Maintenance Circle of BWDB and the Schedule of Rates, July 2006 of Noakhali Region of LGED are applicable and used for the preparation of Cost Estimates.

7.2 Development Plan Costs

Total plan cost includes costs of (a) Water management infrastructures and (b) Internal infrastructures as given below :

A.	i.	Cost of water management infrastructure	...	Tk. 391.969 M
	ii.	Physical contingency	...	Tk. 39.197 M
	iii.	**Sub-Total (i + ii)**	...	**Tk. 431.166 M**
	iv.	Cost of land acquisition	...	Tk. 0.500 M
	v.	**Sub-Total - A (iii + iv)**	...	**Tk. 431.666 M**
B.	vi.	Cost of internal infrastructure	...	Tk. 238.579 M
	vii	Physical contingency	...	Tk. 23.858 M
	viii.	**Sub-Total - B (vi + vii)**	...	**Tk. 262.437 M**
C	ix.	**Total Civil Works Cost (iii + viii)**	...	**Tk. 693.603 M**
	x.	**Total A + B (v + viii = ix + iv)**	...	**Tk. 694.103 M**

7.3 Cost Escalation

Cost estimates have been prepared considering unit costs of work items for the year 2006-07. If implementation starts after elapse of say 'n' years the escalated cost (C_E) after 'n' years can be calculated from the formula as follows.

$C_E = C \times (1 + x)^n$, where

C = Base year estimated cost

x = Rate of yearly increase of cost

n = Number of years after elapse of base year

C_E = Estimated cost after elapse of 'n' years.

So, considering yearly increase of cost as 10%, Development Plan Cost in 2009-10 will be

$$C_E = C \times (1 + \frac{10}{100})^3$$

= Tk. 694.103 Million x 1.331

= Tk. 923.851 Million

CHAPTER- 8 : ENVIRONMENTAL IMPACT STUDY

8.1 Methodology

CDSP/BWDB intends to conduct a detailed environmental study for the project according to Bangladesh Environmental Conservation Act of 1995 and Bangladesh Environmental Conservation Rules of 1997 and Guideline of CDSP/BWDB for Environmental Impact Assessment.

As such an Initial Environmental Examination (IEE) Report for this project is prepared on the basis of project interventions proposed following the ToR supplied by the project proponent (CDSP/BWDB).

The methodology recommended in FAP-16 guidelines for IEE and EIA and further detailed in ISPAN manual for EIA and Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) projects (February, 2005.WARPO) will be followed. Moreover, guideline for EIA as prepared by Department of Environment (DoE) for conducting IEE and EIA will be followed strictly.

A set of pre-designed checklist and questionnaire is used for collection of primary data and secondary information were collected from different govt. and non-government organizations to make an effective Environmental Report for the project.

8.2 Requirement for Initial Environmental Examination (IEE)

Projects under Flood Control category have to first conduct IEE which helps in understanding the potential extent of environmental changes and in finding ways to mitigate by considering the available information, or past experience or standard operating practices. The steps for conducting IEE are:

- Collection of baseline information in respect of the project and the environmental setting of the project and its site.
- Setting of boundaries of an IEE by identifying the significant issues.
- Selection of Important Environmental Components (IECs).
- Impact assessment, suggesting mitigation measures.
- In the event IEE of the project reveals that further investigation is to be carried out then the sponsors will have to carry out a detailed EIA.

8.3. Description of the Project

8.3.1 Project Area

The area consists of the following two main chars, in the southward extension of southern Noakhali by progressive land accretion.

- Char Nangulia of about 8,994 ha of area.
- Noler Char of about 2,691 ha

8.3.2 Physical Interventions of the Project

The main interventions of the project are as follows:

- Construction of Embankment,
- Excavation/Reexcavation of Internal Drainage khals, and
- Construction of Sluice.

Besides, there will be some construction works for internal infrastructure development like:

- Internal road communication development,
- Bridge and Culverts,
- Multipurpose Cyclone Shelter,
- Tube wells and
- Latrines etc.

8.3.3 Basic Data of the Project

The basic data of the project are furnished in **Table- 8.3.3**

TABLE – 8.3.3
Basic Data of the Project

1.	Name of the Project:	Feasibility study on the Development at New Chars in the vicinity of Bayer Char (Char Nangulia and Noler Char).
2.	Project Executor:	Char Development and Settlement Project (CDSP)/Bangladesh Water Development Board (BWDB).
3.	Project Location:	• Char Nangulia, Shubarna Char and Hatiya Upazilas of Noakhali District. • Noler Char, Hatiya Upazila of Noakhali District.
4.	Area of the project:	• Char Nangulia of about 8,994 ha • Noler Char of about 2,691 ha and

8.3.4 Present Status of the Project

The project is now at the initial stage of development. The project area is mainly level saline tidal inundation/flood prone area. Land development will be the major requirement in the newly accreted char lands for the settlement of land less people.

8.4 Description of Environmental Baseline

8.4.1 Project Bounding

The primary requirement of Environmental Assessment Study is to delineate the geographical boundary of the "Project Area" and the "Impact Area". The "Project area" is the physical location of different components of the project while the "Impact area" encompasses the geographic extent of the significant environmental and socioeconomic impacts resulting from implementation of the proposed Project. It is recognized that the benefits of the proposed project will be considerably extended to the national scale. For the present IEE, the focus of the study will be limited to the area of Char Nangulia and Noler Char, within the 1 Km. on all sides has been considered for environmental analysis.

8.4.1.1 Hydro-Morphology

Tidal Inundation/Water Logging

The project area is comprised of medium low char land in tidal area. The land is mostly flooded by tidal inundation during the monsoon season.

Tides come up till mid-Char Nangulia. The lower part is affected by salinity. Drainage is hampered by a saucer-shape topography in the northern part and siltation of the lower Nangulia Khal and the confluence with Mamur Khal (Katakhali Khal silts up faster than Nangulia Khal). Part of the drainage problem in the northern area was solved last year temporarily by draining through Char Majid by embankment cutting and was very effective as people could cultivate T. Aman paddy successfully for the first time.

Morphological Change

Nangulia Char area has been formed due to the impact of induced siltation in the area after construction of cross dam No. 2 in Southern Noakhali. The process of

siltation has been continuing southward resulting in accretion of land masses joining main land. Serious erosion is not a problem in the area.

8.4.1.2 Soil Condition

Soil condition of the area is more or less plain alluvium seasonally saline land covered by silt residuum.

8.4.1.3 Air Quality

The project site is located beside the Bay of Bengal and in a rural setting without any kind of industrial activity. The air quality in existence may rightly be designated as normal not to warrant any concern for human health or environmental degradation. From visual inspection, this air appears to be clean.

8.4.1.4 Ambient Noise

The project area is quite noiseless, as there are no activities other than agricultural land cultivation in the area. So it was felt that the noise level at the base line situation in the project area is within the allowable limits of the standard set by DoE.

8,4.2 Land Use

8.4.2.1 Land use Pattern of the Area

Table-8.4.2.1 shows the land use pattern of the study area. The data shows that out of the total land of Char Nangulia, 77% are cultivable land, 5% homestead and the remaining 18% consisting of forest, grazing/fallow lands, rural infrastructures, ponds and khals.

Table– 8.4.2.1

Land use Pattern

Name of Chars	Land Use (Percent)			
	Cultivable land	Homestead	Others	Total
Char Nangulia	77	5	18	100
Noler Char	75	6	19	100

Source: Field Survey Database, 2006

Land use map of the project area is shown in Figure G 6.2.2b.

8.4.2.2 Present Cropping Practices

According to the soil resources use guideline, the cultivable lands of the project area have been classified as mainly high and medium high land. In the monsoon water depth exceed more than 30 cm. Present cropping patterns are shown in the following **Table – 8.4.2.2**

Table – 8.4.2.2
Land use Pattern of different Crops
Char Nangulia

Land type	Crop Area (%)	Type of Crops
Fo (High Land)	59	Homestead, Agro-forest, Aman, Aus, Rabi
F1 (Medium High Land)	34	Aus, Aman, Rabi
F2 (Medium Low Land)	6	Rabi, Fisheries
F3 (Low Land)	1	Fisheries

Sources: Field Survey database 2006

Note : Natural capture fishery is there in the khals and low lands .

8.4.2.3 Surface Water

The Hatiya River flows, up land and tidal, are mostly in south and southwestern directions. It is the main drainage artery and seems to be in rather stable conditions. The Mamur and Caring Khals, boundary tidal channels of he chars, are highly dynamic, shallow and unstable (seem to silt up). A branch of the river (Nangulia khal) was previously linked with this river. This is now silted up and it remains as a small drainage nala passing the project area. It now carries the rainfall runoff from its catchment and remains active and flowing in rainy season when there is plenty of rainfall. In other time of the year it remains dry. There has been no industrial effluent in this region to the river. Therefore, at the moment water pollution is not seen except that the water is saline during dry season and not suitable for agriculture. The project area is between 3-5m above the mean sea level. The land surface slopes gently towards the south.

8.4.3 Description of Environment

8.4.3.1 Physical Resources

Average monthly rainfall and evapotranspiration of Noakhali are shown below

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Rainfall (mm)	5	22	54	147	302	564	622	478	277	173	60	11	2717
ET0 (mm/day	2.40	3.26	4.49	5.40	5.41	4.39	4.27	4.29	4.25	3.87	3.04	2.25	3.94

Relative humidity, temperature, wind speed and Sunshine hors of Noakhali are:

Items	Minimum	Maximum	Mean
Relative Humidity (%)	60	89	78
Temperature (0C)	10.9	35.5	25.8
Wind speed (m/s)	1.2	4.5	2.6
Sunshine (hrs/day)	3.0	8.2	6.7

Source: Agro-climate Survey of Bangladesh, FAO

8.4.3.2 Ecological Resources

Terrestrial Ecosystem

Natural ecosystem and species make many important contributions to human welfare. Yet these very important resources are seldom being used in ways that will be able to meet the growing pressures of future high demands for both goods and services that depend upon these natural resources.

Terrestrial Fauna

The consultant collected information on terrestrial fauna of the project area during the field visit. Species of terrestrial faunas of the area are not so rich. Information of local fauna like : Venpu Bang, Pana Bang, Chika/Chucho, Badur, Pati Shial/ Shial, Indur, shalik, crow, dove, sparrow, Bok, Crane, Snipe, etc. were collected during the visit.

Terrestrial Flora

The consultant also collected information on terrestrial flora of the project area during the field visit.

These are local forest or lumber trees include Mehagani, Margosa(Nim), Shal etc. Fruit trees include Mango, Litchi, Lemon Tree, Guava, Betel Nut, Kolagach, Coconut and Palm trees. Estuarine flora Reeds like Kushla etc. Local weeds: Fern, Thankuni, gima, katchu etc.

Aquatic ecosystem

Aquatic Fauna and Flora

The consultant collected information on Aquatic fauna and Aquatic flora species during the field visit at the project area.

Few of the aquatic flora and faunas like: shaluk, kalmi, Helencha, water hyacinth, duckweed and Kuno Bang, Guishap, Kakra, Shamuk, Shrimp (diff. Species), Zhinuk etc. respectively exist in the area.

8.4.4 Gender Situation

Women of the project area are little bit different than the other parts of Bangladesh. They give efforts in and outside income earning activities in addition to their regular household chores. They work in crop field like seedbed preparation, transplanting, harvesting etc. They also do all types of post harvesting activities.

Women in the women headed households are passing their lives with economic hardship. They are looking for better income opportunities for their subsistence. They need financial and technical support from the Government for income generation. They hope that the project activities will make employment opportunity for them.

8.4.5 Aesthetic Values, Recreational Resources and Development

There are no area of aesthetic values in the project area. There exists a reserved forest of Forest Department in the vicinity of the area.

8.4.6 Historical/Archeological Relics

There are no Historical and Archeological relics in the project area.

8.5 Screening of Potential Environmental Impacts and Mitigation Measures

Name of the Project	:	Char Nangulia and Noler Char .
Location (Upazila/Dist.)	:	Shubarna char and Hatiya Upazilas, Noakhali District.
Name of UP	:	Purba Char Bata and Chanandi Unions
Area of the Project	:	Gross area : 8,994 ha, Char Nangulia 2,691 ha, Noler Char
Population (2001 census)	:	.....

8.5.1 Description of Environmental Impacts

The project mainly consists of char areas. Environmental Impact of proposed project has been identified and summarized by the environmental specialist, which is shown in the following **Table No 8.5.1**

Table - 8.5.1

Description of Present Condition and Analysis of Possible Impact

Sl. No.	Selected IECs	Present Condition	Possible Impact
	Physical Environment		
1	Regional hydrological regime, flood pattern, etc.	Hatiya a tidal river with upland flow and Mamur and Caring tidal khals inundates the project area.	Condition of the area will be improved by preventing tidal inundation flood.
2	Natural flushing	The Project area is having natural flushing in monsoon.	Implementation of the Project will control the Tidal saline inundation/flood and allow flushing out of salinity by monsoon rain.
3	Ground water table	not known	Ground water table will not be changed for Implementation of the Project.
4	Water quality	Saline during dry season.	Water quality will improve by controlling saline water intrusion.
5	Water logging and drainage	There is drainage congestion in the Project area	Water logging and drainage congestion will be improved.
6	Erosion and siltation	There is no erosion problem but siltation problem is there.	Internal channel siltation problem will be prevented, but at D/S of sluice siltation may continue.
7	Soil Characteristics/salinity	The soil in the Project area is silty loam and soil salinity is there.	Soil salinity will decrease progressively by monsoon flushing
Biological Environment			
1	Wetland and aquatic habitat	Wetland and aquatic habitat like Hatiya River, Mamur khal, Caring Khal etc. are major aquatic habitat.	Wetland characteristic inside protected area will change from saline towards sweet.
2	Terrestrial habitat	Terrestrial habitat exists but no ecological	No impact on Terrestrial habitat will occur due to the Project

Sl. No.	Selected IECs	Present Condition	Possible Impact
		sensitive area are seen in the project area.	implementation.
3	Natural and culture fishery	Natural and culture fishery resources in the area are existing.	Natural saline water fishery inside the project will be hampered by construction of sluice on khal, but there will be better scope to increase culture fishery.
4	Wildlife and biological diversity	Wildlife and biological diversity are not perceived in the Project area.	Wildlife and biological diversity will not be affected by the Project activities.
5	Unwanted aquatic weed and hyacinth	Unwanted aquatic weed and hyacinth are not significant in the Project area.	No impact on Unwanted aquatic weed and hyacinth in the Project area.
6	Natural forests	Natural forests perceived in the vicinity of the project area.	No impact on natural forests by the Project activities.
7	Tree plantation activities	Limited tree plantation activity perceived in the project area.	Project activity will create scope for tree plantation on the slopes of the embankment and creation of mangrove forest outside the embankment.
Social Environment			
1	Land Acquisition/land loss	No need for the project.	No land acquisition is needed. So no impact.
2	Agricultural development	Mainly T. Aman grows.	Agri. crop production will be increased by about 13487 tons/year.
3	Road transport	No road transport except limited rickshaw is seen in the project area.	Road transport will be improved in the project area by the implementation of the project.
4	Employment scopes	Employment scopes in the area is limited	The Project will create scope for employment.
5	Health and nutrition	Health and nutrition facility is not good.	The Project will increase the Health and nutrition situation.
6	Community impact (Fishermen and other professional)	Limited fishermen in the project.	The project activity will create opportunity to rehabilitate the fishermen and other professional in fish culture, tree plantation and agricultural activities.
7	Culture and heritage	No culture and heritage location is seen.	Culture and heritage situation will be improved due to increased economy.

8.5.2 Impacts & Mitigation

Possible Impact and Mitigation measures were identified and describes in the following **Table No 8.5.2.**

Table 8.5.2

Summary Sheet of Potential Impacts & Mitigation Measures

Significant impact issue		Type of impact		Mitigation measure	Residual impact
		Beneficial	Adverse		
Physical Environment					
1	Regional hydrological regime, flood pattern, etc.	✔		Protection against tidal saline inundation.	
2	Natural flushing		✔	Timely gate operation of the sluice/regulator to allow natural drainage/flushing during monsoon to the extent T. Aman is not damaged.	Insignificant
3	Water logging and drainage	✔		Improvement through re-excavation of khals and construction of drainage sluices.	
4	Erosion and siltation		✔	Regular silt clearing at D/S of sluice are to be done under annual maintenance programmes, if siltation is a problem.	Insignificant
5	Soil characteristics/ salinity	✔		Improvement through prevention of saline inundation and leaching out of soil salinity through improved drainage.	
6	Wetland and aquatic habitat	✔		Improvement from saline environment.	
7	Natural and culture fisheries	✔		Better environment for culture fishery.	
8	Natural forests and plantation	✔		Increased scope on embankment slopes and berms.	
Social Environment					
1	Agricultural development	✔		Prevention of crop damage and scope for HYVs.	
2	Employment scopes	✔		Construction and O & M activities and increased agricultural activities.	
3	Health and nutrition	✔		Increased food production and increased income	
4	Community impact	✔		Land settlement programme for landless people.	
5	Culture and heritage	✔		Increased social contact between settled people.	

However, during the construction period some temporary adverse impacts are anticipated which are mainly: Noise pollution; Air pollution; Water quality; Waste disposal; Epidemic diseases etc.; Sanitation & health including latrines, urinals etc; Possible accidents; Safety measures;

Discussion of the anticipated adverse impacts follows.

Noise pollution

Impact:

There is little scope of generating noise in the project area. The construction of the embankment is generally performed manually by the local labors. Compaction of the embankment is usually done by the local labors by hand compaction. However use of rollers for better compaction would not create any hazards to the environment. In construction of regulators mixer machine and other construction equipments and vehicles will not generate any hazards to the environment. Usual noise at cyclone shelters will be generating when threat of cyclone is announced and people take shelter for a short period. So no adverse impact is anticipated in respect of noise.

Mitigation: *No mitigation measure is required.*

Air pollution:

Impact

Smoke: Smoke will generate at project site as the machinery's, equipments, & vehicles etc will be operating or moving over the roads during construction period of the project area. There will be some impact that is very much negligible. However no mitigation measure is required.

Dust: Dust will be generated at project site as machinery's, equipment's and vehicles will be used in construction of the embankment and regulator of the project for a very short time.

Mitigation: *No mitigation measure is necessary.*

Water Quality

Impact:

Surface water & Ground Water: There is little scope of affecting the surface or ground water by the disposal of wastes. Human waste of labors will create nuisance in the area but impact is not significant. However, there will be some impacts on surface water due to the project activities during the construction period. These impacts are temporal.

Mitigation:

Mitigation measure is not required.

Drinking Water

Impact:

During construction period, one or two deep hand tube wells would be provided for supplying of Arsenic free drinking water to the labors working at site. Usually, the labors carry food & drinking water with them from their own homes. Adverse environmental impact is not anticipated.

Mitigation:

Deep hand tube well would be provided at project site for drinking water & water will be tested before supplying to the laborers.

Waste Disposal

Impact:

Insignificant environmental impacts are anticipated due to waste disposal. There will be no significant office waste. Some concrete wastes may arise due to construction of regulators.

Mitigation:

Construction wastes should be dumped at the fixed place without spreading it scatteredly.

Disposal of human wastes may be accomplished through temporary latrines & urinals, which can be used as organic manure.

Epidemic diseases

Impact:

There will be labor camp in the project area for the construction works. However there will be local labors who will attend works in the morning & leave project site in the evening. For construction of embankment and regulators, contractor will provide