Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives

FINAL PLAN REPORT

SURVEY TO MITIGATE WATER LOGGING PROBLEM IN KHULNA CITY

JUNE 2011

KHULNA CITY CORPORATION (KCC)

KHULNA

Survey to Mitigate Water Logging Problem in Khulna City

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SURVEY TO MITIGATE WATER LOGGING PROBLEM IN KHULNA CITY

FINAL PLAN REPORT

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INTRODUCTION

1.1 Project Background

Urbanization is an inevitable phenomenon for a developing country like Bangladesh. It is an indicator of national development. Urban population increases with socio-economic development of the country. The national population census defined **urban area** as, "*Developed area around (i) an identifiable central place where, (ii) amenities like metalled roads, communication facilities, electricity, gas, water supply, sewerage, sanitation etc., usually exist, (iii) which area densely populated and a majority of the population are non-agricultural and (iv) where community sense is well developed.*" Bangladesh shows rapid increase in its urban population. According to the population census of 2001, about 23.39% of the total population of the country or about 29 million people live in the urban areas. Presently it would be approximately 25%. By the year 2015, the share of urban population will be about 37% (Population Census, 2001). More than 60% of the national GDP is derived from the non-agricultural sectors that are based in urban areas (Economic Census, 2003). A major share of the foreign remittance goes to purchase the urban land. Surplus foreign earning is invested in business and manufacturing sector in urban areas. These phenomena indicate the increasing role of urban areas being played in the national economy. The expansion of urban economy leads to the growth of urban population and concomitant spatial urban growth.

In the wake of urbanization, urban problems are taking critical shapes. One of the most critical problems faced during the process of urbanization is designing an efficient drainage system for the concerned area. Drains and natural streams in the urban areas do not function as an integrated drainage network due to different factors like silting up, unplanned or deficient construction and lack of maintenance. Encroachments on drainage reservations cause inundation of low-lying areas. Drains often become obsolete or inadequate due to unprecedented and unsupervised or unexpected expansion of cities. The ultimate result is water logging.

Khulna city is not free from drainage problems. Besides the conventional problems, being a low lying coastal delta area, the city faces some unique problems too. In many areas, the city dwellers experience tremendous water logging problem during the rainy season when it is high tide. At that time, the water levels of Bhairab and Rupsha rivers rise so high that the city water cannot be drained out into these rivers through a conventional drainage system even if the system proves to be adequate for the area on papers. The only option then left is to pump the water from the drains. Let alone the under developed low lying areas of the city, this causes water logging even at some part of the city where there already exists a proper drainage system. Eventually, water logging causing serious damage to roads and other infrastructures developed by Khulna City Corporation (KCC) and other line agencies. Consequently, KCC has to incur huge financial outlay to restore or rehabilitate the infrastructure. Therefore, developing a well planned drainage network with adequate pumping option in this city has become very urgent. Keeping this in view, a development project titled "**Excavation, re-excavation and preservation of natural canal and rivers and construction of bridge with a view to mitigate water logging problem in Khulna City**" was proposed by the Local Government Division (LGD). But in the meeting of the Project Evaluation Committee (PEC), the project was suspended in absence of detailed survey or study for estimating the cost of all works involved. It was decided in the meeting that KCC would conduct survey work to assess the need for all required interventions. In light of that, KCC initiated the project titled **"Survey to Mitigate Water Logging Problem in Khulna City"** for preparing an integrated Drainage Master Plan for the project area in 2010.

1.2 Objectives of the Project

Under this project, Khulna City and the proposed extended areas would be surveyed to gather information on ward-wise population, road network, drainage network, footpaths, locations of dustbins, open spaces, natural channels and rivers, road islands, dividers and slums. After collecting all these information different types of maps such as drainage map, contour map, road network maps will be prepared for assessing the actual needs and estimating relevant costs for developing integrated Drainage Master Plan for Khulna City.

According to the Scope of Services in the Terms of Reference the specific objectives of the project are:

a) Detail topographic survey of all types of roads (Pucca, semi-pucca, katcha), drains (Pucca, semi-pucca, katcha), channels, rivers, islands & dividers, footpath, open spaces, vegetation, location of dustbins, waste generation points etc.
b) Preparation of detailed land use map
c) Preparation of contour map
d) Design and cost estimation of drains, excavation works of channels and rivers, etc.
e) Training of KCC Officials

The output of the survey will be preserved in a database, which will be used to prepare different types of infrastructure development project to develop required infrastructure in the city in a coordinated way. The Project will also make transfer of knowledge through tracking as and when necessary.

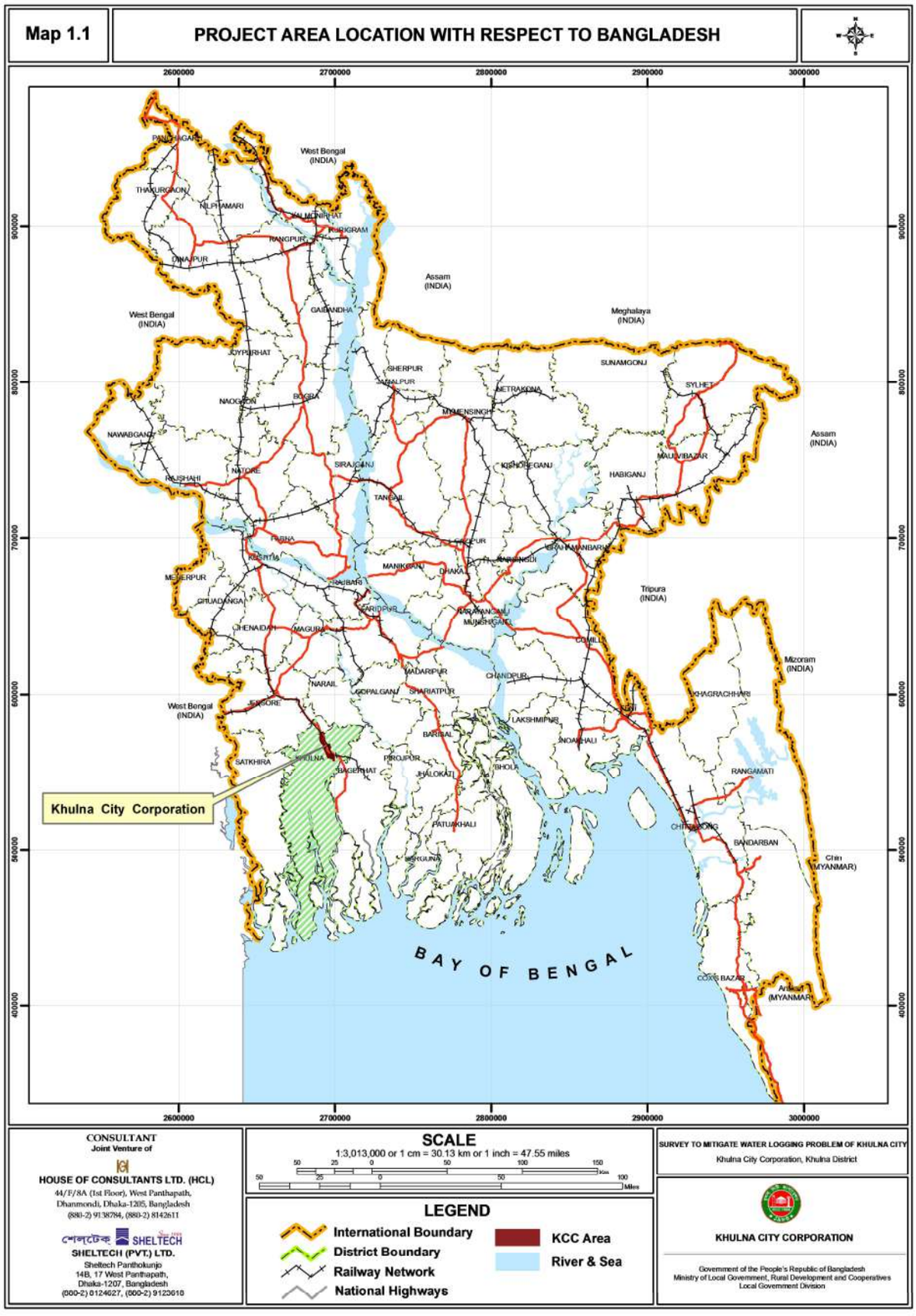
1.2.1 Basic Principles of the Project Development

The principles under which Drainage Services operates are:

- Protect municipal infrastructure investment by maintaining the existing drainage and treatment facilities;
- Provide an acceptable level of services to city dwellers;
- Maximize environmental protection;
- Support orderly development of the City;
- Operate drainage services in an efficient and effective manner.

1.3 Description of the Study Area

Khulna is one of the seven Divisional Cities of Bangladesh. It is the 3rd largest industrial city and also an important port city of the country. The city has moderate population density with an estimated total population of about 9 lakh. Khulna Division is located in the South-West Region of the country (**Map-1.1**). The study area covers entire Khulna City Corporation (KCC) with an extended area comprising Phultola Upazila (part), Khan Jahan Ali Thana, Dumuria Upazila (part) and Batiaghata Upazilla (part). Planning area consists of 430 BS Mouza sheets of 38 mouzas of which 20 mouzas are within KCC area and the rest outside the KCC area (**Map-1.2).** The approximate area of the project is about 85.38 km^2 (19353.26 acres). Khulna City Corporation covers an area of 46.65 km^2 while the extended area covers about 38.73 km^2. Total population of the Master Plan area is 901,794 according 2001 population census. Population of KCC area in 2001 was 770,498, while the population of extended area is 131,296. Ward-wise population distribution in the KCC and the extended area as per the population census 2001 is presented in **Table-1.1.**


Map 1.1
PROJECT AREA LOCATION WITH RESPECT TO BANGLADESH
2600000
2700000
2800000
2900000
3000000
900000
800000
700000
600000
500000
400000
West Bengal (INDIA)
Assam (INDIA)
Meghalaya (INDIA)
Tripura (INDIA)
Mizoram (INDIA)
Chin (MYANMAR)
Arakan (MYANMAR)
PANCHAGARH
THAKURGAON
NILPHAMARI
LALMONIRHAT
KURIGRAM
RANGPUR
DINAJPUR
GAIBANDHA
JOYPURHAT
SHERPUR
JAMALPUR
NAOGAON
BOGRA
MYMENSINGH
NETRAKONA
SUNAMGONJ
SYLHET
NAWABGANJ
NATORE
SIRAJGANJ
KISHOREGANJ
MAULVIBAZAR
HABIGANJ
RAJSHAHI
TANGAIL
PABNA
KUSHTIA
MANIKGANJ
DHAKA
NARAYANGANJ
MUNSHIGANJ
BRAHMANBARIA
MEHERPUR
CHUADANGA
KUSTIA
FARIDPUR
JHENAIDAH
MAGURA
COMILLA
MADARIPUR
CHANDPUR
NARAIL
GOPALGANJ
SHARIATPUR
JESSORE
LAKSHMIPUR
BARISAL
NOAKHALI
KHAGRACHHARI
SATKHIRA
KHULNA
PIROJPUR
BHOLA
JHALOKATI
RANGAMATI
PATUAKHALI
BARGUNA
CHITTAGONG
BANDARBAN
COX'S BAZAR
BAY OF BENGAL
Khulna City Corporation
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Dhaka-1207, Bangladesh
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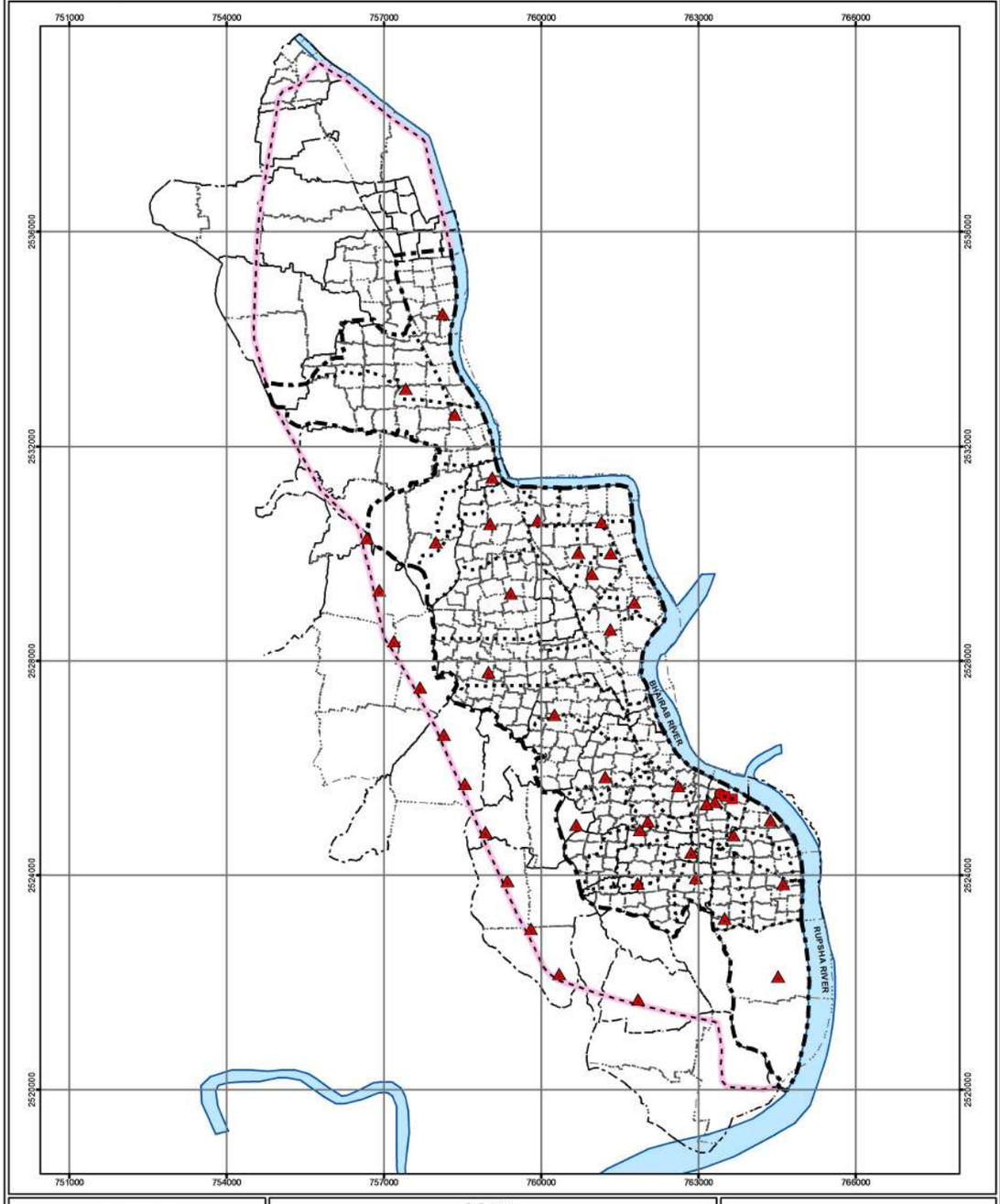
SCALE
1:3,013,000 or 1 cm = 30.13 km or 1 inch = 47.55 miles
LEGEND
International Boundary
District Boundary
Railway Network
National Highways
KCC Area
River & Sea
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Map 1.2 **ADMINISTRATIVE BOUNDARY OF THE PROJECT AREA**



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SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles

0 850 1,700 3,400 5,100 6,800 Meters
0 2,950 5,900 11,800 17,700 23,600 Feet

LEGEND

- KCC Boundary
- Ward Boundary
- Project Boundary
- Mouza Boundary
- Sheet Boundary
- Khulna City Corporation
- District Headquater
- BM Pillar
- River & Sea

SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District

KHULNA CITY CORPORATION

Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Table-1.1: Population Distribution of the Project Area

Ward /Area Name	Area in Acres	BBS Population 2001
A. KCC Area		
Ward 01	476.86	20311
Ward 02	534.58	18815
Ward 03	951.98	23016
Ward 04	517.77	14299
Ward 05	196.65	15314
Ward 06	545.68	20995
Ward 07	113.03	14808
Ward 08	235.52	18545
Ward 09	891.32	34614
Ward 10	206.17	18518
Ward 11	94.72	19398
Ward 12	170.75	52036
Ward 13	292.69	19959
Ward 14	671.14	26444
Ward 15	355.39	25724
Ward 16	577.36	35881
Ward 17	585.82	30352
Ward 18	404.73	16765
Ward 19	123.37	26321
Ward 20	120.48	22539
Ward 21	338.43	24984
Ward 22	168.30	21633
Ward 23	125.51	18332
Ward 24	386.52	42959
Ward 25	184.35	27106
Ward 26	164.17	18087
Ward 27	206.26	31489
Ward 28	181.84	22404
Ward 29	163.60	20431
Ward 30	300.62	35827
Ward 31	993.84	32592
Total of KCC Area	**11279.44 (45.65 km^2)**	**770498**
B. Extended Area		
Aranghata Union (Daulatpur Thana)		10807
Atra Gilatala Union (Khan Jahan Ali Thana)		69421
Jugipole Union (Daulatpur Thana)		31676
Alutala (Jalma Union, Batiaghata Upazila)		545
Dubi (Jalma Union, Batiaghata		439

Ward /Area Name	Area in Acres	BBS Population
		2001
Upazila)		
Harintana (Batiaghata Upazila)		5308
Kholabaria (Batiaghata Upazila)		291
Krishnonagar (Batiaghata Upazila)		4751
Mathavanga (Batiaghata Upazila)		160
Bil Pabla (Ghutudia Union, Dumuria Thana)		3948
Chak Asankhali (Ghutudia Union, Dumuria Thana)		410
Chak Mathurabad (Ghutudia Union, Dumuria Thana)		543
Lata Paharpur (Ghutudia Union, Dumuria Thana)		2997
Total Extended Area	**9819.38 (39.73 km^2)**	**131296**
Total Project Area	**21098.82 (85.38 km^2)**	**901794**

Source: HCL-SPL Data Base and BBS 2001

1.4 Socio-Economic Profile of the Project Area

1.4.1 Population Distribution

The distribution of population is highly skewed in the project area and the most densely populated areas are found to be in and around the city core. Very high density of population was found in Ward no.13, 20, 24 and 28, registering more than 400 persons per hectare. The moderately populated areas are Mujgunni, Sonadanga, Goborchaka, Moheswarpasha, Boyra, Banorganti, Lobonchora, Rayer Mahal, Pabla etc (Ward no.5, 6, 7,10,11,12,21,29,30 and 31). Low density of population is found in the fringe areas of the city. Average population density of KCC area is moderate (18,191 sq. km in 2001). Spontaneous development exists in CBD area and in Ward nos. 20, 21, 22 and 23. The nature of density and distribution of population is a common demographic character in KCC area depending on various urban activities like, commerce, industry, administrative and residence, etc.

1.4.2 Population Density

Table-1.2 shows the change in the population density (per sq. km) from 1961 to 2001 for KCC area. The density has nearly doubled in 2001 since the independence of Bangladesh in 1971. Most of the areas of KCC are characterized by urban activities. However, the increase in the density of population followed the historical trend of Urbanization. Demographic information has been extracted from different census years from Bangladesh Population Census 2001 to project density.

Table- 1.2: Density of Population in KCC Area 1961-2001

Sl. No.	Year	KCC Population/sq.km
01	1961	1740
02	1974	9506
03	1981	12216
04	1991	14420
05	2001	16928

Source: *Bangladesh Population Census 2001, Community Series, District Khulna.*

1.4.3 Growth of Population

After the partition of India and with the creation of East Bengal province under Pakistan, many Muslim refugees migrated mostly into Khulna town and the adjoining areas. A second phase of refugee influx was seen in 1965 with the breakout of communal riots in Calcutta. However, the refugee movement was not a one-way process. In exchange, many Hindus had left Khulna town as well as from the adjacent areas and other areas of the then East Pakistan. The exact movement of the post-partition refugees from Khulna urban area is difficult to assess. But an indicative refugee influx in Khulna district may give an idea of their volume moving into the urban area assuming that most of them had taken shelter in the urban areas. Thus, out of the total population of the district of 2.08 million, about 1.2 percent was refugees and this accounted for 3.7 percent of total refugees of East Bengal (GOP, 1951; BBS 1974). The refugee influx from India into Khulna town was not demographically significant. Nevertheless, the War of Liberation, 1971 in Bangladesh forced many urban dwellers of Khulna to leave the country but almost all of them were repatriated immediately after the war. Based on census information, **Table-1.3** shows the growth of population since the beginning of this century.

Table-1.3: Population of Khulna Municipality/ City Corporation Area 1901-2006

Sl No	Year	Municipality/ KCC Population	Growth Rate/year
01	1901	10,430	--
02	1911	18,170	5.55
03	1921	23,500	2.57
04	1931	28,000	1.75
05	1941	34,000	1.94
06	1951	42,220	2.17
07	1961	80,220	6.42
08	1974*	4,37,300	13.04
09	1981	5,61,950	3.58
10	1991	6,63,340	1.66
11	2001	7,70,231	2.71
12	2006	8,30,454	2.71 (estimated as same)

***Source**: Bangladesh Population Census, 1974-2001*.
Note: * The census of 1971 was not held because Liberation War in Bangladesh. So, census was held in 1974 after independence.

During the post independence years, Khulna City experienced huge population increase. It was mainly due to rural urban migration.

1.4.4 Occupational Status

Occupational status of the household is highly relevant for assessing the socio-economic status of any area like Khulna City. It has a great impact on employment and alleviating poverty. A large number of people are engaged in business sector and the percentage accumulating to about 34%. It is followed by the second largest percentage of 20% engaged in private and NGO sector. Only 14% are working under government sector. The survey results revealed that some people have more than one occupation. Females are mostly engaged in household activities. It may be mentioned that only 0.98% of the working force is unemployed in Khulna city. Of the total surveyed population, about 3.21% are students.

1.4.5 Income Level

Most of the households (31.23%) covered by survey belong to the monthly income group of above Tk. 15,000. The lowest income group falls below Taka 3000 (1.74%), who are also the hard core poor. A recent study by the Ministry of Local Government for different projects set poverty line at TK. 6000 as the monthly household income. It also sets poverty line for the hard core poor at Taka 3000. It is dividend that about 12.53% household in the present study is below or within poverty line. It was observed that about 24.66% of the households have average income of Tk. 7,500; another 19.42% households have monthly

income in the range of Taka 9000-12000. Only 12.16% households' monthly income is above Tk. 12,000 and the next followed by about 11% households in the range of Taka 3000-6000. Level of income of households in the KCC area is presented in **Table-1.4.**

Table- 1.4: Income Pattern of the Household in KCC Area

Income Class in Taka (Monthly)	Income	
	Households	Percentage
Below 3000	108	1.74
3000-6000	669	10.79
6000-9000	1529	24.66
9000-12000	1204	19.42
12000-15000	754	12.16
More than 15000	1936	31.23
Total	**6200**	**100**

Source: HCL-SPL *Socio-economic Survey, 2010*

1.4.6 Expenditure Level

Most of the households covered by survey belong to the monthly expenditure group of Tk. 6,000-9,000 (27.74%). The lowest expenditure group falls below Tk. 3,000 (2.37%). It was observed that about 22.71% of the households have expenditures in the range of Tk. 6,000-9,000. Another 18.73% households have monthly expenditure above Taka 15,000. Only 15.23% households' monthly expenditure is in the range of Tk. 3,000-6,000 and the next 13.23% households are in the range of Tk. 12,000-15,000. Expenditure of a family actually depends on its income level. Levels of expenditure of households in the KCC area are presented in **Table-1.5.**

Table- 1.5: Expenditure Pattern of the Household in KCC Area

Expenditure Class in Taka (Monthly)	Expenditure	
	Households	Percentage
Below 3000	147	2.37
3000-6000	944	15.23
6000-9000	1720	27.74
9000-12000	1408	22.71
12000-15000	820	13.23
More than 15000	1161	18.73
Total	**6200**	**100**

Source: *Socio-economic Survey, 2010*

1.5 An Overview on Population Projection Procedure

Perhaps no single factor is more important for planning than the size and composition of a region's population and the way it will change in the future. Estimating future population for a specific period over a particular area is one of the most difficult tasks in the planning process. BBS Census population data have been used for the population projection. Following the annual growth rate for the study area available from the 2001 Population Census, the projection up to the year of 2031 with ten years interval has been made with the help of Compound Rate of Growth Method.
To calculate the future population growth of the area, the following formula is used.

$$P_n = P_o (1+ r)^n$$

Where,

P_o = Population in the base year,
P_n = Population in the projected year,
n = number of intermediate years,
r = annual rate of growth.

1.5.1 Projection of Population

In order to calculate the population of 2031, projection has been made on the basis of 2001 census data at ten years interval. It is found that the project area records an increase of 1,253,218 persons by 2031. The projected population increase in the year 2011 was 302,681 compared with the 2001 population. Detail statistics of population projection of the project area is shown in **Table-1.6**.

Table-1.6: Population Projection for the Project Area Up to 2031

Ward Name/Extended Area	Area in Acres	BBS Population	Growth Rate ®	Projected Population		
		2001		2011	2021	2031
Ward 01	476.86	20311	3.84	29606	43154	62903
Ward 02	534.58	18815	3.84	27425	39976	58270
Ward 03	951.98	23016	3.84	33549	48902	71280
Ward 04	517.77	14299	3.84	20843	30381	44284
Ward 05	196.65	15314	3.84	22322	32537	47427
Ward 06	545.68	20995	3.84	30603	44608	65021
Ward 07	113.03	14808	3.1	20095	27269	37005
Ward 08	235.52	18545	3.1	25166	34151	46343
Ward 09	891.32	34614	3.1	46972	63742	86499
Ward 10	206.17	18518	3.1	25129	34101	46276
Ward 11	94.72	19398	3.1	26323	35722	48475
Ward 12	170.75	52036	3.1	70614	95825	130036
Ward 13	292.69	19959	3.1	27085	36755	49877
Ward 14	671.14	26444	3.1	35885	48697	66083
Ward 15	355.39	25724	3.1	34908	47371	64283
Ward 16	577.36	35881	3.1	48691	66075	89665
Ward 17	585.82	30352	3.1	41188	55893	75849
Ward 18	404.73	16765	2.98	22487	30162	40457
Ward 19	123.37	26321	2.98	35305	47354	63517
Ward 20	120.48	22539	2.98	30232	40550	54390
Ward 21	338.43	24984	2.71	32643	42650	55724
Ward 22	168.30	21633	2.71	28265	36929	48250
Ward 23	125.51	18332	2.71	23952	31294	40888
Ward 24	386.52	42959	2.71	56128	73335	95816
Ward 25	184.35	27106	2.98	36358	48767	65411
Ward 26	164.17	18087	2.98	24260	32541	43647
Ward 27	206.26	31489	2.71	41142	53754	70233
Ward 28	181.84	22404	2.71	29272	38245	49970
Ward 29	163.60	20431	2.71	26694	34877	45569
Ward 30	300.62	35827	2.71	46810	61160	79908

Ward Name/Extended Area	Area in Acres	BBS Population	Growth Rate ®	Projected Population		
		2001		2011	2021	2031
Ward 31	993.84	32592	2.71	42583	55637	72693
Total of KCC	**11279.44**	**770498**	**3.07**	**1042535**	**1410618**	**1908659**
Extended Area						
Aranghata Union		10807	3.84	15753	22961	33469
Atra Gilatala Union		69421	2.02	84790	103561	126488
Jugipole Union		31676	2.02	38689	47254	57715
Alutala		545	1.46	630	728	842
Dubi		439	1.46	507	587	678
Harintana		5308	1.46	6136	7093	8199
Kholabaria		291	1.46	336	389	450
Krishnonagar		4751	1.46	5492	6349	7339
Mathavanga		160	1.46	185	214	247
Bil Pabla		3948	1.78	4710	5619	6703
Chak Asankhali		410	1.78	489	583	696
Chak Mathurabad		543	1.78	648	773	922
Lata Paharpur		2997	1.78	3575	4265	5088
Total Extended Area	**9819.38**	**131296**	**2.12**	**161940**	**199736**	**246353**
Total Project Area	**21098.82**	**901794**	**2.94**	**1204475**	**1610354**	**2155012**

1.6 Land Use

The land uses of the project area are shown in **Table- 1.7** and **Figure-1.1**. In the land use pattern, 17 types of land uses are found. It is evident from the table that two types of land uses are dominant in Khulna City Corporation, residential land use occupies 32.57%, followed by agriculture which is 31.21%. Water bodies cover 13.69%, transport & communication covers about 4.10% and health services only 0.22%. Comparative Land use categories between KCC and Extended Area have been shown in **Table-1.8**. Existing land-use scenario of the project area has been presented in **Map-1.3**.

Table- 1.7: Existing Land Use Classification of KCC including the extended Area

Landuse Categories	Area in Acres	Area in Hectares	%
Residential	6871.39	2780.77	32.57
Agriculture	2888.87	1169.09	13.69
Waterbody	6585.07	2664.90	31.21
Industrial and Manufacturing Activities	1050.96	425.31	4.98
Transportation and Communication	865.26	350.16	4.10
Restricted Area	411.44	166.50	1.95
Education and Research	365.21	147.80	1.73
Administrative	621.54	251.53	2.95
Commercial Activities	655.48	265.26	3.11
Mixed Use	252.95	102.37	1.20
Vacant Land	249.97	101.16	1.18
Community Facilities	84.38	34.15	0.40
Open spaces	74.31	30.07	0.35

Landuse Categories	Area in Acres	Area in Hectares	%
Recreational Area	65.27	26.41	0.31
Health Care Services	45.79	18.53	0.22
Graveyard	7.87	3.18	0.04
Miscellaneous	3.06	1.24	0.01
Total	**21098.82**	**8538.44**	**100**

Source: Land Use Survey, 2010

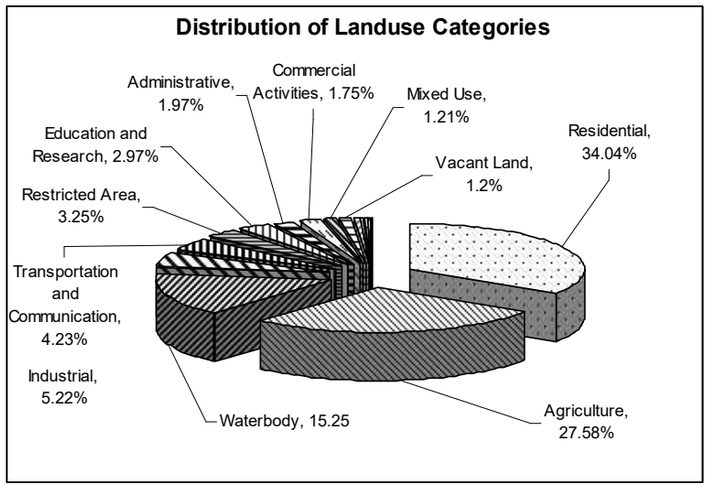


Figure-1.1: Landuse Distribution in the Project Area

Table- 1.8: Comparative Picture of Landuse in KCC and Extended Area

Landuse Categories	KCC Area		Extended Area		Project Area	
	Area in Acres	%	Area in Acres	%	Area in Acres	%
Residential	4883.12	23.14	1988.27	9.42	6871.39	33.75
Waterbody	2168.48	10.28	720.39	3.41	2888.87	28.20
Agriculture	812.61	3.85	5772.46	27.36	6585.07	15.12
Industrial and Manufacturing Activities	823.25	3.90	227.71	1.08	1050.96	5.17
Transportation and Communication	613.24	2.91	252.02	1.19	865.26	4.20
Administrative	394.88	1.87	16.56	0.08	411.44	3.23
Commercial Activities	323.30	1.53	41.91	0.20	365.21	2.95
Education and Research	309.53	1.47	312.01	1.48	621.54	1.95
Restricted Area	220.02	1.04	435.46	2.06	655.48	1.73
Mixed Use	239.94	1.14	13.01	0.06	252.95	1.20
Vacant Land	233.31	1.11	16.66	0.08	249.97	1.18
Community Facilities	70.53	0.33	13.85	0.07	84.38	0.40
Open spaces	65.65	0.31	8.66	0.04	74.31	0.35
Recreational Area	64.96	0.31	0.31	0.00	65.27	0.31
Health Care Services	45.79	0.22	0.00	0.00	45.79	0.22
Graveyard	7.77	0.04	0.10	0.00	7.87	0.04

Landuse Categories	KCC Area		Extended Area		Project Area	
	Area in Acres	%	Area in Acres	%	Area in Acres	%
Miscellaneous	3.06	0.01	0.00	0.00	3.06	0.01
Total	**11279.44**	**53.46**	**9819.38**	**46.54**	**21098.82**	**100.00**

Source: Land Use Survey, 2010

1.6.1 Residential Area

Total residential land covers 6871.39 acres in project area, which is the highest percentage of land use (33.75%). The highest residential area exists in Ward no. 01, which is 373.63 acres and covering 5.25% of the total Residential Land use in the project area. The lowest residential land (2.63 acres) is in Ward no. 08. **Figure-1.2** represents the distribution of residential land use in the project area.

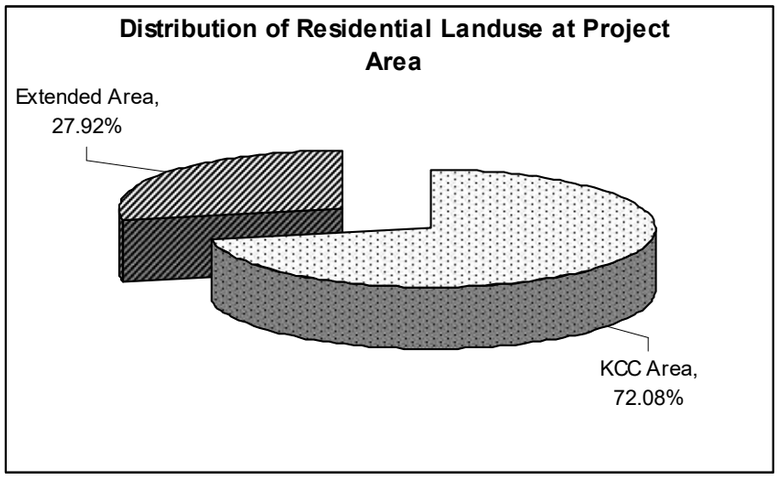
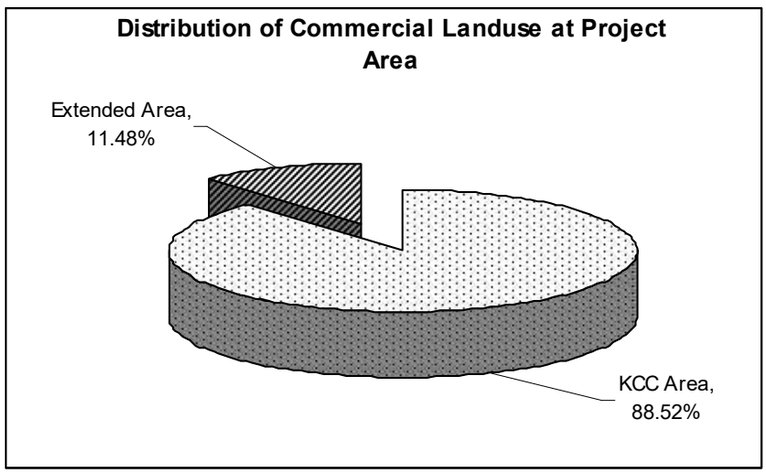
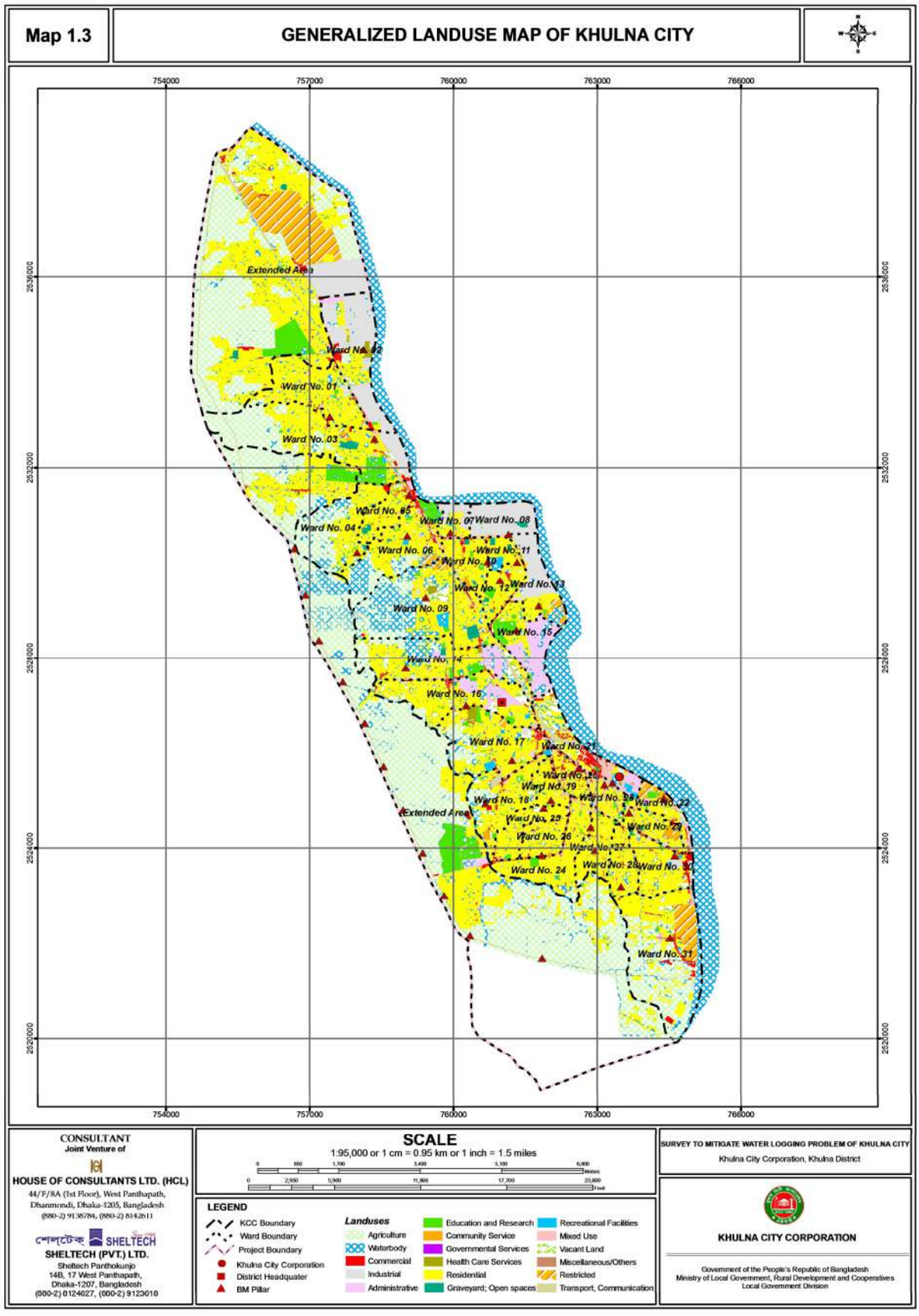


Figure- 1.2: Distribution of Residential Land use in the Project Area

1.6.2 Commercial and Industrial Areas

Land under commercial use in the Project area is only 1.73%. Maximum commercial activities are concentrated at Ward no. 21 covering almost 47.93 acres of total commercial area of 365 acres. The main CBD area i.e. Daak bungalow is located in this ward. The minimum commercial area is at Ward no. 09 covering only 0.17 acres of land. Distribution of the commercial land use is shown in **Figure- 1.3**.




Map 1.3
GENERALIZED LANDUSE MAP OF KHULNA CITY
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Ward No. 02
Ward No. 01
Ward No. 03
Ward No. 05
Ward No. 07
Ward No. 08
Ward No. 04
Ward No. 06
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 13
Ward No. 09
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 19
Ward No. 18
Ward No. 28
Ward No. 22
Extended Area
Ward No. 29
Ward No. 23
Ward No. 26
Ward No. 27
Ward No. 24
Ward No. 30
Ward No. 31
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(000-2) 0124027, (000-2) 9123010
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Khulna City Corporation
District Headquater
BM Pillar
Landuses
Agriculture
Waterbody
Commercial
Industrial
Administrative
Education and Research
Community Service
Governmental Services
Health Care Services
Residential
Graveyard; Open spaces
Recreational Facilities
Mixed Use
Vacant Land
Miscellaneous/Others
Restricted
Transport, Communication
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Land for industrial use in the Project area is about 1050.96 acre, which is 4.98% of the total area. The highest percentage of industrial area is at Ward no. 02 covering 30.15% and the lowest in Ward no. 15. (**Figure-1.4).** Jute mills are one of the most prominent industries in the KCC area. Shrimp processing factories are located along the sides of the rivers, Rupsha and Bhairab.

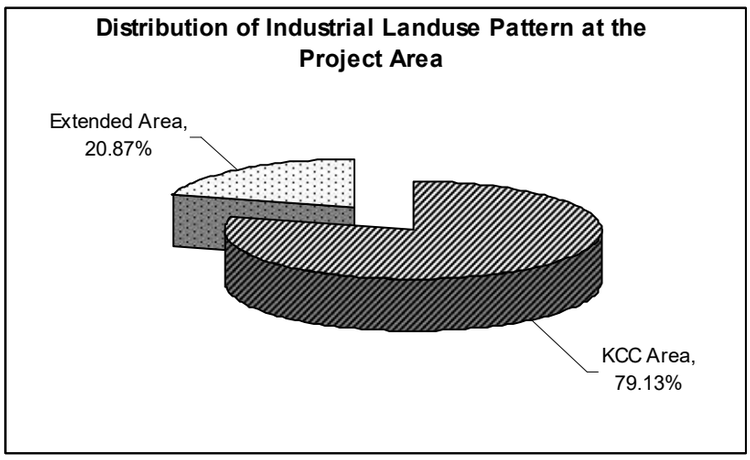


Figure- 1.4: Industrial Landuse Pattern in the Project Area

1.6.3 Restricted Areas

Restricted areas occupy about 655.48 acres of land that is 3.11% of the total area. Cantonment, BGB camp, RAB office and other areas have been considered within this category.

Table- 1.9: Restricted Area Land uses

Area Type	Area (acre)	Percentage
KCC area	220.02	35.57%
Extended Area	435.46	64.43%
Total	**655.48**	**100.00%**

Source: *Land Use Survey, 2010*

1.6.4 Recreation Facilities

Recreational facilities include parks, playgrounds, zoo, cinema halls etc. There is an acute shortage of recreational land in the project area. It reveals that the land use for recreation facilities in the Project area is only 0.31 percent of the total land (65.27 acres).

There are 8 major parks managed by the Khulna City Corporation. These parks are used as the main recreational centers for the city dwellers. **Table-1.10** presents detail of these parks.

Table- 1.10: Major Parks in Khulna City

Name	Area (in acres)	Name	Area (in acres)
Sahid Hadis Park	1.35	Nirala Shishu Park	0.40
Golokmoni Shishu Park	0.50	Sonadanga Shishu Park	0.46
Jatisongho Shishu Park	0.98	Khalispur Wanderland Shishu Park	3.78
Serebangla Road Mini Park	0.57	Sonadanga Park	**

Source: *Khulna City Corporation (KCC)*

1.7 Existing Road Network

Efficient circulation system is one of the key elements for future growth and prosperity of a city. The present condition of transport facilities in Khulna is fairly good. But to cope with the future growth of the city and the development likely to take place for the possible international use of Mongla Port by Nepal and Bhutan, increased trade with India and industrialization through EPZ and subsequent expanding trade and commerce, there is a need to take up transport development programmes in right earnest from now.

Khulna has a fairly good transport system consisting of road, water and railway network. Water and rail transports were prominent in the past, but with the passage of time, road network is getting an edge over the water way and railway transport. Although Khulna is a Metropolitan City, ranking third in the country, it conspicuously lacks an airport.

Khulna City stands at a transit point between the Mongla Port, the regional urban centers and the rich agricultural hinterland. Currently there exist road, railway and waterway communication systems linking Khulna with important regional economic centers. Taking advantage of these transport facilities, a large number of people commute to the city from surrounding regions. The traders use waterways as the cheapest means to haul their goods in bulk from many parts of the country including places as far as Chittagong, Sylhet and Dhaka. However, low level of economic activities in Khulna and Mongla Port do not cause effective use of the existing transport infrastructure. The city enjoys excellent inter-city bus communication with almost all the major cities including the capital.

The project area is served by 824.47 Km of road network. Out of which 515.14 Km and 219.59 Km of road are respectively pucca and semi-pucca. The remaining 89.74 Km of road are kutcha. The highest length of road network is found in Ward No. 09 followed by Ward 16 and Ward 17. It was found that in Ward 09, out of 40.34 Km of road, only 6.22 Km are katcha. In Ward 16 out of 39.90 km of road, 23.40 km are pucca. Ward 11 is without any katcha road. Out of total 37.60 km of road in Ward 17, 22.02 km are pucca, 11.49 Km are semi-pucca and 4.10 Km are kutcha. Road network in Ward 14 comprises of 23.88 Km of pucca road while in Ward 03 comprises of 18.04 Km of pucca road. Extended area is served by 183.79 Km of road, of which about 79.12 Km are pucca. Details are given in the **Table-1.11**, while existing circulation network has been presented in **Map-1.4**.

Table- 1.11: Existing Road Types in the Project Area

Ward Name	Road Type (Length in Km)			
	Pucca	Semi Pucca	Katcha	Total
Ward 01	16.42	9.88	2.57	28.87
Ward 02	14.17	5.30	1.11	20.58
Ward 03	18.04	11.51	4.16	33.72
Ward 04	10.72	3.91	2.99	17.63
Ward 05	10.26	2.30	0.43	12.99
Ward 06	20.47	5.45	2.55	28.46
Ward 07	6.44	0.51	0.23	7.19
Ward 08	4.93	0.82	0.15	5.91
Ward 09	23.57	10.55	6.22	40.34
Ward 10	19.50	0.85	0.42	20.77
Ward 11	7.56	0.34	0.00	7.90
Ward 12	16.29	0.33	0.04	16.66
Ward 13	8.09	1.04	0.53	9.65
Ward 14	23.88	7.17	4.63	35.68
Ward 15	15.52	3.90	1.35	20.77
Ward 16	23.40	13.28	3.23	39.90
Ward 17	22.02	11.49	4.10	37.60
Ward 18	14.14	11.36	1.78	27.29
Ward 19	10.31	0.62	0.18	11.11
Ward 20	9.91	0.42	0.29	10.63

Ward Name	Road Type (Length in Km)			
	Pucca	Semi Pucca	Katcha	Total
Ward 21	16.40	5.05	2.80	24.25
Ward 22	8.25	0.40	0.28	8.94
Ward 23	8.82	0.58	0.31	9.70
Ward 24	19.82	11.83	2.14	33.79
Ward 25	12.38	2.28	0.59	15.25
Ward 26	12.04	2.03	0.33	14.40
Ward 27	14.88	2.59	1.04	18.51
Ward 28	13.74	2.54	1.23	17.51
Ward 29	10.34	0.57	0.41	11.31
Ward 30	14.02	6.88	1.32	22.22
Ward 31	9.70	13.32	8.09	31.12
Extended Area	79.12	70.46	34.22	183.79
Total	**515.14**	**219.59**	**89.74**	**824.47**

Source :*HCL-SPL Physical Feature Survey, 2010*

1.8 Functional Classification of Road Network

The road network of the project area can be classified in the following three categories on the functional point of view:

1. Primary Road
2. Secondary Road
3. Tertiary Road

Table- 1.12: Classification of Road Network in the Project Area

Ward Name	Primary Road	Secondary Road	Tertiary Road	Total
	Km	Km	Km	Km
Ward 01	1.65	10.52	16.70	28.87
Ward 02	0.00	5.06	15.53	20.58
Ward 03	2.37	10.79	20.56	33.72
Ward 04	0.64	3.20	13.78	17.63
Ward 05	0.52	3.39	9.07	12.99
Ward 06	2.05	7.31	19.10	28.46
Ward 07	0.30	0.19	6.70	7.19
Ward 08	0.81	0.00	5.11	5.91
Ward 09	5.39	5.05	29.90	40.34
Ward 10	1.03	3.83	15.90	20.77
Ward 11	0.00	1.72	6.18	7.90
Ward 12	0.00	3.21	13.45	16.66
Ward 13	1.56	1.96	6.13	9.65
Ward 14	3.15	7.37	25.17	35.68
Ward 15	2.39	6.62	11.76	20.77
Ward 16	3.07	7.47	29.37	39.90
Ward 17	2.89	5.43	29.28	37.60
Ward 18	2.51	6.95	17.83	27.29
Ward 19	1.09	3.75	6.27	11.11
Ward 20	1.81	3.01	5.82	10.63
Ward 21	1.70	9.41	13.14	24.25
Ward 22	0.77	3.49	4.68	8.94
Ward 23	0.88	3.72	5.11	9.70

Ward Name	Primary Road	Secondary Road	Tertiary Road	Total
	Km	Km	Km	Km
Ward 24	0.61	7.12	26.06	33.79
Ward 25	0.61	4.86	9.78	15.25
Ward 26	1.69	3.61	9.10	14.40
Ward 27	0.89	4.74	12.87	18.51
Ward 28	0.21	3.65	13.66	17.51
Ward 29	0.13	3.58	7.60	11.31
Ward 30	1.40	5.05	15.77	22.22
Ward 31	1.78	6.27	23.07	31.12
Extended Area	30.91	29.57	123.30	183.79
Total	**74.81**	**181.94**	**567.72**	**824.47**

Source: *HCL-SPL Physical Feature Survey, 2010*

1.9 Existing Railway Network

Railway network of Khulna is a part of Bangladesh Western Railways. The City enjoys a good railway linkage with north-western towns and Dhaka. Different types of Train Services are available from Khulna to other places. These are:

- Inter City Service,
- Mail Service, and
- Local Service.
- Freighter Service.

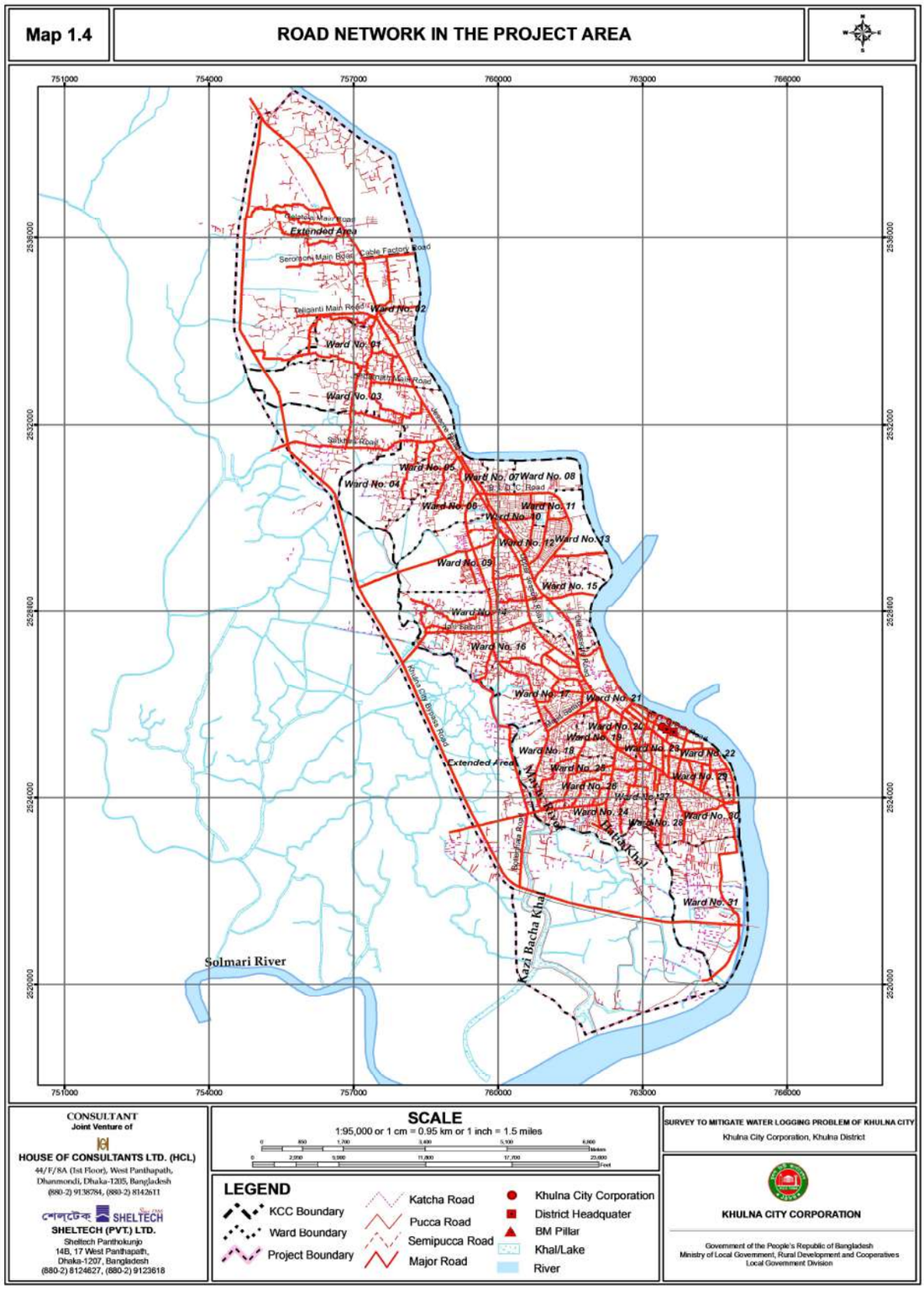
Despite good railway communication and service facilities, the number of passengers is decreasing due to highly competitive bus services with respect to time and fare. However, railway communication has potentials in future if the country wide and international linkages are established with Mongla and Benapole Ports.

The existing length of rail line within the project area is 32.45 km and its right of way coverage varies from place to place as shown in **Table- 1.13**.

Table- 1.13: Railway Scenario of Planning Area

Location	Length in Km	Right of Way (m)
Ward 02	1.76	6.12
Ward 03	1.21	9.27
Ward 05	0.46	7.38
Ward 06	1.23	4.36
Ward 07	0.64	7.65
Ward 08	0.81	19.52
Ward 09	1.58	14.72
Ward 10	0.84	10.65
Ward 13	1.59	24.25
Ward 14	8.59	33.95
Ward 15	1.29	4.30
Ward 21	7.30	35.70
Extended Area	4.94	53.15
Total	32.23	

Source: *Physical Feature Survey, 2010*


Map 1.4
ROAD NETWORK IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Seronjon Main Road
Cable Factory Road
Teliganti Main Road
Ward No. 02
Ward No. 01
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 07
Ward No. 08
Ward No. 06
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 13
Ward No. 09
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 19
Ward No. 18
Ward No. 23
Ward No. 22
Ward No. 26
Ward No. 29
Ward No. 25
Ward No. 27
Ward No. 24
Ward No. 28
Ward No. 30
Ward No. 31
Khulna City Bypass Road
Extended Area
Solmari River
Kazi Bacha Kha
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Major Road
Khulna City Corporation
District Headquater
BM Pillar
Khal/Lake
River
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

1.10 Existing Waterway Network

There is regular Launch communication between Khulna and the adjacent Districts and Upazila towns and important trading centers. Launches operate in 12 routes every day. Besides, the Rocket Steamer Service of BIWTA operates one Steamer service everyday between Khulna and Dhaka via Barisal. A large number of cargo vessels operate between Khulna and other destinations like, Mongla, Dhaka, Chittagong, Barisal, Narayanganj. Nowapara being a major trading centre of the region, a large number of barges operate between Mongla and Nowapara via Khulna every day. The rivers of Bhairab & Rupsha are the perennial rivers serving as important waterway system of the city. These rivers are very stable and navigable round the year. Draft in these rivers varies between 12' to 20' (IWTA, Khulna). The major flow of the Bhairab is blocked near Jessore due to siltation. The river Rupsha gets its upland flow from the river Gorai through Lower Nabogonga River. Waterway in Khulna city is likely to play important role in the transportation system of the city in future particularly, in bulk goods movement.

1.11 Major Traffic Generating Centers and Traffic Congestion Areas

The generation of traffic of an area is mostly dependent on its land use categories and other functional activities. Generally, where commercial, industrial and administrative activities are predominant, there generates more traffic than the residential areas. The intensity of land use, density of population and building has direct relationship with the generation of traffic. Again, the mode and composition of traffic generation varies with the socio-economic characteristics of the population and the nature and type of activities generated by the land use type. Traffic conflict is common and frequent in towns where there is admixture of transport vehicles-slow and fast-in the streets. Areas of conflict occur at points where the intensity of traffic movement is high.

The following are the important traffic generating areas:

Rupsha Ghat, BIWTA Ghat, New Market, Customs Ghat No. 1, Jail Khana Ghat, Kheya Ghat, Fish Ghat No. 5 (No. 6), Railway Station, Sonadanga Bus Terminal, Bus Terminal near CBD (Ferry Ghat Bus Terminal), East Rupsha Bus Terminal (East of River), Batiaghata Ferry Ghat and on the main road all along Nowapara.

Khan-E-Sabur Road at Daulatpur *area* is very narrow with ribbon development on each side of it. This is a critical area of traffic congestion that interrupts free movement of highway traffic. The point about 1000 feet north from the Old Satkhira Road junction is a bottleneck, created by auto-rickshaws and haphazardly standing rickshaws on the road.

Fulbarigate level crossing is an extremely critical point of congestion. Narrow width of pavement, ribbon development on each side and roadside parking of auto rickshaws and rickshaws reduce the usable road space. Widening the pavement and arranging proper parking space for auto rickshaws can solve the problem.

Other major traffic conflict points of the Khulna City are as following:

- Shibbari Morh
- Dakbanglow Morh
- Clay Road Morh
- Picture Place Morh
- Station Road
- Power House Morh
- Ferry Ghat Morh
- Royal Morh
- PTI Morh

- Rupsha Morh
- Moilaputa Morh
- Zora Gate Morh
- Boyra College Morh
- Boyra Bazar Morh
- Notun Raster Morh
- BL College Morh
- Mohosin Morh
- Railgate Morh
- Sonadanga Bus Stand Morh
- Gollamari Morh
- Satraster Morh
- Shantidham Morh

1.12 Public Consultation

Public consultation is an essential element of modern planning system. It helps to get the pulse of stakeholders regarding spatial development. It also helps to find out the demand of the local people easily. Public consultation is a part of the drive to establish good governance at local level. It also makes a plan sustainable and implementable as it receives support of the beneficiaries. Through public consultation, people are made aware about the development activities; it creates consciousness and sense of ownership among them about the project. The Consultants carried out a series of consultation with stakeholders in different phases of the Project. Before embarking upon consultation with the stakeholders, a plan was worked out to proceed systematically to accomplish the tasks of consultation.

1.12.1 Consultation with Ward Councilors

The consultants formally and informally consulted on numerous occasions with the Ward Councilors of respective wards, stakeholders of the ward and local people during project initiation and at different stages of field survey, data collection, planning and preparation of maps. Formal ward wise consultation with general people and the Ward Counselors of respective wards were arranged during Draft Planning stage where problems and prospects of concerned ward and their aspirations from the Plan were identified.

The Consultants also arranged consultation meetings with the local development authorities, discussed about existing condition, and considered their suggestions in the Final Plan.

Processing and Integration of Consultation Findings

The following Table (Table-1.14) presents the Summary of Ward wise Wish List of the people's expectation worked out from the consultation and formal and informal discussions carried out at various places and occasions.

Table- 1.14: Summary of Ward-wise Wish List of Stakeholders

Ward No	Major Issues
Ward 01	• There should be a drain on the eastern part of the Dighi. • A new drain is required at Mondir to Bonikpara Mosque to Kandar Road and Maheswarpasa Main Road • A new drain is required at Bonikpara Main Road to Bonikpara School to Main Road.
Ward 02	• New drain should be constructed by the side the main roads.
Ward 03	New Drains are required along the following roads: • Along the rode side from Muhasin more to Railgate. • Along the DC Road • Along Beel Dakatia • A major outlet is necessary through the beel.
Ward 04	New Drain is required along the following roads:

Ward No	Major Issues
	• Mobarak Sarak • Kanaigazi to Khudir Khal • Madrasha Main Road • Hosen Sha Road • Mahfuz Shaheber Mosque to Sharder Lane • Councilor Office Road
Ward 05	• A major outlet is very essential along the Rail way to save 200 families from water logging
Ward 06	New Drains are required along the following roads: • Rail Road • Culvert on the Jamuna Road • BIDC road Drain should be renewed
Ward 07	• A drain is needed by the side of the Rail Road • A culvert is essential across Jamuna Road. • The drain along the BIDC road should be renewed. • Some small drains are needed in different parts of the Ward
Ward 08	• The side of the drains should be higher. • Drain is needed across Crescent and People's mill. • Culvert is needed under the rail line.
Ward 09	• Drain is needed in Mujgunni to Boyra • Culvert is needed in front of Forest office • Drain is needed in Titumir School to Min Road • Along the side of Stadium to Khan-e-Sabur Road • Mujgunni Dakkinn Para Road Bylane • Drain should be reconstructed along the Rail Road(Covered drain) • Bastuhara Area should be given priority • Drain is essential in residential areas • Drain is needed in Shishu Park to Navy Colony
Ward 10	• Drain should be provided along the residential areas. • Septic Tank should be established in every house so that the latrine waste don't come to the drain
Ward 11	New Drain is required along the following roads: • 16 No Road • People's Mil
Ward 12	• There are a number of drains in the Ward which are kutcha. These drains should be converted to pucca drains". • New drain should be constructed from road no 141 to road no 108 • There are some refugee camps (Bihari Camp) in this area. The drainage system should be improved as there is no pucca road in this area.
Ward 13	• Charghat More to Khalispur School More-drain should be widened and depth should be increased • Drain of Alamnagar Bazar to Bhaluar Beel should be widened
Ward 14	• Drain should be given along BTS Road Side • Drain along the Mohila College
Ward 15	• There should be drain along the Polytechnic Institute Boundary. • All the drains should be properly interlinked and properly slopped. • Need a sluice gate at the custom gate
Ward 16	New drain is required by this side of main road • Along UCEP School • UCEP School to Al Faruk School to Hasana Bag Mosque to Mayur River • Drain should be reconstructed along Boyra Main Road • Boyra Main Road to Taltala • Boyra Cross Road to Karim Nagar

Ward No	Major Issues
Ward 17	• Construction of new drains. • Repairing the existing drains.
Ward 18	The KDA bypass is the main hindrance for the natural flow of rain water. Before the construction of this road, the rain water used to flow to Mayuer River naturally. The bypass road disturbs the natural flow of khals and it would be solved through proper drainage planning. The khals are as follows: • North Bank Khal • Arambag Khal • Golam Muktadir Khal • Tomijuddin Khal
Ward 19	• Construction of new drains. • Repair the existing drains. • Removal of the obstacles from the drain such as electric pole. • Increase the height of the culverts.
Ward 20	• The difference of water level between high and low tide in the rainy season is very little. So when it rains for long time (3-4 hrs) during rainy season, water cannot be drained out to river. So there should be some sort of retention pond which could contain rain water for 3 to 4 days duration. • Sheikhpara- Baganbari drain should be widened. • Stagnation in Forajipur lane and Deben Babu lane. • Drain should be widened in Sheikhpara (Puraton) old mosque • Drain should be widened in Hazi Ismail Road and B.K. Rai road • Drain should be widened to Sheikhpara Cross Road-2 to Hazi Ismail Road.
Ward 21	• All the water of the Ward should be drained out to Bhairab River. Though the natural slope is towards the Mayur River, this Ward is very near to Bhairab River. • There should be an outlet in Jabbar Sarani
Ward 22	New Drain is required along the following roads: • Natun Bazar Approach Road • WAPDA Road
Ward 23	• There should be new drain from Dak Banglow taxi stand to Ferighat More
Ward 24	• Mayur River should be re-excavated
Ward 25	• The existing drain from Solaimannagar to Atimkhana road to North Bank Khal should be widen
Ward 26	• New outlet being constructed throughout this Ward should be widened. • New culverts are needed in different parts of the Ward.
Ward 27	New Drain is required along the following roads: • Mistry Para Main Road • Baghmara Eidga Bylane
Ward 28	• Construction of new drains, repair and clean up the existing drains.
Ward 29	• All the household waste of Khulna is thrown into the drains. These wastes clog the drain and lessen the efficient operation. Again the TNT line, WASA pipe lines are running through the drainage network of KCC which also creates clogging. • New drain behind the Ward office 19 is required. • The culvert should be repaired properly. • Overloaded vehicles destroy the drains. So construction of drains should be made considering this matter. • Drain is needed in Babu Kha Road
Ward 30	• New drain is required in main road
Ward 31	Widening and Re excavation is required for the following drains: • Motiakhali Khal • Sluicegate Khal

Ward No	Major Issues
	• Labanchora Khal • Khetrokhali Khal • Rampura-Harintana Khal • New drain is required in main road

1.12.2 Consultation with Mayur Rokkha Committee

A consultation meeting was arranged on August 25, 2011 between the Consultants' Team with Mayur Rokkha Committee (Mayur River Protection Committee) who mainly works and provides strategies and guidelines to prevent illegal encroachment of the Mayur River and other existing khlas and to mitigate water logging problems in Khulna City area. Representatives from KCC were also present in this meeting. The Committee presented a report addressing problems regarding illegal encroachment of exiting khals with specific proposals to mitigate the problems which have been integrated in the drainage Master Plan. Some specific problems regarding existing khals and recommendation to ameliorate them have been summarized in the **Table-2.15** below:

Table-2.15: Problems and suggestions on existing Khals/Canals of Project area by Mayur Rokkha Committee

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Sluice Gate Canal and Canals under Chak Mathurabad Mouza **Connection:** Mayur River	1. Eastern part of the canal has been filled up. 2. Sluice gate established by BWDB is narrow and outdated.	1. Remove the illegal encroachment and demarcate the canal area by Zila Administration. 2. Repair the sluice gate.
Kaderer Canal **Connection:** Mayur River	1. Canal has been filled up. 2. Though the canal has a connection with Mayur River shown in mouza map but it does not exist. 3. Sluice gate established by BWDB is narrow.	1. Remove the illegal encroachment. 2. Make necessary steps against illegal construction. 3. Construct a wide sluice gate.
Mayur River **Connection:** Hatia River, canal between Dubi and Harintana	1. Dam on Mayur River at Modinabad Housing near Nirala Graveyard. 2. Filled up the river with soil.	1. All the dam should be removed from the Mayur River in an urgent basis. 2. Construct a foot over bridge over the river. 3. Arrange necessary steps to eradicate illegal encroachment and encroacher. 4. Sewerage connection with the river/ canal should be disconnected.
Nirala Canal **Connection:** Mayur River to Tablig Mosque through Prantik R/A	1. Construction of buildings on the both side of the river. 2. Culvert on the canal is too narrow to discharge wastewater properly.	1. Width of the drain should be increased and to construct new pucca drain beside the areas of the canal which would be connected to the Mayur River. 2. Remove illegal encroachment by demarcating the total area of the canal. 3. Reconstruction of culvert. 4. Excavation of canal.
Drain on the East side of Nirala KDA R/A	Blockage of drain as allotment of plot given by the KDA on the area of drain of Nirala R/A, it creates water logging.	1. Reconstruct the drain. 2. Remove illegal encroachment.
Nirala Canal **Connection:** Tablig Mosque to Nirala Graveyard	Construction of multi-storied building by filling canal	1. Construction of new drain in the Nirala R/A.

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Chorichora Canal **Connection:** Mistripara, Horintana Canal to South of Nirala Graveyard	1. Canal has been filled up by dumping waste. 2. illegal encroachment on the north and south of the Harintana Canal	1. Excavation of the canal on priority basis and make connection with the Mayur River and Harintana Canal. 2. Remove illegal encroachment. 3. Stop construction of road on the canal.
Rupsa Sahebkhali Canal and Sluice Gate, **Connection:** Kazibacha to Rupsha River	1. Mismanagement of sluice gate. 2. Water flow has been disturbed as the drain level is high in some areas.	1. Remove the temporary garage, constructed by KCC, from the canal/ drain. 2. Proper management of the sluice gate by reconstructing it. 3. Create proper leveling of the drain.
PTI More/ Piper More Canal **Connection:** PTI 28 no Ward Office to Harintana Khal	1. Drain between PTI More to Miapara Pipe More is narrow and has been encroached. As a result, water cannot drain out properly which creates water logging. 2. Illegal encroachment decreases the width of the canal/ drain. 3. Household waste has been thrown in to drain that disturbs normal water flow and which resulting water logging.	1. Repair and widen the drain from PTI More to Miapara Piper More in an urgent basis. 2. Remove the illegal encroachment.
Matiakhali Canal **Connection:** Horintana Canal to Kazibacha River	1. Illegal encroachment of canal reduces width of the canal/ drain. 2. A road has been constructed on the canal by KCC.	1. Excavation of the canal on priority basis and removal of the road which is constructed over the Canal. 2. Remove illegal encroachment. 3. Construction of 15’ wide pucca drain. 4. Widening of the old culvert over the canal. 5. Reopening the sluice gate on the east side of the canal and make a connection with the Kazibacha River.
Matiakhali Canal **Connection:** Horintana Canal to Kazibacha River	1. Illegal encroachment of canal by earthen filling. 2. Canal bed has been already filled up.	1. All the dam in the canal should be removed and excavated the canal so that water can flow easily. 2. Take proper arrangements to prevent the encroachment. 3. Some culvert should be constructed
Labanchora Gora Canal **Connection:** Khetrokhali khal to Kazibacha River	1. Construction of different type of structures which hamper the normal water flow of the canal. 2. There are several dam and roads on the canal. 3. WAPDA sluice gate, constructed under the WAPDA embankment is totally damaged as such canal water cannot be discharged to the Kazibacha River.	1. Remove all illegal construction and building such as 31 no ward office and UPHC from the canal. 2. Excavate the whole canal. 3. Construct new culvert on the priority basis. 4. Activate the WAPDA sluice gate. 5. Removal of all the roads and dam from the canal. 6. Construction of a ghat on the bank of Rupsa River.
Labanchora 1 No Sluice Gate Canal **Connection:** Southern Part of Khetrokhali Canal to Kazibacha River	1. Construction of different type of illegal structures which hamper the normal water flow of the canal. 2. Sluice gate area has been blocked by dumping waste which results improper discharging of water.	1. Remove illegal encroachment. 2. Proper management of sluice gate area. 3. Construction of a ghat on the bank of Rupsa River.

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Labanchora Canal beside Khan A Sobur's House **Connection:** Kazibacha River	1. Canal has been filled up.	1. Fixed the boundary of the canal according to map. 2. Canal should be excavated. 3. Establish a mini sluice gate under the embankment of the eastern part of the canal and connected it with the Kazibacha River.
Drain of Barabazar and Station Road **Connection:** Bhairab River	1. Water logging because of construction of shop and warehouse over the drain of Barabazar Area	1. Railway authority should be informed to remove all the construction over the drain. 2. All the drain should be cleared.
Labanchora 2 no Sluice Gate Canal **Connection:** Behind the Mistripara to Labanchora 2 no Sluice Gate Canal (between Harintana, Labanchora and Mathavanga Mouza)	1. Sluice gate has been unsuitable for use. 2. Water cannot be lifted properly.	1. Sluice gate should be repaired. 2. Ensure the lifting of water properly.
Gollamari/ North Bank Canal **Connection:** Zila Election Office to Mayur River (beside Gollamara Kasaikhana)	1. Illegal structure has been built up on the canal. 2. Culvert near the Zila Election Office has been unsuitable for use. 3. Canal/ drain have been filled up by wastes and silt. 4. KCC constructed slaughter house on the canal near Gallamari. 5. Wastes have been blocked due to water pipe, T&T and electric pipe under the culvert. 6. A ticket counter has been constructed over the drain.	1. Drain/ Canal should be cleared in an urgent basis. 2. Demarcation of canal according to map and remove the illegal encroacher. 3. Make necessary steps for the buildings which were constructed on the drain. 4. Placements of water, electricity and T&T were properly. 5. Remove the slaughter house.
Mander Khal **Connection:** Banargati Arambag to Mayur River	1. Waste blockage the water flow. 2. Illegal encroacher encroach the canal by earth filling. 3. KCC constructs brick soling road on the northern part of the canal. 4. A case has been developed as the location of the canal is not correct in the settlement map.	1. Demarcation of canal according to map and remove the illegal encroacher. 2. Canal should be excavated proper drainage of water should be ensured. 3. Necessary steps should be taken for illegal all encroacher.
Hazi Tomijuddin Khal **Connection:** KDA M. A. Bari Road to Mayur River	1. Drain is not enough for water discharge. 2. Bed of canal has been filled up by water hyacinth.	1. Widen the drain 2. Clear the water hyacinth.
Sobujbag R/A area's Canal behind the Bus Terminal **Connection:** KDA M.A Bari Road to Mayur River	1. Construct building by encroaching canal. 2. KDA and KCC construct road on canal. 3. By filling the western part of the canal, different people grabbed it illegally.	1. Recover the canal by removing the illegal encroacher. 2. Culvert should be constructed over the canal. 3. Excavate the canal.

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Canal beside the Western Part of the Bus Terminal	1. Water logging creates in Jubo Unnoyon Odhidoptor, Mohila Krira Complex as the canal has been filled up. 2. Drain beside the bus terminal has been used as a dustbin.	1. Create a drain and connected it to the Mayur River.
Nabinagar Canal **Connection:** Nabinagar Culvert via KDA M.A Bari Road via truck Terminal to Mayur River	1. Construction of buildings on canal. 2. KDA and KCC construct road on the canal. 3. No drain between 227 and 193 no plots. 4. Level of drain of LGED is higher than the other drain.	1. Demarcation of canal according to map and remove the illegal encroacher. 2. Construct a culvert on the northern part of Probaho (NGO) Office. 3. Construct 10ft wide drain behind the plot of the east side of M.A. Bari Road. 4. Excavate the drain and canal.
Khuder Khal **Connection:** Mayur River to Dewana	1. Filled up by silt and water hyacinth. 2. Drain filled up by the waste of the city. 3. Illegal encroachment.	1. Dragging the river. 2. Remove illegal encroachment. 3. Regularly clean the drain. 4. Waste of the graveyard and crimson ground should be removed applying modern technique.
Taltola Khal **Connection:** Mujgunni Road (Hasanbag to Khudir River)	1. Drain cannot clean properly as there is a road on the canal. 2. Canal between the Outer Bypass western drain to Khude River has been illegally encroached.	1. Drain should be clear monthly as there is road over the drain. 2. All illegal encroachers should be removed from Outer Bypass Road to Khudir River and the canal must be excavated in an urgent basis.
Taltola Khal **Connection:** Mujgunni Road (Southern part of UCEP School)	1. Roads have been constructed beside the canal. 2. Fish cultivated in the canal by creating dam on the canal. 3. There is no connection between the drain beside the Outer Bypass to canal. 3. Water cannot discharge properly as there is no connection between the canal and Khudir River.	1. Dam should be removed from the canal 2. Canal should be open for all by withdrawing its lease. 3. Land, within the boundary of UCEP (if any), should be recovered. 4. Connection between Khudir River and Canal should be made by acquiring the land of the western part of the canal. 5. KCC and Zila Administration recovered the land of the canal by joint survey.
Canal on the Western-side of Hospital **Connection:** Mujgunni Road to Khudir River via Nursing Institute	1. There is no drain in the area of Nursing Center. 2. Rest of the canal has been filled up by silt.	1. 15’ wide drain should be constructed in the Nursing Center and make a connection with the Khudir River. 2. Construct 15’ wide drain in the KDA plot beside the Outer Bypass and make a connection of it with the previous drain. 3. Canal should be excavated.
Choto Boyra Crimson Ground Drain **Connection:** Mujgunni Road to Khudir River via Boyra Islamia College	1. Drain is filled up with waste and silt which obstruct the water flow.	1. Regularly clear the drain and remove the silt.
Betkemari Canal **Connection:** Boyra Islamia College to Khudir River	1. Canal becomes narrow as there are illegal encroachments 2. Water Hyacinth.	1. Illegal encroachments should be removed by delineating the area of canal according to map. 2. Canal should be cleared.

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Choto Boyra Crimson Ground Drain **Connection:** Mujgunni Road to Khudir River via Boyra Islamia College	1. Drain is filled up with waste and silt which obstruct the water flow.	1. Regularly clear the drain and remove the silt.
Drain beside Rayermohol Bazar **Connection:** Rayermohol Bazar to Khudir River	1. Water logging as water cannot discharge through the drain. 2. Water cannot discharge through the canal beside the bazaar because of illegal encroachment.	1. Drain constructed under STIIFPP Project, should be connected to the Khudir River. 2. Illegal encroachments should be removed by delineating the area of canal according to map.
Bastuhara Canal **Connection:** Bastuhara to Khudir River via Pabla Karikor Para	1. Obstacle has been created for water discharge due to water hyacinth. 2. Canal bed has been filled up by silting.	1. Water Hyacinth should be removed from Bastuhara Canal to Khudir river. 2. Remove the silt from the canal bed.
Chowdhuri Canal in Deyana **Connection:** 4 no. Ward Office to Bastuhara Canal	1. Canal has been filled up by waste and water hygiene.	1. Canal must be excavated for water discharge.
Deyana Dakshin Para Canal **Connection:** Khudir River	1. Water cannot flow due to dam in the western side of the canal. 2. Illegal encroachment of canal.	1. Excavate and remove the waste/ water hygiene should be removed from the canal. 2. Stop fish cultivation in the canal and make the canal open for all. 3. Remove all the barricade/ dam from the canal. 4. Demarked the area of the canal and remove the illegal encroachment.
Kazibacha River and Tetultola Ten Vent Sluice Gate Canal **Connection:** Hatia River	1. Water flow has been disturbed as water hygiene is blocked by dam, net established for fish cultivation. 2. There arise disputes by giving the lease according to FCDI project	1. Water Hyacinth should be cleaned. 2. Net and barricade should be removed from the river. 3. Remove the illegal encroacher. 4. Canal should be widened and excavated. 5. Height of Road and sluice gate should be increased.
Mayur River to Kazibacha River	1. Water flow of river has been disturbed due to water hyacinth.	1. Water hyacinth should be cleared. 2. Dragging the river.
Mathavanga Canal **Connection:** Hatia River and other canals	1. Water flow of river has been disturbed due to water hyacinth. 2. Sluice gate has been disabled.	1. Canal must be cleaned.
Surimari Canal **Connection:** Kolabaria/ Narikelbaria Canal	1. Canal has been leased. 2. Illegal encroachment on the both side of the canal. 3. Water flow of river has been disturbed due to water hyacinth.	1. Lease of the canal should be cancelled. 2. Water hyacinth should be cleared. 3. Demarked the area of the canal and remove the illegal encroachment.
Kolabaria/ Narkelbaria Canal **Connection:** Hatia River to Kolabaria Canal	1. Canal has been leased. 2. Illegal encroachment on the both side of the canal. 3. Fish has been cultivated in the canal by different people. 4. There are some narrow bridge/ culverts over the canal	1. Lease of the canal should be cancelled. 2. Demarked the area of the canal and remove the illegal encroachment. 3. Excavated the canal. 4. Clean the canal. 5. Reconstruction of narrow culvert/ bridges.

Name of Khal/Canal	Problems due to Illegal Encroachment	Suggestions/Proposals
Canals of Dubi, Kolabaria and Alutola Mouza **Connection:** Mayur River to Canals of Dubi and Kolabaria Mouza	1. Some part of the canal has been excavated. Water cannot flow normally due to illegal encroachment and filling the land. 2. Construction of building on the canal.	1. Demarked the area of the canal and remove the illegal encroachment. 2. Excavate the canal. 3. Lease of the canal should be cancelled.
Koyaltola Canal	1. Some part of the canal has been filled up. 2. There are two dam over the canal. 3. Lease land by the Zila Administration.	1. Demarked the area of the canal and remove the illegal encroachment. 2. Excavate the canal. 3. Lease of the canal should be cancelled. 4. Construction of culvert.
Abaibunia Canal	1. Fish cultivated illegally. 2. Canal has been filled up. 3. There are dam on the canal.	1. Demarked the area of the canal and remove the illegal encroachment. 2. Excavate the canal. 3. Construct a culvert. 4. Remove the dam.
Harintana Canal **Connection:** Mayur River to Lobonchora 2 no. Sluice Gate	1. Canal has been filled up by dumping waste.	1. Excavate the canal. 2. Construct two culverts.
Majumder Canal **Connection:** Mayur River to Khulna University	1. Canal has been registered as private property. 2. Eastern part of the canal has been filled up. 3. Water cannot be discharged properly in the WAPDA embankment area due to a culvert.	1. Records of all canals should be updated regularly. 2. Need to construct two culverts/ sluice gate. 3. Cannal should be excavated and connected to the Mayur River. 4. Removal of the illegal encroachment. 5. Make necessary steps to illegal construction.
Kader Canal **Connection:** Mayur River	1. Canal has been filled up. 2. The canal is connected with Mayur River as per CS mouza map, but it does not exist now. 3. Sluice gate established by BWDB is narrow.	1. Removal of the illegal encroachment. 2. Make necessary steps to eradicate illegal construction. 3. Construct a wide sluice gate.
Sluice Gate Canal and Canals under Chak Mathurabad Mouza **Connection:** Mayur River	1. Eastern part of the canal has been filled up. 2. Sluice gate established by BWDB is narrow, out of date.	1. Removal of the illegal encroachment and demarcate the canal area by Zila Administration. 2. Repair the sluice gate.
Bil Pabla Bashtala Canal and Sluice Gate Canal **Connection:** Mayur River	1. Canal has been filled up by dumping waste. 2. Sluice gate on the Khudir River is outdated.	1. Dumping of waste should be discouraged. 2. Sluice gate should be repaired.
Two Canals in Beel Pabla Connected to Khudir River	1. Canal has been filled up by dumping waste.	1. Require excavation of the canal.
Canal between Beel Pabala and Lota Paharpur Mouza **Connection:** Khudir River	1. Canal has been filled up by dumping waste.	1. Require excavation of the canal.

Chapter 2
EXISTING DRAINAGE SYSTEM AND ENVIRONMENT

2.1 General

Though Khulna was declared a City Corporation only back in 1984, the history of the city goes back to 1882 when it was first declared a municipality and a district town with the seat of district administration and market. Khulna was able to attract people of surrounding areas during the British period. After partition, Khulna became an important center of the region for commercial and industrial development. Establishment of a port, first at Chalna and then shifted to Mongla helped the city gain further momentum. Many new industries grew up and commercial activities increased many fold. Gradually, the town turned into a jute trading and processing center.

After the independence of Bangladesh in 1971, the population growth continued but the industrial sector did not grow matching its increased population. In fact, the process of industrialization almost stopped after the Liberation War and a huge labor force in the city was forced to seek alternative employment elsewhere. The city thus experienced a declining trend until 1990s. Then the economy started to revive based on shrimp farming and processing activities, and the activities related to the establishment of a new University, Medical College and Bangladesh Institute of Technology (BIT), presently KUET, etc.

Just to provide an institutional profile of the city of Khulna, it contains divisional and district administrations, some specialized institutions like the Khulna City Corporation (KCC), Khulna Development Authority (KDA) and more than a dozen of sectoral agencies dealing with basic urban services in sanitation, health, water supply and maintenance of roads, culverts, bridges, drains and street lights, maintenance of public safety and environment, housing, transport and communication etc.

Though history of the city development is bright, its internal drainage system did not keep pace with the city's growth. Except bank protection works, no major and effective drainage work has been undertaken up until the implementation of STIFPP-I. But in the present KCC area as well as in the proposed extension area covering low lands, a free style development was allowed without looking after the drainage complexities, especially in the new areas.

2.2 Drainage Development Plan

To prepare an effective Drainage Development Plan for the project area, the following procedure was delineated:

A. Study of Drainage System
   1 Existing network of drainage system
   2 Catchment Boundary
   3 Flow Direction

B. Studying Existing Water Bodies

C. Observing Present Practice of Drainage

D. Identification of Problems

Detailed methodology of collecting different survey data and their findings are presented in the Survey Report submitted earlier in May 2011. Only the salient features and the outputs are summarized in this report. After preparing the drainage layout plan, the consultants discussed it with the local people and Councilors and also verified in the field. Ward-wise people's wish list has also been presented in **Chapter 1** of this report**.**

2.3 Topography and Land Level

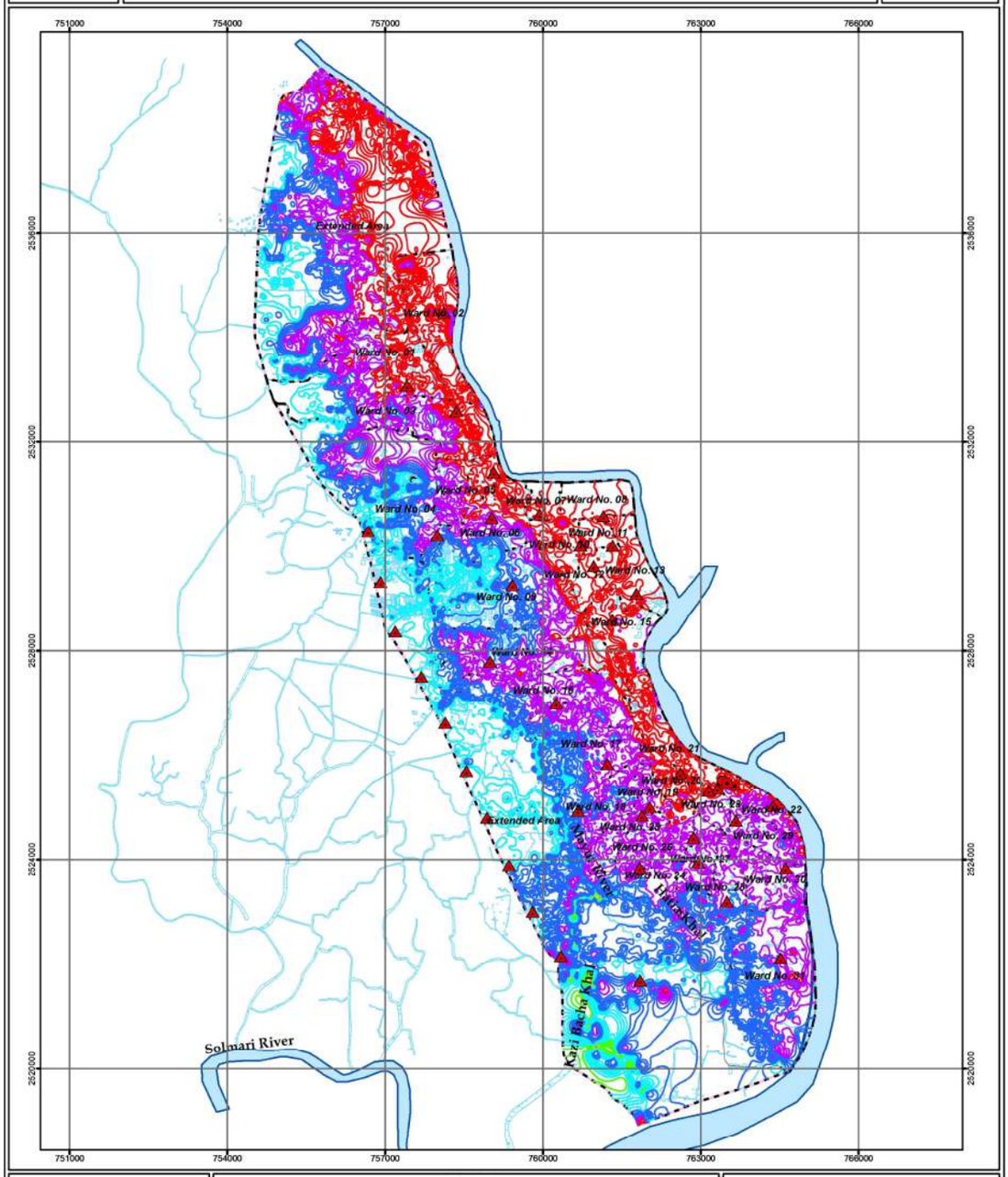
The spatial growth of Khulna City is explained by its topography. There exists natural levee along the right bank of the Bhairab & the Rupsha Rivers. Elevation of the levee varies from 2.13 m SOB to 4.27m SOB. The general slope of the land is from north to south along the bank of the river and the lateral slope is away from the river bank. The area offers excellent opportunities for the development of human settlements. This levee extends about ½ km. to 4 km inside from the river bank.

The original Khulna City grew up near the southern end of the levee and extended towards northwest. After the construction of Khulna-Jessore road and development of economic activities, the city started to take shape along the Khulna-Jessore corridor. Next to levee follows flood plain. The elevation of the flood plain, on an average is about 1.22 mSOB. Beyond the flood plains, there exist swamp and tidal marsh, where the city area is growing and proposed to be extended up to the existing By-Pass Road on the west.

The physiography of Khulna is broadly characterized by tidal flood plains having lower relief and crisscrossed by innumerable river channels. The elevation sharply decreases towards the west. In the north-south direction, the city finds its way to expand naturally on moderately high lands. From topographic point of view, it was anticipated that the city's growth will follow the levee and flood plains, north ward and southwest. But after the construction of bypass, the city has a tendency to grow towards the west up to the Bypass. Topography of Khulna City has been presented in **Map- 2.1**.

Table- 2.1 presents Ward-wise area, maximum, minimum and average elevation of GL. It also shows the land formation of the extended area.

Map 2.1 **TOPOGRAPHIC MAP OF KHULNA CITY**



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SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles

LEGEND

KCC Boundary
Ward Boundary
Project Boundary

Contour
-11.00 - -7.50
-7.49 - -5.50
-5.49 - -3.50
-3.49 - -1.50
-1.49 - 0.00
0.01 - 1.25
1.26 - 2.50
2.51 - 5.75

Khulna City Corporation
District Headquater
BM Pillar
Khal/Pond/Ditch/Lake
River

SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District

KHULNA CITY CORPORATION

Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Table- 2.1: Ward Wise Spot Levels of the Project Area

Ward Name	Area (Acres)	Minimum_RL (m SOB)	Maximum_RL (mSOB)	Average_RL (mSOB)
Ward 01	476.86	-0.22	4.70	2.8666
Ward 02	534.58	1.37	4.52	3.7133
Ward 03	951.98	-1.74	5.93	2.0576
Ward 04	517.77	-1.19	3.98	1.118
Ward 05	196.65	1.08	4.61	2.7130
Ward 06	545.68	-1.62	4.41	1.4991
Ward 07	113.03	2.82	4.04	3.4467
Ward 08	235.52	3.30	4.89	3.9105
Ward 09	891.32	-2.19	4.02	0.8262
Ward 10	206.17	1.53	3.84	3.2306
Ward 11	94.72	0.00	4.18	3.6426
Ward 12	170.75	3.01	3.94	3.4807
Ward 13	292.69	2.50	4.76	3.512
Ward 14	671.14	-1.17	4.27	1.7757
Ward 15	355.39	2.27	4.42	3.2346
Ward 16	577.36	-2.90	3.46	1.5323
Ward 17	585.82	-4.57	3.68	1.2175
Ward 18	404.73	-5.81	2.94	1.2730
Ward 19	123.37	1.21	3.25	2.965
Ward 20	120.48	2.13	4.01	3.2127
Ward 21	338.43	0.00	4.03	3.1851
Ward 22	168.30	0.00	3.17	2.2962
Ward 23	125.51	0.52	4.04	2.8064
Ward 24	386.52	-1.08	3.68	1.6920
Ward 25	184.35	1.16	2.99	1.8521
Ward 26	164.17	0.35	2.99	1.8734
Ward 27	206.26	-0.63	2.82	1.8283
Ward 28	181.84	-0.78	2.97	1.5569
Ward 29	163.60	0.98	2.59	1.8367
Ward 30	300.62	0.66	2.80	1.8194
Ward 31	993.84	-1.74	3.77	1.0997
Extension Area	**9819.38**	**-1.18**	**4.95**	**0.8388**
Project Area	**21098.82**	**-11.18**	**7.09**	**2.2923**

***Source**: HCL-SPL Physical Feature Survey, 2010*

Existing Drainage Network

There are 1165.48 km of man-made drains within the project area. Of which 1124.00 km are pucca and 41.48 km are katcha. Most of these are Reinforced Cement Concrete (RCC) drains while the rest being brickworks. These man-made drains have varied widths ranging from less than 0.1 m to 9.0 m. There are 155 km of pucca drains having width less than 0.5 m; about 270 km of pucca drains have width ranging from 0.05 m to 2.0 m. About 1.16 km of pucca drains have width greater than 5.0 m. Details of existing man made drains are presented in the **Table-2.2** and **Table-2.3**.

Table-2.2: Length of Man Made Drainage System in the Project Area

Type of Drain	Length (km)
Katcha	41.48
Pucca	1124.00
Total	**1165.48**

Source: *Physical Feature Survey, 2010*

Table-2.3: Drainage Classification with Width

Type of drains	Width (in meter)				
	<=0.5m.	>0.5 - <=1m.	>1.0 - <=2m.	>2.0 - <=5m.	>5.0m.
Pucca in km	475.27	278.66	259.27	111.12	41.16
Katcha in km	12.07	21.12	6.10	2.12	0.06

Source: *Physical Feature Survey, 2010*

The existing drainage network is inadequate to meet the present needs of the project area while most of the Wards have less coverage than the desired drainage requirement. The existing drainage network in the Project area is presented in **Map-2.2**. Ward 2 has no man-made drain. In most of the other Wards, the drainage coverage is very small. Ward wise drainage coverage is shown in **Table- 2.4**.

Table-2.4: Ward wise Drainage Coverage in the Project Area

Ward No.	Drainage Covered Area (in acre)	Built-up Area (in Acre)	Drainage Coverage (%)	Deficiency in Acre	Deficiency (%)
Ward 01	240.63	370.20	65	129.57	35
Ward 02	102.19	255.46	40	153.28	60
Ward 03	177.35	443.36	40	266.02	60
Ward 04	59.91	171.18	35	111.26	65
Ward 05	47.59	105.75	45	58.16	55
Ward 06	153.96	307.91	50	153.96	50
Ward 07	25.84	57.42	45	31.58	55
Ward 08	139.07	213.95	65	74.88	35
Ward 09	125.56	313.91	40	188.34	60
Ward 10	94.60	157.66	60	63.07	40
Ward 11	30.13	60.25	50	30.13	50
Ward 12	86.41	132.93	65	46.53	35
Ward 13	40.79	116.54	35	75.75	65
Ward 14	270.25	450.42	60	180.17	40
Ward 15	138.12	251.12	55	113.00	45
Ward 16	254.96	424.94	60	169.98	40
Ward 17	180.60	361.20	50	180.60	50
Ward 18	127.88	255.76	50	127.88	50
Ward 19	76.11	108.73	70	32.62	30

Ward No.	Drainage Covered Area (in acre)	Built-up Area (in Acre)	Drainage Coverage (%)	Deficiency in Acre	Deficiency (%)
Ward 20	90.28	112.85	80	22.57	20
Ward 21	139.40	253.45	55	114.05	45
Ward 22	110.94	170.68	65	59.74	35
Ward 23	93.04	116.30	80	23.26	20
Ward 24	274.49	343.11	80	68.62	20
Ward 25	135.58	169.47	80	33.89	20
Ward 26	127.50	150.00	85	22.50	15
Ward 27	161.96	190.54	85	28.58	15
Ward 28	148.69	174.93	85	26.24	15
Ward 29	84.59	130.13	65	45.55	35
Ward 30	135.66	226.10	60	90.44	40
Ward 31	232.23	516.07	45	283.84	55
Total	**4106.31**	**7112.32**		**3006.06**	

Source: *Physical Feature Survey, 2010*

2.4.1 Capacity and Gravity

Capacity and gravity of these drains are not sufficient to carry the excess rainwater that usually accumulates during the monsoon. Besides, inadequate drainage sections, absence of proper inlets and outlets and lack of proper maintenance hamper the natural flow of water. Water remains stagnant for long time on roads and built-up areas creating water logging. Through the physical infrastructure survey and extensive field observation, the Consultants identified several outfalls to the Bhairab and Rupsha Rivers passing through the eastern periphery of the KCC area undergoing inadequate maintenance. Most of the katcha drains are found without any outlet.

BWDB and LGED worked under the Secondary Town Integrated Flood Protection Project (STIFPP-1) for construction of flood protection embankment, bank protection works, regulators and drains (**Table-2.5**). It was expected that upon completion of the drainage, flood problem could be mitigated to a further extent in the urban areas. But still there remains a lot of works to be done for drainage improvement in KCC area. Salient features of the works done by LGED and BWDB are given below.

Table- 2.5: Drains Constructed by LGED under STIFPP-1 in KCC Area

Area	Length (Km)	Types of Drains	
		Pucca (Km)	Kutcha (Km)
KCC	113.25	111.87	1.38
Total	**113.25**	**111.87**	**1.38**

Source: *LGED*

There are 6 regulators and 8 sluice gates (**Table- 2.6, 2.7**) which drain out storm water from KCC area. The 10 vent regulator located at Alutala performs major drainage function of the Khulna City. Out of these, 4 regulators drain out storm water into the Rupsha River and the other two regulators drain out into the Khudir Khal, the upstream of the Mayur River.

Table- 2.6: Flood Protection Works Executed by BWDB under STIFPP-1 in KCC Area.

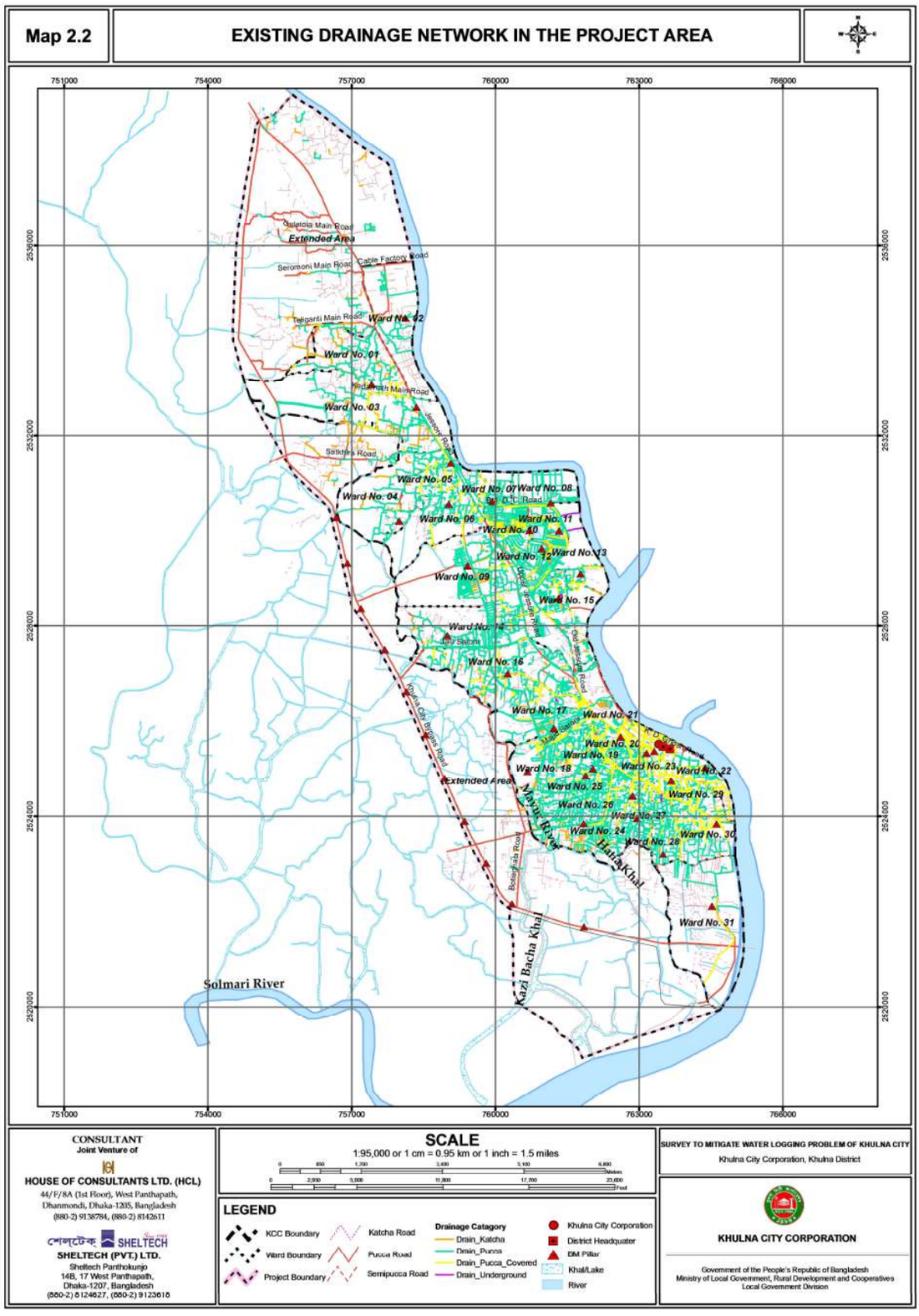
Sl. No.	Name of Works	Quantity
1.	a. R1 : 1V-1.50 m x 1.80 m b. R2 : 1V-1.50 m x 1.80 m c. R3 : 2V-1.50 m x 1.50 m d. R4 : 3V-1.50 m x 1.80 m e. R5 : 4V-1.50 m x 1.80 m f. R6 : 2V-1.50 m x 1.80 m	1 No at Rupsha river 1 No at Rupsha river 1 No. at Rupsha river 1 No. at Rupsha river 1 No at Khudir Khal 1 No at Khudir Khal
2.	Rehabilitation of existing regulator	3 nos.
3.	River Bank Protection	2.89 km
4.	a. Ansar Flour Mills b. Daulatpur College Stretch c. Roosevelt Jetty Street d. Hospital Stretch	270 m 405 m 850 m 1215 m
5.	Temporary Bank protection by permeable spur.	400 m.
Total		**2990m**

Source: *BWDB, Khulna*

Table- 2.7: Existing Drainage Control Structure Constructed by BWDB

Sl. No.	Name of Structure	Size	Operation & Maintenance	Sl. No	Name of Structure	Size	Operation & Maintenance
Sluice Gates:							
01.	S' – 1	1V - 0.90 m x 1.20 m	KCC	05.	S" – 1	3-1.50 x 1.80 M	O&M Division-II
02.	S' – 2	1-0.90 x 1.20 M	- do -	06.	S" – 2	2-1.50 x 1.80 M	BWDB, Khulna
03.	S' – 3	1-1.20 x 1.30 M	- do -	07.	S" – 3	10-1.50 x 1.80 M	- do -
04.	S' – 4	Culvert under KCC	- do -	08.	S" – 4	1-1.50 x 1.80 M	- do -
Closure:							
09.	Alutala Closure		- do -	11.	Kazibacha Closure		- do -
10.	Kazibacha Closure		- do -				

Source: *BWDB, Khulna*


Map 2.2
EXISTING DRAINAGE NETWORK IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Ward No. 01
Ward No. 02
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 09
Ward No. 10
Ward No. 11
Ward No. 12
Ward No. 13
Ward No. 14
Ward No. 15
Ward No. 16
Ward No. 17
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 21
Ward No. 22
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
Ward No. 31
Solmari River
Kazi Bacha Khal
Harta Khal
Jessore Road
Satkhira Road
Khulna City Bypass Road
Boira Fatla Road
Rupsha Ferry Ghat
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath, Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath, Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Drainage Catagory
Drain_Katcha
Drain_Pucca
Drain_Pucca_Covered
Drain_Underground
Khulna City Corporation
District Headquater
BM Pillar
Khal/Lake
River
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

2.5 Natural Drainage System

Natural drainage areas include marshes, natural channels, beels, haors, baors etc. While developing, some areas may be retained with little or no modification, while the other areas may call for considerable alteration. As part of the development site plan review procedure, the proposal for development should be evaluated considering protection of natural vegetation for multipurpose uses in a system or watershed basin. Identification of natural areas cannot follow any arbitrary formula. Natural channels and rivers in the project area have been shown in **Map- 2.3**. A short description on some of the existing natural channels is given below:

Nirala Khal

A tributary of Mayur River, Nirala khal runs from the north and is divided into two branches. One of these branches running towards the west direction and connected with Baniakhamar Khal (near the present Tablig Mosque). This khal was also connected with Bagmara khal near Harintana and discharges water from west Baniakhamar and Musalman para. Once this khal was navigable and used to travel through.

At present, the northern part of the khal is already lost, whereas the southern part is on way of encroachment due to spontaneous urban growth. A major portion of this khal lost its existence for unplanned development and lost its connection with Bagmara and Musalman para. Consequently, its capacity decreasing to discharge the excess runs off from Bagmara and Musalman para. At present, the khal has virtually squeezed into a narrow drain with lesser discharge capacity.

Purbo Nirala Khal

Purbo Nirala Khal falls into Mayur River, comes straight from the north and have connected with Nirala khal. This khal used to discharge water from Bagmara, Musalman para and part of Iqbalnagar. The khal was in full operation till 1974-75. But since then, it gradually lost its appearance due to encroachment and turned into its present condition like as a narrow drain.

Motiakhali Khal

Motiakhali khal starts from Tootpara Ghat and falls into river Rupsha flowing through the southern part of greater Tootpara. This is the largest khal, which served the city core area to discharge storm and waste water for decades. This is a wide khal varying in width from 30 to 40 ft. at different locations and it runs from west towards east. Before falling into the Rupsha River, this khal travels approximately 1.7 Km.

Chori Chora Khal

At present this khal served Mistiripara and Dolkhola area and runs towards the south and finally joins Bagmara khal before falling into Mayur River. The width of the khal is 20 to 30 feet at different parts. According to the statement of local people, this khal was in function till 1975-76, and used to drain out the water from Mistiripara, parts of east Baniakhamar and Moulovipara.

Over the time the Mistiripara khal has narrowed down to 5-feet only due to illegal encroachment. The rest of the khal is being used for road or had gone under the ownership of nearby landowners. The drain now discharges waste water from Mistiripara, part of East Baniakhamar and Moulovipara.

North Khal

It is one of the longest khals of Khulna City originating from Baniakhamar khal, runs over a large area of west Baniakhamar area and finally falls into Gollamari River near Gollamari Bridge. The width of the khal at different locations used to vary between 30-40 feet. This Khal drains out water from a large area of Khulna City especially of the mid town area, i.e. Iqbalnagar, Bashupara, Farazipara and Musalman para. Presently, North khal has turned into a 10 feet wide small surface drain.

Mayur River

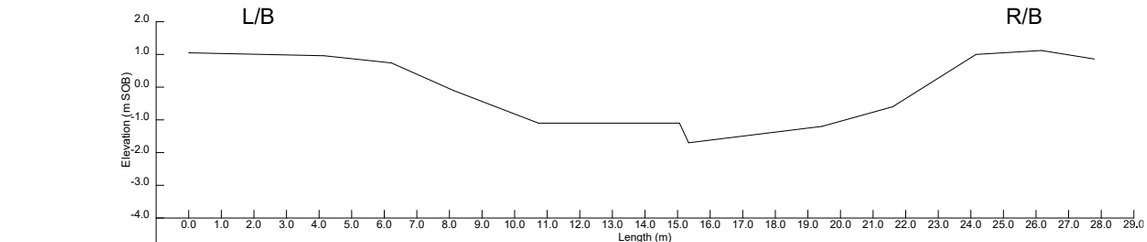
Gollamari-Mayur River runs along the western part of Khulna City and connects with the Rupsha River on the south. Motiakhali Khal and Kajibacha River are also connected with this river on the south-west.

Gollamari-Mayur River is the major drainage channel through which a large volume of water both from urban Khulna and adjacent Beel Pabla and Beel Dakatia area, discharged into the river Rupsha. The Mayur River is the main drainage channel of the eastern part of Polder 28/2, via 10-vent sluice at Alutola.

Moreover, a number of outlets of KCC connect with this river. So, this river is going to play an important role to drain out excess water from most of the urban areas as well as from the vulnerable Beel Dakatia.

A typical Cross-section of Mayur Khal is presented in **Figure-2.1**.

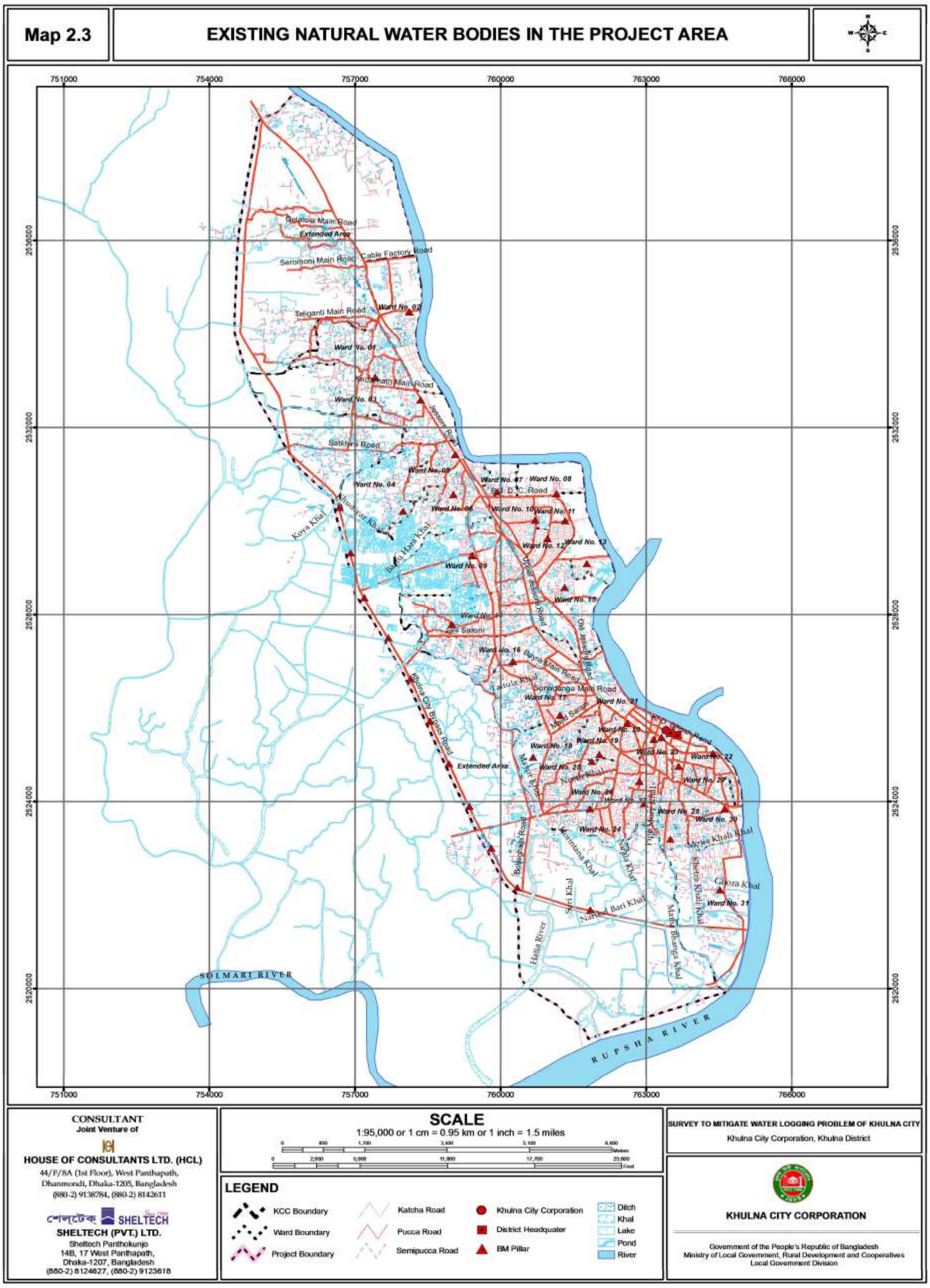
Figure-2.1: Typical Cross Section of Mayur Khal



PRE-WORK													
RL.(m SOB)	1.05	0.96	0.74	-0.1	-1.1	-1.1 -1.7	-1.2	-0.6	1.0	1.12	0.86		
Chainage as Surveyed (m)	0.00	4.16	6.22	8.12	10.73	15.06 15.34	19.43	21.60	24.16	26.17	27.79		

X-Sec at Ch.11+973 Km.of Mayur River

Apart from the man-made drains, KCC area has approximately 41.48 km of khals and rivers covering an area of 1661 acres of natural drainage system for retention and drainage of storm and household waste water. But unplanned spatial development activities and rapid growth of settlements are causing encroachment of these water bodies, water courses and natural drainage paths. These unplanned development activities are creating obstacles to natural drainage, reducing retention basins and reducing drainage capacity. Poor drainage capacities of the existing khals and water bodies cause longer flood duration in inland areas aggravating the flood damage and creating ecological imbalance.


Map 2.3
EXISTING NATURAL WATER BODIES IN THE PROJECT AREA
SOLMARI RIVER
RUPSHA RIVER
Hatia River
Koya Khal
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath, Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH
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SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Khulna City Corporation
District Headquater
BM Pillar
Ditch
Khal
Lake
Pond
River
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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2.6 Beel/Marsh Land

Beel Dakatia is the major beel in the project area, part of which is located in Ward 01. Besides, there are some low lying areas in the western part of KCC area.

2.7 Other Water Bodies (Pond-Ditch)

The Project area has approximately 3,592 ponds and ditches covering an area of 1,010 acres. These water bodies acts as retention reservoir of storm and household water. KCC area covers about 710.16 acres of water bodies. Ward wise water bodies have been shown in **Table-2.8**. Existing water bodies in the project area have been presented in **Map-2.4.**

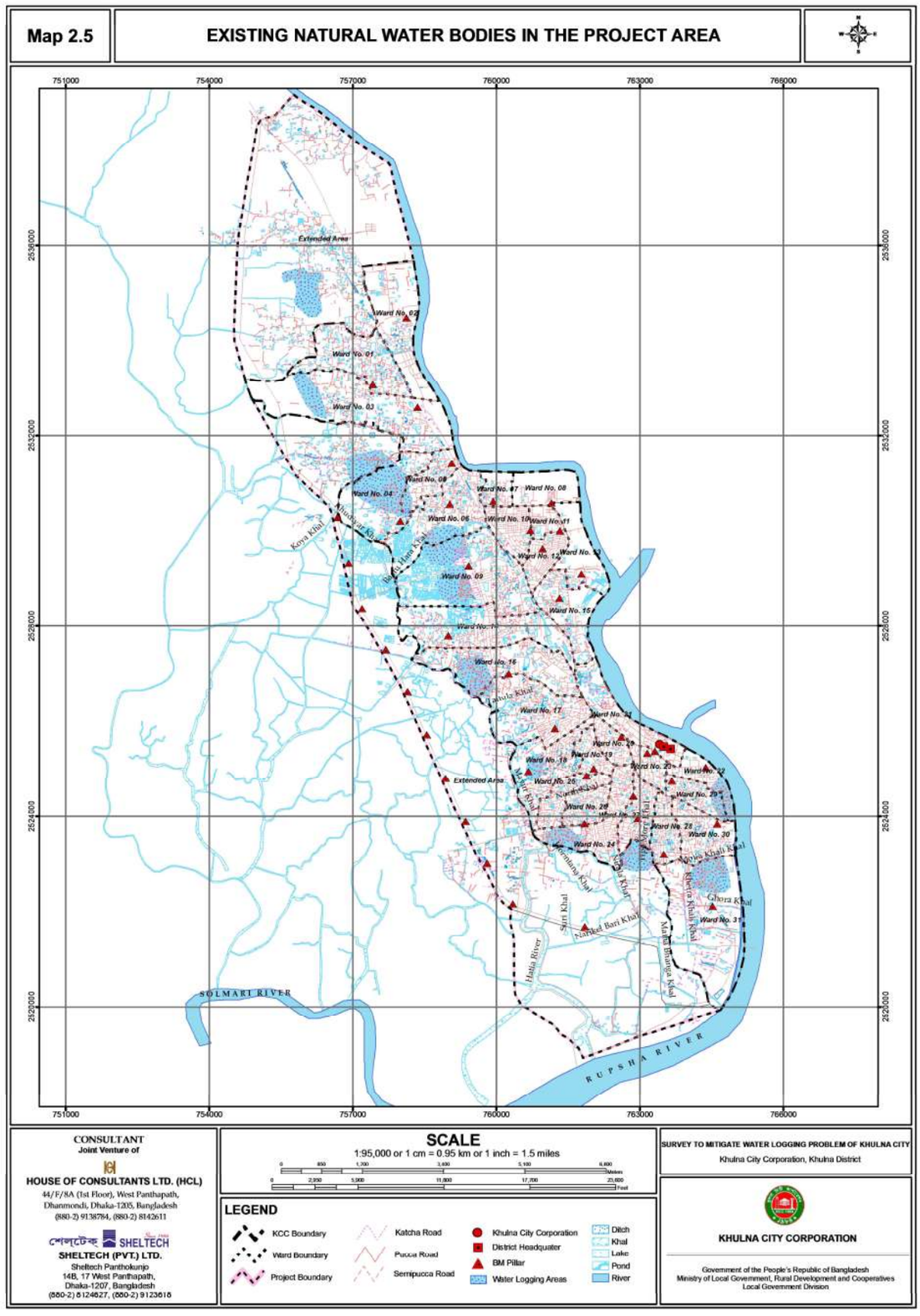
Among the existing water bodies, the highest number of ponds is found in Ward 04 covering about 5.95% of the total water bodies of KCC area.

Table-2.8: Ward-wise Water Bodies in the Project Area

Ward Name	Water body	Number	Acres	%
Ward 01	Pond	139	40.18	3.98%
	Ditch	35	3.33	0.33%
Ward 02	Pond	51	19.09	1.89%
	Ditch	24	1.95	0.19%
Ward 03	Pond	133	45.82	4.53%
	Ditch	31	2.99	0.30%
Ward 4	Pond	218	57.98	5.74%
	Ditch	22	2.10	0.21%
Ward 05	Pond	39	7.34	0.73%
	Ditch	13	0.89	0.09%
Ward 06	Pond	122	53.82	5.32%
	Ditch	24	2.51	0.25%
Ward 07	Pond	17	5.89	0.58%
	Ditch	9	0.64	0.06%
Ward 08	Pond	2	0.73	0.07%
	Ditch	0	0.00	0.00%
Ward 09	Pond	205	99.26	9.82%
	Ditch	66	10.71	1.06%
Ward 10	Pond	15	3.78	0.37%
	Ditch	1	0.00	0.00%
Ward 11	Pond	0	0.00	0.00%
	Ditch	1	0.07	0.01%
Ward 12	Pond	8	6.77	0.67%
	Ditch	0	0.00	0.00%
Ward 13	Pond	27	24.64	2.44%
	Ditch	1	0.10	0.01%
Ward 14	Pond	153	53.54	5.30%
	Ditch	30	2.39	0.24%

Ward Name	Water body	Number	Acres	%
Ward 15	Pond	65	40.31	3.99%
	Ditch	8	0.84	0.08%
Ward 16	Pond	96	25.98	2.57%
	Ditch	64	5.74	0.57%
Ward 17	Pond	66	28.38	2.81%
	Ditch	41	8.73	0.86%
Ward 18	Pond	71	16.32	1.61%
	Ditch	48	8.01	0.79%
Ward 19	Pond	17	3.30	0.33%
	Ditch	2	0.08	0.01%
Ward 20	Pond	9	1.64	0.16%
	Ditch	3	0.29	0.03%
Ward 21	Pond	41	20.71	2.05%
	Ditch	18	2.59	0.26%
Ward 22	Pond	10	3.16	0.31%
	Ditch	2	0.19	0.02%
Ward 23	Pond	9	1.92	0.19%
	Ditch	1	0.12	0.01%
Ward 24	Pond	28	10.28	1.02%
	Ditch	22	1.46	0.14%
Ward 25	Pond	33	4.59	0.45%
	Ditch	23	1.40	0.14%
Ward 26	Pond	45	9.93	0.98%
	Ditch	17	1.67	0.16%
Ward 27	Pond	24	3.88	0.38%
	Ditch	24	2.25	0.22%
Ward 28	Pond	31	7.32	0.72%
	Ditch	18	3.73	0.37%
Ward 29	Pond	26	6.67	0.66%
	Ditch	12	1.33	0.13%
Ward 30	Pond	30	9.88	0.98%
	Ditch	22	2.97	0.29%
Ward 31	Pond	46	20.81	2.06%
	Ditch	7	7.20	0.71%
Extended Area	Pond	1029	278.21	27.52%
	Ditch	198	22.50	2.23%
Total		**3592**	**1010.87**	**100.00%**

Source: *Physical Feature Survey, 2010*


Map 2.5
EXISTING NATURAL WATER BODIES IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Ward No. 02
Ward No. 01
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 09
Ward No. 10
Ward No. 11
Ward No. 12
Ward No. 13
Ward No. 14
Ward No. 15
Ward No. 16
Ward No. 17
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 21
Ward No. 22
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
Ward No. 31
Kova Khal
Mayur Khal
Hari Hara Khal
Tatulia Khal
Mayur River
Nonai Khal
Dighalia Khal
Sonamura Khal
Dora Khal
Sati Khal
Nahkeel Bari Khal
Hatia River
Mayra Bhanga Khal
Rupsha Khal Khal
Ghora Khal
Boyra Khal Khal
SOLMARI RIVER
RUPSHA RIVER
CONSULTANT
Joint Venture of
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SCALE
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LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Khulna City Corporation
District Headquater
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Water Logging Areas
Ditch
Khal
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SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

2.8 Encroachments and Blockages

Physically it is found that most of the natural drainage channels in the project are actually dying. Significant portion of these channels are encroached by the local influential people. A full fledged dredging is essential to resuscitate the natural flow of the channels and to open them up to serve effectively as drainage channels. Unplanned spatial development activities and rapid growth of settlements and population are causing encroachment on these water bodies that is reducing retention basin and drainage capacity. These are causing long-lasting water logging in inland areas and aggravating the drainage and creating ecological imbalance. However, the peripheral water level in the Rupsha River and the Bhairab River are the major cause of drainage congestion especially during the monsoon.

Areas subject to major inundation due to drainage congestion are mentioned below in **Table- 2.9**:

Table- 2.9: Areas Subject to major Inundation due to Drainage Congestion

Ward Name	Location
Ward 03	Mahersharpasha
Ward 04	Deayna Paschim Para
Ward 09	Mijgunni Housing, Bastuhara
Ward 06	Choto Boyra, Rayer Mohal
Ward 22	Natun Bazar, Rupsha Beri Badh area
Ward 24	Gollamari
Ward 27	Nodal Point of Khan Jahan Ali and KDA Avenue (nearby and surrounding Royal Hotel), Tootpara, West Tootpara, Tootpara Monirbari khal Par, East Bania Khamar
Ward 31	Rupsha Shipyard area, Labanchora

Area experiencing inundation and water logging have been shown in **Map- 2.5**. The reasons for water-logging have been identified as the following:

(i) Improper operation and maintenance of khals/drains.
(ii) Encroachment and blockage in the existing khal/drains,
(iii) Absence of integrated drainage network,
(iv) Haphazard city expansion,
(v) Uncontrolled and haphazard disposal of solid waste into the drainage system,
(vi) Siltation in the drainage channels with consequent reduction of discharge capacity,
(vii) Construction of structures in areas lower than the peripheral water level without land development
(viii) High level of water at the outfall into the Rupsha River especially when it is high tide during the monsoon.

2.9 Identification of Drainage Problems and Issues

There is no planned drainage system especially in its peripheral areas. The drainage scheme may be extended and taken up phase wise with the progress of urban expansion which depends on some factors, such as population growth, extent of flood damage, affordability of KCC and viability of the project, etc.

The problems identified during the study are presented below:

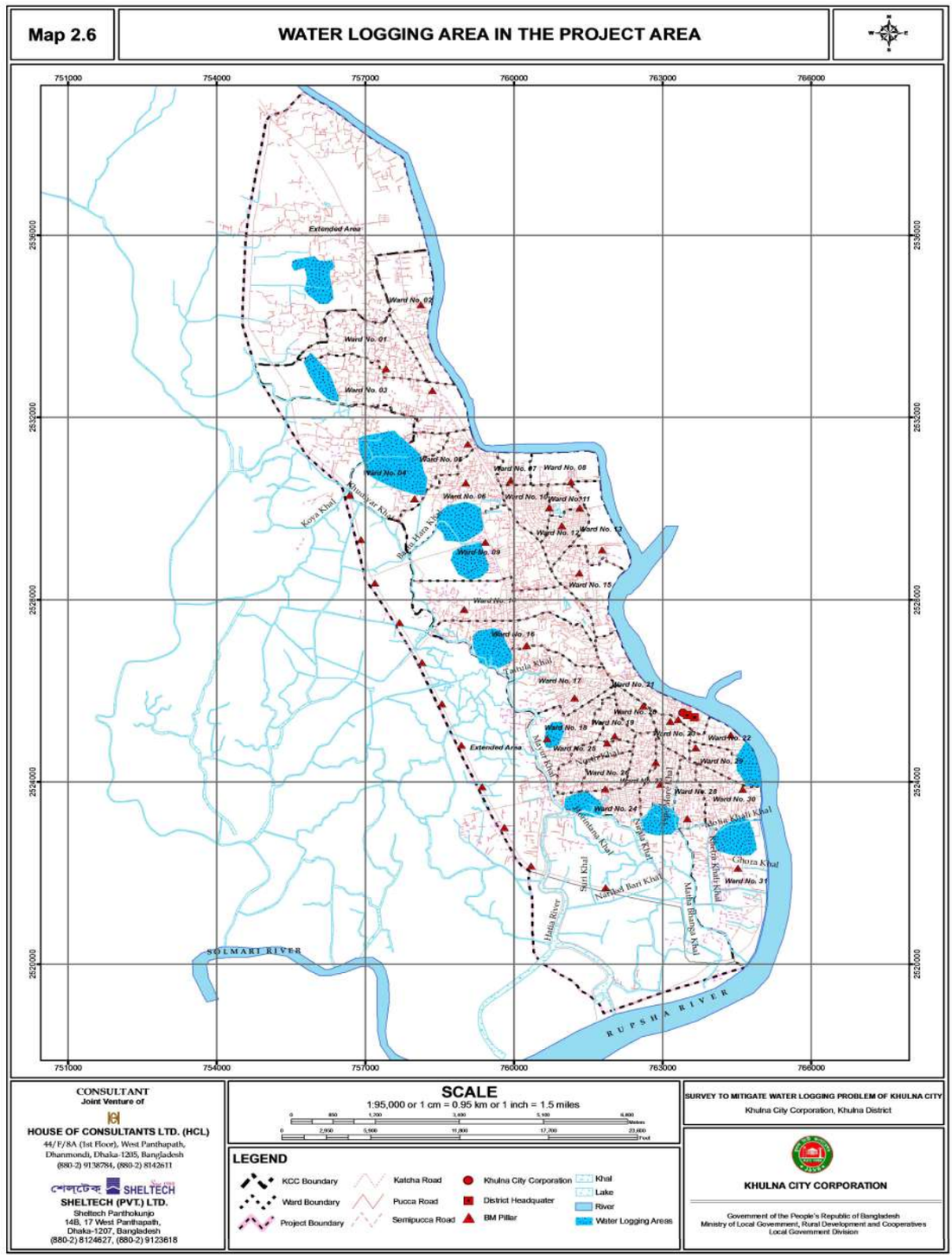
Major Drainage Problems & Issues

- The present practice is to drain the water of the city area through the existing network system by gravity to the Rupsha and the Bhairab Rivers.

- These Rivers being tidal, drainage is impeded during high tides; WL 3 mPWD (2.54 mSOB) during July to September
- Only about 25% of KCC having GL above RL 3 mPWD (2.54 mSOB) may have continuous gravity drainage without any interruption.
- The Lowest Water Level is about 1.4 mPWD (0.94 mSOB) in July. The area between 1.4 mPWD and 3.0 mPWD may have partial gravity drainage during the Low Tide.
- The rest of the area having a ground level less than 1.4 mPWD needs continuous pump drainage during the monsoon.
- However, the area between 1.4 mPWD to 3.0 mPWD cannot be isolated. Therefore, if pump drainage is introduced, this area should also be included within the pump drainage facilities.
- The situation has been aggravated due to the construction of dwelling areas in low lands where free style construction has been allowed.
- The present practice of draining out the excess run-off through the Flap gated sluices during the low tide and preventing the inflow of high tidal water by closing the Flap gates, may be a solution for agricultural land where submergence is acceptable for longer period, at least three days, but for a city area, it is not acceptable, where there are valuable properties. Even more than one hour submergence may cause colossal damages. This is especially applicable under the prevailing hydrological and hydraulic phenomena in Khulna City area. However, the existing practice of gravity drainage may be complimentary to pump drainage during the lean period. The situation may further aggravate under the future global warming condition.
- Specifically the area on the eastern side of Khulna – Jessore highway can be isolated for gravity drainage.
- Other areas will have to be drained out by pumps.

Other Problems and issues

- Existing pacca drains do not cover the entire city area.
- Some of the drains have been damaged, walls yielded, may be due to some construction faults.
- In many cases the top slabs have been damaged, may be due to inadequate design but in most cases, due to bad construction.
- Across large drains, big size concrete slabs have been provided without Manholes which cannot be lifted for cleaning the drains.
- Some of the existing drain sizes may not be adequate.
- Most, rather almost all of the existing drains need regular or routine cleaning
- The existing Flap gates need regular O&M. Some of the Sluices do not have any gate as well.
- Saline conditions lead to more rapid deterioration of concrete and steel works.
- New drains are to be planned, designed and to be constructed along both sides of existing and new roads.
- Random disposal of solid waste in the drains is a serious hazard for efficient drainage.


Map 2.6
WATER LOGGING AREA IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Ward No. 02
Ward No. 01
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 10
Ward No.11
Ward No. 12
Ward No. 09
Ward No. 15
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 22
Ward No. 25
Ward No. 29
Ward No. 27
Ward No. 28
Ward No. 30
Ward No. 24
Ward No. 31
Koya Khal
Khalispur Khal
Jhilla Hara Khal
Tachula Khal
Mayur Khal
Sonai Khola
Sonadanga Khal
Nabaghata Khal
Nalnad Bari Khal
Shiri Khal
Hatia River
Ghora Khal
Matha Bhanga Khal
SOLMARI RIVER
RUPSHA RIVER
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
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Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Khulna City Corporation
District Headquarter
BM Pillar
Khal
Lake
River
Water Logging Areas
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

2.10 Flow Direction and Drainage structure

Based on the survey carried out and extensive and intensive field visits, Ward by Ward, the existing drainage pattern and their outfall have been identified (**Map- 2.6)**. Based on the field observation, discussion with beneficiaries and Ward Councilors, a layout plan of the existing drainage network has been developed and presented in **Map-2.2.** The conditions of the existing system have also been identified through field survey. Out of 1124.00 km of existing pacca drains, about 445 km needs re-construction. **Chapter 4** presents the existing condition of drains in the project area and recommendation for repair, re-construction and new construction.

It has been observed that over the years KCC preferred open drainage system, as it is easy for maintenance. Piped storm water drainage system's operation and maintenance is beyond the affordable limit of KCC. The situation demands a comprehensive Drainage Master Plan with an integrated network of drainage system for the project area and proper link-up with the existing Secondary Town Integrated Flood Protection Project infrastructures recently executed by the BWDB and LGED and also with the existing drainage sluices and regulators constructed earlier by the BWDB.

2.11 Hydrology (Drainage and Flooding)

Established Urban Areas Free from Annual Flooding

In the past, the storm water of Khulna City had been drained out through some natural drainage system (e.g., creek and canals). Due to rapid urbanization and increasing development activities over the years, these natural drainage and water retention areas have gradually been converted into built-up areas. Some of them are replaced by narrow surface drains. As a result, some parts of the city are flooded regularly during intensive rainfall particularly in the monsoon. But the central part of the City is adequately provided with the drains. For this reason, the main CBD area is always free from annual flooding.

Areas Protected from Annual Flooding by Embankment

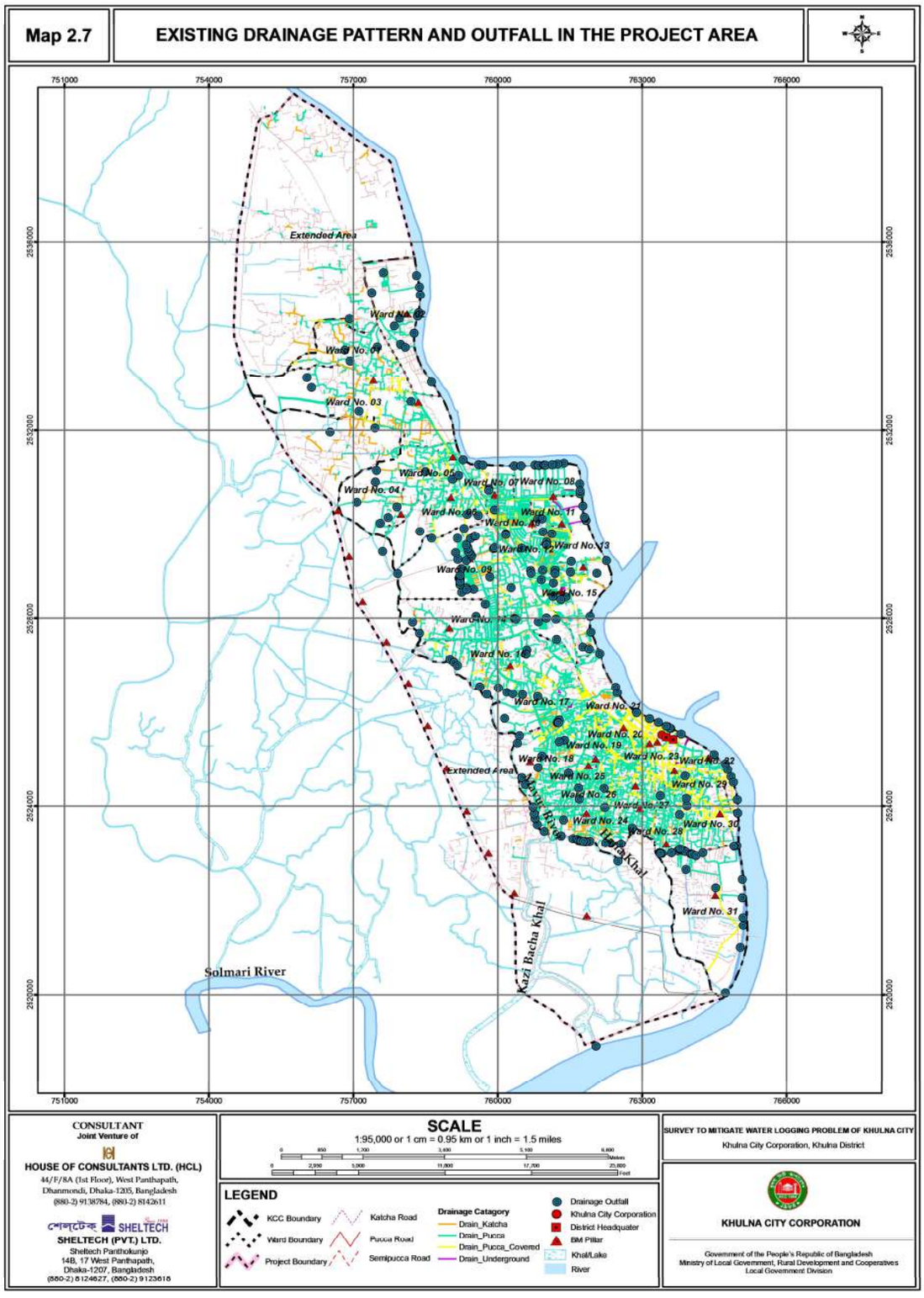
As learned from household survey conducted by the Consultant (2011), about 38% of households regularly experience short-term water logging (e.g. 1 day) in Khulna City. Victims of longer water logging are found in Ward 31, 21, 20 and 22. These wards are well protected by embankment but need pumping. With the increase of sea level in near future, these areas could be under threat of water logging. Special attention should be given to these areas while initiating future development of the city.

Areas Experiencing Annual Flooding

Most of the waterlogged areas are located in Wards 10, 14, 27, 30 and 31. In these Wards, percentages of households affected by annual water logging are 90%, 94%, 100%, 93% and 98% respectively. These Wards are located near Rupsha and Mayur River. Mayur River is being silted up and garbage is thrown into it by the residents nearby. During the rainy season, drainage water cannot be discharged to the required level into the Rupsha River and the surrounding areas by gravity due to high tidal water level.

2.12 Nomenclature of Drains

Normally, to identify drains within an integrated drainage system, the drains are denoted as primary, secondary or tertiary drains. The most upstream drains are marked as tertiary drains. But the proposed drainage system being very complex, outfall drains and quaternary drains are introduced where the quaternary drains being the most upstream and the outfall drains being the trunks of different systems. The three outfall drains in this project are marked as M, L and D4, where M is the first letter of Mayur, L is the first letter of Lobonchora and D4 stands for the local name 'Drain No. 4'.


Map 2.7
EXISTING DRAINAGE PATTERN AND OUTFALL IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
Extended Area
Ward No. 02
Ward No. 01
Ward No. 03
Ward No. 05
Ward No. 07
Ward No. 08
Ward No. 04
Ward No. 06
Ward No. 11
Ward No. 10
Ward No. 13
Ward No. 12
Ward No. 09
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 19
Ward No. 18
Ward No. 22
Ward No. 32
Extended Area
Ward No. 25
Ward No. 29
Ward No. 26
Ward No. 27
Ward No. 24
Ward No. 28
Ward No. 30
Ward No. 31
Solmari River
Kazi Bacha Khal
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SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Katcha Road
Pucca Road
Semipucca Road
Drainage Catagory
Drain_Katcha
Drain_Pucca
Drain_Pucca_Covered
Drain_Underground
Drainage Outfall
Khulna City Corporation
District Headquater
BM Pillar
Khal/Lake
River
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Chapter 3
DRAINAGE DEVELOPMENT PLAN AND IMPLEMENTATION STRATEGY

3.1 Introduction

This Chapter of the Planning Report deals with the Development Plan proposals for drainage and mitigation of water logging of the Project Area. In each part the Consultants move with goals and objectives followed by evaluation of existing conditions. After that development proposals have been set for each component.

Following are the objectives of drainage management plan for the Project Area:

A. To allow smooth drainage of storm water and the waste water of the town.
B. To develop a comprehensive drainage network with area coverage and capacity.
C. To prevent encroachment to natural drainage system.
D. To create awareness about disposal of solid waste in the drainage system.

3.2 Development Policies

From the forgoing discussion in **Section 2.9** on problems and issues**,** following policies have been developed for effective drainage improvement in the Project area.

Policy-01: Development of hierarchical drainage network for the Project area

Policy-02: Protection of the natural drainage system of the city.

Policy-03: Regular cleaning of drainage system and excavation of Khals

Policy-04: Motivational drive among citizens against indiscriminate waste dumping

Policy-05: Effective Drainage Improvement for Khulna City Corporation (KCC) to meet the present as well as the future requirement.

Policy-06: Drainage by the side of all roads would be considered to safeguard the longivity of roads (and other properties).

Policy-07: Pump Drainage for most of the area to mitigate the drainage problem especially during the high tides in monsoon.

Policy-08: To practice Gravity drainage during the lean periods and low tides.

Policy-09: City drainage requirement is to be planned to remove excess water within very short time. To achieve this, the City drainage is to be isolated from the agricultural area.

Policy-10: In spite of enforcement of law, it is apprehended that, most of the existing water bodies within KCC and the proposed extended area will be developed for habitation in future. This would be taken into consideration in planning.

Policy-11: Effective facilities and measures are to be taken to prevent solid waste dumping in the drains.

Policy-12: Strengthening capacity of KCC for effective control, all infrastructures for KCC should be managed by KCC and for this, adequate manpower and equipment are to be deployed.

Policy-13: Provisions required for the Need Based O&M Budget for regular and routine maintenance, Seasonal maintenance and emergency maintenance of all infrastructures,

Policy-14: Planned land development for different urban uses is to be considered and for this, minimum formation level(s) is to be specified keeping in view the drainage capabilities and levels.

Policy-15: For pollution control, every industry should have their own Treatment Plants before disposal of the effluent in the public drainage and water bodies.

Policy-16: Residential and other habitations should have their own septic tanks and soak pits.

Policy-17: Phase-wise Implementation of drainage Improvement Plan

Policy-18: Improvement of Environmental Situation through Improved Drainage System

Policy-19: Complementary Non-structural Measures to Protect Right of Way and Other Aspects

Policy-20: Encouraging the Involvement of NGOs, CBOs and Civil Societies in Planning, Improvement and Maintenance of Drainage System

Policy-21: For cleaning up waste product or silt from drains, KCC would procure drain cleaning equipments.

Policy-22: Provision of sewerage treatment plant by KWASA

3.3 Development Strategies

a. Planning Horizon : 32 years

b. Implementation of the project would be in phases on priority basis.

c. Drainage options
   - Gravity Drainage
   - Isolated city drainage
   - Pump drainage
   - Combination of the three options but those should be location specific.

d. Introduction of Building Control Regulation for deciding the minimum allowable site elevation, plinth levels from the designed drainage water level for residential and commercial buildings.

e. NGO's, CBO's may be deployed for collection and disposal of solid wastes which are hindrance for efficient drainage.

f. Development of Moyur River and other open channels to increase its drainage capacity and prevention of encroachment.

   Most of the city drains are connected to Moyur. The discharge is also very high as has been calculated and shown subsequently. Only option to carry such a large volume of water is through open channel, may be lined or unlined as the case may be. However, efforts would be to minimize the pollution by erecting Trash Rack at the outfall of all the incoming drains to arrest the Floating debridges. Other soluble pollutions are to be treated in a Treatment Plant to be installed at the upstream of the Pump House.

g. Drainage water from some city area is now falling into Sholmari River through Koya River. This has to be diverted ultimately through Moyur as the local people has already raised objection.

h. For any new construction or land development in the KCC or KDA, the minimum formation level should be at 2.4 SOB.

i. Retention of excess water in the canal system in the Planning Area.

j. Proposed drainage system for the Project Area is to be planned with a view to discharge most, of the storm run-off through existing Primary Khal by gravity and there from to the Bhairab or Rupsha River by gravity if the topography permits, otherwise by pump drainage by different Drainage System.

k. The proposed drainage master plan is likely to be co-coordinated with other utility providing organizations to avoid over-lapping and duplication. As such, very close co-ordination with DPHE, BWDB and other utility organizations should be maintained during the project implementation so that, disruption does not take place in utility services.

l. Following this Master plan other subsequent stages are:
- Detail Area Planning (DAE)
- Regional Development Plan (RDP)
- Detail Design & Implementation

The above stages are to be followed while implementation of the project. The stages are as per the recommendation of the planning commission guidelines.

3.4 Development Planning

3.4.1 Options for Development

Based on the available information discussed above, the Consultants propose the following alternative development options for different features of the drainage improvement plan for the proposed project area:

A. Drainage System

- Option-1: Gravity Drainage System
- Option-2: As above Isolation of City Drainage System from external influence
- Option-3: Pump Drainage
- Option-4: Combination of the above options.

B. Development of Moyur River and other Open Channel

- Option-1: Unlined
- Option-2: Lined

C. Water Treatment Option

- Oprtion-1: Business as Usual
- Oprtion-2: Removal of Floating debris
- Oprtion-3: Water Treatment Plant.

3.4.2 Drainage System

3.4.2.1 Option 1: Gravity Drainage System

This option is same as it is being practiced now. Except that, the katcha drains would be improved into pacca drains. The existing damaged pacca drains would be repaired or modified as per requirement. Siltation of the existing pacca drains and floating debris would be removed. O&M would be improved by improving required man-power, additional equipment and the need based budget allocation.

3.4.2.2 Option 2: Isolation of City Drainage

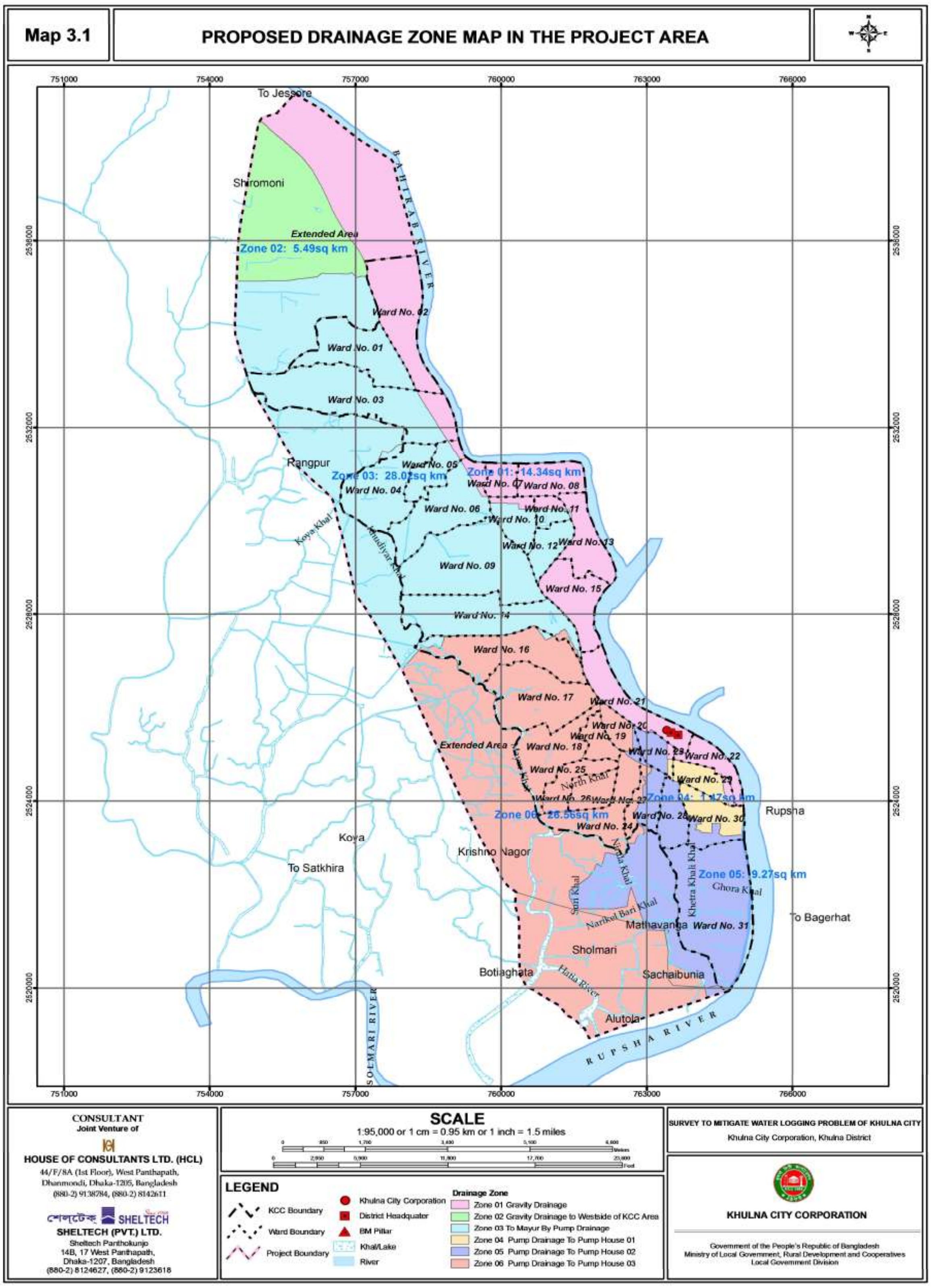
This option is the same as above but confining the city area from external flooding especially on the western side. All the openings through the By Pass road (Bridges and culverts) would be closed so that no flood water from external source could come into the city area. It may be mentioned that the hydraulic condition on the western periphery in Polder 25, 28/1, 28/2 of BWDB is highly dynamic and unpredictable due to siltation problem. Further, the drainage requirement for the polders and the city area are not same. One is for agriculture and the other is for protection of city area, having more valuable properties and demands, drainage of excess run off in short duration. Under the existing condition, drainage water of some of the areas on the northern side of KCC is flowing outside the city area. Area under Zone 2 (**Map-3.1**) will follow the existing flow pattern in future as well. While for Zone 3, although the present flow pattern is towards the Koya River, these will be diverted through the Moyur River for various practical reasons. These are further discussed in this section subsequently.

3.4.2.3 Option 3: Pump Drainage

Option 3 is same as Option 2 except that the drainage water during the peak time would be bailed out by pumps. Currently drainage of KCC area is influenced by tidal variations in the outfall River Rupsha. The gravity drainage is impaired by high tides half the day every day during monsoon. To overcome this, pumps may be required during high tides especially during the monsoon when gravity drainage is not possible. Existing sluices with Flap gates will continue to operate for gravity drainage and will continue as a complementary to pump drainage. For the prevailing isolated drainage system, there may be a number of pump stations. Regarding type of pump, KDA recommended duel purpose, irrigation cum-drainage. Non habitat area within KCC may be irrigated till their development. But unfortunately, the source of water (Bhairab and Rupsha) is saline especially during the dry season when irrigation may have high demand. Therefore, the duel purpose pump is not recommended. Mechanically, the pump may be of two types: conventional vertical type and submersible. Submersible pump is less costly (about 60%) and needs less O&M. It is environment friendly too. However, its unit capacity under the present technical know-how is limited to $7m^3$/sec. Submersible pumps are recommended for the project except for the Alutola Pump Station.

3.4.2.4 Recommended Drainage Option

The recommended option is a combination of the three above options. Gravity drainage would be provided where the land is above the HTL during the monsoon and pump drainage would be provided in the areas where gravity drainage is not possible. As most of the area would be under pump drainage, the KCC area should be isolated, so that external water does not leak in. Based on the nature of topography, the KCC area is divided into six zones for effective drainage. These are discussed in the following section.


Map 3.1
PROPOSED DRAINAGE ZONE MAP IN THE PROJECT AREA
To Jessore
Shiromoni
Extended Area
Zone 02: 5.49sq km
Ward No. 02
Ward No. 01
Ward No. 03
Rangpur
Zone 03: 28.02sq km
Zone 01: 14.34sq km
Ward No. 04
Ward No. 05
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 09
Ward No. 10
Ward No. 11
Ward No. 12
Ward No. 13
Ward No. 14
Ward No. 15
Ward No. 16
Ward No. 17
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 21
Ward No. 22
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
Ward No. 31
Koya Khal
Extended Area
Zone 06: 26.56sq km
Zone 05: 9.27sq km
Rupsha
Koya
To Satkhira
Krishno Nagor
Ghora Khal
To Bagerhat
Mathavanga
Sholmari
Botiaghata
Sachaibunia
Alutola
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SOLMARI RIVER
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SCALE
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LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Khulna City Corporation
District Headquater
BM Pillar
Khal/Lake
River
Drainage Zone
Zone 01 Gravity Drainage
Zone 02 Gravity Drainage to Westside of KCC Area
Zone 03 To Mayur By Pump Drainage
Zone 04 Pump Drainage To Pump House 01
Zone 05 Pump Drainage To Pump House 02
Zone 06 Pump Drainage To Pump House 03
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
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3.4.3 Drainage Zoning

Based on the topography, hydraulic issues in the Project area has been divided into six zones. These are :

Zone 1 : Gravity Drainage
Zone 2 : Pump Drainage
Zone 3 : Pump Drainage
Zone 4 : Pump Drainage
Zone 5 : Pump Drainage
Zone 6 : Pump Drainage

Zone 1: Zone 1 is on the eastern side of the Khulna-Jessore Highway along the banks of Bhairab and Rupsha Rivers (**Map 3.1**). This is the highest area in KCC, elevation varying from 2.70m SOB to 4.60m SOB. Ward nos. 02,07,08,10 (part), 11 (part) 13, 15 and 21 fall within this Zone. Total area is about 14.34 Sq. km. The present drainage pattern is towards Bhairab and Rupsha Rivers. This area being above flood level, effective drainage is achieved by gravity.

There are seven drainage sluices existing in this Zone. These are presented in **Table 3.1**.

Table 3.1: Existing Drainage Sluices in Zone 01

Sl. No.	Zone	Ventage	Condition	Outfall Channel
1	Alam Nagar Ghat	1 Vent	Good	Rupsha
2	Sluice near Shashanghat Khal, Khalishpur	1 Vent	Good	Rupsha
3	Naval HQ	1 Vent	Good	Rupsha
4	Custom Ghat 1	1 Vent	Needs repair	Rupsha
5	Custom Ghat 2	1 Vent	Needs repair	Rupsha
6	Custom Ghat 3	1 Vent	Needs repair	Rupsha
7.	Mongla Port Athority	1 Vent	Proposed	Rupsha

These sluices are planned to be repaired to incorporate with the future drainage system Visa vice these will also work in conjunction with the drainage system proposed especially on the western side. Consultants propose to follow the present flow direction for the future drainage planning. To minimize the cost, existing drains will be used as far as possible with necessary modifications and repairing works where required. New drains however are also planned to increase the drainage capacity. Gravity drainage has been applied as it is being practiced now.

There is a small area on the southern tip of the Zone where the minimum land elevation is about 2.1 m SOB. This is below the high TWL (2.90 m SOB) in the peripheral River Rupsha causing inundation. The Consultants do not propose any pump drainage for this small area as it would be very costly. On the other hand, water from this area cannot be diverted towards Zone 4 in the downstream where pump drainage is provided. It is expected that the excess water from this area may easily be drained out through other neighboring Zones with some short period of inundation.

Zone-2: Zone 2 is on the northern tip of the Project area bounded by Zone 1 on the east, Zone 3 on the south and the Khulna Bypass Road on the west **(Map 3.1)**. This area is outside the present KCC. Land elevation varies from 3.3 mSOB to -0.30 mSOB. The general slope of the land is from east to west. The present drainage pattern is towards the Koya River system across the Bypass Road by gravity. For future planning, the consultants propose to maintain the present drainage pattern. But the problem may arise with the fact that, the area on the west of the Bypass Road upto Koya River has already been planned to be urbanized and the land development will obviously be above HTL (2.90m SOB). In that case, the area under this Zone being at lower level will face drainage congestion. On the other hand, if the drainage water of the area is diverted towards Moyur, the capacity of the proposed Alutola PH at the outfall of Moyur has to be increased. But pump drainage being very costly, should be avoided as far as possible.

A more practical option therefore, is to raise the land above the HTL so that the present flow pattern can be maintained even if the area on the west upto Koya is raised above HTL for urbanization. The area under Zone 2 being outside the present KCC area is no yet densely populated. Therefore the Consultants suggest that for any land development and extension of urbanization in this area the minimum land formation level should be raised above the HTL i.e. about 2.90m SOB.

Zone 3: Zone 3 is on the southern side of Zone 2. It is bounded by Zone 2 on the north, Zone 1 on the east, Zone 6 on the south and the Khulna Bypass Road on the west. A large portion of this area is within KCC. Ward nos. 1, 3, 4, 5, 6, 9, 10 (part), 11 (Part), 12 (Part) and 14 are in this Zone. Total area is about 28 sq. km. Land elevation varies from -0.06 mSOB to 3.90 mSOB. The General land slope is from the east to the west. The longitudinal slope is from north to south. Currently the general flow pattern is from the east to the west across the Bypass Road through Koya River and Ramdia Khal (**Map 3.1**). Under the future condition, the area on the west of the Bypass Road will be urbanized. In fact, urbanization has already been started and the land development is obviously above the flood level i.e. (2.90m SOB). In that case, the new area being above the flood level will have gravity drainage with high drainage level. No pump drainage will be required. On the other hand, the area under Zone 3 being at lower level and have already been habited, cannot be raised. As a result, the area will face drainage congestion.

The Consultants therefore, propose that the present flow pattern in this area may be maintained till the area on the western side of the Bypass is developed and consequently drainage of this Zone is impeded. Then the drainage in this area will have to be diverted towards Moyur River, where from the water will be bailed out along with the area under Zone 6 by the proposed Alutola pump house. Alutola PH and the drainage conveyance system are to be designed accordingly. In this area, as per the drainage capability, the minimum land formation should be maintained at 1.40 m SOB and above up to 2.40m SOB.

Zone 4: Zone 4 is on the south eastern side of KCC. It is bounded by Zone 1 on the north, Rupsha river on the east, and Zone 5 on the south and west side. Ward nos. 29 and 30 are under this Zone. The area is about 1.50 sq. m. This is a densely habited area. But the land level is low, varying from 0.60m SOB to 2.10m SOB. The general slope of the land is from north to south and finally towards the east.

This area is already developed but at low formation levels. Therefore, it cannot drain out water by gravity resulting drainage congestion.

To mitigate the drainage problem the Consultants have proposed pump drainage under PH-1. All the existing drainage system in this area will converge to the PH-1 for bailing out excess rainfall-runoff to Rupsha River.

There is an existing 3 Vent sluice in this Zone at Rupsha Ghat. This is in good condition. The Sluice will continue to work as a complementary to the proposed PH. It will work during the period of low tides when drainage will be possible by gravity.

Zone 5: Zone 5 is on the south and west side of Zone 5. It is bounded by Zone 1 and Zone 4 on the north, Zone 4 and Rupsha River on the east and Zone 6 on the south and west. Ward nos. 20 (part), 23 (part), 27 (part), 28, 30 (part), 31 and some extension areas on the western side. Total area is about 9.0 sq km.

This area is also densely habited. But the land is formidably low having serious drainage congestion. Land elevation varies from 0.30m SOB to 3.30m SOB. The general slope is from north to south and east to west. The area being low and habituated, scope of further land development is difficult.

There are three existing Drainage Sluices in this Zone. These are presented in **Table 3.2** below:

Table 3.2: Existing Drainage Sluices in Zone 05

Sl. No.	Zone	Ventage	Condition	Outfall Channel
1.	Motiakhali Khal	2 Vent	Not Good	Rupsha
2.	Labonchara Khal-1	3 Vent	Gates are Damage	Rupsha
3.	Labonchara Khal 2	2 Vent	Gate are Damage	Rupsha

Therefore, the Consultants have proposed pump drainage in this area. PH-2 at Labonchora with a capacity of 42m^3/s has been proposed to bail out the excess run-off from the area. There are some drainage sluices in this area. These are to be repaired and will remain as complementary to the pump drainage. These regulators will drain out water by gravity when the River water level permits.

Zone 6: Zone 6 is on the west side of Zone 5. It is bounded by Zone 3 on the north, Zone 1 and 5 on the east, Rupsha River on the south and the Bypass Road and Botiaghata on the west. Ward nos. 16, 17, 18, 19, 20 (part), 24, 25, 26, 27 (part) and some of the extended area fall under the Zone. Total area is about 27 sq. km. Land level varies from 3.30 mSOB to -1.0 mSOB. The general slope of the area is towards Moyur River which is the main drainage artery of the area. There is a longitudinal slope from north to south. The area on the eastern side (left bank) of Moyur River is mostly built up, with a wide variation in land level varying from 3.30 mSOB to -1.0 mSOB. The area on the western side of Moyur is mostly the extended area which is very low. The ground level varies from 2.70m SOB to -0.90 mSOB

The extended area where there is no development should be raised above the proposed drain level 0.5 to 1.30 mSOB. However, the other areas which are already built up e.g. the Khulna University but at lower level have to be drained out by pumps. A large PH has been proposed at Alutola for this purpose. This will drain out the excess runoff of this Zone and Zone 3 as stated above.

In this Zone, there is an existing sluices at Alutola (10 vent). The condition is not so good. However, this will be repaired and will be complementary to the proposed PH. Gravity drainage will be possible when the River WL permits.

3.4.4 Development of Moyur River and Other Open Channels

The Moyur River is now being silted up aggravating the drainage congestion. It has been proposed by KCC that the Moyur River may be developed to play a major role for improvement of drainage in KCC area and also to convert the khas land by its sides for greenery and recreation. This may be achieved by converting it into a lined one.

There are about 40 open Drainage Channels in the KCC area. Most of the channels have been silted up, occupied by un authorized encroachments or damed for crossing. Some of those are recoverable and some are not. Of the open channels, 33 have been considered for development planning under the proposed Drainage Network Systems. These are presented in Table 3.2 below. Some of the channels will be improved by Block lining, some by RCC and some others are mixed RCC Block lining Details are given in the Design drawings.

Table 3.3: Drains Proposed for Development

ID	Name	Length	Existing Condition	Proposed	Zone
1	Mayur Khal	6093.02	Earthen	Block	Zone 6
2	Chori Chora Khal	1360.00	Earthen	Block	Zone 5 & 6
3	Printik Khal	740.52	Earthen	RCC	Zone 6
4	Purbo Nirala Khal	625.81	Earthen	Block	Zone 6
5	Nirala Khal	2441.94	Earthen	Block	Zone 6
6	Khudiyar Khal	5599.75	Earthen	Block	Zone 3
7	Taltula Khal	704.81	Earthen	Block	Zone 6
8	Bastu Hara Khal	2127.02	Earthen	Block	Zone 3
9	Horintana Khal	3681.64	Earthen	Block	Zone 5
10	Labanchaora 2 No. Sluice Gate Khal	3698.69	Earthen	Block	Zone 5
11	Ghora Khal (Western Part)	547.42	Encroached	Abandoned	Zone 5
12	Ghora Khal (Eastern Part)	503.05	Earthen	No Proposal	Zone 5
13	North Khal	2030.78	RCC	RCC	Zone 6
14	Motia Khali Khal	1795.75	Earthen	RCC	Zone 5
15	Khetra Khali Khal	1398.81	Mixed	RCC	Zone 5
16	Nobinagar Khal	1005.69	Earthen	Block	Zone 6
17	Labonchora South Khal	838.73	Earthen	RCC	Zone 5
18	Hatia River	5992.29	Earthen	Block	Zone 6
19	Batkamari Khal	510.36	Encroached	No Proposal	Zone 6
20	Rayermahal Bazar Khal	134.09	Earthen	RCC	Zone 3
21	Matha Bhanga Khal	1792.08	Enclosed	No Proposal	Zone 5
22	Narikel Bari Khal	2155.35	Earthen	No Proposal	Zone 6
23	Suri Khal	879.52	Earthen	No Proposal	Zone 6
24	Pipe More Khal	847.18	RCC	RCC	Zone 5
25	Khan-E-Sabur Bagar Bari Khal	679.38	Enclosed	No Proposal	Zone 5
26	Tomijuddin Khal	346.62	Earthen	RCC	Zone 6
27	250 Bed Hospital Khal	584.47	Mixed	RCC	Zone 6
28	Choto Boyra Shoshan Ghat Khal	157.31	Earthen	No Proposal	Zone 6
29	Deana Chowdhury Khal	1057.54	Earthen	RCC	Zone 3
30	Koya Khal	1103.51	Earthen	No	Extended

				Proposal	Area
31	Mander Khal	173.01	Earthen	RCC	Zone 6
32	Labanchora 1 No. Sluice Gate Khal	1145.04	Earthen	RCC	Zone 5
33	Rayermohol Molla Para Khal	724.78	Earthen	RCC	Zone 6

3.4.5. Water Treatment Options

Construction of water treatment plant for the entire city effluent would be very costly and time consuming for implementation, especially in case of KCC, where the drainage systems are segregated and it would be very difficult to bring all the sewerages from different drainage systems to a single point for treatment before falling into the Mayur. On the other hand, building Treatment Plant for each of the drainage system, would also be difficult and practically not feasible involving land acquisition, pollution and other social hazards.

Therefore, we propose the following options as suggested in the KDA Master Plan:

- Educate the beneficiaries and take action against pollutions.
- To provide better sanitation for low income and town centre areas through construction of pit latrines and public toilets respectively.
- Mechanical removal of solid wastes as a routine cleaning and maintenance works.
- Enforcing law to build treatment plant for the industries for treating their effluent.
- Catch pits at the outlets of residential house and at the end of road side Gutters to collect the solid wastes.
- Silt Trap and Trash Racks at the outfall of Main Drain falling into the open channels like Moyur and others.
- In the long term planning, treatment plants may be constructed at each of the outfall drain before discharging the drainage water in Rupsha and Bhairab.

3.5 Drainage Layout Plan

The first step in the detailed design of drainage system is to prepare a drainage layout plan taking into consideration the existing system.

- The future requirement both for the existing and the extended areas.
- Missing linkages and meeting requirement of the capacity shortfalls.

3.5.1 Methodology

To start with it was decided that:

- The existing drainage system would be used as far as possible to minimize the cost and to avoid the social and environmental hazards.
- Existing drains would be repaired and modified where required.
- Drains would be provided on both sides of existing roads. (as far as possible)
- New drains would be provided where required and there should be linkage between the existing and new drains.
- Capacity of the existing drains would be increased where required as per the catchment area delineated and the runoff co efficient.
- Existing flow direction would be maintained to avoid any major modification in the existing system.

In order to meet the above requirements, the following survey works as described in **Chapter 2** have been carried out.

- Topographic survey
- Cross-section and long sections.
- Land use survey
- Survey of the conductions of the existing drains and

- The flow directions.

Based on the survey works, drainage layout plan for the existing drains and the future development has been shown in **Map 3.1**. The map shows the existing drainage, system, repairing and remodeling works for the existing drains and the new drains. **Table 3.4** represents a summary of the total lengths of drains both for the existing and extension areas by Wards. Total length of the existing drain is about 1,124 km; of these about 445 km needs reconstruction. The length of new drain is about 911 km. Thus, the total length of drainage system in the project area is about 2,035 km.

Ward-wise details of the drainage system are provided in **Chapter-4.**

Table 3.4 Summary of Drainage System

Ward	Existing Length (m)	Reconstruction Length (m)	New Length (m)	Total (m)
Ward No 1	13,347.77	47,110.24	54,246.42	114,704.43
Ward No 2	4,152.35	3,996.12	29,286.58	37,435.05
Ward No 3	1,3590.90	17,967.21	33,396.16	64,954.27
Ward No 4	1,1691.40	6,451.36	26,102.81	44,245.57
Ward No 5	11,901.00	8,488.43	9,639.62	30,029.05
Ward No 6	18,980.60	30,261.43	27,689.26	26,931.29
Ward No 7	8,039.12	1,420.32	5,419.51	14,878.95
Ward No 8	9,245.68	256.33	6,403.37	15,905.38
Ward No 9	34,760.00	22,298.24	32,714.70	89,772.94
Ward No 10	34,124.50	5,049.31	13,691.07	52,864.88
Ward No 11	8,871.70	9,080.58	2,624.78	20,577.06
Ward No 12	17,265.60	2,926.11	29,117.45	49,309.16
Ward No 13	10,899.40	2,448.28	10,136.89	23,484.57
Ward No 14	29,034.60	23,077.87	53,836.05	105,948.52
Ward No 15	16,935.90	10,990.95	20,281.07	48,207.92
Ward No 16	25,204.30	16,388.97	52,169.08	93,762.35
Ward No 17	30,046.80	18,339.23	43,501.25	91,887.28
Ward No 18	17,567.00	6,017.84	31,837.98	55,422.82
Ward No 19	16,025.20	26,668.83	4,147.94	46,841.97
Ward No 20	8,543.02	15,397.38	7,661.58	31,601.98
Ward No 21	9,156.02	22,989.03	23,600.07	55,745.12
Ward No 22	6,703.82	11,289.42	10,907.40	28,900.64
Ward No 23	8,518.81	14,751.92	2,070.18	25,340.91
Ward No 24	32,166.50	27,360.12	25,953.85	85,480.47
Ward No 25	13,561.50	3,133.44	11,432.76	28,127.70
Ward No 26	18,347.00	12,552.81	2,241.78	33,141.59
Ward No 27	19,794.20	14,583.29	15,955.27	50,332.76
Ward No 28	11,003.80	5,436.33	10,021.76	26,461.89
Ward No 29	5,972.91	9,989.15	5,520.65	21,482.71
Ward No 30	17,622.30	16,997.03	20,738.93	55,358.26
Ward No 31	9,070	817.96	36,953.27	46,841.23
Extended Area				
Primary Drain		23,100.20	38,658.21	61,758.41
Secondary drain		6,634.31	86,994.05	93,628.36
Tertiary Drain	187,257.00	643.20	125,806.17	313,706.37
Total Drainage Network Length in Kilometer				
Primary Drain	30.5976	158.5748	67.7363	256.9087
Secondary drain	10.8749	220.9157	149.849	381.6396
Tertiary Drain	637.928	65.42276	693.1726	1396.52336

Source: Field Survey Works, 2010 & Layout Planning

3.5.2 Catchment Areas/Contributing Areas

The catchment area is the total area upstream of a drain that can contribute flow. This includes the total area contributing flows to upstream drains. The contributing area is measured in hectares.

The catchment area starting from the Tertiary has been identified and delineated in the map based on the topographic survey, land-use map and the existing drainage pattern. These have been discussed with the Ward Councilors and also verified in the field. The catchment areas are then measures by GIS.
The catchment area is then multiplied by the run-off and storage co-efficient to give the effective contributing area. Runoff co-efficient for different land-use is presented in **Table 3.5**.

Table 3.5: Runoff Co-efficient

Type of Area	Coefficient
Pave areas- roads and markets	0.9
Areas of paddy (flooded	0.8
Densely built-up areas	0.7
Central areas mixed commercial and housing	0.6
Residential areas with detached houses	0.4
Walled areas and gardens	0.3
Large permeable areas (e.g. dry paddy)	0.3

Source: Urban drainage Manual, LGED

Storage co-efficient is presented in **Table 3.6**.

Table 3.6: Storage Coefficients

Type of area	Coefficient for ground slope		
	Less than 1:1000	Less than 1:500	Greater than 1:500
Paved areas-roads and markets	0.8	0.9	1.0
Densely built up areas	0.8	0.9	1.0
Central areas mixed commercial and housing	0.7	0.8	1.0
Residential areas with detached houses	0.7	0.8	0.9
Walled areas and gardens	0.6	0.7	0.8
Large permeable areas (e.g. dry paddy)	0.5	0.6	0.8
Paddy fields (flooded)	0.3	0.4	0.5

Source: Urban drainage Manual, LGED

3.5.3 Time of Concentration

The Rational Method requires that the time of concentration be calculated so that the appropriate rainfall intensity can be read from the rainfall intensity duration curve. The time of concentration is made up of two elements, the time taken for flow to travel along the drain and the time of entry.

The time of entry is the time taken for the water to travel from the most remote point in the contributing area. The velocity of over land flow is dependent on the ground surface, the ground slope and the distance to the drain. The Manning's Kinematic Wave equation is used to estimate the time of entry with the minimum time of entry set as 4 minutes. This equation was selected because this is derivative of Manning's equation that deals with the roughness of the surfaced and rainfall intensity. The Manning's Kinematic Wave equation is:

$$T_i = \frac{K_u}{I^{0.4}}\left(\frac{nL}{\sqrt{S}}\right)^{0.6} \quad ------(a)$$

Where,

T_{ti} = Time of Entry (min.)
n = Roughness coefficient (see Table below)

L = Flow length [(m) or (ft)]

I = Rainfall intensity [(mm/hr) or (in/hr)]

S = Surface slope, [(m/m) or (ft/ft)]

K_u = Empirical coefficient equal to 6.92 (0.933 in English units)

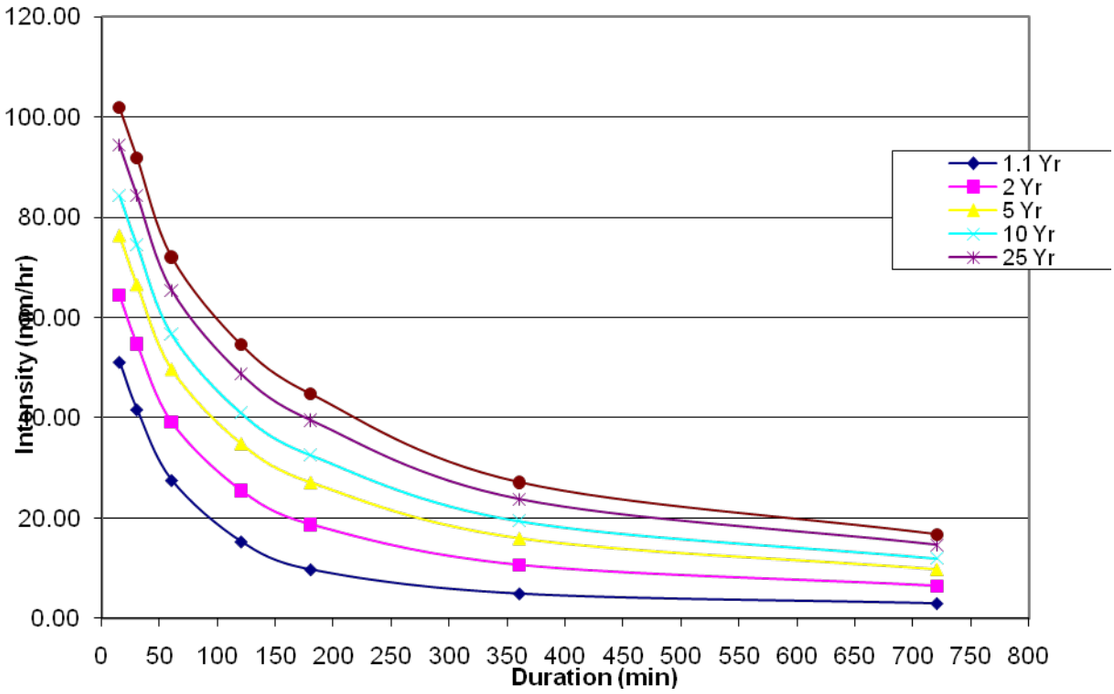
Since it depends on time of concentration which is not initially known, the computation is an iterative process. An initial estimate of time of concentration is assumed and used to obtain the rainfall intensity from the IDF curve for the locality **Figure 3.1**.

Time of concentration is then computed from Equation (a) and used to check the initial. If they are not the same, the process is repeated until two successive values are same.

Table 3.7: Manning's Roughness Coefficient (n) for Overland Sheet Flow

Surface Description	n
Smooth asphalt	0.011
Smooth concrete	0.012
Ordinary concrete lining	0.013
Good wood	0.014
Brick with cement mortar	0.014
Vitrified clay	0.015
Cast iron	0.015
Corrugated metal pipe	0.024
Cement rubble surface	0.024
Fallow (no residue)	0.05
Cultivated soils	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Range (natural)	0.13
Grass	
Short grass prairie	0.15
Dense grasses	0.24
Bermuda grass	0.41
Woods*	
Light underbrush	0.40
Dense underbrush	0.80
*When selecting n, consider cover to a height of about 30 mm. This is only part of the plant cover that will obstruct sheet flow.	

Figure 3.1: Rainfall Intensity Curve for Different Return Period of Khulna



3.5.4 Rainfall Intensity

Rainfall Intensity: The design rainfall intensity in mm/hr is defined as the average rate of precipitation of a given time period during a storm event. This is a variable value, and is dependent on the particular rainfall characteristics of the area, on the return period selected for the rainfall events, and on the time required for the run-off to flow from the most remote part of the catchment area to the point under consideration (defined as the time of concentration, TC in minutes).

Daily Rainfall Analysis: Data for individual storm events are scarce and inadequate for design but relatively long term daily rainfall records are available for most areas. **Rainfall intensity data for durations less than one day is however only available for Dhaka**. It is therefore, necessary to assume that the relationship observed between the Dhaka daily rainfall and the Dhaka rainfall data for durations of less than one day has the same relationship for the rainfalls in the project Area. A procedure to estimate rainfall for durations less than one day for other locations can then be proposed.

The ratio between the project town (KCC) daily rainfall and the Dhaka mean annual maximum rainfall data is then calculated.

The procedure to calculate the adjustment factor is thus:

- The Dhaka long term mean annual maximum daily rainfall = 138mm **(Average 1)**.
- Obtain annual maximum daily rainfall data for rain gauge nearest to project and calculate mean annual maximum daily rainfall for period of record to give **(Average 2).**
- From the mean annual maximum daily rainfalls measured at Dhaka tabulated in **Table 3.8.** We are to calculate the mean annual maximum daily rainfall for the same period of record in bullet 2 above, to give **Average 3.** Years with missing data in the project area must also be excluded from the calculation of the Dhaka average.

Table-3.8: Dhaka Annual Maximum Daily Rainfall

Year	Maximum daily Total Rainfall (mm	Year	Maximum daily Total Rainfall (mm	Year	Maximum daily Total Rainfall (mm
1953	90.0	1968	145.0	1983-84	133.0
1954	n/a	1969	86.0	1984-85	15.0
1955	115.0	1970	152.0	1985-86	92.0
1956	326.0	1971	251.0	1986-87	176.0
1957	73.0	1972	231.0	1987-88	138.0
2958	137.0	1973	168.0	1988-89	135.0
1959	n/a	1974	106.7	1989-90	118.0
1960	141.0	1975	143.0	1990-91	94.0
1961	185.0	1976	163.0	1991-92	123.0
1962	116.0	1977	100.0	1992-93	90.0
1963	189.0	1978	128.0	1993-94	140.0
1964	114.0	1979	108.0	1994-95	74.0
1965	177.0	1980	91.0	1995-96	83.0
1966	257.0	1981-82	81.0	Number of years of data	41.0
1967	125.0	1982-83	146.0	Average	138.8
				Std Dev.	53.6

Source: UDM, LGED

Table 3.9 lists the adjustment factors for a number of towns in Bangladesh. From the table, it may be seen that the adjustment factor for Jessore with Dhaka is available. This being close, is also proposed to be used for KCC.

Table 3.9: Conversion Factors for Rainfall Intensity Data

Name of Pourashava	Conversion Factor	Name of Pourashava	Conversion Factor
Bagerhat	1.28	Jhenidah	1.08
Barguna	1.12	Madaripur	1.09
Barisal	1.12	Magura	0.96
Brahmanbaria	1.21	Munshigonj	0.99
Chandpur	0.84	Natore	0.84
Chapai Nawabgonj	0.85	Noakhali	1.38
Comilla	0.95	Patuakhali	1.53
Faridpur	0.95	Rajpur	1.11
Feni	1.79	Rajbari	0.99
Gaibandha	1.15	Rangamati	1.38
Gopalgonj	1.10	Sirajgonj	1.19
Jamalpur	1.20	Tangail	0.86
Jessore	1.20	Thukurgaon	0.96

Source: UDM, 1998

Rainfall Intensity Data: The rainfall data for Dhaka has been analysed using the Gumbel Analysis Method (Ref. U Dr. Mahsul) and the derived return period rainfalls for a range of storm durations are presented in **Table 3.10.** The values have been adjusted to take in account the frequency of maximum daily rainfalls occurring during the period of observation and the long term average values. For use in a specific project area, the rainfall intensity values given in **Table- 3.10** are to be multiplied by the rainfall factor.

Table-3.10: Predicted Rainfall Intensities at Dhaka

Return Period	Rainfall Intensity (mm/hr) in given duration						
	15 minutes	30 minutes	1 hour	2 hours	3 hours	6 hours	12 hours
1.1	73.5	59.9	39.6	22.0	14.0	7.1	4.3
2	92.4	78.6	56.2	36.7	27.0	15.4	9.4
5	109.7	95.7	71.4	50.1	39.0	23.0	14.1
10	121.1	107.0	81.4	58.9	46.9	28.0	17.3
25	135.6	121.3	94.1	70.1	56.9	34.3	21.2
50	146.3	132.0	103.5	73.4	64.3	39.0	24.1

Source: UDM, LGED

For convenience, a full tabulation of rainfall intensities at two minutes' internals for return period of 1, 2, 5 and 10 years for Dhaka, is included in **Table-3.11.**

Table 3.11: Rainfall Intensity data (mm/hour) in Dhaka

Tine (mins)	Dhaka Tr=1.1	Dhaka Tr = 2	Dhaka Tr = 5	Dhaka Tr = 10
4	86.0	109.8	128.3	139.9
6	83.9	106.4	124.3	136.1
8	81.7	103.2	121.1	132.6
10	79.4	100.1	117.8	129.4
12	77.2	97.2	114.8	126.3
14	75.0	94.5	112.0	123.4
16	72.8	91.9	109.3	120.7
18	70.7	89.5	106.7	118.1
20	68.6	87.1	104.3	115.7
22	66.6	84.9	102.0	113.3
24	64.6	82.8	99.8	111.1

Tine (mins)	Dhaka Tr=1.1	Dhaka Tr = 2	Dhaka Tr = 5	Dhaka Tr = 10
26	62.7	80.8	97.7	108.9
28	60.9	78.8	95.7	106.9
30	59.2	77.0	93.8	104.9
32	57.5	75.2	91.9	103.1
34	55.9	73.5	90.2	101.3
36	54.3	71.9	88.5	99.5
38	52.8	70.4	86.9	97.8
40	51.4	68.9	85.3	96.2
42	50.0	67.5	83.8	94.7
44	48.7	66.1	82.4	93.2
46	47.5	64.8	81.0	91.7
48	46.2	63.5	29.6	90.3
50	45.1	62.3	78.3	89.0
52	43.9	61.2	77.1	87.7
54	42.9	60.0	75.9	86.4
56	41.8	58.9	74.7	85.2
58	40.8	57.9	73.6	84.0
60	39.9	56.9	72.5	82.8
62	38.9	55.9	71.4	81.7
64	38.0	54.9	70.4	80.6
66	37.2	54.0	69.4	79.6
68	36.3	53.1	68.4	78.5
70	35.5	52.3	67.5	77.5
72	34.8	51.4	66.5	76.6
74	34.0	50.6	65.7	75.6
76	33.3	49.8	64.8	74.7
78	32.6	49.1	64.0	73.8
80	31.9	48.3	63.1	72.9
82	31.3	47.6	62.3	72.1
84	30.7	46.9	61.6	71.2
86	30.1	46.3	60.8	70.4
88	29.5	45.0	60.1	69.6
90	28.9	45.0	59.1	68.9
92	28.4	44.3	58.6	68.1
94	27.8	43.0	58.0	67.4
96	27.3	43.0	57.4	66.7
98	26.8	42.5	56.6	66.9
100	26.3	42.0	56.4	65.3
102	25.8	41.0	54.4	64.6
104	25.4	40.0	54.8	63.9
106	25.0	40.4	54.2	63.3
108	24.5	39.9	53.6	62.7
110	24.1	45.9	63.0	63.0
112	23.3	38.0	52.5	61.4
114	23.3	38.5	51.9	60.8
116	22.9	38.0	51.4	60.3
118	22.5	37.6	50.9	59.7
120	22.2	37.1	50.4	59.1

Note: The rainfall intensities given above have been adjusted to long term average values to be consistent with the Dhaka daily rainfall short term to long term rainfall ratios.
Source: UDM, LGED

3.5.5 Design Flow

Open drains are designed to flow full when carrying the design flow with an allowance for freeboard. Pipe drains and box culvers are designed to flow full with the additional capacity available when the flow depth is just below the top of the drain not taken into account.

The design flow is the peak runoff resulting from design storm rainfall on the catchment. The design storm return periods for drainage design are given below in **Table 3.12**.

Table 3.12: Drainage Design Return Periods

Location	Design Storm Frequency	Drain Freeboard
Tertiary Drainage	Once in 1.1 years	100mm
Secondary Drainage	Once in 2 years	150mm
Primary Drainage	Once in 5 years	200mm
Outfall drain water levels (10 day mean peak)	Mean annual maximum water level	300mm

Source: UDM, LGED

3.5.6 Outfall Water Level

The Outfall Water Level is the guiding factor for effective drainage of the project area and also to decide the ultimate mode of drainage for the project area.

In the project, the excess runoff is planned to be discharged in the Bhairab and Rupsha Rivers. Historical Water Level in the river is available at the BWDB Water Level Station sw 241 Rupsa-Pasur near Khulna Daak Bungalow. Water Level for the station is available over the period 1985 to 2008. This is a tidal river. Twenty four years highest monthly HTL and LTL have been analyzed for a recurrence frequency of 1:10 years. **Figure 3.2** presents the Hydrograph based on the analysis. Comparing this level (HTL 2.91m, SOB) with the catchment area, it appears that most of the area needs pump drainage during the monsoon. **Map 3.2** shows the areas under different modes of drainage. These are summarized below in **Table 3.13.**

Table 3.13: Zone Wise Catchments Area for Drainage

Zone	Location	Area (ha)
Zone 1 : Gravity Drainage	Aharab & Rupsha	1,434
Zone 2: Gravity & Drainage	NW Corner KCC Towards Koya Khal	549
Zone 3: Initially by Gravity to Koya Khal and by Pump Drainage	Alutola PH	2,800
Zone 4 : Pump Drainage	Custom Ghat	147
Zone 5 : Pump Drainage	Labonchara	927
Zone 6 : Pump Drainage	Alutola	2,656
Total:		8,513

3.5.7 Cross Drainage Structures

While planning the drainage system the drains have crossed several roads. These crossings require different types of structures like Bridges and Box Culverts. A total of more than 2000 Culverts are proposed in order to improve the drainage system. Details on these cross drainage structures are presented in the Design Report.

3.5.8 Design of Structures

Hydraulic Design and typical drainage have been prepared following the international, BWDB and LGED Guidelines/Standards.

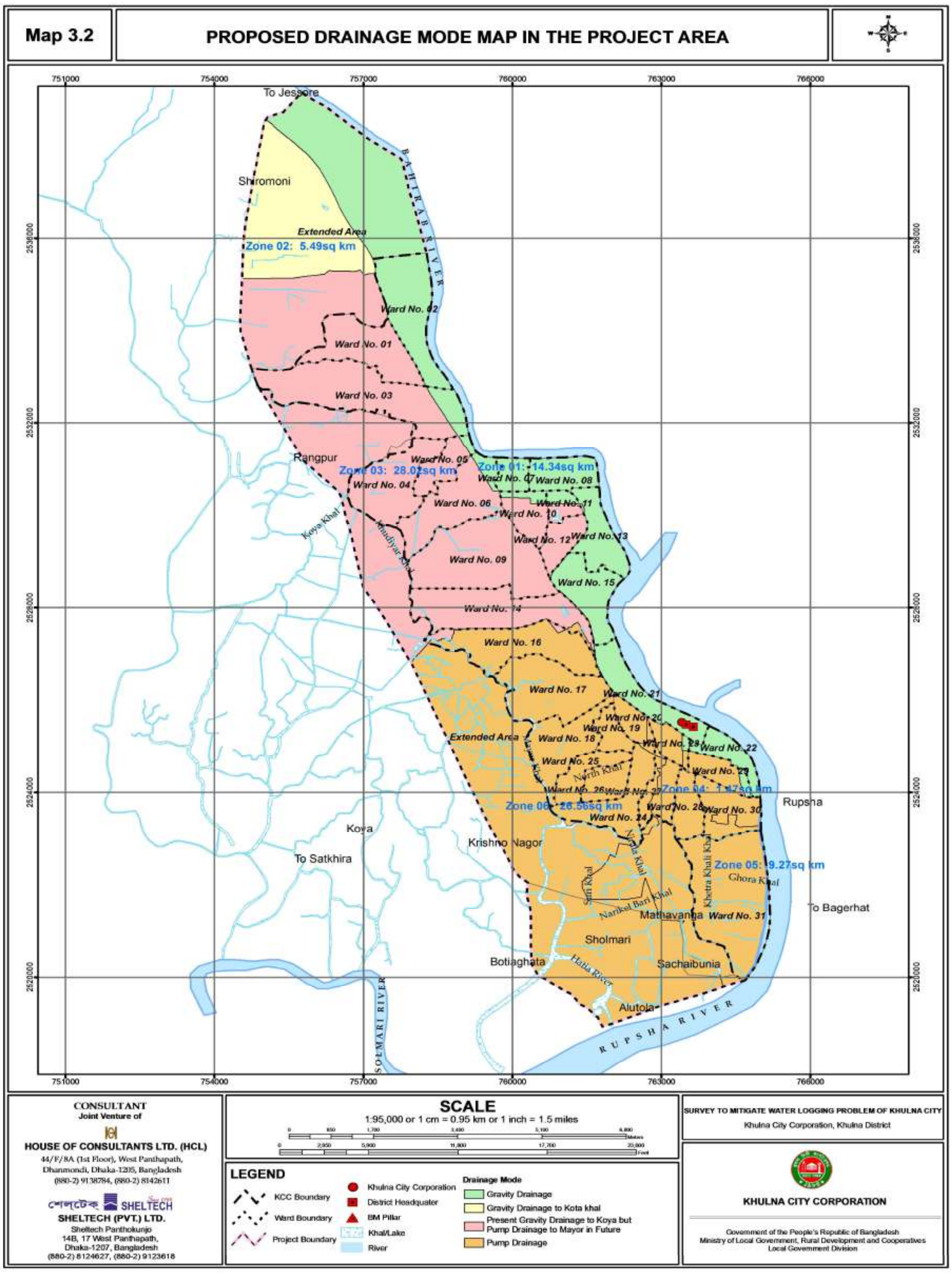
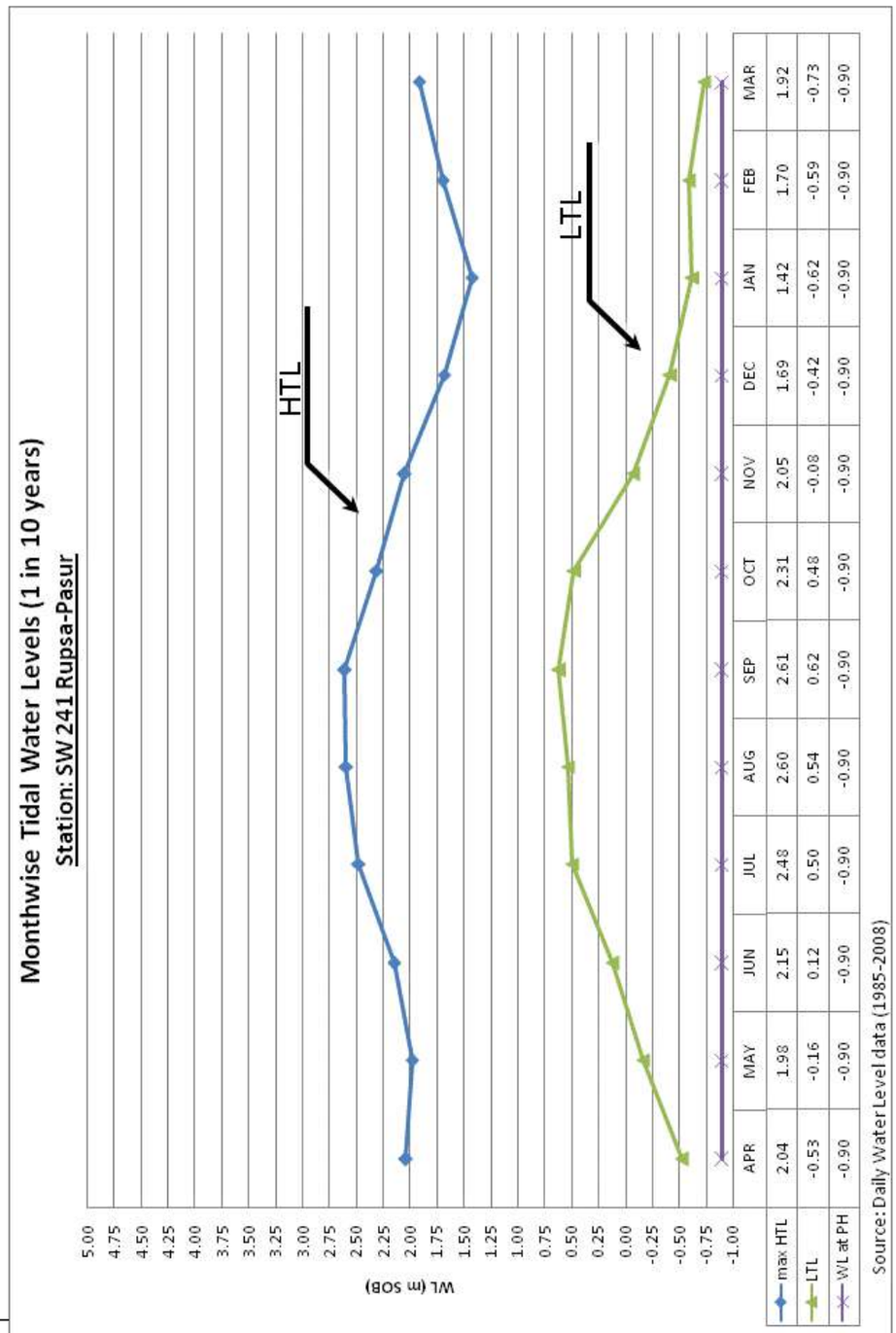

Map 3.2
PROPOSED DRAINAGE MODE MAP IN THE PROJECT AREA
To Jessore
Shiromoni
Extended Area
Zone 02: 5.49sq km
BAHIRAB RIVER
Ward No. 02
Ward No. 01
Ward No. 03
Rangpur
Zone 03: 28.02sq km
Zone 01: 14.34sq km
Ward No. 05
Ward No. 04
Ward No. 07
Ward No. 08
Ward No. 06
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 13
Koya Khal
Ward No. 09
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 19
Extended Area
Ward No. 18
Ward No. 23
Ward No. 22
Ward No. 25
North Khal
Ward No. 26
Ward No. 27
Ward No. 28
Zone 06: 26.56sq km
Ward No. 24
Ward No. 29
Ward No. 30
Rupsha
Koya
Krishno Nagor
To Satkhira
Zone 05: 9.27sq km
Ghora Khal
Khetra Khali Khal
Narikel Bari Khal
Mathavanga
Ward No. 31
To Bagerhat
Sholmari
Botiaghata
Sachaibunia
Hatia River
Alutola
RUPSHA RIVER
SOLMARI RIVER
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Khulna City Corporation
District Headquater
BM Pillar
Khal/Lake
River
Drainage Mode
Gravity Drainage
Gravity Drainage to Kota khal
Present Gravity Drainage to Koya but Pump Drainage to Mayor in Future
Pump Drainage
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Figure 3.2: **Month-wise Tidal Water Level**[1]



	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
max HTL	2.04	1.98	2.15	2.48	2.60	2.61	2.31	2.05	1.69	1.42	1.70	1.92
LTL	-0.53	-0.16	0.12	0.50	0.54	0.62	0.48	-0.08	-0.42	-0.62	-0.59	-0.73
WL at PH	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90	-0.90

[1] From May 1 ed by Survey of Bangladesh (SOB) with technical cooperation of Japan International Cooperation Agency (JICA) with a view to establish tidal observatory, determine mean sea level, establish national vertical datum and to establish a first order leveling network for Bangladesh covering 70% of the country. During the project, elevations of all SOB benchmarks were computed based on the new datum and compared with old elevations. The new elevations were found to be lower than the old elevations. But the difference was not consistent throughout the country. The variations were from 4 cm to 50 cm at different locations from north-western part of the country to the south-eastern part. It was claimed that, this inconsistency in differences were caused because of uncertain reference surface for the old SOB elevation. It was found that, the variation of the old and the new levels at Khulna city area is approximately 30 cm. The data found during the field survey also supports this information. Previously, to convert an SOB level to a PWD level, one had to add 0.46 m or 1.51 ft with the SOB levels. As it was found that, in the Khulna city region there is an additional difference of 30 cm with the new SOB levels, to convert the levels found using an SOB benchmark into a PWD benchmark here; one has to add 0.76 m with the SOB levels.

3.6 Technical Requirement for Selection of Pump

3.6.1 Location of the Pump Stations

In the KCC Area, three Pump Houses have been proposed, one at Rupsha Ghat in Drainage Zone 4, the second one at Labonchora in Zone 5 and the third one at Alutola in Zone 6 as per requirement of the Project. These Pumps will be used to bail out the excess drainage water from the project area especially during the Monsoon season when the river water level will not permit any gravity drainage. The Drainage system design and the physical inventory of the project reveal that the existing land level, hydraulic gradient, and the drainage system alignment will be effective for installation of pump capacity, 10 cumec at Rupsha Ghat, 40 cumec at Labonchora and 120 at Alutola for effective drainage of the proposed project.

3.6.2 Pump Station Proposed Capacities

The static head calculation for the Pump Stations, have been done based on the lowest drainage water level in the country side for the three Pump Stations (PS). These are +1.23m PWD for Rupsha Ghat PS (-)0.34m PWD for the Labonchara PS and (-)0.54m PWD for the Alutola PS. The highest river water level in the Rupsha River is 3.37 m PWD occurring once in 10 years' The highest levels at the Pump Intakes are +1.73m PWD for the Rupsha Ghat and +0.16m PWD for the other two PS.

The drainage calculations have been done on the basis of the highest continuous precipitation occurring once in 10 years for evacuation of the same in one hour. The lowest water level at the pump suction side has already been stated above. Comparing the static heads based on the lowest drainage basin water level and the highest river water level for drainage purpose is the highest static head generated during drainage.

3.6.3 Number and size of the Pumps

Selection of the number of pumps should be made so as to break down pump(s) capacity upto 25% so that it does not disrupt or have any major effect on the ultimate scheduled programme targeted for the project. Considering the above criteria and phasing for extending the repair and maintenance facility factors, the total number and capacity of pumps for the Pump Stations are proposed below:

Sl. No.	Particular	Pumps (No.)	Unit Capacity (m^3)s	Total Capacity (m^3)s	Max. Static Head (m)
1	Rupsga Ghat Pump Station	5	2	10	2.14
2	Labonchara Pump Station	6	7	42	3.71
3	Alutola Pump Station	10	15	120	3.91

3.6.4 Selection of type of Pumps

Comparaison of Conventional Vertical Turbine and Submersible Motor type of Pumps

In the conventional vertical turbine pumps, motors are installed above the water level. It requires long shaft for pump coupling, guide bearings, floors for motor, bearing housings, bearing brackets, volute casing, cooling system, major embedded components and parts, traveling overhead crane and super structured pump house for motor and traveling crane and related fitting, fixing, setting, centering, alignment, adjustment etc. works at site are needed during pump installation.

In comparison with the conventional vertical pumps, Submersible Motor Pumps have very short shaft, integrally coupled, easy to install without centering and alignment at site.
The advantages of submersible motor pump over the conventional Vertical Turbine Pump are for its easy installation, repair and no external cooling system requirement, less maintenance components, less installation time, low cost, low power consumption, less civil construction (no pump house super structure is required), less weight, easy O&M, less down time, low vibration, sound less operation and no centering of pump and motor etc. required at site during installation.

Further, the following auxiliary and ancillary components, equipment with its structural construction will not be required for submersible motor pump:

- Pump house super structure over ground level
- Over head traveling crane
- Cooling water pump(s) with its accessories, as pumps will be immersed in water
- Raw water pump
- Warm water pump
- Cooling tower
- Sand separator for auxiliary pump
- Auto strainer
- Bilge pump
- Conventional drainage pump
- Embedded parts for traveling crane, motor, bearing brackets, volute casing etc.

These mechanical and electrical supplies and installations and civil constructions will not be required to implement the project with Submersible Motor Pump. These will drastically reduce (up to 35%) the total cost of the project, shortening the project implementation period and will create an environmental friendly atmosphere in the plant arena.

On these context, Submersible motor type pump have been proposed for the Project. However, the maximum capacity of Submersible motor Type Pumps so far manufactured is limited upto 7.0 cumec. Therefore, the first two Pump Stations are propose to be Submersible Motor Type and the third one being of high capacity should be VT Type.

3.6.5 Calculation for Total Dynamic Head

Total dynamic head represents the net work to be done by a pump for pumping operation. To ascertain the pump capacity and power requirement, total dynamic head of the proposed pumps are required to be calculated as mentioned bellow:

Total Head = Static head + Losses
= $(H_d - H_s) + (H_t + H_p + H_b + H_{fg} + H_o)$

Where:

H_s is the head at pump intake which varies with the variable water level at intake depending on drainage WL water level.

H_d is the discharge side head at pump discharge assuming to lift water at HT level.
H_t = Loss in trash rack
H_p = Loss in delivery pipe
H_b = Loss in bend
H_{fg} = Loss in flap gate
H_v = Loss in discharge velocity head
H_o = Other losses.

3.6.6 Prime Mover Speed

To avoid gear box power loss in power transmission and sound pollution in the locality, directly coupled motor with motor pole variation for speed reduction is chosen for the pumps of the Project. It will keep the sound level within the permissible decibel in and around the Pump Station free of environmental sound pollution hazards.

So, asynchronous type multi pole motors are chosen as prime mover of pumps.

RPM of the motor will be calculated as mentioned bellow:

$$RPM = \frac{120 \times f}{p}$$

Where,

RPM = Prime mover rotation per minute
f = Frequency of power supply
p = Chosen Number of poles of the motor

3.6.7 Specific Speed of Pump

For selection of pump configuration specific speed of pump is required to be calculated. Specific speed of pump n_s is the rotational speed at which a geometrically and hydraulically similar pump discharges unit quantity discharge under unit head, operating at the best (peak) efficiency point. Specific speed of n_s for different PS are calculated below:

$$n_s = \frac{n \times Q^{1/2}}{H^{3/4}}$$

ns= Specific Speed
n = rotational speed of Pump r/min. (Ref. section 3.13.16)
H = best efficiency head developed, m
Q = best efficiency discharge,m^3/minute

Based on the above, specific speed and the type of pumps for the three PS are given below

Particular	For Rupsha Ghat	Labonchara	Alutola
Specific Speed n_s	3,604	3,185	4,486
Type of Pump	Axial Flow	Axial Flow	Axial Flow

3.6.8 Basis of selection of Pump Type configuration criteria

Type of Pumps	Specific Speed, n_s
Turbine Pump	90-200
Volute Pump	90-700
Mixed flow Pump	600-1000
Axial flow Pump	1300-1900

3.6.9 Net Positive Suction Head (NPSH)

Submergence of pump is dependent on NPSH. For a particular pump it requires certain minimum NPSH requirement i.e. NPSH required ($NPSH_R$) and minimum submergence to prevent cavitation and knocking.

3.6.10 Available Net Positive Suction Head ($NPSH_A$) [3]

Net positive suction head is the total suction head over vapour pressure at the highest point of the impeller inlet edge. The NPSH available $NPSH_A$ for the pump, at a given site, is calculated from the equation :

$NPSH_A = H_a + H_s - H_v - H_L$ (Refer appendix)

Where :

H_a = atmospheric head
H_s = suction head
H_v = water vapour head and
H_L = suction side head losses.

For a particular pump it requires certain minimum NPSH (i.e. $NPSH_R$) and a minimum submergence to prevent cavitations and knocking.

3.6.11 Required Net Positive Suction Head ($NPSH_R$) & Minimum Pump Submergence

The required Net Positive Suction Head $NPSH_R$ should be less than that available at a particular location. The minimum submergence of pump should be specified by the manufacturer by the pump supplier which must be complied $NPSH_R$ & minimum pump submergence.

3.6.12 Losses in the Designed Pumping System

Loss in trash rack

$$H_t = \frac{2\,\mu\, Q^2 (a+0.5b)\, \sin\infty e}{g\, A_c^2 (a+b)}$$

For rack bar of squire nose and tail with sharp corners for L/a =12,
μ = 6.2 & ∞ = 1.00 where
a = thickness of the rack bar
b = clear distance between bars
Q = pump discharge
A_c = water area of cross-section, assuming 50% of the net area of the screen is blocked

- Loss in delivery pipe

H_p = Delivery pipe is very short to reckon appreciable loss to record.

- Loss in bend

H_b = Assumed negligible as there is no bend.

- Loss in flap gate

- Loss in discharge velocity head

$H_v = \frac{v_o^2}{2g}$

Where-
V_o = average velocity of water at pump outlet =
g = acceleration due to gravity. = 9.81 m/sec^2

- Other losses

H_o = Assumed to be negligible.

3.6.13 Losses in Pump and Motor Itself

These losses are reckoned as the efficiency of pump and its prime mover and should not be less than 83% & 95% respectively i.e.:

Pump efficiency η_p = 83% at design head
Motor efficiency η_m = 95% at rated at design head.

3.6.14 Static Head

Based on the highest river water level 3.37m PWD, the lowest and highest water level for different PS are given below:

Particular	Rupsha Ghat	Labonchara PS	Alutola PS
Highest WL	1.73	0.16	0.16
Lowest WL	1.23	-0.16	-0.54

Static Head (Max.) = Discharge side highest level (FSL) - Suction side lowest level. These are given below

Particular	Rupsha Ghat	Labonchara PS	Alutola PS
Static Head	2.14	3.71	3.91
Design Head	3.00	4.75	5.00

3.6.15 Design Head

Considering the parameters mentioned above, Design Head=Design Static Head + losses. Design Heads are presented in above Table.

The pump shall deliver the design capacity at design head at design efficiency. The pumps shall be capable to operate continuously within the operating range as indicated by maximum and minimum water levels at pump intake. The capacity of pump is designed at the total heads given above and the performance of the pumps will be limited to operate at max. efficiency zone at design head.

The selected pump's all openings and passages should be large enough permit the passage of solid waste of spheres up to 25 mm in diameter and any trash & stingy materials which pass through a large collection in the system and also capable to pump up to the designed useful life.

3.6.16 Selection of Pump/ Prime Mover Speed

To avoid gear box power loss transmission and sound pollution in the thickly populated urban area, directly coupled motor is chosen for the pumps in the project. It will keep the sound level within the permissible decibel in and around the pump station free of environmental sound pollution hazards. As the pump and the motor shaft will be integrated and coupled directly the prim mover speed will be equal to pump speed.

A squirrel induction type motor with 8 pole are selected as prime mover of pumps for the Rupsha Ghat PS and 12 poles for the other two.

The RPM of the motor/pump is calculated as bellow:

$$RPM = \frac{120 \times f}{p} = \frac{120 \times 50}{8} = 750 \text{ for Rupsha Ghat PS}$$

and

$$= \frac{12 \times 50}{12} = \text{for the other two PS}$$

Where,

RPM = Prime mover rotation per minute
f = Frequency of power supply
p = Chosen number of poles of the motor
8 nos. for the Rupsha PS and 12 nos. for the other two PS

Low RPM pumps and prime movers require lesser maintenance cost and operational hazards.

3.6.17 Power Requirement

Power requirement per Pump Unit are calculated by the formula mentioned below:

$$P = \frac{9797 \times Q H \gamma}{\eta_p \eta_m} \text{ KW}$$

Where:
P = Power requirement for the prime mover (in KW)
Q = Pump discharge =5 m^3
H = Design head =……. m
Y = Specific weight of pumped liquid = (for silt carrying water taken as 1.03)
η_p = Pump efficiency (83% considered)
η_m = Motor efficiency (95% considered)

Description	Rupsha Ghat (KW)	Labonchara PS (KW)	Alutola PS (KW)
	76	420	948
Total Power Required	380	2,520	9,480
Auxiliary	20	80	120
Gr. Total	**400**	**2600**	**9,600**

Thus the total power requirement for Pump operation is 12,600 KW

3.6.18 Sub-Station

3.6.19 Rupsha Ghat Pump Sub-station

Power would be supplied through a 33 KV Sub-station for operation of pumps and other auxiliary services as mentioned bellow:

Main Transformer : 33/6.6 KV, 2.50 MVA - 2 Nos.
Auxiliary Transformer : 6.6/.415 KV, 26 VA - 2 Nos.

For station services including necessary, transmission line, switch yard, panels & switch gears.

3.6.20 Labonchara Pump station

Main Transformer : 33/.415 KV, 2.5 KVA - 2 Nos.
Auxiliary Transformer for station services with necessary panels & switch gears. : 33/.415KV, 100 KVA - 1 Nos.

Alutola Pump Station : 33/.415 KV, 6 KVA - 2 Nos.
Auxiliary Transformer for station services with necessary panels & switch gears. : 33/.415KV, 150 VA - 1 Nos.

33 KV incoming line voltage has been selected to minimize line loss and to avoid hazards of direct domestic connection from the proposed BWDB substation feeder. It causes pump operation disruption due to apprehended domestic consumer's line fault and time elapse for its repair and maintenance.

3.6.21 Transmission lines

From Boalkhali Power Station to Alutola via Rupsha Ghat and Labonchara 33KV Transmission line

33 KV pole mounted transmission line with cross arms,
insulators, wires, guys, jumper, earth wires etc. : 30 Km

3.6.22 Backup or Standby Power

Standby generators are not recommended as it will not be economically viable. However, express feeders electrical line transmission without domestic connection from PDB substations to pump stations sub-station are suggested for uninterrupted power supply to the proposed pump stations.

3.6.23 Gravity Flow through PS

The PS will be designed in such a way that these may have facilities for gravity drainage when the River WL will permit ie. The Pumps will be operated only when gravity drainage is not possible.

Typical Drawing of the three Pump Houses are presented at the end of this chapter.

Chapter 4
DESCRIPTION OF EXISTING AND PROPOSED DRAINAGE SYSTEM

4.1 Description of Existing and Proposed Drainage Network in the Project Area

This Chapter describes the existing and the proposed drainage network system of the Project Area. Drainage network proposals of KCC area have been presented on ward basis. Total drainage network have been classified into five different categories as outfall, primary, secondary tertiary and quaternary drains depending on their functions.

4.1.1 Detailed Drainage Plan of Ward 01

Ward 01 is on the northern part of Khulna City located on the western side of Khulna-Jessor Highway close to the Khulna University of Engineering and Technology (KUET). The area adjoins Beel Dakatia where the minimum spot level is about -0.22 mSOB, maximum spot level is found about 4.70 mSOB and the average spot level is about 2.87 mSOB. The natural slope goes down from Jessore road to Khulna City Bypass.

In this ward, the present drainage condition is very poor. There exist about 29,720 m of pucca drains in the ward. All the drains are connected to nearby natural canal in and around the Ward. There is about 1,489.39 m of natural channels in Ward 01. Details have been presented in the **Table-4.1**.

Table- 4.1: Existing Drainage Network in Ward 01 {this table is only a repetition of the text, not a details}

Drainage Category	Existing Length (m)
Natural Canal	1,489.39
Pucca Drain	29,719.65 {keep the num.format same for all data for length}
Total	**31,209.04**

About 47,872 m of drains has been proposed by the Consultants in Ward 01. Out of this, about 17,516 m of drains have been newly proposed. About 6,940 m, 22,949 m, 13,440 m and 4,054m of primary, secondary, tertiary and quaternary drains respectively have also been proposed (**Table-4.2**). Proposed Drainage network of Ward 01 has been presented in **Map- 4.1**.

No drains in Ward 01 are found to be in good condition. Reconstruction of 5,239 m of drains and construction of about 480 m of new primary drains is proposed. There is proposal for 11,448 m of secondary drains and for reconstruction of 3,221 m of existing secondary drains. About 2,192m of tertiary and 3,388m of quaternary drains are proposed.

Table- 4.2: Proposed Drainage Network in Ward 01

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	7.80	480.06	11,448.21	2,191.97	3,388.43	**17,516.47**
OK/Repair	0.00	1,221.07	8,279.18	3,450.93	610.51	**13,561.68**
Reconstruction	481.58	5,238.79	3,221.62	7,796.78	55.25	**16,794.01**
Total	**489.39**	**6,939.92**	**22,949.01**	**13,439.67**	**4,054.18**	**47,872.17**

There are proposals for primary, secondary and tertiary drains which will pass through the Ward. All other secondary and tertiary drains are connected with primary drains. Details have been presented in **Table- 4.3 and Map- 4.1**.

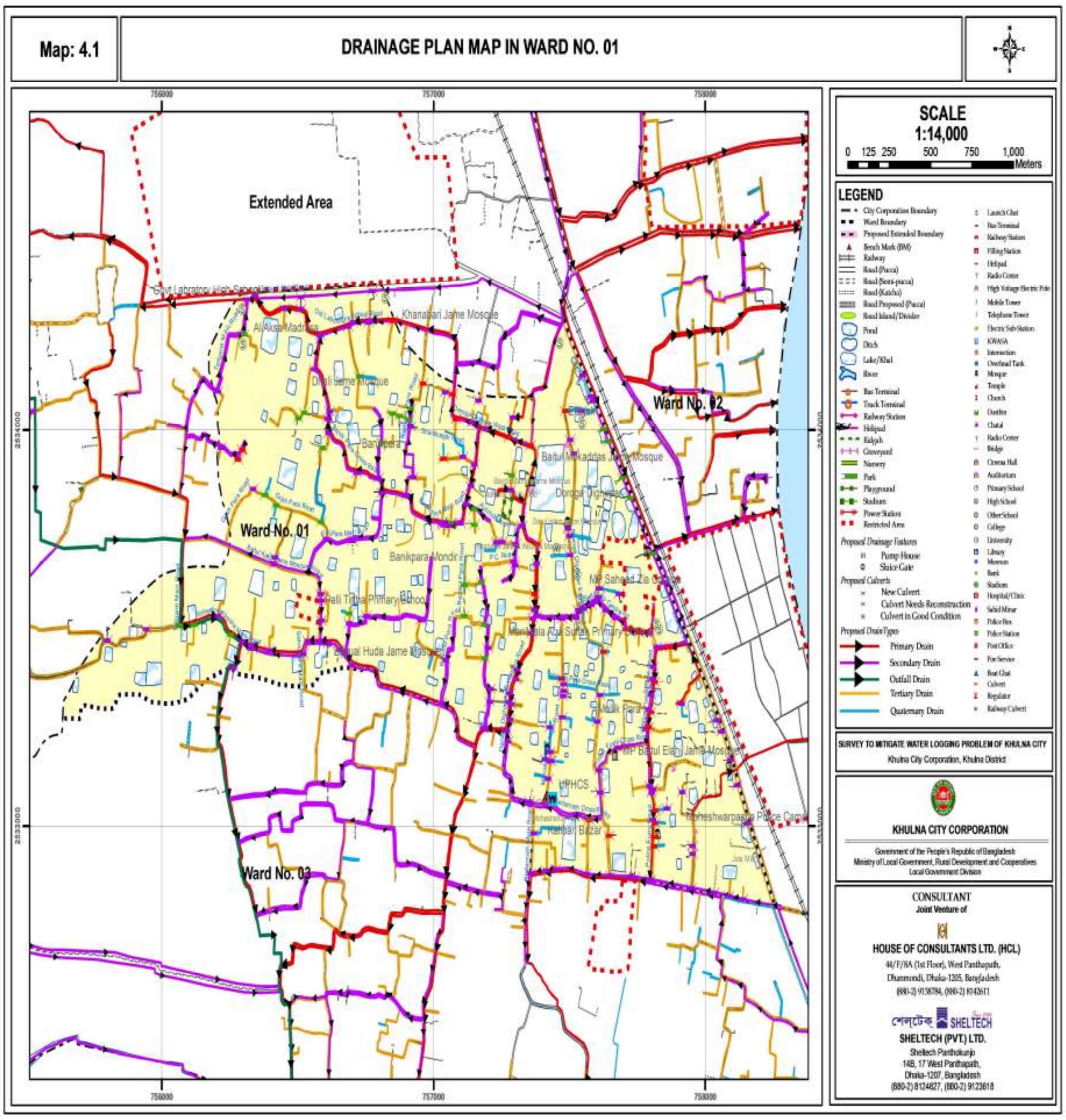
Table- 4.3: Proposed Primary Drainage System in Ward 01 {It is just a tabular form of the text but not a detail}

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-B1-P1N	Daroga Dighipar West Road,	Old Laboratory School Road	Teliganti Main Road	M-B1
M-B1-P1S	Banikpara Main Road,	Teleganti Boundary Road	Teliganti Main Road	M-B1
M-B1-P5-P1	Daroga Dighirpar Extention Road		De Para Road (Ward 03)	M-B1
M-B1-P2-P1	Daroga Dighirpar Extention Road		Moheshwarpasha Main Road	M-B1
M-B1-P5	Police Fari Road		Kedarnath Main Road	M-B1

There are about 132 culverts this Ward. These culverts are not in good condition or can't fulfill the future requirement. About 85 and 37 culverts have been proposed for reconstruction and new construction respectively (**Table- 4.4**).

Table- 4.4: Proposed Culvert in Ward 01

Culvert	New	OK/Repair	Reconstruction	Total
Number	37	47	85	**169**


Map: 4.1
DRAINAGE PLAN MAP IN WARD NO. 01
Extended Area
Ward No. 01
Ward No. 02
Ward No. 03
Khanabari Jame Mosque
Banikpara Mondir
Kahabir Bazar
SCALE
1:14,000
0 125 250 500 750 1,000
Meters
LEGEND
Proposed Drainage Features
Pump House
Sluice Gate
Proposed Culverts
New Culvert
Culvert Needs Reconstruction
Culvert in Good Condition
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
SHELTECH (PVT.) LTD.

4.1.2 Detailed Drainage Plan of Ward 02

Ward No 02 is on the northeastern part of the Khulna city, located beside the Khulna Jessore highway. This area is situated on the bank of the Bhairab River where the minimum, maximum and average spot height is about 1.37m PWD, 4.52m PWD and 3.72m PWD respectively. The natural slope of this area is from Jessore road to the Bhairab River.

There exist about 16,596.86m pucca drains in this area. The present drainage condition is very poor. All the drains are connected to nearby natural canal. There is about 869.47m natural channels in Ward 02. Details have been presented in the **Table-4.5**.

Table- 4.5: Existing Drainage Network in Ward 02

Drainage Category	Existing Length (m)
Natural Canal	869.47
Pucca Drain	16,596.86
Total	**19,266.33**

The Consultants have proposed total 33,182m different types drainage network within Ward 02 in which about 16,223m drains will have to be newly built. About 15,655m, 10,420m, 4,823m and 2,282m Primary, Secondary, Tertiary and Quaternary drains have been proposed in this Ward respectively (**Table-4.6**). Proposed drainage network of Ward 02 is given in **Map- 4.2**.

The condition of existing primary drains is poor. About 5,228m, 852m and 1617m primary, secondary and tertiary have been proposed for reconstruction respectively. In this ward, about 7568m primary drain, 5,670m secondary drain, 2124m tertiary drain and 860m quaternary drain have also been proposed for new construction. Total 16,223m new drain and 7,695m drain for re-construction have been proposed.

Table- 4.6: Proposed Drainage Network in Ward 02

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	7,568.18	5,670.75	2,124.10	860.33	**16,223.36**
OK/Repair	2,860.13	3,898.82	1,081.90	1,422.35	**9,263.20**
Reconstruction	5,227.55	851.15	1,617.22	0.00	**7,695.91**
Total	**15,655.86**	**10,420.72**	**4,823.22**	**2,282.68**	**33,182.47**

There are a number of primary, secondary and tertiary drains in and around the Ward. As the area is much close to the Bhairab River, gravity drainage system is more applicable there. Thus, the outfall of proposed entire primary drain is along the Bhairab River. The primary drains named “BH-P9N” and “BH-P9S” passes along the Cable Factory Road and finally falls into the Bhairab River. The primary drain “BH-P10” passes along the Mirerdanga Uttar Boundary Road and also falls into the Bhairab River. The primary drains “BH-P13N”, “BH-P13S”, BH-P15N and “BH-P14S” passes along the S/R Siraji Road and Mirerdanga Eidgah Road respectively. Rest of the primary drains passes along different Roads within the Ward and falls into the Bhairab River. Secondary and tertiary drains of this Ward are connected to primary drains. Details have been presented in **Table- 4.7 and Map- 4.2**.

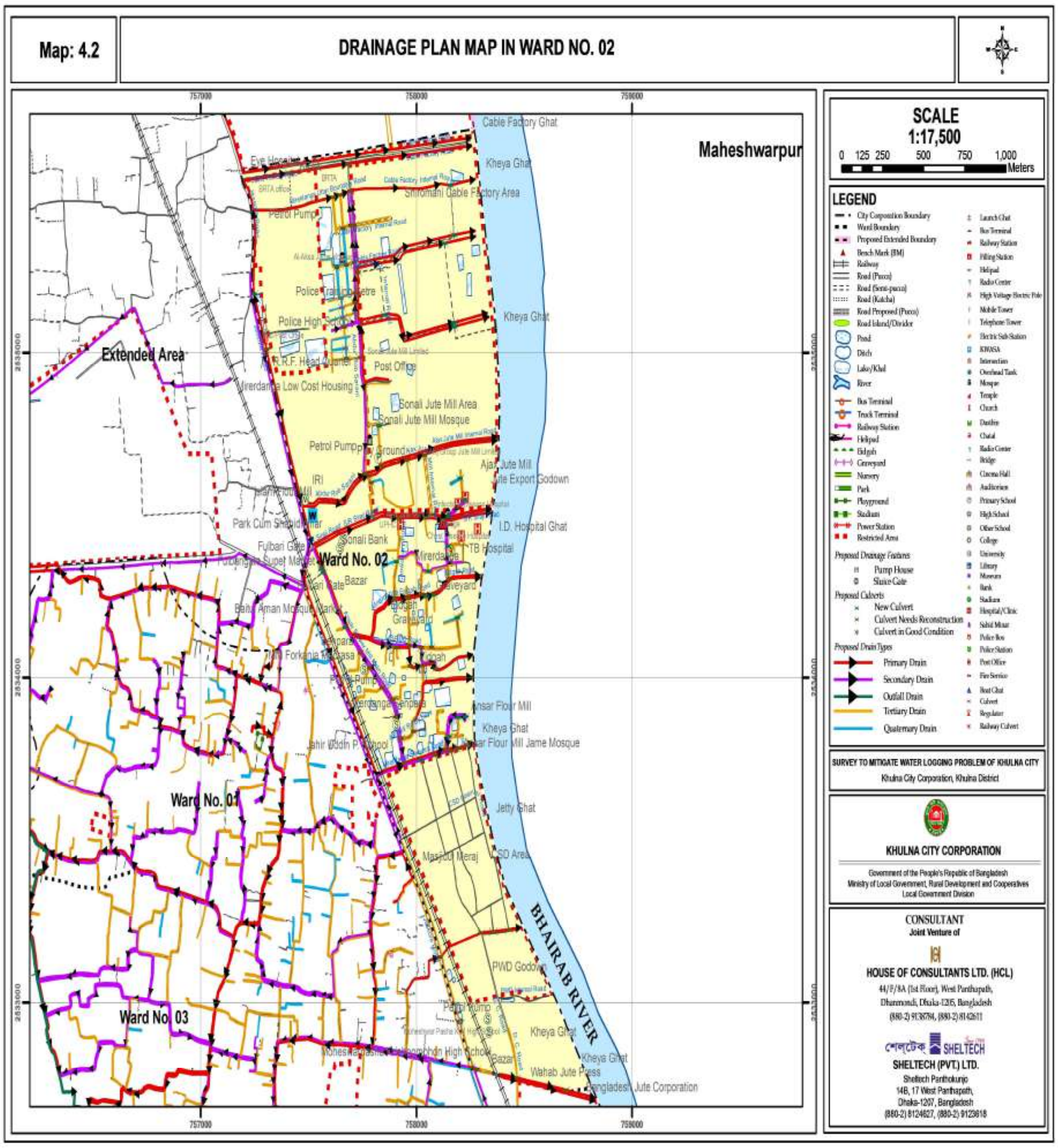
Table- 4.7: Proposed Primary Drainage System in Ward 02

Name of the Drain	Name of the Road		Outfall Drain
	Start	End	
BH-P9N	Cable Factory Road	-	Bhairab River
BH-P9S	Cable Factory Road	-	Bhairab River
BH-P10	Mirerdanga Uttar Boundary Road	-	Bhairab River
BH-P13N	S/R Siraji Road	-	Bhairab River
BH-P13S	S/R Siraji Road	-	Bhairab River
BH-P15N	Mirerdanga Eidgah Road	-	Bhairab River
BH-P15S	Mirerdanga Eidgah Road	-	Bhairab River
BH-P16	BFIDC Road	-	Bhairab River
BH-P17N	Hindu Para Road	-	Bhairab River
BH-P17S	Hindu Para Road	-	Bhairab River
BH-P18	Mirerdanga Senpara Road	-	Bhairab River
BH-P19N	Nagar Ghat Road	-	Bhairab River
BH-P19S	Nagar Ghat Road	-	Bhairab River

There are about 47 culverts in Ward 02. Present condition of existing culverts is very poor and these would not be able to fulfill the future requirement. About 31 and 35 culverts have been proposed for reconstruction and new construction respectively (**Table- 4.8**).

Table- 4.8: Proposed Culvert in Ward 02

Culvert	New	OK/Repair	Reconstruction	Total
Number	35	16	31	**82**


Map: 4.2
DRAINAGE PLAN MAP IN WARD NO. 02
SCALE
1:17,500
0 125 250 500 750 1,000
Meters
LEGEND
Maheshwarpur
Extended Area
Ward No. 02
Ward No. 01
Ward No. 03
BHAIRAB RIVER
Cable Factory Ghat
Kheya Ghat
Sonali Jute Mill Area
Sonali Jute Mill Mosque
Post Office
Petrol Pump
Jetty Ghat
PWD Godown
Wahab Jute Press
Bangladesh Jute Corporation
Ansar Flour Mill
Sonali Bank
TB Hospital
I.D. Hospital Ghat
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
CONSULTANT
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4.1.3 Detailed Drainage Plan of Ward 03

This Ward is in between the Khulna City Bypass and the Bhairab River, located the western part of the City. Minimum spot height of this area is about -1.74m PWD, while maximum spot height is found about 5.93m PWD and the average is about 2.06m PWD. The natural slope is from Jessore road to Khulna City Bypass.

The ward has about 36,780 m pucca drain and about 1,918m natural canal. All the drains are connected to nearby natural canals. Most of drains in this Ward are in very poor condition. Details presented in the **Table-4.9**.

Table- 4.9: Existing Drainage Network in Ward 03

Drainage Category	Existing Length (m)
Natural Canal	1,917.97
Pucca Drain	36,779.92
Total	**38,697.89**

Total 58,264m drainage networks have been proposed by consultant in Ward 03 including about 2,1243m new drains. About 7,542m, 15,273m, 25,854m and 7,676m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.10**). Proposed Drainage network of Ward 03 has been shown in **Map- 4.3**.

Condition primary drains is not good found in Ward 03. Reconstruction of 6,434m drains and construction of about 627m new primary drains have also been proposed. About 6,962m and 4,373m secondary drains have been proposed for reconstruction and new construction respectively. Constructions of 11,550m new tertiary drains and about 3,335m new quaternary drains have also been proposed.

Table- 4.10: Proposed Drainage Network in Ward 03

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,358.30	626.77	4,373.19	11,550.26	3,334.90	**21,243.41**
OK/Repair	0.00	481.78	3,938.01	8,441.17	2,754.86	**15,615.82**
Reconstruction	559.67	6,433.17	6,962.22	5,862.61	1,586.85	**21,404.52**
Total	**1,917.97**	**7,541.73**	**15,273.43**	**25,854.04**	**7,676.60**	**58,263.76**

According to the data in **Table-4.11,** the primary drain “M-B1-P5” started from Police Fary Cross Road (Ward 01), passing along the Kedarnath Main Road and finally falls into the outfall drain “M-B1” at Moddhyodanga Main Road. The primary drain named “M-B1-P5-P1” started from Daroga Dighirpar Extention Road (Ward 01) passing along the Depara Road, Rishi Para Road and ended at Moddhyodanga Main Road. There are two primary drains “M-B1-P3” and “M-B1-P4” both are passing the along Depara Road and finally fall into the same outfall drain “M-B1” at Kartikerkul Main Road. The primary drain “M-B1-P2” that started from Fokirbari Road (Ward 01) passing along the Fulbari Road, Teliganti Main Road, Moheshwarpasha Main Road (Ward 01) falls into the outfall drain “M-B1” at South Boundary Road. The primary drain “M-B1-P6” that started from north side of Jessore Road passing along the Old Satkhira Road and falls into the outfall drain “M-B1” at Deana Paschim Para Main Road (Ward 04). Table-4.11 shows that the entire primary drainage outfall in this Ward is “M-B1”. Detailed data of entire proposed drainage net work in Ward 03 is presented in **Map- 4.3**.

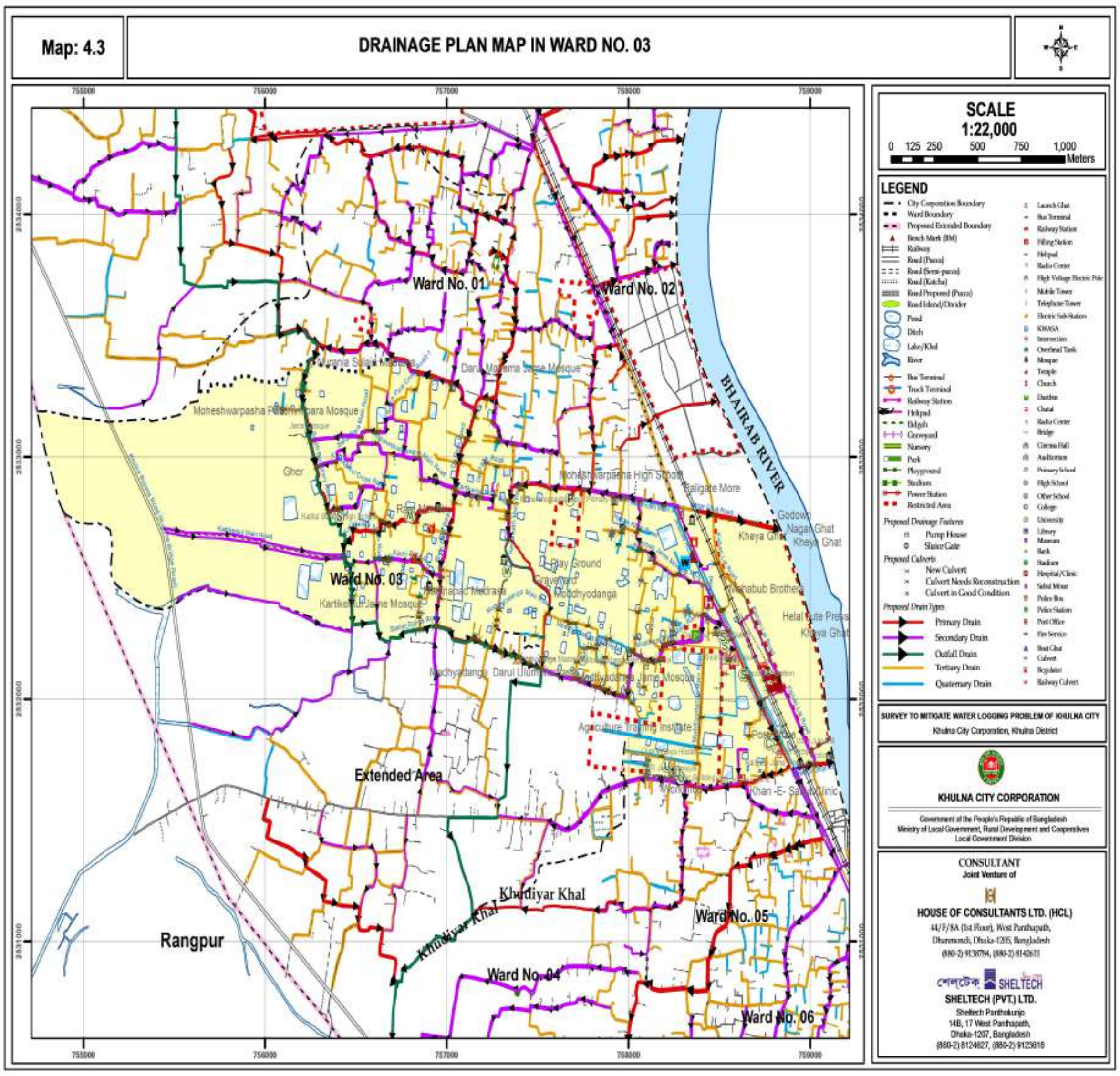
Table- 4.11: Proposed Primary Drainage System in Ward 03

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-B1-P5	Police Fari Cross Road (Ward 01)	Kedarnath Main Road	Moddhyodanga Main Road	M-B1
M-B1-P5-P1	Daroga Dighirpar Extention Road (Ward 01)	De Para Road, Rishi Para Road	Moddhyodanga Main Road	M-B1
M-B1-P3	De Para Road	Phul Bari Road, Teliganti Main Road, Moheshwarpasha Main Road (Ward 01)	Kartikerkul Main Road	M-B1
M-B1-P4	De Para Road		Kartikerkul Main Road	M-B1
M-B1-P2	Fokirbari Road (Ward 01)	Teliganti Main Road, Moheshwarpasha Main Road (Ward 01)	South Boundary Road	M-B1
M-B1-P6	North side of Jessore Road	Old Satkhira Road	Deana Paschim Para Main Road (Ward 04)	M-B1

The proposal of Culvert in Wad 03 is presented in **Table- 4.12.** About 31 and 35 culverts have been proposed for reconstruction and new construction respectively. There are total 67 culverts, which are very poor condition and not adequate for fulfill the future demand.

Table- 4.12: Proposed Culvert in Ward 03

Culvert	New	OK/Repair	Reconstruction	Total
Number	35	16	31	**82**


Map: 4.3
DRAINAGE PLAN MAP IN WARD NO. 03
SCALE
1:22,000
LEGEND
Ward No. 01
Ward No. 02
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
BHAIRAB RIVER
Extended Area
Khudiyar Khal
Rangpur
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
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4.1.4 Detailed Drainage Plan of Ward 04

Ward 04 is in the south western part of the KCC, located between the Khulna City Bypass and Ward 05. Minimum spot height of this Ward is about -1.19m PWD, while maximum height is about 3.98m PWD and the average height is about 1.12m PWD. The natural slope is from Jessore road towards Khulna City Bypass.

The present drainage condition in this Ward is not satisfactory. There exist about 18,769m pucca drains that are very poor in all respect. All the drains are connected with nearby natural canals in and around the Ward. There are about 2,260m natural canals in Ward 04 (**Table-4.13)**.

Table 4.13: Existing Drainage Network in Ward 04

Drainage Category	Existing Length (m)
Natural Canal	2,260.89
Pucca Drain	18,769.18
Total	**21,030.07**

About 29,382m drainage network is proposed for Ward 04 including about 11,396m new drains. About 4,679m, 10,742m, 11,196m and 1,951m primary, secondary, tertiary and quaternary drains have been proposed there respectively (**Table-4.14**). Proposed drainage network of Ward 04 has been shown in **Map- 4.4**.

Reconstruction of 4,679m drains and construction of about 1,812m new primary drains have been proposed. About 3,805m and 3,499m secondary drains have been recommended for reconstruction and new construction respectively. Existing tertiary drain in this Ward is about 11,196m. About 3,720m and 1,550.55m new tertiary and quaternary drains have also been proposed.

Table- 4.14: Proposed Drainage Network in Ward 04

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	814.29	1,812.82	3,498.90	3,719.46	1,550.55	**11,396.01**
OK/Repair	0.00	0.00	3,437.27	5,506.83	400.39	**9,344.48**
Reconstruction	0.00	2,866.72	3,805.45	1,969.45	0.00	**8,641.62**
Total	**814.29**	**4,679.54**	**10,741.62**	**11,195.73**	**1,950.93**	**29,382.11**

Prpposal has been made for three primary drains, which are named M-B1-P6, M-P1N and M-P1S. The primary drain “M-B1-P6” starts from north side of Jessore Road (Ward 03) passing along the Old Satkhira Road, Hossain Shah Road and finally falls into the outfall drain “M-B1” at Deana Paschim Para Main Road through Uttar Para khal. The primary drain “M-P1N” originated from Anjuman Sarak (Ward 05) passing along the Deana Pabla Main Road (Ward 05), Deana Boundary Road (Ward 05), Ayub Ali Road (Ward 05), Hossain Shah Road, Hazi Mobarak Road, Shekmot Ullah Road, Kenai Morol Road and falls into outfall drain “M” at Goldar Para Road through Golder para khal. The primary drain “M-P1S” originates from Anjuman Sarak (Ward 05) passing along the Deana Pabla Main Road (Ward 05), Deana Boundary Road (Ward 05), Ayub Ali Road (Ward 05), Hossain Shah Road, Azizul Haque Road, Deana Main Road, Deana Dakshin Para Main Road and falls into the outfall canal (Khudir Khal) “M”. All other secondary and tertiary drains are connected with primary drains. Details have been presented in **Table- 4.15 and Map-4.4**.

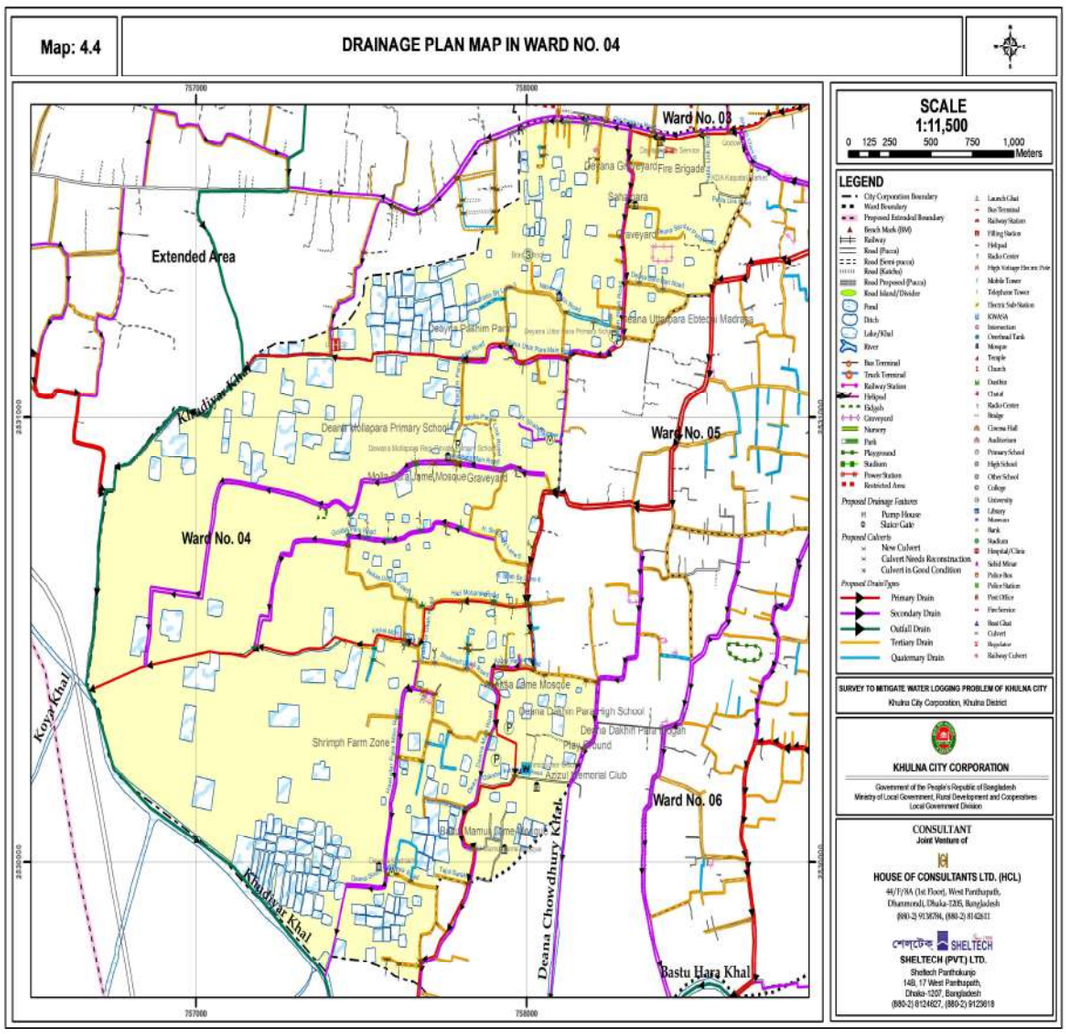
Table- 4.15: Proposed Primary Drainage System in Ward 04

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-B1-P6	North side of Jessore Road (Ward 03)	Old Satkhira Road, Hossain Shah Road	Deana Paschim Para Main Road	M-B1
M-P1N	Anjuman Sarak (Ward 05)	Deana Pabla Main Road (Ward 05), Deana Boundary Road (Ward 05), Ayub Ali Road (Ward 05), Hossain Shah Road, Hazi Mobarak Road, Shekmot Ullah Road, Kenai Morol Road	Goldar Para Road	M
M-P1S	Anjuman Sarak (Ward 05)	Deana Pabla Main Road (Ward 05), Deana Boundary Road (Ward 05), Ayub Ali Road (Ward 05), Hossain Shah Road, Azizul Haque Road, Deana Main Road, Deana Dakshin Para Main Road	LGED Road, Khudir Khal	M

There exist about 82 culverts in ward no 04 that need to be repaired and reconstructed. Considering the future requirement, about 42 and 16 culverts have been proposed for reconstruction and new construction respectively (**Table- 4.16**).

Table- 4.16: Proposed Culverts in Ward 04

Culvert	New	OK/Repair	Reconstruction	Total
Number	16	40	42	**98**


Map: 4.4
DRAINAGE PLAN MAP IN WARD NO. 04
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
Extended Area
Khudiwar Khal
Koya Khal
Khudiwar Khal
Deana Chowdhury Khal
Bastu Hara Khal
Shrimph Farm Zone
Deana Uttarpara Ebtedai Madrasa
Deana Mollapara Primary School
Deana Dakhin Para High School
Deana Dakhin Para Eidgah
Play Ground
Azizul Memorial Club
SCALE
1:11,500
0 125 250 500 750 1,000
Meters
LEGEND
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
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4.1.5 Detailed Drainage Plan of Ward 05

Ward No. 05 is situated in the southwestern part of the KCC, in between Bhairab River and KCC Ward No. 04. Minimum spot height of this area is 1.08m PWD, where maximum and average spot heights are 4.61m PWD and 2.72m PWD respectively. Different natural slopes in this Ward due to Rail line. The natural slope of the southwestern part of rail line is from Jessore road to Khudir Khal and in the northeastern part of rail line the slope is from Jessore Road to Bhairab River.

There is about 18,052 m pucca drainage system in Ward 05. All the existing drains in this Ward are connected with nearby natural canal. The total length of existing natural canals within this Ward is about 860m. Details presented in the **Table-4.17**.

Table- 4.17: Existing Drainage Network in Ward 05

Drainage Category	Existing Length (m)
Natural Canal	860.45
Pucca Drain	18,052.35
Total	**18,912.80**

The Consultants have proposed about 20,914m drainage network in Ward 05. Out of this total network, about 2,931m is new drain. About 3,619m, 3,101m, 1,1381m and 2,813m primary, secondary, tertiary and quaternary drains have been proposed respectively in this Ward (**Table-4.18**). Proposed Drainage network of Ward 05 is given in **Map- 4.5**.

In this Ward about 3,066m primary drains, about 1,877m secondary drains and about 1,654m tertiary drains have been proposed for reconstruction. Also proposed 1,885m new tertiary drains (**Table-4.18**).

Table- 4.18: Proposed Drainage Network in Ward 05

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	0.00	11.50	1,885.13	1,034.16	**2,930.78**
OK/Repair	552.88	1,212.64	7,842.04	1,778.63	**11,386.19**
Reconstruction	3,066.14	1,877.45	1,653.59	0.00	**6,597.18**
Total	**3,619.02**	**3,101.59**	**11,380.75**	**2,812.79**	**20,914.15**

The primary drain “M-P1N” starts from Anjuman Sarak and passing along different roads of Ward 04 finally falls into outfall drain “M” at Goldar Para Road (Ward 04) through Golder para khal. Another two proposed primary drain like “M-P1S” and BH-P20N & BH-P20S started from Deana Pabla Main Road and Steamer Ghat Road respectively. These roads fall into the outfall canal (Khudir Khal) “M” and Bhairab River. Details have been presented in **Table- 4.19 and Map- 4.5**.

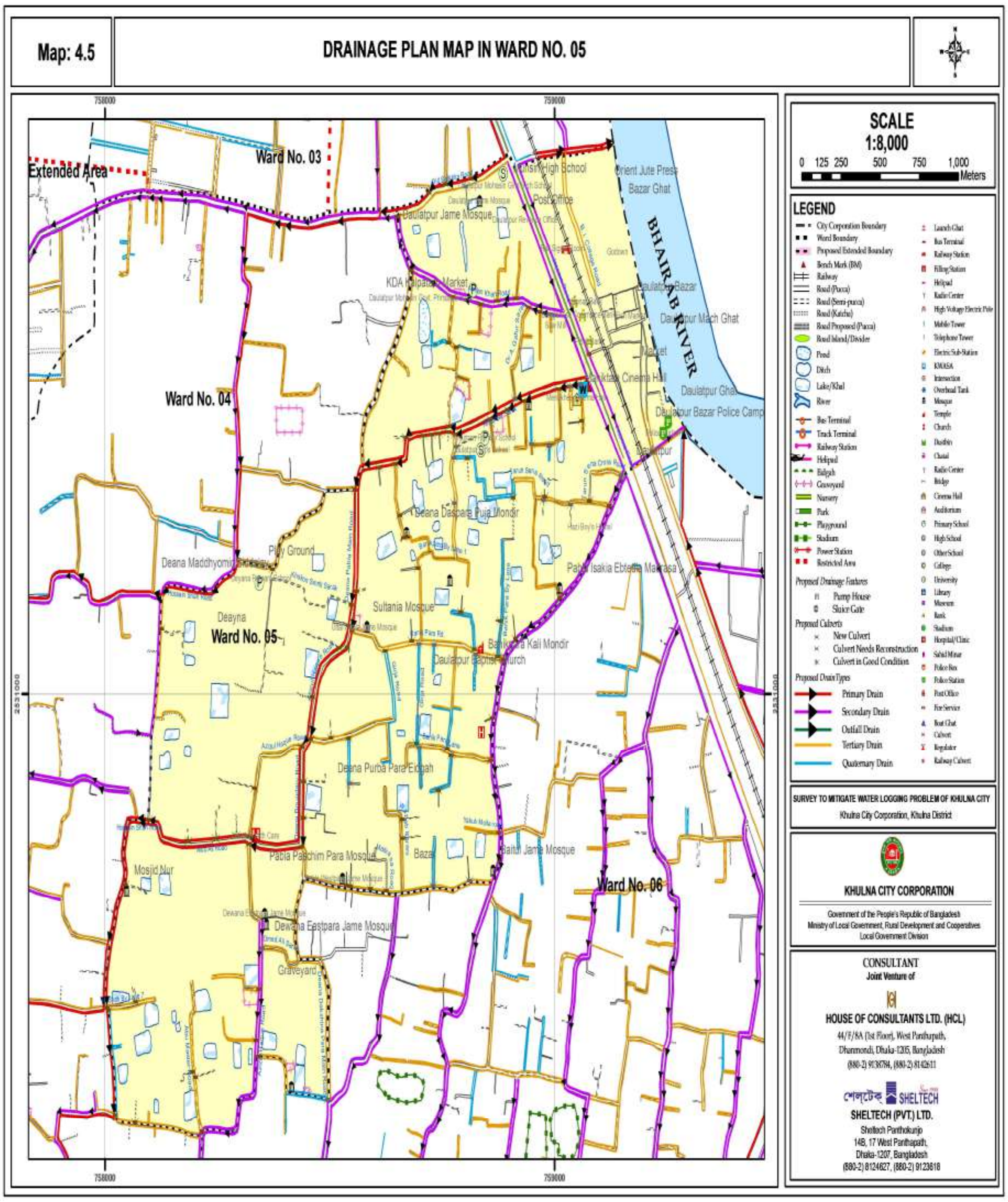
Table- 4.19: Proposed Primary Drainage System in Ward 05

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P1N	Anjuman Sarak	Deana Pabla Main Road, Deana Boundary Road, Ayub Ali Road, Hossain Shah Road (Ward 04), Hazi Mobarak Road (Ward 04), Shekmot Ullah Road (Ward 04), Kenai Morol Road (Ward 04)	Goldar Para Road (Ward 04)	M
M-P1S	Deana Pabla Main Road	Deana Boundary Road, Aiub Ali Road, Hossain Shah Road, Azizul Haque Road (Ward 04), Deana Main Road (Ward 04), Deana Dakshin Para Main Road (Ward 04)	LGED Road, Khudir Khal	M
BH-P20N & BH-P20S	Steamar Ghat Road		-	Bhairab River

The number of proposed culverts in this Ward is 67 including 6 nos of culverts. The proposed repair and reconstruction culverts under this Ward are 25 and 36 respectively. (**Table- 4.20**).

Table- 4.20: Proposed Culvert in Ward 05

Culvert	New	OK/Repair	Reconstruction	Total
Number	6	25	36	**67**


Map: 4.5
DRAINAGE PLAN MAP IN WARD NO. 05
SCALE
1:8,000
0 125 250 500 750 1,000
Meters
LEGEND
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
Extended Area
Ward No. 03
Ward No. 04
Ward No. 05
Ward No. 06
BHAIRAB RIVER
Daulatpur Jame Mosque
KDA Kollapara Market
Daulatpur Bazar
Daulatpur Mach Ghat
Oriental Jute Press
Bazar Ghat
Deayna
Deana Purba Para Eidgah
Pabla Paschim Para Mosque
Sultania Mosque
Baitul Jame Mosque
Mosjid Nur
Graveyard
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
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4.1.6 Detailed Drainage Plan of Ward 06

Ward No. 06 is located between the Bhairab River and Bastuhara and Khudir Khal. This area is the south western part of the Khulna City, where the minimum spot height is about -1.62m PWD, maximum spot height is found 4.41m PWD and the average height is 1.50m PWD. Becouse of Rail line there are two different natural slopes. The natural slope of the south western part of rail line moves from Jessore road to Bastuhara and Khudir Khal and the slope of the northeastern part moves from Jessore Road to the Bhairab River.

The condition of present drainage systems is not updated in this ward. There are about 32,787m poor quality pucca drains in this Ward. All the drains are connected with nearby natural canal. There are about 3,057m natural canals in Ward 06. Details have been presented in the **Table-4.21**.

Table- 4.21: Existing Drainage Network in Ward 06

Drainage Category	Existing Length (m)
Natural Canal	3,057.45
Pucca Drain	32,787.00
Total	**35,844.45**

About 43,752m drainage network have been proposed by the Consultant in Ward 06 including 10,092m new drains. About 6,025m, 13,871m, 21,168m and 2,687m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.22**). Proposed Drainage network for Ward 06 has been shown in **Map- 4.6**.

Existing condition of most primary drains is very poor. Reconstruction of 4,185m primary drains and construction of most 856m new primary drains have been proposed. Total 5,856m and 2,409m secondary drains have been proposed for reconstruction and new construction respectively. The proposals for new construction of tertiary and quaternary drains in Ward 06 are 5,711m and 1,116 respectively.

Table- 4.22: Proposed Drainage Network in Ward 06

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	855.68	2,408.59	5,711.34	1,116.17	**10,091.79**
OK/Repair	984.51	5,606.50	12,224.55	1,425.55	**20,241.11**
Reconstruction	4,185.11	5,856.20	3,232.20	145.11	**13,418.62**
Total	**6,025.31**	**13,871.30**	**21,168.09**	**2,686.83**	**43,751.52**

A numbers of primary drains pass through this Ward towards M-P2 and M-P2E. The drains “M-P2-P2W” started from Jessore Road passing along the Mujgunni Moha Sarak, west side of Keshab Lal Road falls into outfall canal “M-P2” at Bastuhara Khal. The primary drain “M-P2-P2E” that started from Jessore Road passing along the east side of Keshab Lal Road also falls into the outfall canal “M-P2” at Bastuhara Khal. Another primary drain named “M-P2-P2E-P1” pass along the north side of Keshab Lal Road finally falls into the outfall drain “M-P2-P2E” at east side of Mujgunni Moha Sarak. All the secondary and tertiary drains within this Ward are connected to the primary drains. Details have been presented in **Table- 4.23 and Map- 4.6**.

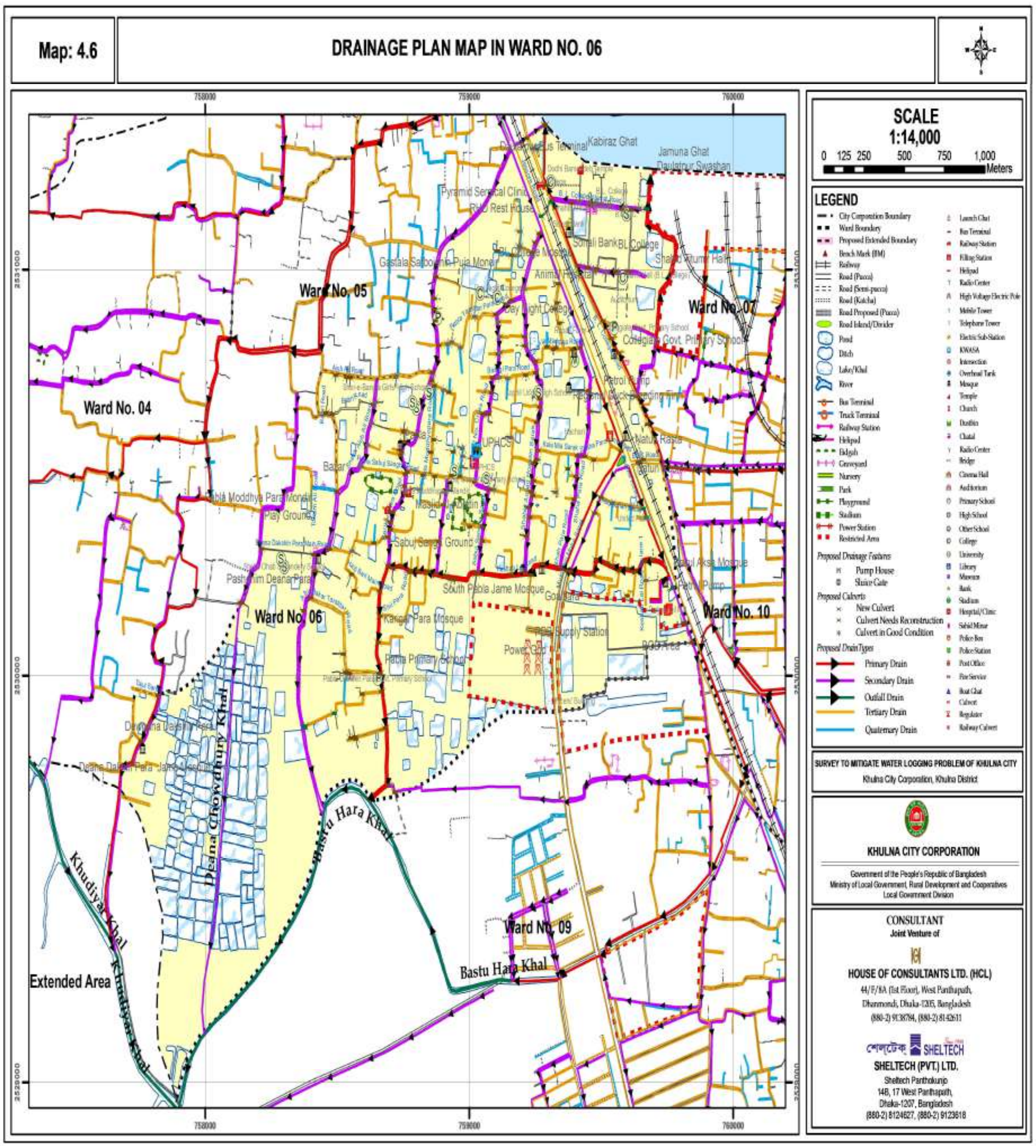
Table- 4.23: Proposed Primary Drainage System in Ward 06

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P2-P2W	Jessore Road	Mujgunni Moha Sarak, west side of Keshab Lal Road	Bastuhara Khal	M-P2
M-P2-P2E	Jessore Road	East side of Keshab Lal Road	Bastuhara Khal	M-P2
M-P2-P2E-P1	West side of Jessore Road	North side of Keshab Lal Road	East side of Mujgunni Moha Sarak	M-P2-P2E

There are a total 111 culverts in Ward 06, most of them need repair and reconstruction. In this Ward 20 nos. new culverts have been proposed by the consultants (**Table- 4.24**).

Table- 4.24: Proposed Culverts in Ward 06

Culvert	New	OK/Repair	Reconstruction	Total
Number	20	56	55	**131**



Map: 4.6
DRAINAGE PLAN MAP IN WARD NO. 06
SCALE
1:14,000
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 04
Ward No. 05
Ward No. 06
Ward No. 07
Ward No. 09
Ward No. 10
Extended Area
Deana Chowdhury Khal
Bastu Hara Khal
Khudiya Khal
Kabiraz Ghat
Jamuna Ghat
BL College
South Pabla Jame Mosque
Sabuj Sangha Ground
Power Station
Proposed Drainage Features
Pump House
Sluice Gate
Proposed Culverts
New Culvert
Culvert Needs Reconstruction
Culvert in Good Condition
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
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4.1.7 Detailed Drainage Plan of Ward 07

This Ward is located the northern part of the City, in between BIDC Road and the Bhairab River. This area is on the bank of the Bhairab River where the minimum, maximum and average spot heights 2.82m PWD, 4.04m PWD and 3.45m PWD respectively. The natural slope of this area moves from BIDC Road to the Bhairab River.

There are 9,675m pucca drains in this Ward. All the drains are connected to nearby natural canals in and around the Ward. There are 857m natural canals in this Ward. Details have been presented in the **Table-4.25**.

Table- 4.25: Existing Drainage Network in Ward 07

Drainage Category	Existing Length (m)
Natural Canal	857.51
Pucca Drain	9,674.99
Total	**10,532.50**

The Consultants proposed 13,154m different categories of drainage network in Ward 07. About 2,093m, 2,878m, 6,350m and 1,878m primary, secondary, tertiary and quaternary drains respectively have been proposed (**Table-4.26**). The proposed all categories new drains are 3,864m. Drainage network of Ward 07 has been given in **Map- 4.7**.

Reconstruction of 1,334m drains and construction of about 40m new primary drains have been proposed. About 907m and 459m secondary drains have been proposed for reconstruction and new construction respectively. Tertiary drains in Ward 07 are about 6,305m where construction of 2,593m new drains have been proposed.

Table- 4.26: Proposed Drainage Network in Ward 07

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	39.79	458.62	2,593.28	772.57	**3,864.27**
OK/Repair	718.60	1,511.98	3,005.76	1,105.77	**6,342.11**
Reconstruction	1,334.22	907.34	706.26	0.00	**2,947.83**
Total	**2,092.61**	**2,877.94**	**6,305.31**	**1,878.34**	**13,154.20**

Most of the proposed primary drains within this Ward fall into the Bhairab River. This area is on the bank of the river Bhairab, where gravity drainage system is more applicable. The primary drain “BH-O1E” passing along the east side of Kashipur Meghna Road falls into the Bhairab River. The drain named “BH-O1W” pass along the west side of Kashipur Jamuna Road and also falls into the Bhairab River. The primary drain “BH-P22W” started from BIDC Road passing along the west side of Padma Road and finally falls into the the Bhairab River. All the secondary and tertiary drains are connected with these primary drains. Details presented in **Table- 4.27, Map- 4.7**.

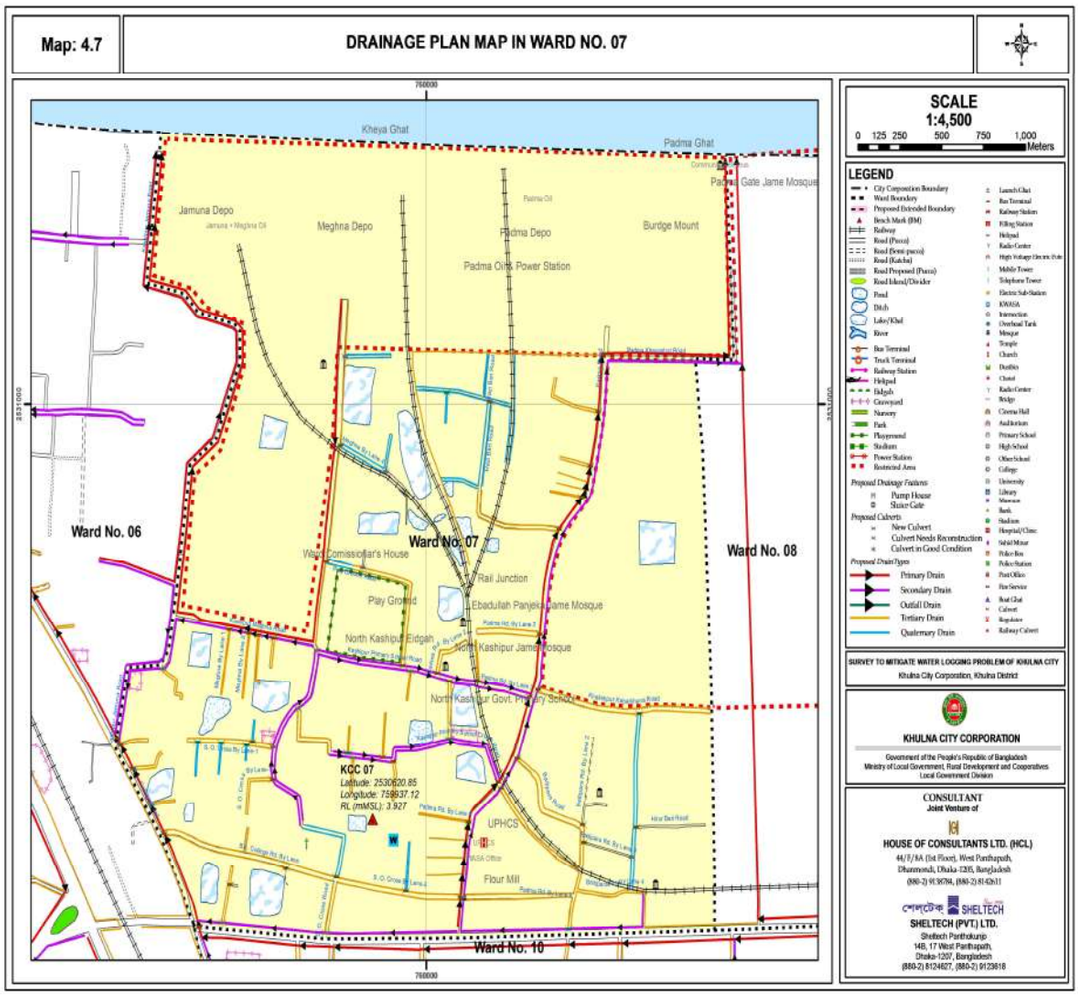
Table- 4.27: Proposed Primary Drainage System in Ward 07

Name of the Drain	Name of the Road		Outfall Drain
	Start	End	
BH-O1E	Kashipur Meghna Road	Bhairab River	Bhairab River
BH-O1W	West side of Kashipur Jamuna Road	Bhairab River	Bhairab River
BH-P22W	BIDC Road, Padma Road	Bhairab River	Bhairab River

Total 42 nos. of new culverts have been proposed, where repairable, reconstruction and new construction culverts are 17, 15 and 1o respectively. **Table- 4.28** describes the entire proposal.

Table- 4.28: Proposed Culverts in Ward 07

Culvert	New	OK/Repair	Reconstruction	Total
Number	10	17	15	**42**


Map: 4.7
DRAINAGE PLAN MAP IN WARD NO. 07
SCALE
1:4,500
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 10
Kheya Ghat
Padma Ghat
Padma Gate Jame Mosque
Jamuna Depo
Meghna Depo
Padma Depo
Burdge Mount
Padma Oil & Power Station
Ward Commissioner's House
Rail Junction
Play Ground
Ebadullah Panjeki Jame Mosque
North Kashipur Eidgah
North Kashipur Jame Mosque
North Kashipur Govt. Primary School
KCC 07
Latitude: 2530620.85
Longitude: 758637.12
RL (mMSL): 3.927
UPHCS
Flour Mill
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
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SHELTECH
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618

4.1.8 Detailed Drainage Plan of Ward 08

Ward No. 08 is situated on the bank of the Bhairab River, where minimum spot height is 3.30m PWD, maximum height is found 4.89m PWD and the average height is 3.91m PWD. The natural slope is from BIDC Road to the Bhairab River.

The present condition of existing drains in this Ward is poor. There is about 7,520m pucca drains in this Ward. All the drains of this Ward are connected with nearby natural canals. The total length of natural canals is about 665m. Details have been presented in the **Table-4.29**.

Table- 4.29: Existing Drainage Network in Ward 08

Drainage Category	Existing Length (m)
Natural Canal	664.64
Pucca Drain	7,519.85
Total	**8,184.49**

Three jute industries are located in this area having their own drainage facilities. This is why only the primary drainage systems have been considered for future drainage development. About 5,211m drainage network have been proposed by the Consultant in Ward 08. Out of this, total network of about 251m will be new. About 4,922m, 235m and 54m primary, secondary and tertiary drains have been proposed in this Ward respectively (**Table-4.30**). Proposed Drainage network of Ward 08 has been given in **Map- 4.8**.

No drain is in good condition in this ward. Reconstruction of 2,124m drains and construction of about 196m new drains have been proposed. A total of 235m secondary drains have been recommended in the Ward 08. About 55m drains have been proposed for reconstruction. Tertiary drain in Ward 08 is about 54m where construction of 54m reconstruction drains have been proposed.

Table- 4.30: Proposed Drainage Network in Ward 08

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Total
New	196.74	54.50	0.00	**251.24**
OK/Repair	2,600.31	180.68	0.00	**2,780.99**
Reconstruction	2,124.84	0.00	54.12	**2,178.96**
Total	**4,921.89**	**235.17**	**54.12**	**5,211.19**

The area is located on the bank of the river Bhairab where gravity drainage system is more applicable. That's why the entire primary drains outfall is proposed along the Bhairab River. The primary drain named "BH-P22E" and "BH-P23W" started from the BIDC Road passing through the Peoples Jute Mill and falls into the Bhairab River. The drains "BH-P23E", "BH-P24" and "BH-P25N" & "BH-P25S" started from Khalishpur Jute Mill, BIDC Road and Crecent Jute Mill respectively. All of these proposed primary drains finally fall into the Bhairab River. Almost all of the secondary and tertiary drains within this Ward are connected to primary drains. Details have been presented in **Table- 4.31 and Map- 4.8**.

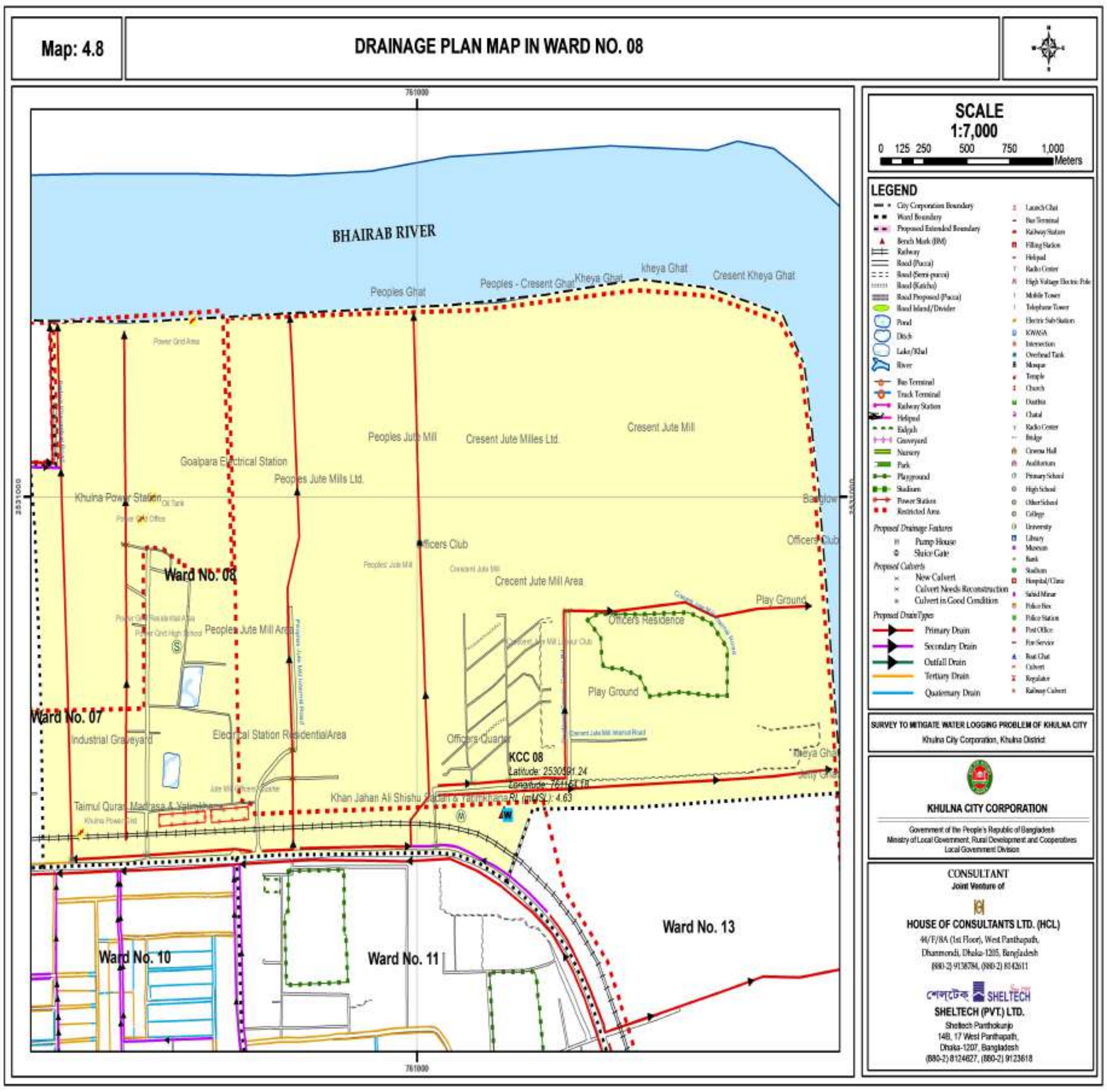
Table- 4.31: Proposed Primary Drainage System in Ward 08

Name of the Drain	Name of the Road		Outfall Drain
	Start	End	
BH-P22E & BH-P23W	BIDC Road	Bhairab River	Bhairab River
BH-P23E	Khalishpur Jute Mill	Bhairab River	Bhairab River
BH-P24	BIDC Road, West side of Crecent Jute Mill	Bhairab River	Bhairab River
BH-P25N & BH-P25S	Crecent Jute Mill Internal Road	Bhairab River	Bhairab River

A small number of culverts have been proposed in Ward 08. Total number of proposed culverts are 9 where, repairable and reconstruction are 6 and 3 respectively. (**Table- 4.32**).

Table- 4.32: Proposed Culverts in Ward 08

Culvert	New	OK/Repair	Reconstruction	Total
Number	0	6	3	**9**



Map: 4.8
DRAINAGE PLAN MAP IN WARD NO. 08
SCALE
1:7,000
0 125 250 500 750 1,000
Meters
LEGEND
BHAIRAB RIVER
Peoples Ghat
Peoples - Cresent Ghat
Kheya Ghat
Cresent Kheya Ghat
Peoples Jute Mill
Cresent Jute Milles Ltd.
Cresent Jute Mill
Goalpara Electrical Station
Peoples Jute Mills Ltd.
Khulna Power Station
Officers Club
Ward No. 08
Cresent Jute Mill Area
Play Ground
Officers Residence
Peoples Jute Mill Area
Ward No. 07
Industrial Graveyard
Electrical Station ResidentialArea
Officers Quarter
KCC 08
Taimul Quran Madrasa & Yatimkhana
Ward No. 10
Ward No. 11
Ward No. 13
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Ministry of Local Government, Rural Development and Cooperatives
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4.1.9 Detailed Drainage Plan of Ward 09

Ward No. 09 is located between the Jessore Road and Bastuhara Khudir Khal. Major part of the western side of this area is ditch or low land where minimum spot height is about -2.19m PWD, maximum spot height is 4.02m PWD and the average spot height is 0.83m PWD. The natural slope is from Jessore road to Bastuhara and Khudir Khal.

There are about 50,548m pucca drains and 2,486m natural canals in Ward 09. All the drains in this Ward are connected with to canals. Details have been presented in the **Table-4.33**.

Table- 4.33: Existing Drainage Network in Ward 09

Drainage Category	Existing Length (m)
Natural Canal	2,486.02
Pucca Drain	50,548.73
Total	**53,034.75**

About 70,312m drainage network has been proposed in this Ward 09, where newly proposed drains are about 21,504m. The proposed primary, secondary, tertiary and quaternary drains in this Ward are about 5,247m, 16,192m, 36,514m and 9,859m respectively (**Table-4.34**). Proposed drainage network is presented in **Map- 4.9**.

Reconstruction of about 3,257m drains and construction of about 1,598m new drains have been proposed. About 7,670m and 2,630m secondary drains have been proposed for reconstruction and new construction respectively. Proposal for construction of 10,139m new tertiary and 4,635m quaternary drains have also been recommended.

Table- 4.34: Proposed Drainage Network in Ward 09

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	2,500.36	1,598.28	2630.16	10,139.02	4,635.71	**21,503.53**
OK/Repair	0.00	391.92	5,892.06	21,999.34	4,912.75	**33,196.06**
Reconstruction	0.00	3,256.83	7,669.78	4,375.18	310.46	**15,612.25**
Total	**2,500.36**	**5,247.03**	**16,192.01**	**36,513.53**	**9,858.92**	**70,311.85**

The consultants have proposed three primary drains that are M-P2, M-P3 and M-P3-P2. The drain “M-P2” start from north side of Khalishpur Road No. 19 (Ward No 10) passing along the Road No. 11 (Ward No 10), east side of Jessore Road, north side of Mujgunni Housing Main Road falls into outfall canal (Mayur Khal) “M” through Bastuhara Khal . The primary drain named “M-P3” started from right side corner of New Market Road (Ward No12) passing along the west side of BIDC Road, south side of Mujgunni Main Road, Mujgunni Housing Main Road finally falls into the outfall canal (Mayur Khal) “M”. The drain “M-P3-P2” started from the west side of Jessore Road passing along the north side of Mujgunni Main Road finally falls into the outfall drain “M-P3” at the east side of Mujgunni Moha Sarak. All secondary and tertiary drains are connected to primary drains. Details presented in **Table- 4.35 and Map- 4.9**.

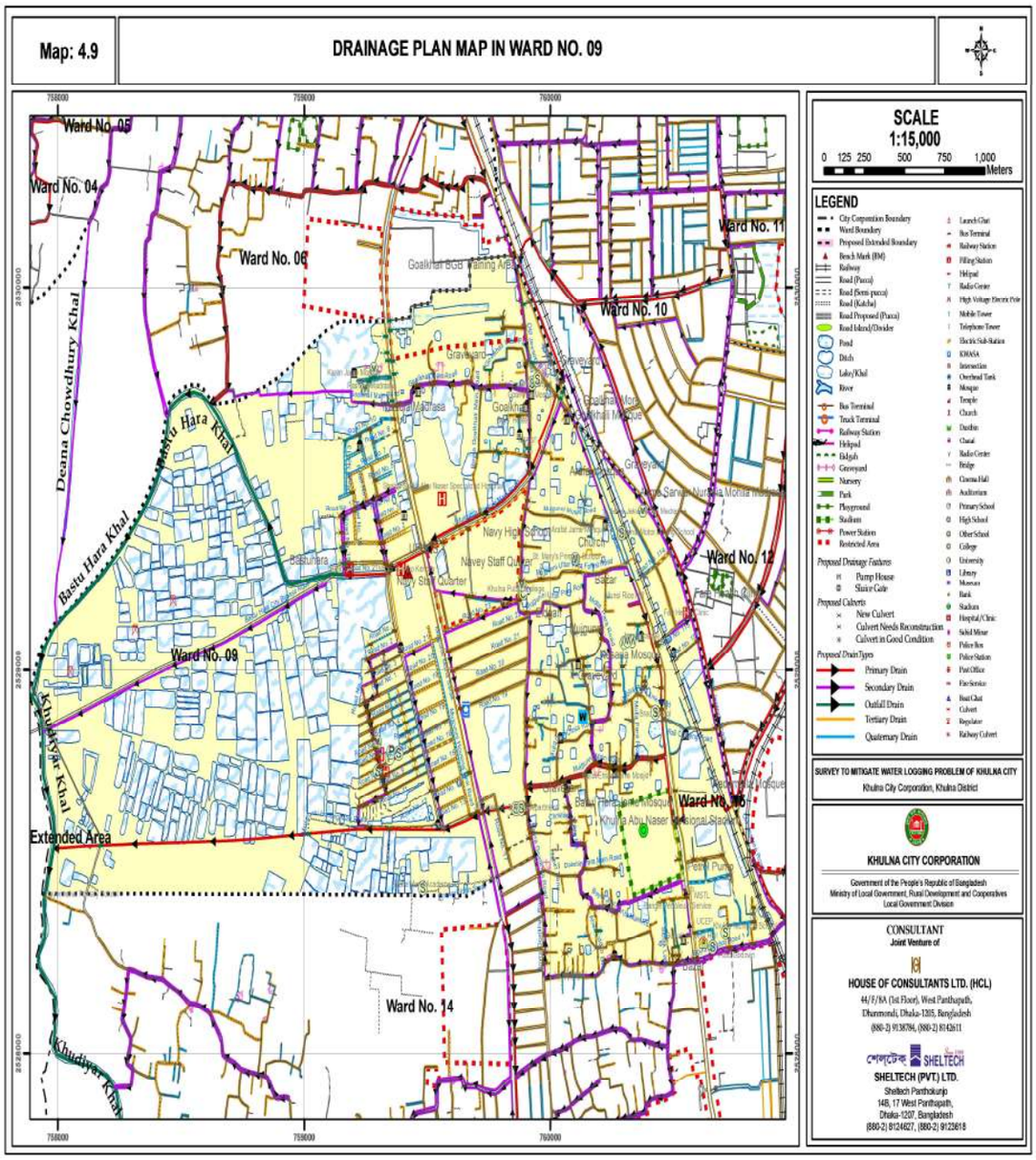
Table- 4.35: Proposed Primary Drainage System in Ward 09

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P2	Khalishpur Road No. 19 (Ward No 10)	Road No. 11 (Ward No 10), Jessore Road, Mujgunni Housing Main Road	Bastuhara Khal	M
M-P3	New Market Road (Ward No12)	BIDC Road, Mujgunni Main Road, Mujgunni Housing Main Road	Mayur Khal	M-P2
M-P3-P2	Jessore Road	Mujgunni Main Road	East side of Mujgunni Moha Sarak	M-P3

A large number of culverts (160 nos.) have been proposed for repair, reconstruction and newly construction in Ward 09. These have been presented in **Table- 4.36**.

Table- 4.36: Proposed Culverts in Ward 09

Culvert	New	OK/Repair	Reconstruction	Total
Number	57	72	88	**217**


Map: 4.9
DRAINAGE PLAN MAP IN WARD NO. 09
Ward No. 05
Ward No. 04
Ward No. 06
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 09
Ward No. 15
Ward No. 14
Extended Area
Deana Chowdhury Khal
Basta Hara Khal
Khudiyar Khal
SCALE
1:15,000
0 125 250 500 750 1,000
Meters
LEGEND
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
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4.1.10 Detailed Plan of Ward 10

Ward 10 is the central part of Khulna City located in between Old Jessore Road on the west, BIDC Road on the north and Khalishpur Road no. 18 on the east. This area is a part of Khalishpur planned residential area where minimum, maximum and average spot height is about 1.53m PWD 3.84m PWD and 3.23m PWD respectively. The natural slope maintains from BIDC road to Old Jessore Road.

There are a numbers of pucca drains in this Ward, connected to existing natural canals. Details have been presented in the **Table-4.37**.

Table- 4.37: Existing Drainage Network in Ward 10

Drainage Category	Existing Length (m)
Natural Canal	476.12
Pucca Drain	35,677.54
Total	**36,153.66**

In this Ward, about 4,013m, 7,540m, 20,604m and 5,605m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.38**). Considering rapid growth of population in this Ward, the consultant proposed 37,762m drainage network that includes about 3,280m new drains. Proposed drainage network of Ward 10 has been shown in **Map- 4.10**.

Reconstruction of 3,143m and construction of 84m new primary drains have been proposed there. A total of 7,540m secondary drains have been recommended in which about 1,977m and 398m drains are for reconstruction and new construction respectively. Tertiary drains in Ward 10 are about 20,604m where construction of 2,051m new drains have also been proposed.

Table- 4.38: Proposed Drainage Network in Ward 10

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	84.14	397.67	2,050.86	748.03	**3,280.69**
OK/Repair	786.53	5,165.15	17,183.28	4,789.28	**27,924.24**
Reconstruction	3,142.78	1,976.65	1,369.52	67.69	**6,556.65**
Total	**4,013.45**	**7,539.47**	**20,603.66**	**5,604.99**	**37,761.58**

The proposed primary drain “BH-P21” starts from the east side of New Market Road (Ward No. 11) passed along the left side of BIDC Road and right side of BL College Road and finally falls into the Bhairab River. The drain naming “M-P2-P1” starts from south corner of khalishpur Road No. 26 passed along the west side of Road No. 18, south side of Road No. 19 and finally falls into the outfall drain “M-P2” at Road No. 11. The drain “M-P2” started from north side of khalishpur Road No. 19 passing along the Road No. 11, east side of Jessore Road, north side of Mujgunni Housing Main Road (Ward No 09) falls into outfall canal (Mayur Khal) “M” through Bastuhara Khal. The another primary drain “M-P2-P1-P1” starts from west side of Road No. 16 passing along the east side of Old Jessore Road and Road No. 11 finally falls into the outfall drain “M-P2-P1” at south side of Road No. 19. Most of the secondary and tertiary drains are connected to these primary drains proposed by the consultant. Details have been presented in **Table- 4.39 and Map- 4.10**.

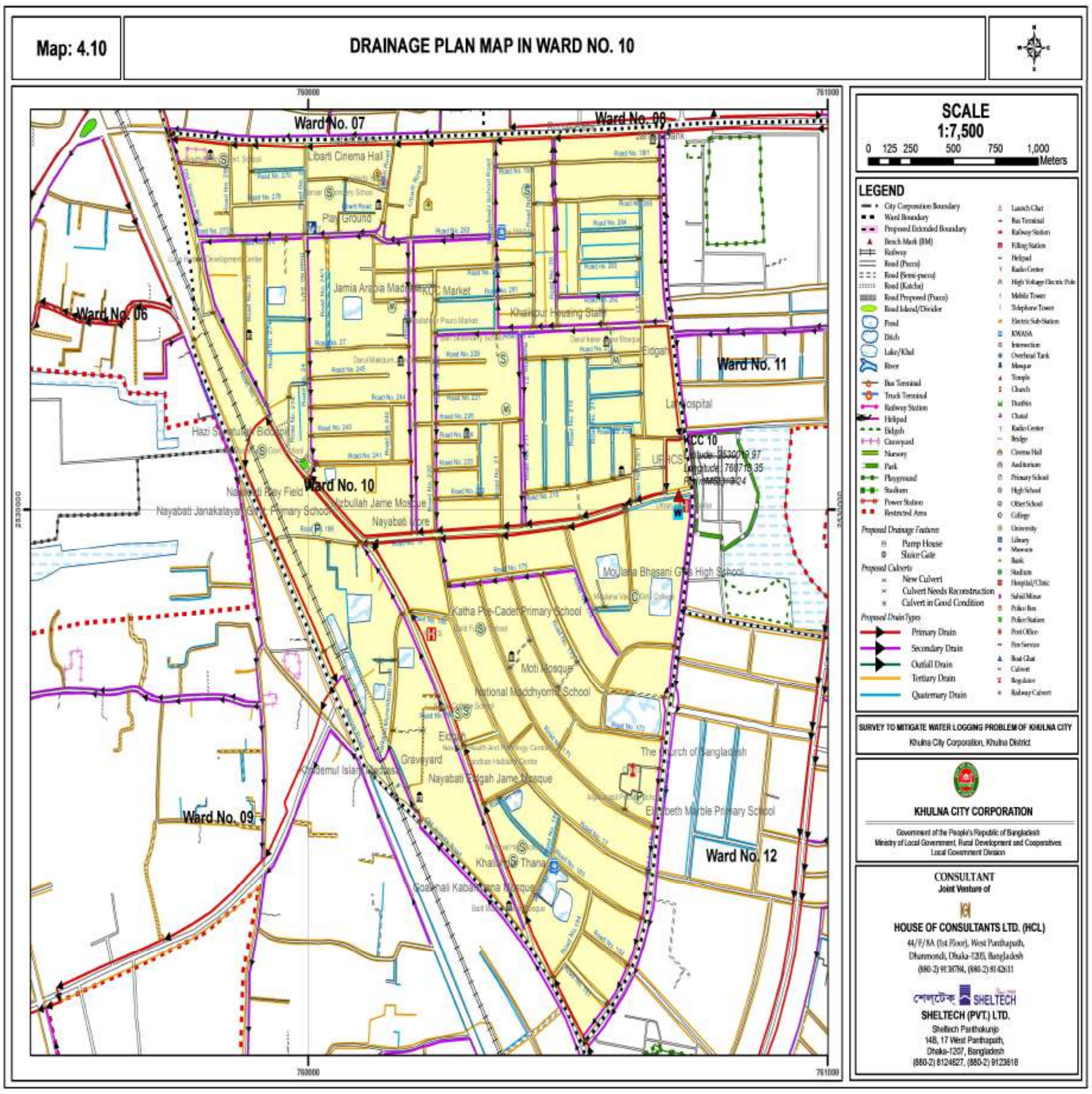
Table- 4.39: Proposed Primary Drainage System in Ward 10

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
BH-P21	East side of New Market Road (Ward No 11)	Left side of BIDC Road, Right side of B L College Road	Bhairab River	Bhairab River
M-P2-P1	Khalishpur Road No. 26	West side of Road No. 18, South side of Road No. 19	Road No. 11	M-P2
M-P2	Khalishpur Road No. 19	Road No. 11, Jessore Road, Mujgunni Housing Main Road, Bastuhara Khal	Mayur Khal	M
M-P2-P1-P1	West side of Road No. 16,	East side of Old Jessore Road and Road No. 11	South side of Road No. 19	M-P2-P1

There are a large number of culverts in Ward 10. Most of these should be repaired or reconstructed. Consultant proposed 41nos. new culverts for construction in this Ward (**Table- 4.40**).

Table- 4.40: Proposed Culverts in Ward 10

Culvert	New	OK/Repair	Reconstruction	Total
Number	41	70	31	**142**


Map: 4.10
DRAINAGE PLAN MAP IN WARD NO. 10
SCALE
1:7,500
0 125 250 500 750 1,000 Meters
LEGEND
Ward No. 07
Ward No. 08
Ward No. 06
Ward No. 10
Ward No. 11
Ward No. 09
Ward No. 12
Play Ground
Graveyard
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
CONSULTANT
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4.1.11 Detailed Drainage Plan of Ward 11

This Ward is the central part of the Khulna City, with Khalishpur Road No 18 on the west and BIDC Road on the north. The area is also a part of Khalishpur planned residential area. The minimum spot height of this area is about 0.00m PWD, Maximum spot height is 4.18m PWD and the average spot height is about 3.64m PWD. The natural slope moves from BIDC road to Khalishpur Road No. 18.

There is about 11,890m pucca drain and about 661.32m natural canals in this Ward. All the drains are connected to natural canals in and around the Ward. Details presented in the **Table-4.41**.

Table- 4.41: Existing Drainage Network in Ward 11

Drainage Category	Existing Length (m)
Natural Canal	661.32
Pucca Drain	11,890.11
Total	**12,551.43**

Total 9,404m drainage network have been proposed in Ward 11, which includes 684m new drains of different catagories. About 1,828m, 1,405m, 4,210m and 1,961m primary, secondary, tertiary and quaternary drains have been proposed in this Ward respectively (**Table-4.42**). Proposed drainage network of Ward 11 has been presented in **Map- 4.11**.

Reconstruction of 911m drains and construction of 76m new primary drains have been proposed. About 590m and 9.50m secondary drains have been proposed for reconstruction and new construction respectively. Construction of 181m new drains have been proposed apart from existing 4,210m drain.

Table- 4.42: Proposed Drainage Network in Ward 11

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	75.89	9.52	180.75	417.67	**683.83**
OK/Repair	841.74	805.33	3,362.71	1,543.63	**6,553.42**
Reconstruction	910.56	589.99	666.74	0.00	**2,167.29**
Total	**1,828.19**	**1,404.84**	**4,210.21**	**1,961.31**	**9,404.54**

A number of primary, secondary and tertiary drains have been proposed in this Ward that fall into the Bhairab River. The proposed primary drain “BH-P21” passing along the left side of BIDC Road, right side of BL College Road and finally falls into the Bhairab River. The drain “M-P2-P1-P1” started from the west side of Road No. 16 passing along the east side of Old Jessore Road and Road No. 11 and finally falls into the outfall drain “M-P2-P1” at the south side of Road No. 19. The primary drain naming “M-P3-P1” started from the east side of Road No. 16 passing along the east side of Old Jessore Road and finally falls into the outfall drain “M-P3” at Kodomtola More. 19. Existing all other drains like secondary and tertiary are connected to these primary drains. Details have been presented in **Table- 4.43 and Map-4.11**.

Table- 4.43: Proposed Primary Drainage System in Ward 11

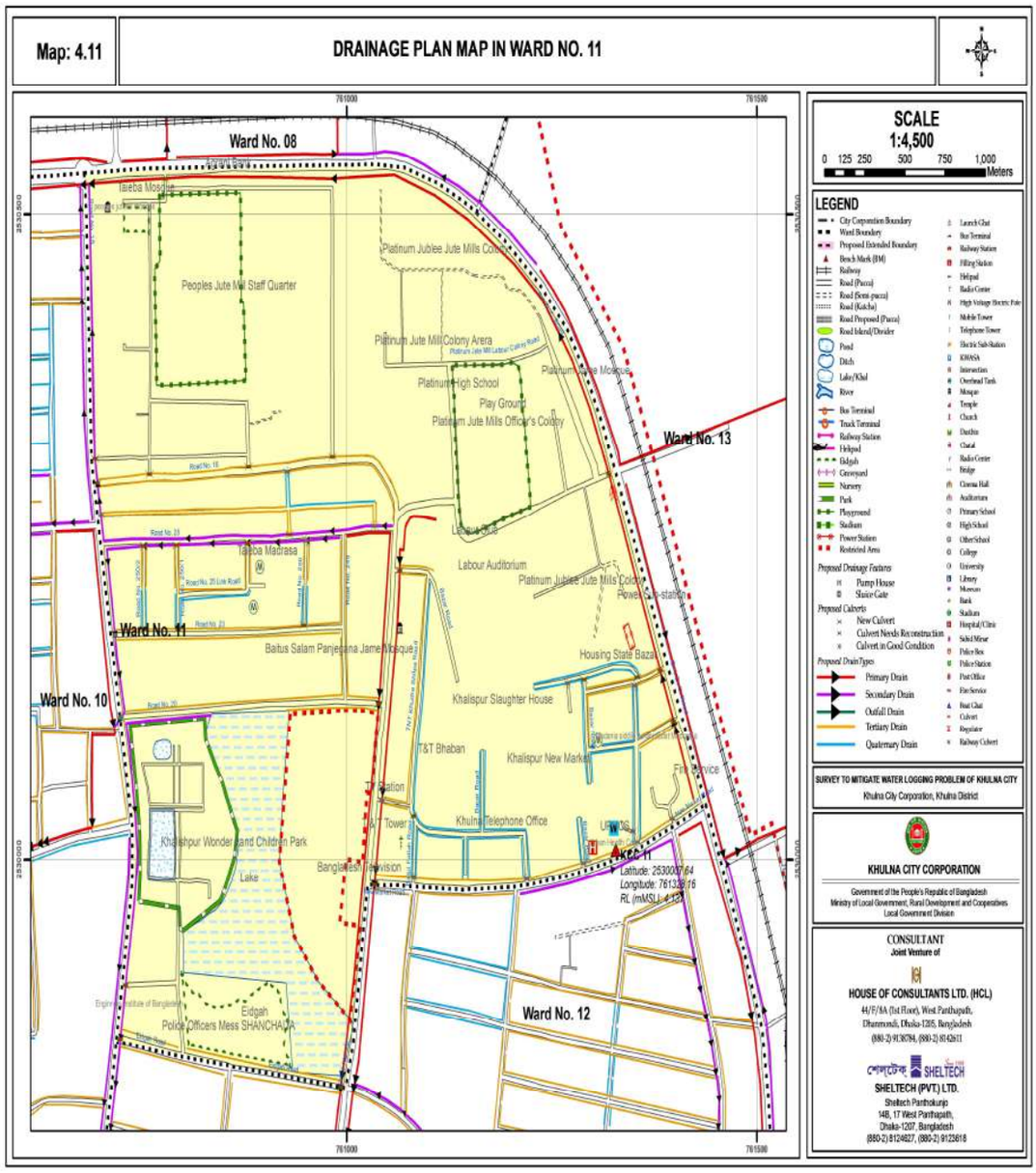
Name of the	Name of the Road	Outfall Drain

Drain	Start	Passing Along	End	
BH-P21	East side of New Market Road (Ward No. 11)	Left side of BIDC Road, Right side of B L College Road	Bhairab River	Bhairab River
M-P3-P1	East side of Road No. 16,	East side of Old Jessore Road	Kodomtola More	M-P3
M-P2-P1-P1	West side of Road No. 16,	East side of Old Jessore Road and Road No. 11	South side of Road No. 19	M-P2-P1

There exist total 30 numbers of culverts in Ward 11 which are not working properly. About 21 and 8 culverts have been proposed for reconstruction and new construction respectively (**Table- 4.44**).

Table- 4.44: Proposed Culverts in Ward 11

Culvert	New	OK/Repair	Reconstruction	Total
Number	8	21	9	**38**


Map: 4.11
DRAINAGE PLAN MAP IN WARD NO. 11
Ward No. 08
Ward No. 13
Ward No. 11
Ward No. 10
Ward No. 12
Taiebs Mosque
Peoples Jute Mill Staff Quarter
Platinum Jubilee Jute Mills Colony
Platinum Jute Mill Colony Arera
Platinum High School
Play Ground
Platinum Jute Mills Officer's Colony
Labour Club
Labour Auditorium
Platinum Jubilee Jute Mills Colony
Power Sub-station
Taiba Madrasa
Baitus Salam Panjegana Jame Mosque
Housing State Bazar
Khalispur Slaughter House
T&T Bhaban
Khalispur New Market
Fire Service
TV Station
BTV Tower
Khulna Telephone Office
Khalispur Wonderland Children Park
Lake
Bangladesh Television
Eidgah
Police Officers Mess SHANCHAYA
AKCC-11
Latitude: 263000.64
Longitude: 761338.76
RL (mMSL): 4.137
761000
761500
2630500
2630000
SCALE
1:4,500
0 125 250 500 750 1,000
Meters
LEGEND
City Corporation Boundary
Ward Boundary
Proposed Extended Boundary
Bench Mark (BM)
Railway
Road (Pucca)
Road (Semi-pucca)
Road (Kaccha)
Road Proposed (Pucca)
Road Island/Divider
Pond
Ditch
Lake/Khal
River
Bus Terminal
Truck Terminal
Railway Station
Helipad
Eidgah
Graveyard
Nursery
Park
Playground
Stadium
Power Station
Restricted Area
Proposed Drainage Features
Pump House
Sluice Gate
Proposed Culverts
New Culvert
Culvert Needs Reconstruction
Culvert in Good Condition
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
Launch Ghat
Bus Terminal
Railway Station
Filling Station
Helipad
Radio Center
High Voltage Electric Pole
Mobile Tower
Telephone Tower
Electric Sub-Station
KWASA
Intersection
Overhead Tank
Mosque
Temple
Church
Dustbin
Chatal
Radio Center
Bridge
Cinema Hall
Auditorium
Primary School
High School
Other School
College
University
Library
Museum
Bank
Stadium
Hospital/Clinic
Solid Mirse
Police Box
Police Station
Post Office
Fire Service
Boat Chat
Culvert
Regulator
Railway Culvert
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4.1.12 Detailed Drainage Plan of Ward 12

Ward 12 is located between the BIDC Road on the east and Khalishpur Road No 18 on the west. This area is in the center part of the Khulna City and a part of Khalishpur planned residential area. The minimum, maximum and average spot height is about 3.01m PWD, about 3.94m PWD and about 3.48m PWD respectively.

There is about 2,3242m pucca drains in this Ward. The existing drains are connected with nearby natural canal within the Ward. There are about 489m natural canals in this ward. Details have been presented in the **Table-4.45**.

Table- 4.45: Existing Drainage Network in Ward 12

Drainage Category	Existing Length (m)
Natural Canal	489.45
Pucca Drain	23,241.69
Total	**23,731.14**

The Consultants have proposed for development of about 28,204m drainage network in Ward 12. Out of this total network, about 7,736m new drains have been proposed. Proposed primary, secondary, tertiary and quaternary drains are about 4,357m, 3,539m, 17,817m and 2,491m respectively (**Table-4.46**). Proposed Drainage network in Ward 12 has been slow in **Map- 4.12**.

Most primary drains in Ward 12 that need for up gradation. As such, about 2,888m and 128m primary drains have been proposed for reconstruction new construction respectively. Similarly, a total of 3,539m secondary drains have been recommended in which about 1,711m drains for reconstruction and 955m drains have been proposed for new construction. Existing tertiary drain is about 17,817m and additional 5,960m new tertiary drain have been proposed.

Table- 4.46: Proposed Drainage Network in Ward 12

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	128.80	954.97	5,959.86	692.12	**7,735.75**
OK/Repair	1,340.00	872.63	10,520.76	1,589.90	**14,323.31**
Reconstruction	2,888.27	1,711.12	1,336.35	208.85	**6,144.59**
Total	**4,357.07**	**3,538.73**	**17,816.97**	**2,490.87**	**28,203.64**

Development proposal for primary drainage system of Ward 12 is described in **Table-4.47**. The primary drain naming “M-P3” started from the right side corner of New Market Road (Ward No12) that passing along the west side of BIDC Road, south side of Mujgunni Main Road, Mujgunni Housing link Road and finally falls into the Mayur Khal “M”. The drain “M-P2-P1-P1” started from west side of Road No. 16 passing along the east side of Old Jessore Road and Road No. 11 and falls into the outfall drain “M-P2-P1” at the south side of Road No. 19. The primary drain named “M-P3-P1” started from the east side of Road No. 16 passing along the east side of Old Jessore Road and falls into the outfall drain “M-P3” at Kodomtola More. Details presented in **Table- 4.47** and shown in **Map- 4.12**.

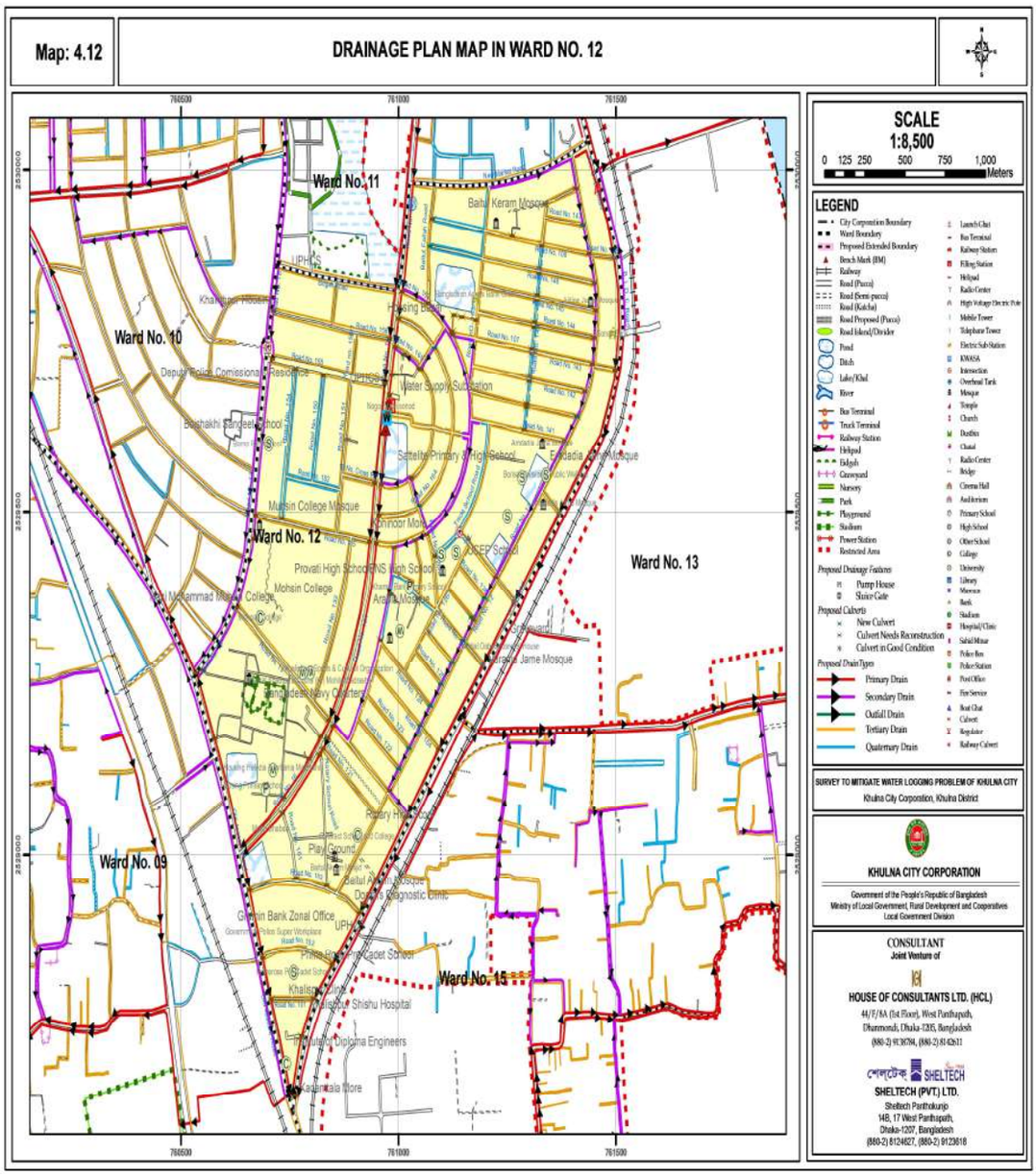
Table- 4.47: Proposed Primary Drainage System in Ward 12

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P3	New Market Road (Ward No12)	BIDC Road, Mujgunni Main Road, Mujgunni Housing Main Road	Bastuhara Khal	M (Mayur Khal)
M-P3-P1	East side of Road No. 16,	East side of Old Jessore Road	Kodomtola More	M-P3
M-P2-P1-P1	West side of Road No. 16	East side of Old Jessore Road and Road No. 11	South side of Road No. 19	M-P2-P1

The consultants have identified total 68 numbers of culverts in Ward 12 and also proposed for construction of 42 nos. of new culverts. As the condition of existing culverts is very poor 46 number and 42 nos. of culverts for reconstruction and new construction respectively have been recommended (**Table-4.48**).

Table- 4.48: Proposed Culverts in Ward 12

Culvert	New	OK/Repair	Reconstruction	Total
Number	42	22	46	**110**


Map: 4.12
DRAINAGE PLAN MAP IN WARD NO. 12
SCALE
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Meters
LEGEND
Ward No. 09
Ward No. 10
Ward No. 11
Ward No. 12
Ward No. 13
Ward No. 15
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
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4.1.13 Detailed Drainage Plan of Ward 13

Ward No 13 is in the eastern part of the Khulna City with the Khalishpur BIDC Road on the west and BIDC Road on the east. This area is located on the bank of the Bhairab River, where minimum spot height is found about 2.50m PWD, maximum spot height about 4.76m PWD and the average spot height about 3.51m PWD. The natural slope is from BIDC Road to the Bhairab River.

There exist about 9,427m pucca drain and about 1,789m natural canals in this Ward. All catagories of drains are connected with nearby natural canals in and around the Ward. Details have been presented in the **Table-4.49**.

Table- 4.49: Existing Drainage Network in Ward 13

Drainage Category	Existing Length (m)
Natural Canal	1,788.98
Pucca Drain	9,426.60
Total	**11,215.58**

About 11,777m drainage network development has been proposed by the Consultant in Ward 13. Proposed primary, secondary, tertiary and quaternary drains in this Ward are about 5,152m, 1,224m, 3,818m and 1,584m respectively (**Table-4.50**). It covers about 3,517m new drains for further development. Proposed drainage network of Ward 13 has been presented in **Map- 4.13**.

Condition of existing primary drains in Ward 13 is unserviceable. Reconstruction of 2,338m drains and construction of 1,122m new primary drains have been proposed. In this Ward, about 277m and 129m secondary drains have been proposed for reconstruction and new construction respectively. Proposed tertiary drains that need to be constructed newly is about 1,794m.

Table- 4.50: Proposed Drainage Network in Ward 13

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,122.26	128.81	1,794.32	471.32	**3,516.71**
OK/Repair	1,691.69	817.96	1,291.03	825.54	**4,626.21**
Reconstruction	2,337.71	277.15	732.38	286.84	**3,634.08**
Total	**5,151.66**	**1,223.92**	**3,817.73**	**1,583.70**	**11,777.01**

Khulna Newsprint Mill and Hardboard Industry are located in this area with their own drainage facilities which are playing an important role as primary drains of its surroundings. The proposed primary drain naming “M-P3-P1A” started in front of Khulna News Print Mill, passing along the east side of BIDC Road and falls into the outfall Drain “M-P3” at Kodomtola More. The primary drain naming “BH-P28N” and “BH-P28S” pass along the north side of Charerhat Main Road and south side of Charerhat Main Road respectively. Both finally fall into the Bhairab River. Another two primary drains “BH-P29N” and “BH-P29S” also fall into the Bhairab River at the place of Khalishpur Shashan Ghat. All the existing secondary and tertiary drains are connected with these primary drains. Details have been described in **Table- 4.51** and presented **Map- 4.13**.

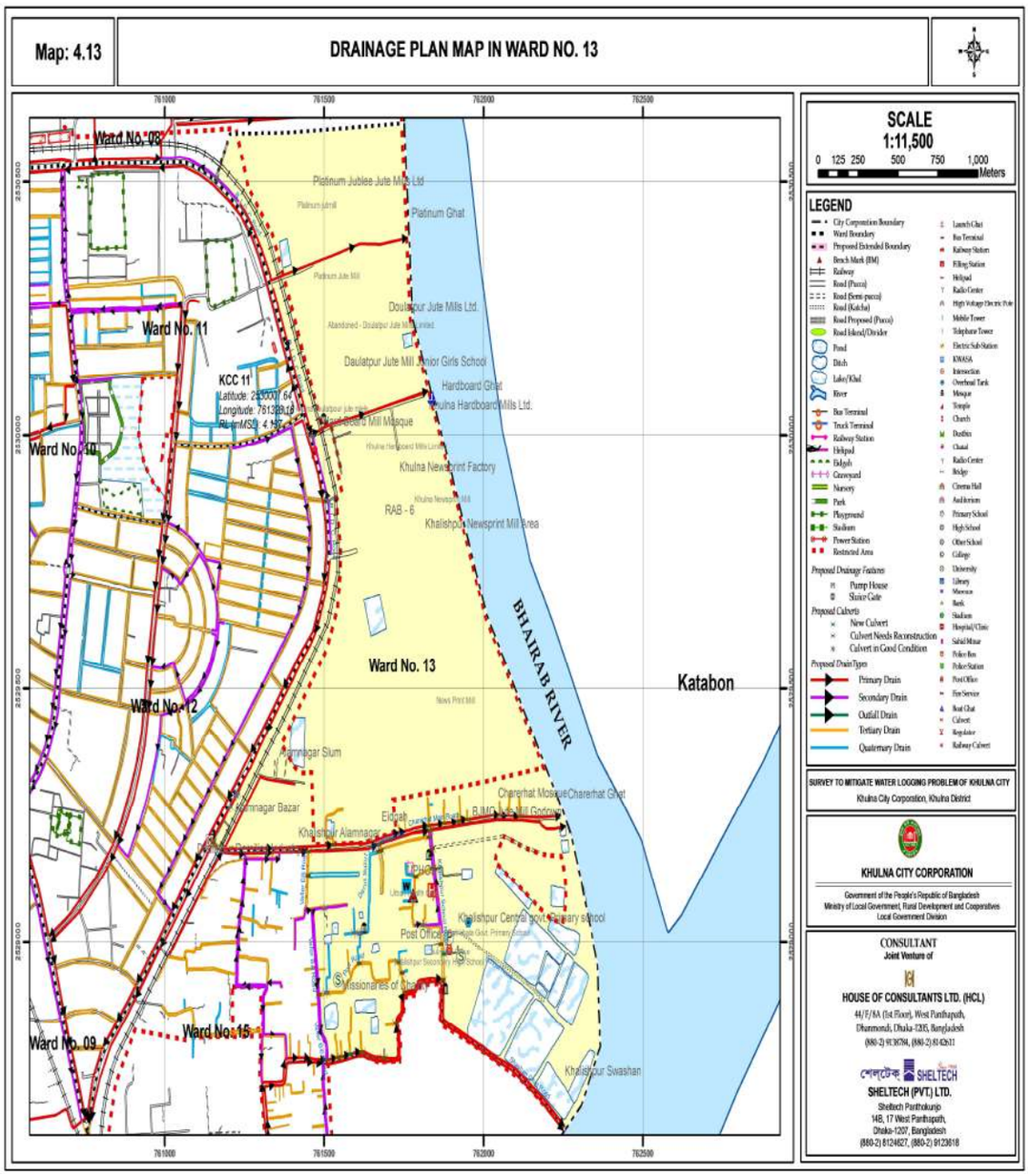
Table- 4.51: Proposed Primary Drainage System in Ward 13

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P3-P1A	Front of Khulna News Print Mill	East side of BIDC Road	Kodomtola More	M-P3
BH-P28N & BH-P28S	Charerhat Main Road		Bhairab River	Bhairab River
BH-P29N & BH-P29S	Polytechnic Institute gate	Rath Khola Road, Polytechnic College Road, Khalishpur School Road, Shashan Ghat Road	Bhairab River	Bhairab River

Only 25 culverts are found in Ward 13. Number of proposed culverts for new construction, reconstruction and repair are 13, 11 and 14 respectively (**Table- 4.52**).

Table- 4.52: Proposed Culverts in Ward 13

Culvert	New	OK/Repair	Reconstruction	Total
Number	13	14	11	**38**


Map: 4.13
DRAINAGE PLAN MAP IN WARD NO. 13
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Meters
LEGEND
Ward No. 08
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 13
Ward No. 15
Ward No. 09
Katabon
BHAIRAB RIVER
Platinum Jubilee Jute Mills Ltd
Platinum Ghat
Doulatpur Jute Mills Ltd.
Daulatpur Jute Mill Junior Girls School
Hardboard Ghat
Khulna Hardboard Mills Ltd.
Khulna Newsprint Factory
RAB - 6
Khalishpur Newsprint Mill Area
Khalishpur Alamnagar
Khalishpur Central govt. Primary school
Khalishpur Swashan
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KHULNA CITY CORPORATION
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Ministry of Local Government, Rural Development and Cooperatives
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4.1.14 Detailed Drainage Plan of Ward 14

This Ward is situated in the western part of the Khulna City, located in between the Old Jessore Road and Khudir Khal. Major part of the western side of this ward is ditch or low land, where minimum spot height is about -1.17m PWD, maximum spot height 4.27m PWD and the average spot height is about 1.78m PWD. The natural slope is from Jessore road to Khudir Khal.

There is 2,282m natural canals in Ward 14.The length of existing pucca drains is about 41,229m. All the drains in this ward are connected with nearby natural canals. Details presented in the **Table-4.53**.

Table- 4.53: Existing Drainage Network in Ward 14

Drainage Category	Existing Length (m)
Natural Canal	2,282.24
Pucca Drain	41,229.32
Total	**43,511.56**

About 63,300m of different categories drainage network have been proposed by the Consultants in Ward 14. Length of total newly proposed drain is about 20,668m. Primary, secondary, tertiary and quaternary drains have been proposed in this Ward are about 4,322m, 14,656m, 32,730m and 10,311m respectively (**Table-4.54**). Proposed drainage network of Ward 14 has been presented in **Map- 4.14**.

About 2,813m primary drains for have been proposed reconstruction and 895m drains for new constructions. About 8,565m and 311m secondary drains have been proposed for reconstruction and new construction respectively. Existing tertiary drains in Ward 14 are about 14,656m, where construction of 11,227m new drains have been proposed.

Table- 4.54: Proposed Drainage Network in Ward 14

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,282.24	894.93	311.21	11,227.06	6,952.95	**20,668.40**
OK/Repair	0.00	613.69	5,779.53	16,199.12	2,720.91	**25,313.25**
Reconstruction	0.00	2,812.98	8,565.17	5,303.52	636.97	**17,318.64**
Total	**1,282.24**	**4,321.60**	**14,655.91**	**32,729.70**	**10,310.84**	**63,300.29**

There is a proposal for development of two primary drains that with outfall in to Mayur Khal and Boyra Bazar More. One proposed primary drain naming “M-P4” started from C.S.D Godown area passing along the north side of Jalil Saroni, and falls into outfall canal (Mayur Khal) “M” at Raymahal Bazar Road. Another proposed primary drain “M-P4-P1” passing along the east side of Mujgunni Moha Sarak and finally falls into the outfall drain “M-P4” at Boyra Bazar More. Entire secondary and tertiary drains within this ward are connected with these primary drains. Details have been presented in **Table- 4.55, Map-4.14**.

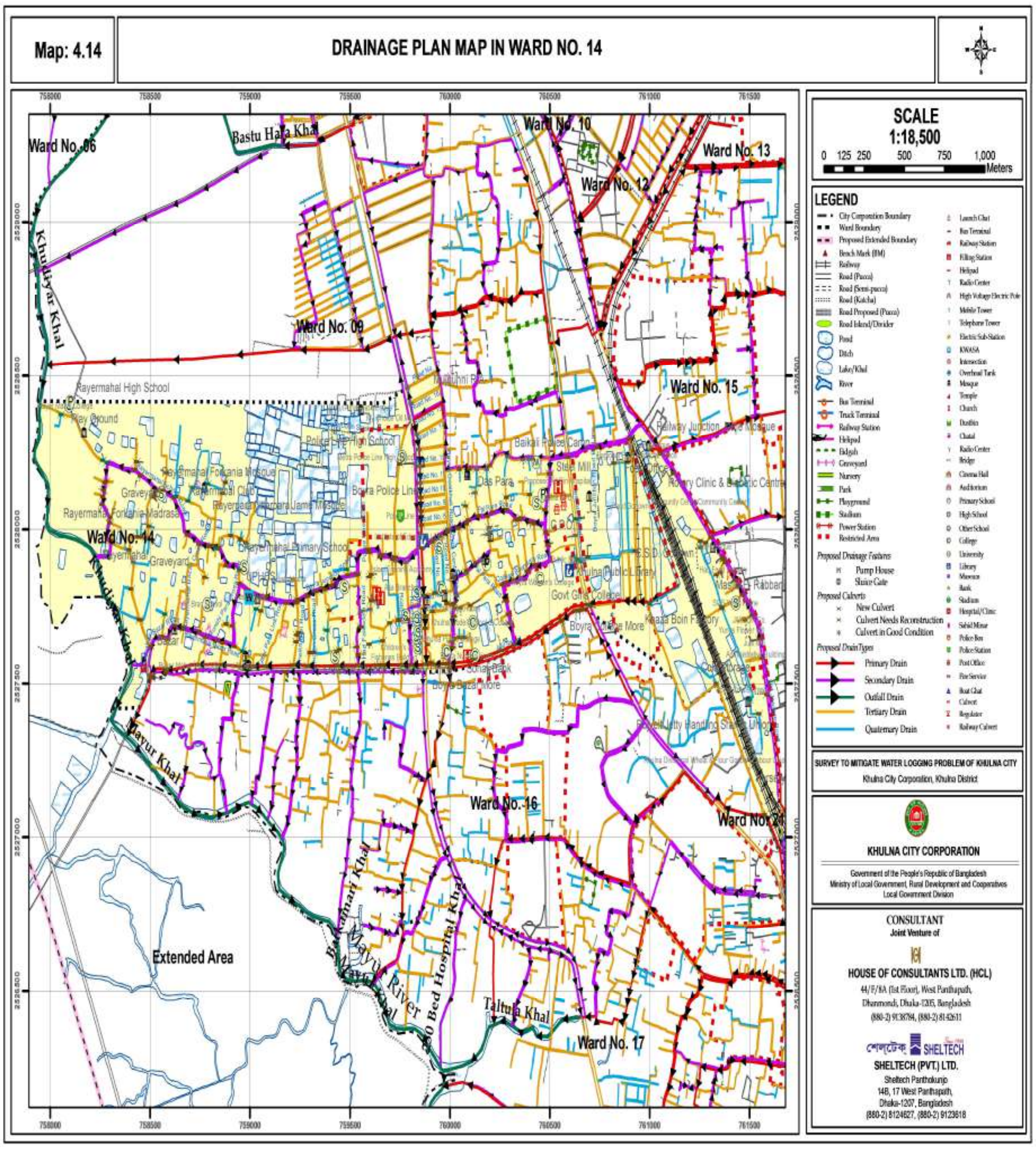
Table- 4.55: Proposed Primary Drainage System in Ward 14

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P4	C.S.D Godown	North side of Jalil Saroni	Mayur Khal	M
M-P4-P1	South side of Boyra Housing Road No. 15	East side of Mujgunni Moha Sarak	Boyra Bazar More	M-P4

There exist a large number of culverts (165 nos.) in Ward 14. Most of these culverts are in a very poor condition and unable to fulfill the future requirement. So the consultant has proposed for construction of about 43 new culverts and reconstruction of 102 existing culverts (**Table- 4.56**).

Table- 4.56: Proposed Culverts in Ward 14

Culvert	New	OK/Repair	Reconstruction	Total
Number	43	63	102	**208**


Map: 4.14
DRAINAGE PLAN MAP IN WARD NO. 14
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Meters
LEGEND
Ward No. 14
Ward No. 09
Ward No. 06
Ward No. 10
Ward No. 12
Ward No. 13
Ward No. 15
Ward No. 16
Ward No. 17
Extended Area
Khudiyar Khal
Bastu Hara Khal
Mayur Khal
Mayur River
Taltula Khal
Rayermahal High School
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Khulna City Corporation, Khulna District
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4.1.15 Detailed Drainage Plan of Ward 15

Ward 15 is located between the Old Jessore Road on the west and Bhairab River on the east. This area is also situated on the bank of the Bhairab River and in the eastern part of the Khulna City. The minimum spot height observed there is about 2.27m PWD, maximum spot height 4.42m PWD and the average spot height is about 3.24m PWD. The natural slope is from Old Jessore Road to the Bhairab River.

As presented in **Table-4.57** that there are about 16,994m pucca drain and about 1,768m natural canal in this Ward. All the drains are connected with natural canals.

Table- 4.57: Existing Drainage Network in Ward 15

Drainage Category	Existing Length (m)
Natural Canal	1,768.47
Pucca Drain	16,944.13
Total	**18,712.60**

The total proposed drainage network in Ward 15 is about 22,388m, where newly drain is about 5,193m. The primary, secondary, tertiary and quaternary drains proposed by the Consultant are 6,237m, 4,223m, 9,748m and 2,180m respectively (**Table-4.58**). Proposed drainage Network of Ward 15 has been presented in **Map- 4.15**.

Existing primary drainage condition in this Ward is very poor. So, about 2,880m primary drains have been proposed for reconstruction and about 970m primary drains for new construction. About 1,488m and 374m secondary drains have been proposed for reconstruction and new construction respectively. Tertiary drains in Ward 15 is about 9,748m, where construction of 2,787m new tertiary drains have been proposed.

Table- 4.58: Proposed Drainage Network in Ward 15

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	969.44	373.56	2,786.59	1,063.47	**5,193.07**
OK/Repair	2,387.50	2,360.77	5,406.05	591.73	**10,746.04**
Reconstruction	2,880.16	1,488.58	1,554.95	525.45	**6,449.14**
Total	**6,237.11**	**4,222.91**	**9,747.59**	**2,180.66**	**22,388.26**

The Office the Mongla Port Authority and Bangladesh Navy are located in this area with their own drainage facilities. A good number of proposed primary drains will pass along the Ward boundary and finally fall in to the Bhairab River. The primary drains naming “BH-P29N” and “BH-P29S” are starts beside the Polytechnic Institute gate (Ward No 15) and passing along the Rath Khola Road (Ward No 15), Polytechnic College Road, Khalishpur School Road, Shashan Ghat Road and falls into the Bhairab River near Khalishpur Shashan Ghat. The primary drain “BH-P30” starts from in front of Khulna Polytechnic Institute More passing along the east side of Old Jessore Road, BNS Titumir Road and falls into the Bhairab River at Bangladesh Navy ghat. Another primary drain named “BH-P31” is starts from in front of Mongla Port Authorities office and passing along the east side of Old Jessore Road, Port Road and also falls into the Bhairab River at Mongla Port Authority and Naval ghat. Detail presented in **Table- 4.59 and Map- 4.15**.

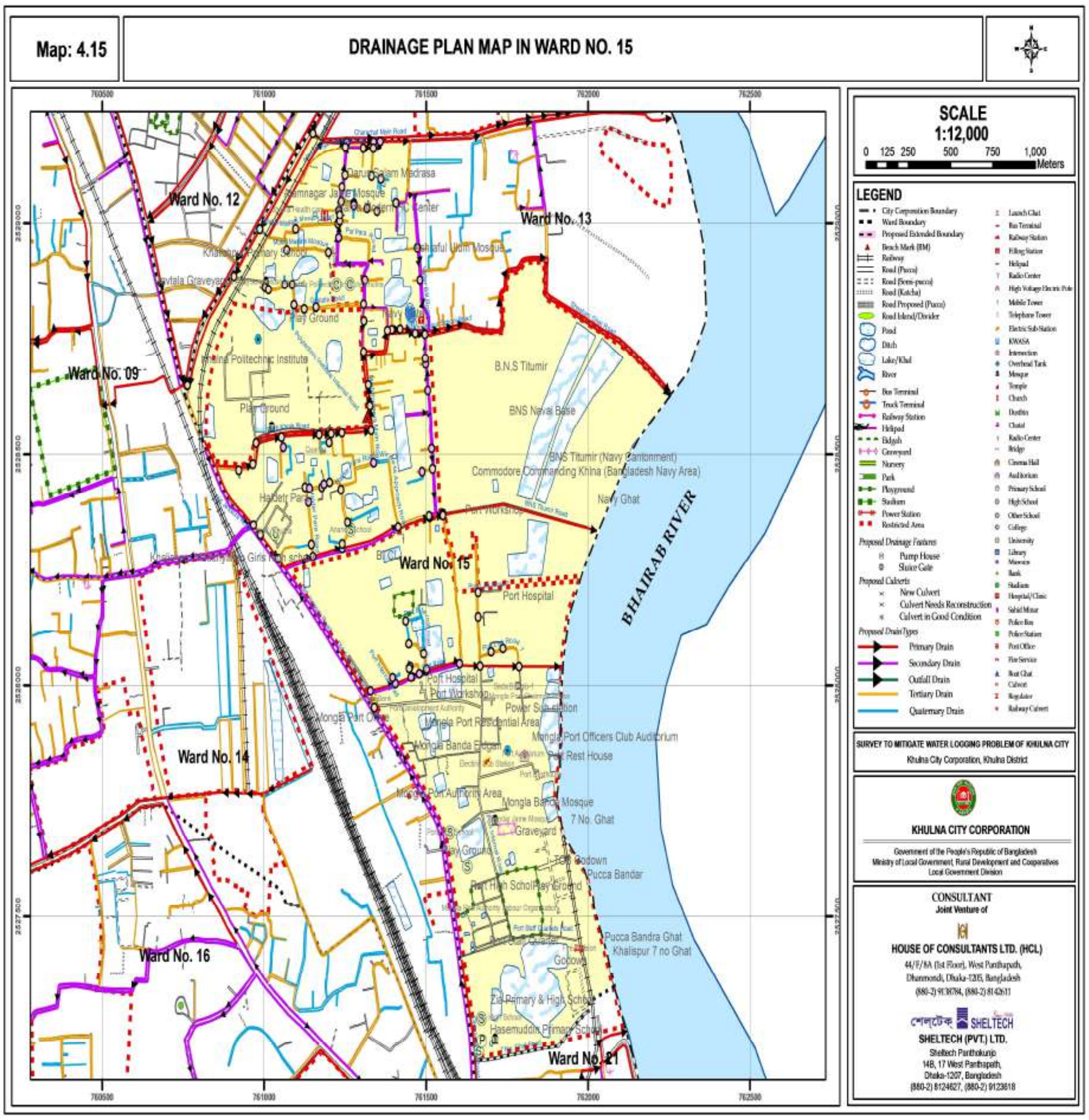
Table- 4.59: Proposed Primary Drainage System in Ward 15

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
BH-P30	Khulna Polytechnic Institute More	East side of Old Jessore Road, BNS Titumir Road	Bhairab River	Bhairab River
BH-P31	In front of Mongla Port Authorities office	East side of Old Jessore Road, Port Road	Bhairab River	Bhairab River
BH-P29N & BH-P29S	Polytechnic Institute gate	Rath Khola Road, Polytechnic College Road, Khalishpur School Road, Shashan Ghat Road	Bhairab River	Bhairab River

The Consultants have recommended 19 new culverts as per future requirement. There exist 60 culverts in this Ward. Most of them have been proposed for repair and reconstruction as per **Table- 4.60**).

Table- 4.60: Proposed Culverts in Ward 15

Culvert	New	OK/Repair	Reconstruction	Total
Number	19	41	19	**79**


Map: 4.15
DRAINAGE PLAN MAP IN WARD NO. 15
SCALE
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0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 12
Ward No. 13
Ward No. 09
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 21
BHAIRAB RIVER
B.N.S Titumir
BNS Naval Base
Port Hospital
Navy Ghat
7 No. Ghat
Pucca Bandar
Graveyard
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
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Khulna City Corporation, Khulna District
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4.1.16 Detailed Drainage Plan of Ward 16

This Ward is the western part of the Khulna City located in between the Old Jessore Road and Mayur Khal. The minimum spot height is about -2.90m PWD, while maximum spot height is 3.46m PWD and the average spot height is about 1.53m PWD. The natural slope usually maintains from Jessore Road to Mayur Khal.

There exist about 2,660m natural canal and about 45,185m pucca drain in this Ward. All the existing drains are connected with nearby natural canals within the Ward. Details have been presented in the **Table-4.61**.

Table- 4.61: Existing Drainage Network in Ward 16

Drainage Category	Existing Length (m)
Natural Canal	2,659.58
Pucca Drain	45,185.34
Total	**43,511.56**

About 64,141m different categories of drainage network have been proposed by the Consultant in Ward 16. Newly proposed drain in this Ward is about 17,948m. About 5,220m, 15,532m, 31,070m and 10,460m primary, secondary, tertiary and quaternary drains have been proposed in this Ward respectively (**Table-4.62**). Proposed drainage network in Ward 16 has been shown in **Map- 4.16**.

Reconstruction of about 3,693m primary drains and construction of 148m new primary drains have been proposed. About 9,864m and 849m secondary drains have been proposed for reconstruction and new construction respectively. A large numbers of new tertiary and outfall drains proposed in Ward 16 which are 11,285m and 1,859m respectively.

Table- 4.62: Proposed Drainage Network in Ward 16

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,858.58	148.47	849.09	11,285.00	3,807.07	**17,948.21**
OK/Repair	0.00	1,378.20	4,818.83	12,845.24	5,692.16	**24,734.43**
Reconstruction	0.00	3,692.77	9,863.93	6,940.46	961.51	**21,458.67**
Total	**1,858.58**	**5,219.43**	**15,531.85**	**31,070.70**	**10,460.75**	**64,141.31**

The proposed primary drains in this Ward are named as M-P5, M-P6-P1 and M-P6. The primary drain naming “M-P5” started from left side of Public Administration Training Institute passing along the west side of Jessore Road, the south side of Jalil Saroni, Boyra Bazar Mosque Road, west side of Islamia College Road, west side of Shashan Ghat Road and falls into outfall canal (Mayur Khal) “M”. The drain “M-P6-P1” is started from the west side of Joragate more passing along the west side of Jessore Road, Boyra Cross Road 1, north side of Boyra Main Road, Boyra Cross Road 2 (Ward No 17) and finally falls into the outfall canal (Taltola Khal) “M-P6” at Nursing Institute (Ward No 17). Another drain “M-P6” starts from the west side of police quarter passing along the west side of Jessore Road, north side of Boyra Main Road, north side of Karimnagar Surmahal Road (Ward No 17), and finally falls into the outfall canal (Mayur Khal) “M” through Taltola Khal (Ward No 17). All categories of secondary and tertiary drains are connected with these proposed primary drains. Details have been presented in **Table 4.63 and Map 4.16**.

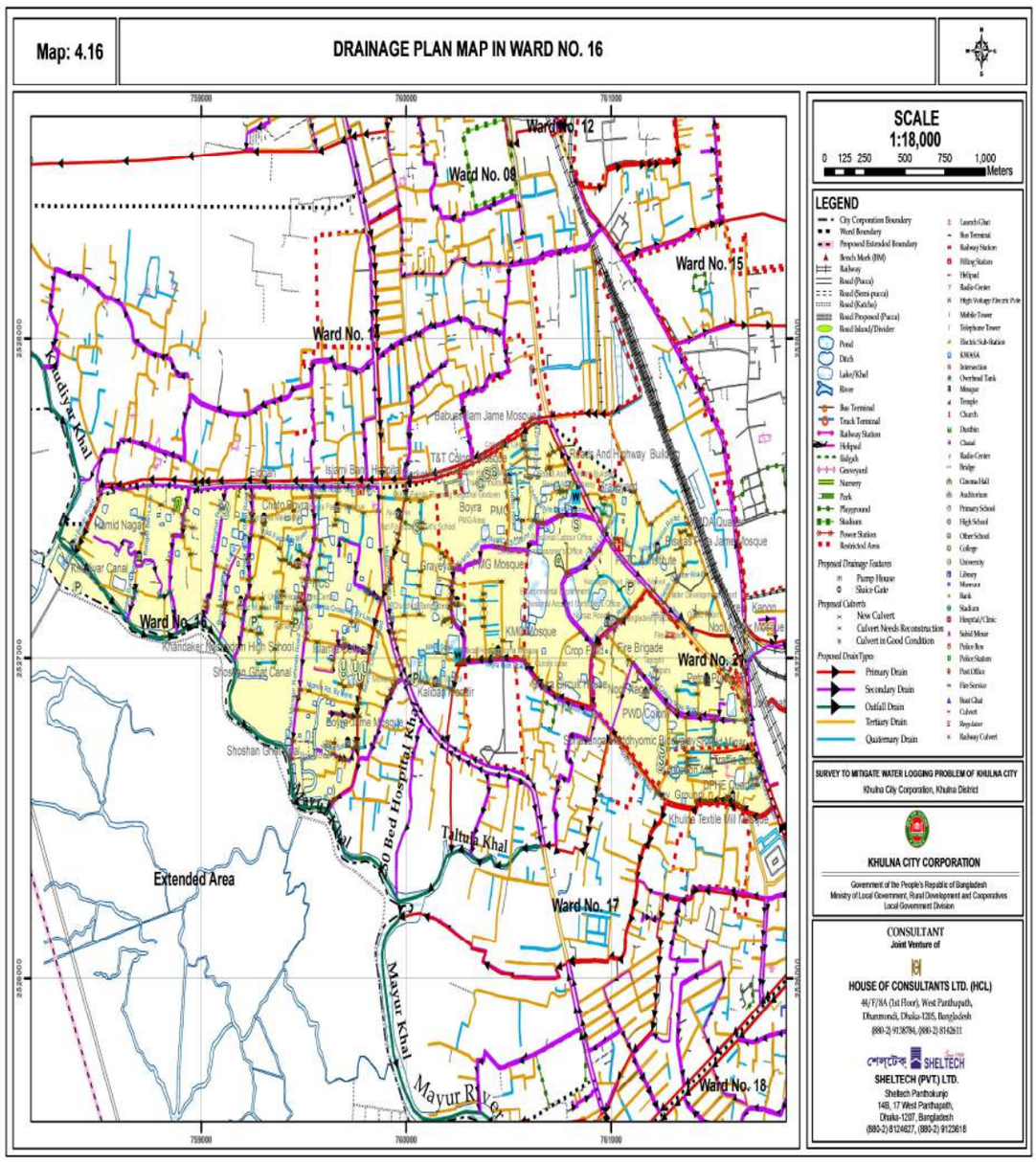
Table- 4.63: Proposed Primary Drainage System in Ward 16

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P5	Left side of Public Administration Training Institute	West side of Jessore Road, South side of Jalil Saroni, Boyra Bazar Mosque Road, West side of Islamia College Road, West side of Shashan Ghat Road	Mayur Khal	M
M-P6-P1	West side of Joragate more	West side of Jessore Road, Boyra Cross Road 1, North side of Boyra Main Road, Boyra Cross Road 2	Taltola Khal at Nursing Institute	M-P6
M-P6	West side of police quarter,	West side of Jessore Road, North side of Boyra Main Road, North side of Karimnagar Surmahal Road	Mayur Khal through Taltola Khal	M

A large numbers of culverts are recommended for reconstruction and repair. According to the future requirement, the Consultants have proposed 46 new culverts (**Table- 4.64**).

Table- 4.64: Proposed Culverts in Ward 16

Culvert	New	OK/Repair	Reconstruction	Total
Number	46	87	110	**243**


Map: 4.16
DRAINAGE PLAN MAP IN WARD NO. 16
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Meters
LEGEND
Ward No. 08
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Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 18
Ward No. 21
Extended Area
Boudiyar Khal
Taltola Khal
Mayur Khal
Mayur River
Shoshan Ghat Canal
Rupsha River
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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4.1.17 Detailed Drainage Plan of Ward 17

Ward 17 is located in between the Jessore Road on the east, Majid Sarani on the south and Mayur River on the west. The minimum spot height is about -4.57m PWD, while maximum spot height is found about 3.68m PWD and the average spot height is about 1.22m PWD. The natural slope is from Jessore road to Mayur Khal.

There are about 44,180m pucca drains and about 2,870m natural canals in this Ward. All the drains are connected to natural canals within the Ward. Details have been presented in the **Table-4.65**.

Table- 4.65: Existing Drainage Network in Ward 17

Drainage Category	Existing Length (m)
Natural Canal	2,870.52
Pucca Drain	44,180.05
Total	**47,050.57**

In this Ward, about 71,291m of different categories of drains have been proposed with about 25,514m of new drains. About 8,130m, 15,088m, 35,938m and 10,464m primary, secondary, tertiary and quaternary drains have been proposed in this Ward respectively (**Table-4.66**). Proposed drainage network in Ward 17 has been presented in **Map- 4.17**.

Reconstruction of about 7,312m primary drains and construction of 47m primary drains have been proposed. Out of total proposed secondary drains, about 4,543m and 4,185m drains have been recommanded for reconstruction and new construction respectively. Newly proposed tertiary drains are about 14,058m and outfall drains are about 1,663m.

Table- 4.66 Proposed Drainage Network in Ward 17

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,662.56	47.23	4,184.97	14,058.06	5,560.71	**25,513.54**
OK/Repair	0.00	771.05	6,359.62	15,291.12	4,807.61	**27,229.40**
Reconstruction	7.96	7,312.15	4,543.37	6,589.11	95.76	**18,548.35**
Total	**1,670.52**	**8,130.43**	**15,087.96**	**35,938.28**	**10,464.08**	**71,291.28**

There are five numbers of proposed primary drains in and around this Ward. The primary drain named “M-P6” started from the west side of police quarter (Ward No 16) that pass along the west side of Jessore Road, north side of Boyra Main Road, north side of Karimnagar Surmahal Road, and finally falls into the outfall river (Mayur River) “M” through Taltola Khal. The drain “M-P7-P1” started in front of KDA New Market passing along the south side of Boyra Main Road, south side of Boyra Cross Road and falls into outfall drain “M-P7” at Mujgunni Moha Sarak. The drain naming “M-P7” started from the west side of Boyra Cross Road passing along Sonadanga R/A Link Road and finally falls into the outfall canal (Mayur Khal) “M”. The drain “M-P8” which started from the south side of Sonadanga Main Road passing beside the Solar Energy Park, Sonadanga Road No. 7, Road No. 5, Mahatab Uddin Road and finally falls into the outfall canal (Mayur Khal) “M”. The drain “M-P8-P1” that started from the Shibbari More passing along the northwest side of Majid Sarani, Mujgunni Moha Sarak and finally falls into the outfall drain “M-P8”. All existing secondary and tertiary drains are connected to these primary drains. Details have been presented in **Table 4.67 and Map 4.17**.

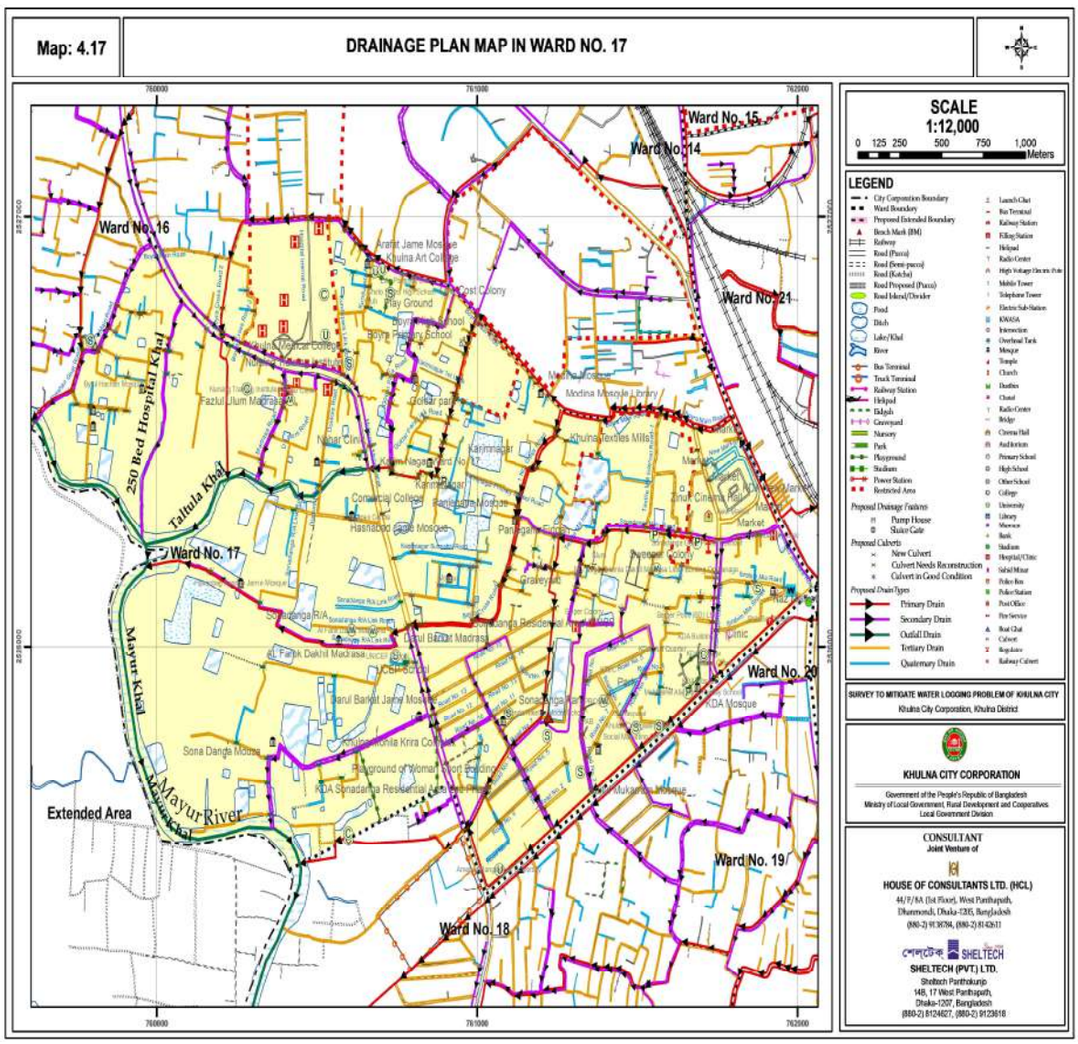
Table- 4.67: Proposed Primary Drainage System in Ward 17

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P7-P1	In front of KDA New Market	South side of Boyra Main Road, South side of Boyra Cross Road	Mujgunni Moha Sarak	M-P7
M-P7	West side of Boyra Cross Road	Sonadanga R/A Link Road	Mayur Khal	M
M-P8	South side of Sonadanga Main Road	Beside the Solar Energy Park, Sonadanga Road No. 7, Road No. 5, Mahatab Uddin Road	Mayur Khal	M
M-P8-P1	Shibbari More	Northwest side of Majid Sarani, Mujgunni Moha Sarak	Mujgunni Moha Sarak	M-P8
M-P6	West side of police quarter	West side of Jessore Road, North side of Boyra Main Road, North side of Karimnagar Surmahal Road	Mayur Khal through Taltola Khal	M

Total number of culvert found in Ward 17 are 172. Most of these culverts are not in good condition or can't fulfill the future requirement. Number of culverts have been proposed for reconstruction and new construction are 92 and 49 respectively (**Table- 4.68**).

Table- 4.68: Proposed Culverts in Ward 17

Culvert	New	OK/Repair	Reconstruction	Total
Number	49	80	92	**221**


Map: 4.17
DRAINAGE PLAN MAP IN WARD NO. 17
SCALE
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LEGEND
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 21
Ward No. 17
Ward No. 20
Ward No. 19
Ward No. 18
250 Bed Hospital Khal
Talhula Khal
Mayur Khal
Mayur River
Extended Area
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
SHELTECH (PVT.) LTD.

4.1.18 Detailed Drainage Plan of Ward 18

This Ward is in the western part of the Khulna City that is physically located in between the KDA Avenue on the east, Majid Sarani on the north and Mayur River on the west. The minimum spot height is about -5.81m PWD, where maximum spot height is found about 2.94m PWD and the average spot height is about 1.27m PWD. The natural slope moves from KDA Avenue to Mayur River.

About 2,907m natural canals run around the Ward. This ward has about 32,455m pucca drainage network. All the drains have been connected to nearest natural canals. Details presented in the **Table-4.69**.

Table- 4.69: Existing Drainage Network in Ward 18

Drainage Category	Existing Length (m)
Natural Canal	2,906.67
Pucca Drain	32,454.95
Total	**35,361.62**

The Consultants have proposed total about 48,478m drainage network in Ward 18. They have recommended for constructing about 15,646m new drains. About 6,191m, 7,805m, 26,519m and 5,656m primary, secondary, tertiary and quaternary drains have also been proposed in this Ward respectively (**Table-4.70**). Proposed drainage network of Ward 18 has been presented in **Map- 4.18**.

Most of the primary drains in this Ward are found out of service. Reconstruction of 5,117m and construction of 860m new primary drains have been proposed. About 3,967m and 808m secondary drains have been proposed for reconstruction and new construction respectively. Exiting tertiary drains in Ward 18 are about 26,519m and about 8,977m new tertiary drains have been proposed.

Table- 4.70: Proposed Drainage Network in Ward 18

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,958.26	859.09	807.87	8,977.17	3,043.16	**15,645.55**
OK/Repair	0.00	214.10	3,029.94	13,591.19	2,457.16	**19,292.39**
Reconstruction	348.40	5,117.30	3,967.30	3,950.86	155.89	**13,539.76**
Total	**2,306.67**	**6,190.50**	**7,805.11**	**26,519.22**	**5,656.20**	**48,477.70**

Proposed primary drain naming “M-P9” started from the KDA Avenue (Shibbari More) passing along the southeast side of Majid Sarani and finally falls into the outfall river (Mayur River) “M”. The drain “M-P10” started from the west side of KDA (Khan-A-Sabur Road) passing along different roads and finally falls into the Outfall River (Mayur Khal) “M” through Nabinagar Khal. Another proposed primary drain named “M-P11S-P11N” have started in front of Sangita Cinema Hall, Khan-A-Sabur Road passing along the west side of Sher - E - Bangla Road, west side of B. K. Roy Road, northwestern side of Hazi Ismail Road, Hazi Ismail Link Road and falls into outfall drain “M-P11S” at Mander Khal. All existing secondary and tertiary drains in this ward are connected to these proposed primary drains. Details have been presented in **Table- 4.71 and Map- 4.18**.

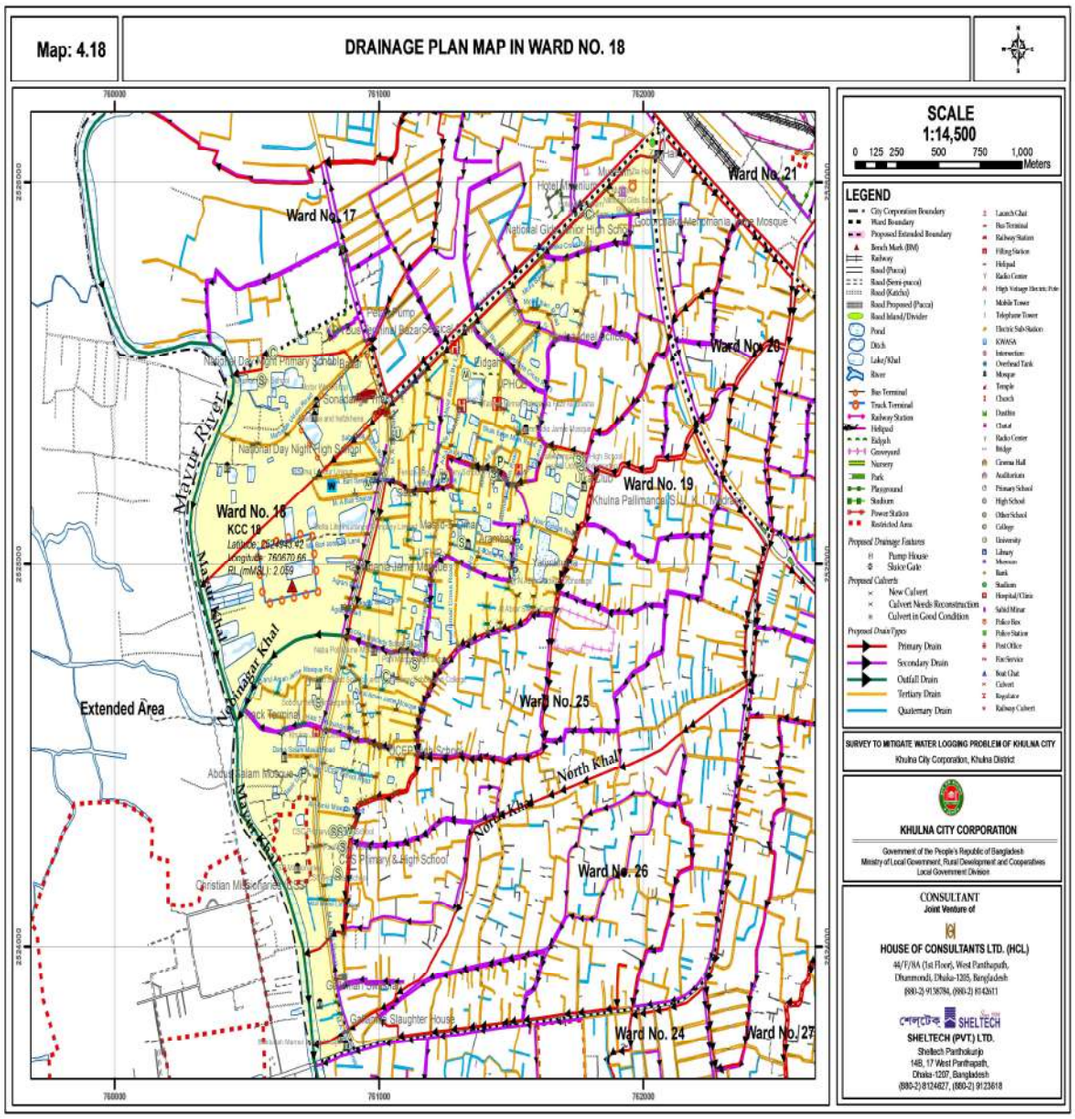
Table- 4.71: Proposed Primary Drainage System in Ward 18

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P9	KDA Avenue (Shibbari More)	Southeast side of Majid Sarani	Mayur Khal	M
M-P10	West side of KDA (Khan-A-Sabur Road)	West side of Sheikh Para Main Road (Ward No 19 & 20), North side of Goborchaka Khanjahan Nagar Main Road, South side of Abdullah Lane, Hatem Ali Sarak, West side of M.A Bari Sharak	Mayur Khal through Nabinagar Khal	M
M-P11S-P11N	In front of Sangita Cinema Hall	Khan-A-Sabur Road, West side of Sher - E - Bangla Road, West side of B. K. Roy Road, Northwestern side of Hazi Ismail Road, Hazi Ismail Link Road	Mander Khal	M-P11S

The consultants have proposed 27 of new culverts. It has existing 131 culverts. As the condition of present culverts is very poor, 84 of culverts have been proposed for reconstruction (**Table- 4.72**).

Table- 4.72: Proposed Culverts in Ward 18

Culvert	New	OK/Repair	Reconstruction	Total
Number	27	47	84	**158**


Map: 4.18
DRAINAGE PLAN MAP IN WARD NO. 18
SCALE
1:14,500
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 17
Ward No. 18
KCC 18
Ward No. 19
Ward No. 20
Ward No. 21
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Extended Area
Mayur River
Mayur Khal
Sonadanga Khal
North Khal
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
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4.1.19 Detailed Drainage Plan of Ward 19

Ward 19 is in the central western part of the Khulna City with the KDA Avenue on the east and Ward no. 18 on the west. The identified minimum, maximum and average spot height of the ward is about 1.21m PWD, 3.25m PWD and 2.97m PWD respectively. The natural slope shows from KDA Avenue to Mayur Khal.

According to the table-4.73, there is about 17,953m pucca drains and 2,456m natural canals in this area. The natural canals around this Ward connect all existing drains of the entire ward. Details have been presented in the **Table-4.73**.

Table- 4.73: Existing Drainage Network in Ward 19

Drainage Category	Existing Length (m)
Natural Canal	3,456.27
Pucca Drain	17,953.43
Total	**21,409.70**

There is a proposal for 20,932m drainage network in Ward 19. Out of this total proposed drainage network, about 3,285m new drains have been proposed. About 2,491m, 4,935m, 11,117m and 2,388m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.74**). Proposed Drainage Network of Ward 19 has been given in **Map- 4.19**.

Primary drains are in poor condition in this ward. Therefore, reconstruction of about 1,799m and construction of about 39m primary drains have been proposed. A total of 4,935m secondary drains, about 2,310m and 291m secondary drains also have been proposed for reconstruction and new construction respectively. Total proposed tertiary drains in Ward 19 are about 11,118m, where construction of 1,915m new drains have been proposed for construction.

Table- 4.74: Proposed Drainage Network in Ward 19

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	38.93	291.15	1,915.50	1,039.41	**3,284.99**
OK/Repair	652.92	2,334.14	8,418.37	1,348.88	**12,754.31**
Reconstruction	1,799.01	2,310.02	783.83	0.00	**4,892.86**
Total	**2,490.85**	**4,935.30**	**11,117.70**	**2,388.29**	**20,932.16**

The proposed primary drain naming “M-P10” is starts from the west side of KDA (Khan-A-Sabur Road) passing along the west side of Sheikh Para Main Road (Ward No 19 & 20), north side of Goborchaka Khanjahan Nagar Main Road, south side of Abdullah Lane, Hatem Ali Sarak, west side of M.A Bari Sharak and finally falls into the outfall canal (Mayur Khal) “M” through Nabinagar Khal. The primary drain “M-P11S-P11N” starts in front of Sangita Cinema Hall, Khan-A-Sabur Road passing along the west side of Sher - E - Bangla Road, west side of B. K. Roy Road, northwestern side of Hazi Ismail Road, Hazi Ismail Link Road and falls into outfall drain “M-P11S” at Mander Khal. The primary drain “M-P11S” started from KDA Avenue passing along the southeastern side of Hazi Ismail Road, south side of Hazi Ismail Cross Road, south side of Hazi Ismail Link Road, and falls into outfall canal “M” through Mander Khal. The primary drain naming “M-P11E” starts from B. K. Roy Road passing along the southeastern side of B. K. Roy Road, southwestern side of KDA Avenue, west side of Sher - E - Bangla Road, Baroda Datta Lane and falls into outfall canal “M” through North Khal. All these proposed primary drains connect the present secondary and tertiary drains within this ward. Details have been presented in **Table 4.75 and Map- 4.19**.

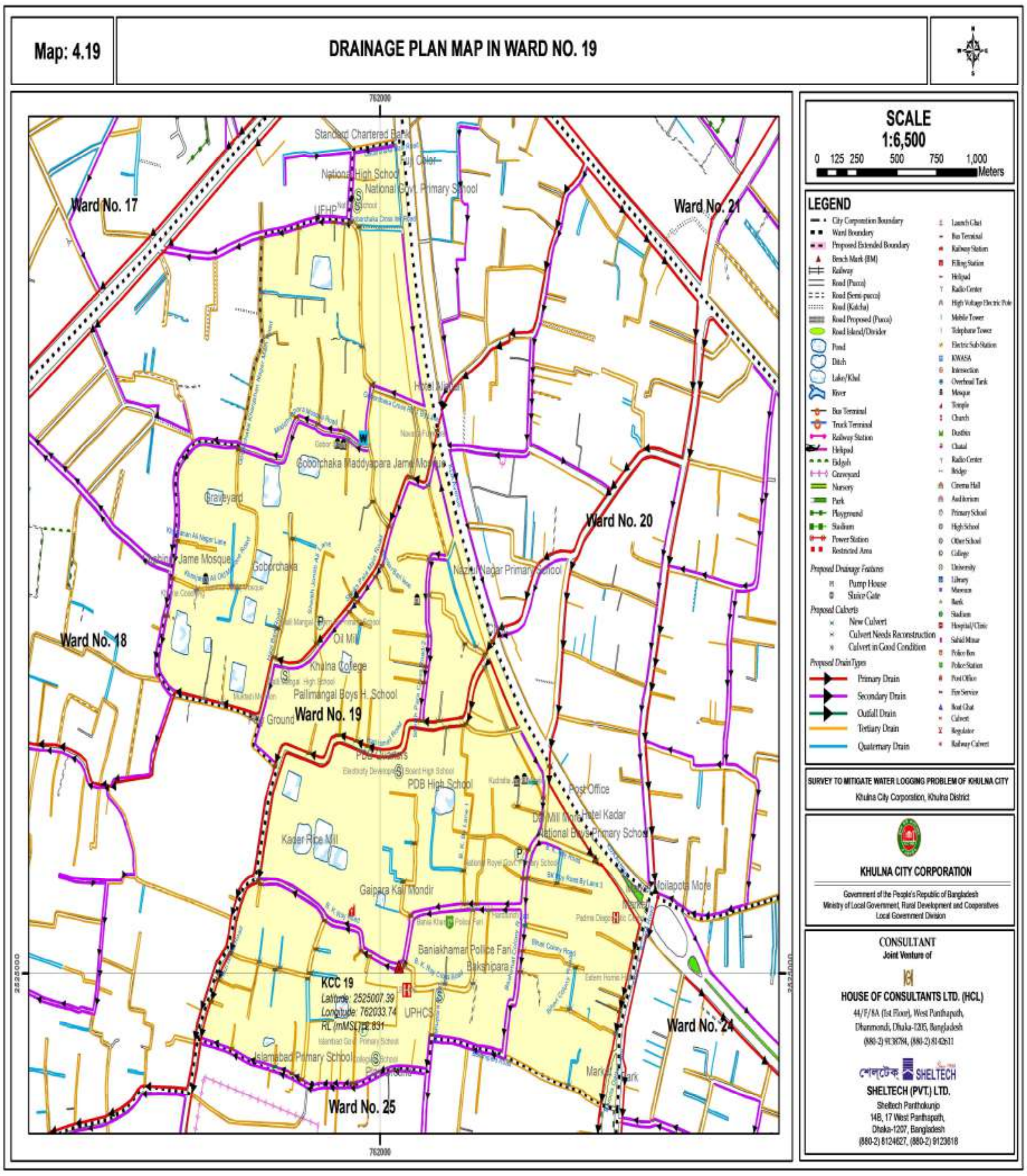
Table- 4.75: Proposed Primary Drainage System in Ward 19

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P10	West side of KDA (Khan-A-Sabur Road)	West side of Sheikh Para Main Road (Ward No 19 & 20), North side of Goborchaka Khanjahan Nagar Main Road, South side of Abdullah Lane, Hatem Ali Sarak, West side of M.A Bari Sharak	Mayur Khal through Nabinagar Khal	M
M-P11S-P11N	In front of Sangita Cinema Hall	Khan-A-Sabur Road, West side of Sher - E - Bangla Road, West side of B. K. Roy Road, Northwestern side of Hazi Ismail Road, Hazi Ismail Link Road	Mander Khal	M-P11S
M-P11S	KDA Avenue	Southeastern side of Hazi Ismail Road, South side of Hazi Ismail Cross Road, South side of Hazi Ismail Link Road	Mander Khal	M
M-P11E	B. K. Roy Road	Southeastern side of B. K. Roy Road, Southwestern side of KDA Avenue, West side of Sher - E - Bangla Road, Baroda Datta Lane	North Khal	M

There exist 54 of culverts in Ward 19 that are in very poor condition and have not fulfill the future requirement. In this ward, 28 and 17 of culverts have been proposed for reconstruction and new construction respectively (**Table 4.76**).

Table- 4.76: Proposed Culverts in Ward 19

Culvert	New	OK/Repair	Reconstruction	Total
Number	17	26	28	**71**


Map: 4.19
DRAINAGE PLAN MAP IN WARD NO. 19
SCALE
1:6,500
0 125 250 500 750 1,000 Meters
LEGEND
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 18
Ward No. 19
Ward No. 24
Ward No. 25
Standard Chartered Bank
National High School
National Govt. Primary School
UFHP
Goborchaka Maddyapara Jame Mosque
Graveyard
Jame Mosque
Goborchaka
Oil Mill
Khulna College
Pallimangal Boys H. School
Ground
Nazir Nagar Primary School
PDB High School
Post Office
Hotel Kadar
National Boys Primary School
Kadar Rice Mill
Galpara Kali Mondir
Moilapota More
Baniakhamar Police Fari
Bakshipara
KCC 19
Latitude: 2525007.39
Longitude: 762033.74
UPHCS
Islamabad Primary School
Market
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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Ministry of Local Government, Rural Development and Cooperatives
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CONSULTANT
Joint Venture of
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4.1.20 Detailed Drainage Plan of Ward 20

This Ward is situated in between the KDA Avenue and Khan-A-Sabur Road. This area is a mixed use zone where, the minimum spot height is about 2.13m PWD, maximum spot height is about 4.01m PWD and the average spot height is about 3.21m PWD. The natural slope usually is from Khan-A-Sabur Road to KDA Avenue.

About 2,798m natural canals and about 16,028m pucca drains have been proposed for this Ward. All the drains are connected to natural canals in and around the Ward. Details are in the **Table-4.77.**

Table- 4.77: Existing Drainage Network in Ward 20

Drainage Category	Existing Length (m)
Natural Canal	2,798.33
Pucca Drain	16,028.27
Total	**18,826.60**

Total 19,952m drainage network have been proposed in this ward that include about 3,695m new drains of different catagories. About 2,871m, 4,347m, 11,372m and 1,362m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.78**). Proposal for drainage network in ward 20 has been presented in **Map- 4.20**.

Most primary drain in this ward is in poor condition. Reconstruction of 1,795m drains and construction of 55m drains will be needed. A total of 4,347m secondary drains have been recommended. About 2,000m and 12m drains have been proposed for reconstruction and new construction respectively. Tertiary drain in Ward 20 is about 11,372m, where construction of 3,394m new drains have been proposed.

Table- 4.78: Proposed Drainage Network in Ward 20

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	54.57	11.72	3,394.72	233.08	**3,694.09**
OK/Repair	1,021.96	2,334.40	7,362.61	1,013.38	**11,732.34**
Reconstruction	1,794.77	2,000.76	614.34	115.41	**4,525.28**
Total	**2,871.30**	**4,346.88**	**11,371.67**	**1,361.86**	**19,951.71**

A number of primary drains have been proposed for this ward. All secondary and tertiary drains are connected to these primary drains. The proposed primary drain naming “M-P10” starts from the west side of KDA (Khan-A-Sabur Road) passing along the west side of Sheikh Para Main Road (Ward No 19 & 20), north side of Goborchaka Khanjahan Nagar Main Road, south side of Abdullah Lane, Hatem Ali Sarak, west side of M.A Bari Sharak and finally falls into the outfall River (Mayur River) “M” through Nabinagar Khal. The drain “M-P11S-P11N” starts in front of Sangita Cinema Hall, Khan-A-Sabur Road passing along the west side of Sher - E - Bangla Road, west side of B. K. Roy Road, northwestern side of Hazi Ismail Road, Hazi Ismail Link Road and falls into outfall drain “M-P11S” at Mander Khal. The drain “M-P11E” starts from B. K. Roy Road passing along many roads and falls into outfall canal “M” through North Khal. The drain “M-P11E-P1” starts in front of Meena Bazaar and passing along the eastern side of Sher -E-Bangla Road and falls into outfall (North Khal) “M-P11E”. Please See **Table- 4.79 and Map- 4.20 for details.**

Table- 4.79: Proposed Primary Drainage System in Ward 20

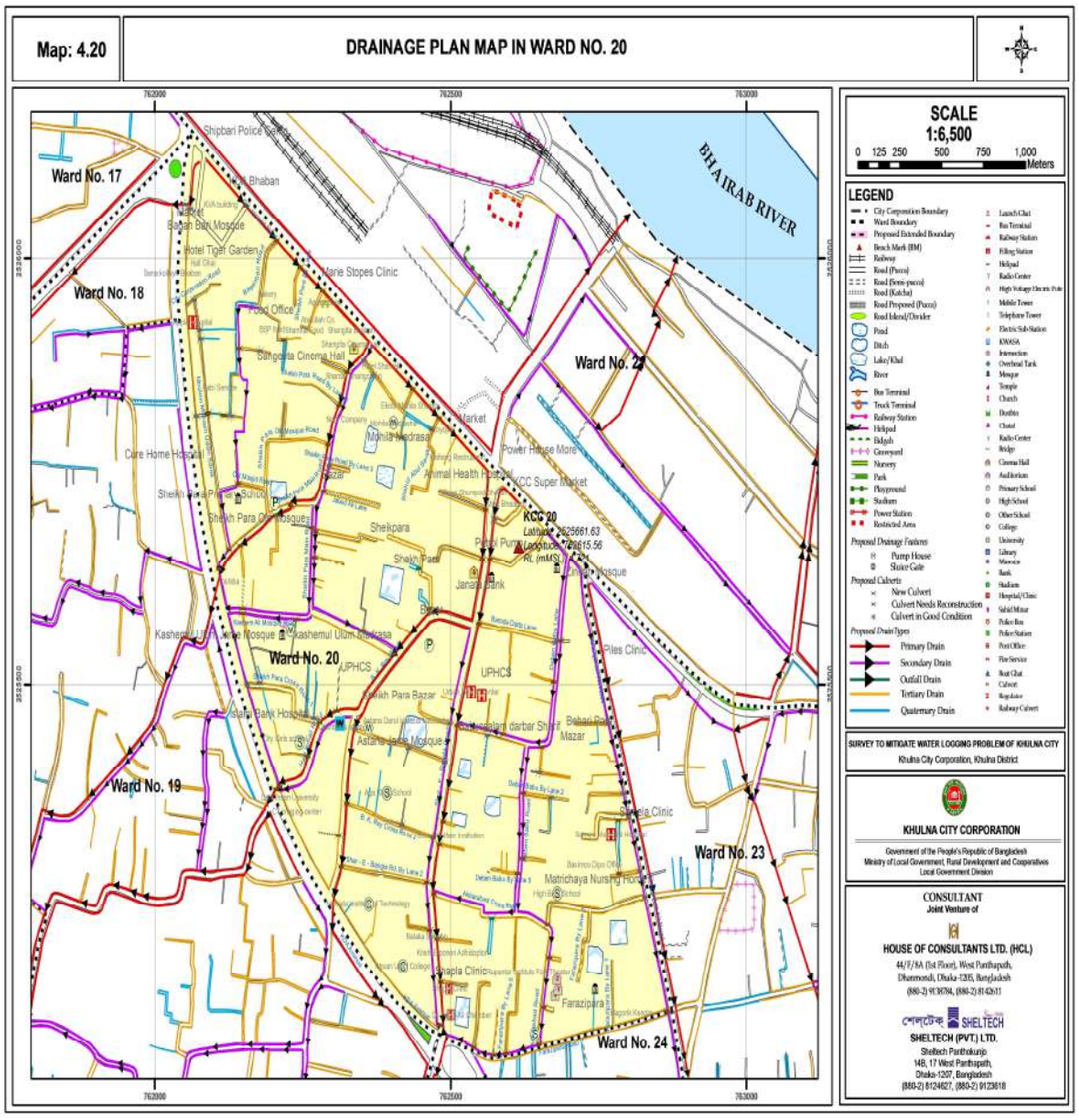
Name of the	Name of the Road	Outfall

Drain	Start	Passing Along	End	Drain
M-P10	West side of KDA (Khan-A-Sabur Road)	West side of Sheikh Para Main Road (Ward No 19 & 20), North side of Goborchaka Khanjahan Nagar Main Road, South side of Abdullah Lane, Hatem Ali Sarak, West side of M.A Bari Sharak	Mayur Khal through Nabinagar Khal	M
M-P11S-P11N	In front of Sangita Cinema Hall	Khan-A-Sabur Road, West side of Sher - E - Bangla Road, West side of B. K. Roy Road, Northwestern side of Hazi Ismail Road, Hazi Ismail Link Road	Mander Khal	M-P11S
M-P11E	B. K. Roy Road	Southeastern side of B. K. Roy Road, Southwestern side of KDA Avenue, West side of Sher - E - Bangla Road, Baroda Datta Lane	North Khal	M
M-P11E-P1	Meena Bazaar	Eastern side of Sher - E - Bangla Road	North Khal	M-P11E

In this ward 61 culverts require reconstruction and repair. The consultants have proposed for reconstruction and new construction of 43 and 06 culverts respectively (**Table- 4.80**).

Table- 4.80: Proposed Culverts in Ward 20

Culvert	New	OK/Repair	Reconstruction	Total
Number	6	28	43	**77**


Map: 4.20
DRAINAGE PLAN MAP IN WARD NO. 20
Ward No. 17
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 23
Ward No. 24
BHAIRAB RIVER
KCC 20
SCALE
1:6,500
0 125 250 500 750 1,000 Meters
LEGEND
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
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4.1.21 Detailed Drainage Plan of Ward 21

Ward 21 is located between the Khan-A-Sabur Road and the Bhairab River. The minimum spot height is about 0.00m PWD, maximum spot height is found about 4.03m PWD and the average spot height of the ward is about 3.19m PWD. The natural slope of the ward is from Khan-A-Sabur Road to the Bhairab River.

There is about 22,510m pucca drains and about 4,988m natural canals in this area. All the existing drains are connected to natural canals. Details presented in the **Table-4.81**.

Table- 4.81: Existing Drainage Network in Ward 21

Drainage Category	Existing Length (m)
Natural Canal	4,987.66
Pucca Drain	22,510.44
Total	**27,498.10**

The Consultant proposed about 28,186m drainage network of different categories in Ward 21. Out of the total network, about 7,628m drains will be newly constructed. About 8,023m, 4,348m, 14,300m and 1,514m primary, secondary, tertiary and quaternary drains respectively have been proposed (**Table-4.82**). Proposed Drainage network of Ward 21 has been shown in **Map- 4.21**.

About 3,830m and 2,397m primary drains have been proposed for reconstruction and new construction respectively. There is a proposal for reconstruction of about 1,835m secondary drains and 1,716m tertiary drains.

Table- 4.82: Proposed Drainage Network in Ward 21

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	2,397.25	670.71	4,001.06	559.61	**7,628.63**
OK/Repair	1,795.11	1,843.24	8,583.29	954.48	**13,176.11**
Reconstruction	3,830.47	1,834.83	1,716.04	0.00	**7,381.34**
Total	**8,022.83**	**4,348.78**	**14,300.39**	**1,514.09**	**28,186.09**

Khulna Railway Station, BIWTA Office, Boro Bazar, (Whole sale Market), Khulna City Corporation, DC Office, Zila Praishad Office, Circuit House and Judge Court are located in this ward. A number of proposed primary drains will pass through the Ward. This area is on the bank of the river Bhairab where gravity drainage system is more applicable. That's why, the outfall of entire proposed primary drains is proposed along the Bhairab River. The proposed primary drain naming "BH-P32" starts from 7 no. Ghat Road and passing along the BIWTA Ghat Road and finally falls into the Bhairab River. The primary drain "BH-P32-P1" is started from rail crossing area passing along the west side of BIWTA Ghat Road and falls into the Bhairab River at through "BH-P32". The drain named "BH-P33" starts from rail crossing area passing along the north side of Railway Quarter Road and falls into the Bhairab River. The drain "BH-P34N" starts from the in front of Bangladesh Biman Office and passing along the east side of Khan-A-Sabur Road and by the Shilpa Bank Bhaban to Railway Quarter Road and finally falls into the Bhairab River. The proposed drain naming "BH-P35" starts Shilpa Bank Bhaban and passing along the east side of Khan-A-Sabur Road, Jabbar Sarani and finally falls into the Bhairab River. The proposed drain "BH-P36" starts from Railway Hospital Road and passing along the Station Road, Bazar Road and finally falls into the Bhairab River. The drain named "BH-P37W" starts from Dakbanglow More and passing along the Clay Road, Bazar Road and falls into the Bhairab River. The drain naming "BH-P37W-P37E" starts from Picture Place Cinema Hall and passing along the north side of Khan-A-Sabur Road, east side of Clay Road and finally falls into the Bhairab River through "BH-P37W". The drain "D1" starts from Khulna Thana and passing along the east side of Sir Iqbal Road, north-eastern side of Khan-A-Sabur Road and finally

falls into the Bhairab River at 1 no. Custom ghat. The proposed primary drain "BH-P37X" starts beside the Khulna City Corporation and passing along the north side of K. D. Ghosh Road, east side of Sir Iqbal Road and finally falls into the Bhairab River at Kali Bari more. Details have been presented in **Table-4.83, Map- 4.21**.

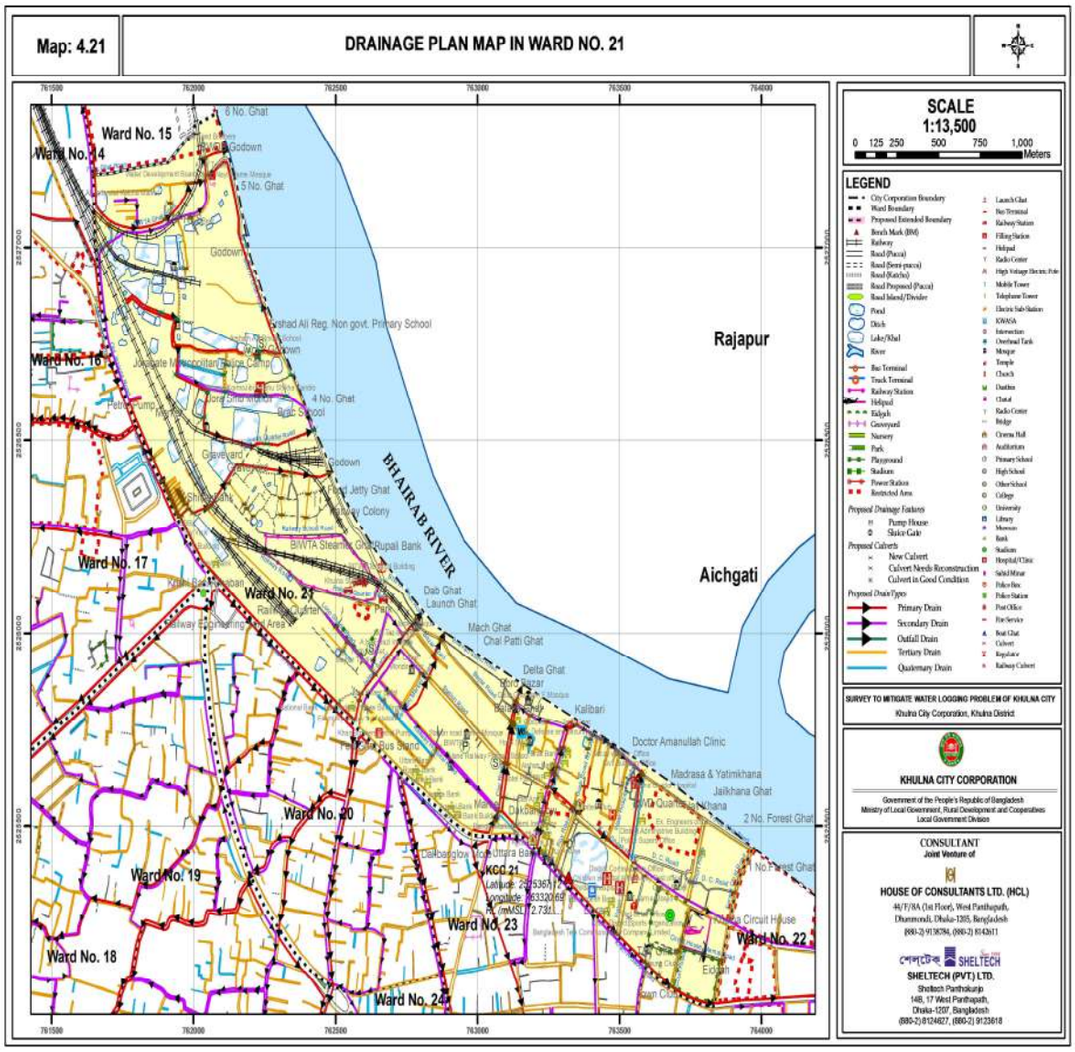
Table- 4.83: Proposed Primary Drainage System in Ward 21

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
BH-P32	7 no. Ghat Road	BIWTA Ghat Road	Bhairab River	Bhairab River
BH-P32-P1	Rail crossing area	West side of BIWTA Ghat Road	BH-P32	Bhairab River
BH-P33	Rail crossing area	North side of BIWTA Ghat Road	Bhairab River	Bhairab River
BH-P34N	In front of Bangladesh Biman Office	East side of Khan-A-Sabur Road, Beside of the Shilpa Bank Bhaban to Railway Quarter Road	Bhairab River	Bhairab River
BH-P35	In front of Shilpa Bank Bhaban	East side of Khan-A-Sabur Road, Jabbar Sarani	Bhairab River	Bhairab River
BH-P36	Railway Hospital Road	Station Road, Bazar Road	Bhairab River	Bhairab River
BH-P37W	Dakbanglow More	Clay Road, Bazar Road	Bhairab River	Bhairab River
BH-P37W-P37E	In front of Picture Place Cinema Hall	North side of Khan-A-Sabur Road, East side of Clay Road	BH-P37W	Bhairab River
D1	In front of Khulna Thana	East side of Sir Iqbal Road, Northeastern side of Khan-A-Sabur Road	1 no custom ghat	Bhairab River
BH-P37X	Beside of the Khulna City Corporation	North side of K. D. Ghosh Road, East side of Sir Iqbal Road	Kali Bari more	Bhairab River

There are large number of culverts (93 no) in the area. Most of them are not functioning properly. Consultants recommended for construction of 34 of new culverts. About 49 and 34 culverts have been proposed for reconstruction and new construction respectively (**Table- 4.84**).

Table- 4.84: Proposed Culverts in Ward 21

Culvert	New	OK/Repair	Reconstruction	Total
Number	34	43	49	**126**


Map: 4.21
DRAINAGE PLAN MAP IN WARD NO. 21
SCALE
1:13,500
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 15
Ward No. 14
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 20
Ward No. 19
Ward No. 18
Ward No. 23
Ward No. 24
Ward No. 22
BHAIRAB RIVER
Rajapur
Aichgati
KCC 21
Latitude: 22°45'36"
Longitude: 89°33'20.69"
RL: mMSL 2.731
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
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SHELTECH
SHELTECH (PVT.) LTD.

4.1.22 Detailed Drainage Plan of Ward 22

This Ward is situated in east of the Ward 23, Ward 29 on the south and the Bhairab River on the north-east side. The minimum spot height of this area is about 0.00m PWD, while maximum spot height is 3.17m PWD and the average spot height is 2.30m PWD. The natural slope is towards Bhairab River.

The length of existing pucca drain in this Ward is 1,6221m. The area has 2,793m natural canal. All of the drains are connected to natural canal in and around the Ward. Details have been presented in the **Table-4.85**.

Table- 4.85: Existing Drainage Network in Ward 21

Drainage Category	Existing Length (m)
Natural Canal	2,792.80
Pucca Drain	16,221.50
Total	**19,014.30**

About 16,577m drainage network have been proposed by the Consultant in Ward 22 including 1170m new drains of different categories. In total 2,070m, 3,819m, 10,096m and 591m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.86**). Proposed drainage network of Ward 22 has been shown in **Map- 4.22**.

The ward does not any good quality primary drains, therefore, about 1,300m primary drain have been proposed for reconstruction. Proposed total secondary drains is about 3,819m that includes about 1,995m and 1,823m drains for reconstruction and new construction respectively. Length of total proposed tertiary drain in Ward 22 is about 10,096m, that includes construction of 1,003m new drains.

Table- 4.86: Proposed Drainage Network in Ward 22

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	5.72	13.36	1,002.90	147.29	**1,169.27**
OK/Repair	765.53	1,810.43	7,853.69	444.05	**10,873.69**
Reconstruction	1,299.57	1,994.82	1,239.59	0.00	**4,533.98**
Total	**2,070.81**	**3,818.62**	**10,096.17**	**591.34**	**16,576.94**

The primary drains proposed in this ward are named as D1 and D2 that fall in to Bhairab-Rupsha River. As this area is situated on the bank of the river Bhairab, so gravity drainage system can be used. The primary drain naming “D1” starts from of Khulna Thana and passing along the east side of Sir Iqbal Road, northeastern side of Khan-A-Sabur Road and finally falls into the Bhairab River at Custom ghat (1 no.) Sluice Gate. The another proposed primary drain “D2” starts from of Seba Clinic, Ahsan Ahmed Road and passing along the north side of Syed Mosta Gausul Haq Road, north side of South Centeral Road, from of Coilla Ghat Kali Bari, Gagan Babu 2nd Goli and finally falls into the Rupsha River through 2 No. Sluice Gate at Rupsha Beribadh Road. All secondary and tertiary drains in this ward are connected to primary drains. Details have been presented in **Table- 4.87 and Map- 4.22**.

Table- 4.87: Proposed Primary Drainage System in Ward 22

Name of the Drain	Name of the Road			Outfall Drain
	Start		End	
D1	In front of Khulna Thana	East side of Sir Iqbal Road, Northeastern side of Khan-A-Sabur Road	1 no custom ghat Sluice Gate	Bhairab River
D2	In front of Seba Clinic	Ahsan Ahmed Road, North side of Syed Mosta Gausul Haq Road, North side of South Centeral Road, In front of Coilla Ghat Kali Bari, Gagan Babu 2nd Goli	2 No Sluice Gate at Rupsha Beribadh Road	Rupsha River

Total number of drains proposed in this ward are 55 of including 4 new proposed drains. There exist 51 culverts. Proposed number of culverts, which require reconstruction are 28 in this ward (**Table- 4.88**).

Table- 4.88: Proposed Culverts in Ward 22

Culvert	New	OK/Repair	Reconstruction	Total
Number	4	23	28	**55**

Map: 4.22
DRAINAGE PLAN MAP IN WARD NO. 22
SCALE
1:9,000
0 125 250 500 750 1,000
Meters
LEGEND
City Corporation Boundary
Ward Boundary
Proposed Extended Boundary
Bench Mark (BM)
Railway
Road (Pucca)
Road (Semi-pucca)
Road (Katcha)
Road Proposed (Pucca)
Road Island/Divider
Pond
Ditch
Lake/Khal
River
Bus Terminal
Truck Terminal
Railway Station
Helipad
Eidgah
Graveyard
Nursery
Park
Playground
Stadium
Power Station
Restricted Area
Proposed Drainage Features
Pump House
Sluice Gate
Proposed Culverts
New Culvert
Culvert Needs Reconstruction
Culvert in Good Condition
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
Launch Ghat
Bus Terminal
Railway Station
Filling Station
Helipad
Radio Center
High Voltage Electric Pole
Mobile Tower
Telephone Tower
Electric Sub-Station
KWASA
Intersection
Overhead Tank
Mosque
Temple
Church
Dustbin
Chatal
Radio Center
Bridge
Cinema Hall
Auditorium
Primary School
High School
Other School
College
University
Library
Museum
Bank
Stadium
Hospital/Clinic
Sahid Minar
Police Box
Police Station
Post Office
Fire Service
Boat Ghat
Culvert
Regulator
Railway Culvert
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
BHAIRAB RIVER
RUPSHA RIVER
Ward No. 21
Ward No. 22
Ward No. 23
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
KCC 22
Daira Judge Residence
DIG Banglow
Town Jame Mosque
Town Eidgah
Civil Surgeon Banglow
Deputy Comissioners Residence
Police Comissioners Residence
Khulna Zilla School
Zilla Scool Quarter
Khulna Club
Officers Club
Victoria Infants Primary school
Moushumi Saw Mill
Kajol Saw Mill
Sonali Saw Mill
BIWTC Workshop
Custom Ghat
Mosjid-E-Nur
Shamim Mosque
Natun Bazar Primary School
WAPDA Quarter
Sonali Stone Factory
Sobi Fish Processing Industry
Rupali Bank
Natun Bazar
Natun Bazar Launch Ghat
Rupsha Market
Rupsha Bari Badh Area
Ananda Niketon Primary School
New Stone House
Fishery Office
H. Abu Bakar Siddikia Jame Mosque
Play Ground
763500
764000
764500
765000
2525000
2524500
2524000

4.1.23 Detailed Drainage Plan of Ward 23

Ward 23 is in the eastern part of the Khulna City. It has Khan-A-Sabur Road on the north, Khanjahan Ali Road on the southeast and Babu Khan Road on the east. The minimum spot height is about 0.52m PWD, maximum spot height is found 4.04m PWD and the average spot height is 2.81m PWD. The natural slope is from Khan-A-Sabur Road to Khanjahan Ali Road.

This 15,313m pucca drainage network and about 2,675m natural canal in this Ward. All the drains are connected to natural canals. Details presented in the **Table-4.89**.

Table- 4.89: Existing Drainage Network in Ward 23

Drainage Category	Existing Length (m)
Natural Canal	2,674.44
Pucca Drain	15,313.46
Total	**17,987.90**

Proposed total drainage network in this ward is about 16,208m including 951m new drain. The primary, secondary, tertiary and quaternary drains have been proposed in this Ward are 2,465m, 3,433m, 8,611m and 1,195m respectively (**Table-4.90**). Proposed drainage network of Ward 23 has been shown in **Map-4.23**.

The consultants have proposed about 1,240m primary drains and about 444m secondary drains for reconstruction. Proposed tertiary drain in Ward 23 is about 8,611m, where 714m new drain have been proposed for constructions.

Table- 4.90: Proposed Drainage Network in Ward 23

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	0.00	4.68	34.18	714.43	198.42	**951.70**
OK/Repair	499.78	1,220.84	2,955.28	7,229.94	996.85	**12,902.70**
Reconstruction	4.07	1,239.42	443.69	666.57	0.00	**2,353.75**
Total	**503.86**	**2,464.94**	**3,433.15**	**8,610.94**	**1,195.27**	**16,208.16**

The primary drain naming “L” started from the east side of Ferry Ghat More (Khanjahan Ali Road) passing along the northeastern side of Khanjahan Ali Road, Binodini Hospital Road, Miapara 2nd Lane finally falls into the Rupsha River by pump drainage system (Pump House 02) through Pipe More Khal, Chori Chora Khal and Labanchora 2 no. Sluice Gate Khal. The drain “L-P1” starts from Dakbanglow More passing along the Cemetery Road, Banibabu Road, east side of Sir Iqbal Road falls into outfall drain “L” near Modern Furniture More. The drain named “D4” starts from Govt. Coronation Girls School passing along the east side of Ahsan Ahmed Road, northeastern side of Khanjahan Ali Road finally falls into the Rupsha River by pump drainage system (Pump House 01) at Rupsha Ghat. All secondary and tertiary drains in this ward are connected to these primary drains. Details presented in **Table- 4.91, Map- 4.23**.

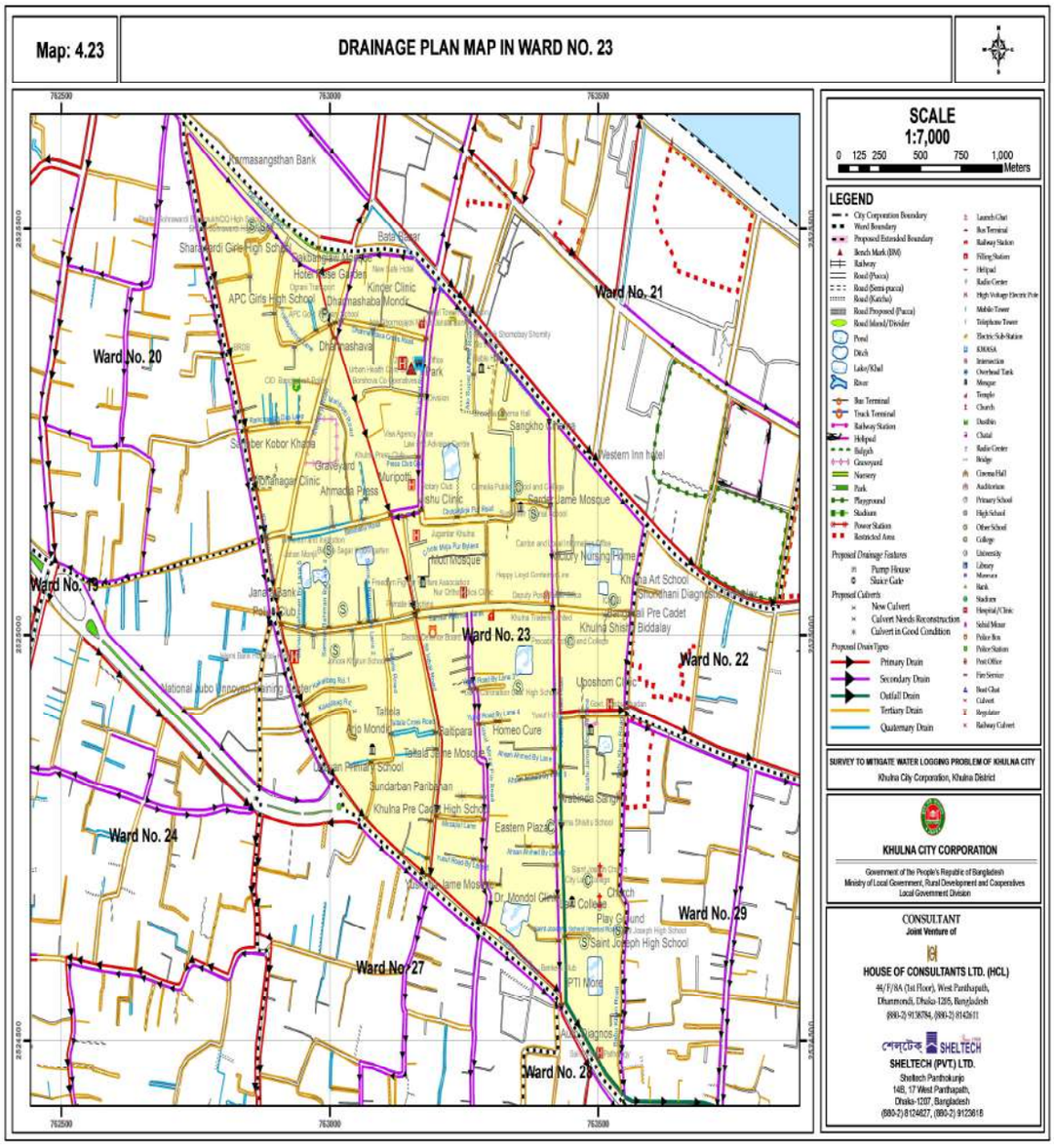
Table- 4.91: Proposed Primary Drainage System in Ward 23

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
L	East side of Ferry Ghat More (Khanjahan Ali Road)	Northeastern side of Khanjahan Ali Road, Binodini Hospital Road, Miapara 2nd Lane	Bhairab River through Pipe More Khal, Chori Chora Khal and Labanchora 2 no. Sluice Gate Khal	Rupsha River
L-P1	Dakbanglow More	Cemetery Road, Banibabu Road, East side of Sir Iqbal Road	Modern Furniture More	L
D4	In front of Govt. Coronation Girls School	Ahsan Ahmed Road, Northeastern side of Khanjahan Ali Road	Rupsha Ghat	Rupsha River

The number of existing culverts in Ward 23 is 64 and consultants proposed 17 and 09 culverts for reconstruction and new construction respectively (**Table- 4.92**).

Table- 4.92: Proposed Culverts in Ward 23

Culvert	New	OK/Repair	Reconstruction	Total
Number	9	47	17	**73**


Map: 4.23
DRAINAGE PLAN MAP IN WARD NO. 23
SCALE
1:7,000
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 20
Ward No. 21
Ward No. 19
Ward No. 23
Ward No. 22
Ward No. 24
Ward No. 27
Ward No. 29
Ward No. 28
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
SHELTECH (PVT.) LTD.

4.1.24 Detailed Drainage Plan of Ward 24

Ward 24 is in the western part of the Khulna City with the Sher -E- Bangla Road on the north-western side, Bagmara Main Road on the east and Nirala Khal on the south. This area is a part of planned Nirala residential area, where the minimum height is -1.08m PWD, maximum spot height is 3.68m PWD and the average spot height is about 1.69m PWD. The natural slope is from Sher -E- Bangla Road to Nirala Khal.

The length of existing pucca drain and natural cannals are about 44,967m and about 5,843m in this Ward. All categories of existing drains are connected with natural canals. Details presented in the **Table-4.93**.

Table- 4.93: Existing Drainage Network in Ward 24

Drainage Category	Existing Length (m)
Natural Canal	5,843.12
Pucca Drain	44,966.91
Total	**50,810.03**

Large numbers of drainage network (about 59,633m) have been proposed by the Consultant in Ward 24. Newly proposed drainage network in this ward is about 14,857m. About 7,005m, 9,763m, 33,183m and 8,964m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.94**). Proposed Drainage network of Ward 24 has been given in **Map- 4.24**.

Condition of present primary drains is not satisfactory. Reconstruction of 4,350m primary drains and construction of 302m new primary drains have been proposed. About 3,330m and 1770m secondary drains have been proposed for reconstruction and new construction respectively. Tertiary drain in this ward is about 33,183m, where construction of 7,600m new drains have also been proposed.

Table- 4.94: Proposed Drainage Network in Ward 24

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	717.64	301.58	1,769.63	7,599.35	4,468.49	**14,856.69**
OK/Repair	0.00	2,354.00	4,662.96	20,889.67	4,075.32	**31,981.95**
Reconstruction	0.00	4,349.50	3,329.99	4,694.06	420.32	**12,793.87**
Total	**717.64**	**7,005.08**	**9,762.58**	**33,183.08**	**8,964.13**	**59,632.51**

The proposed primary drain naming “M-P12-P2-P1”, starts from the south side of Roypara Main Road passing along the east side of Sher - E - Bangla Road/Nirala Road No. 1 finally falls into the outfall drain “M-P12-P2”. The drain “M-P12-P2” starts from Moilaputa More passing along the south side of KDA Avenue, west side of Islampur Road, north side of Roypara Main Road, west side of Musalman Para Road, west side of Tetultala Road, Nirala Road No. 7, east side of Road No. 1, falls into the outfall canal (Purbo Nirala Khal) “M-P12” near Nirala Graveyard. The proposed drain named “M-P12-P1” starts from Dolkhula More passing along the west side of Islampur Road, north side of Baniakhamar Main Road, west side of Bagmara Main Road finally falls into the outfall canal (Purbo Nirala Khal) “M-P12” at Bagmara Bridge. The drain “M-P12-P3”, which is started from Nirala 1 No More passing along the south side of Sher - E - Bangla Road and finally falls into the outfall canal (Nirala Khal) “M-P12” through Printik Khal. All of the secondary and tertiary drains in this ward are connected with these primary drains. Details presented in **Map- 4.24**.

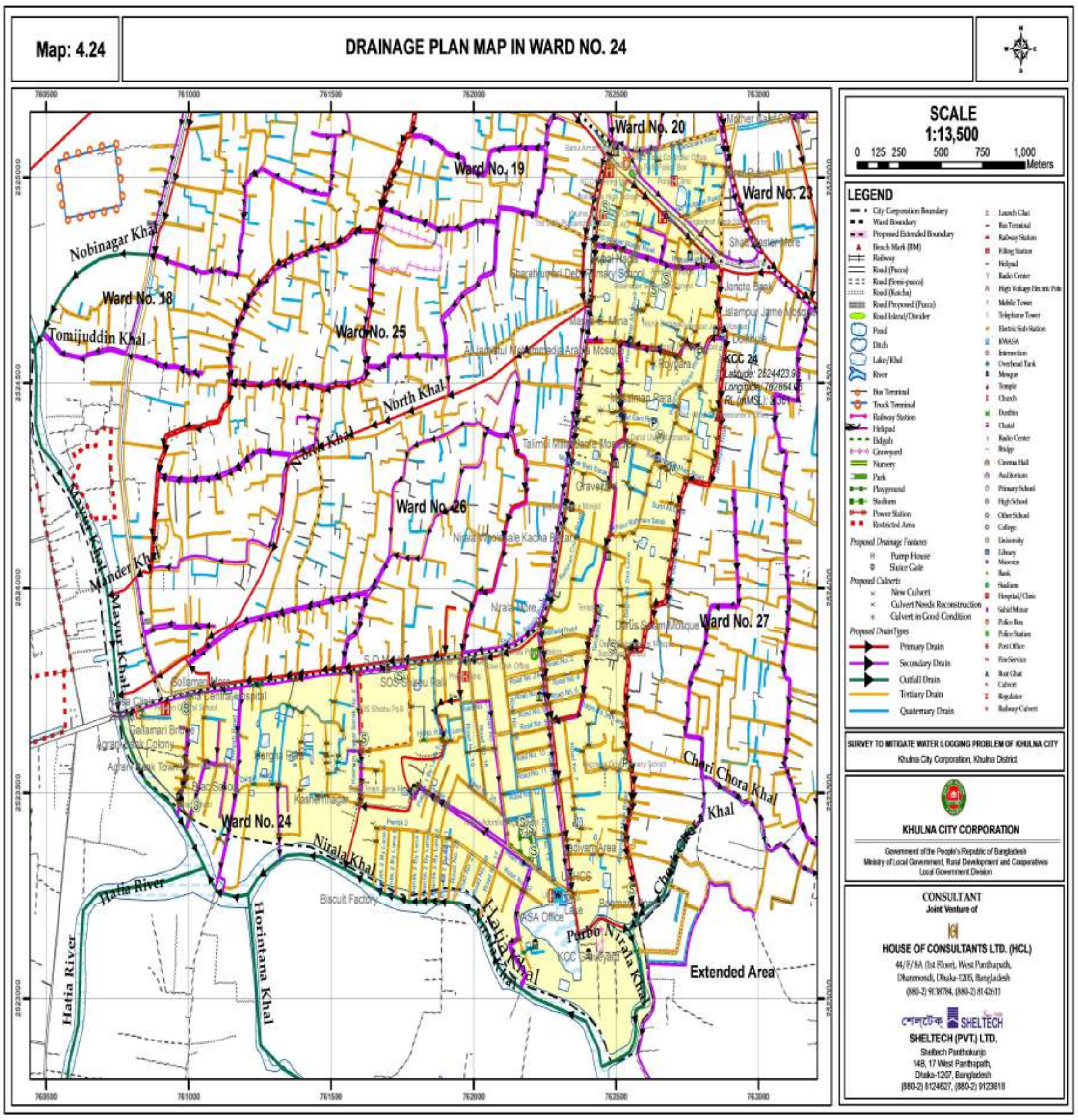
Table- 4.95: Proposed Primary Drainage System in Ward 24

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P12-P2-P1	South side of Roypara Main Road	East side of Sher - E - Bangla Road, East side of Nirala Road No. 1	Nirala Road No. 1	M-P12-P2
M-P12-P2	Moilaputa More	South side of KDA Avenue, West side of Islampur Road, North side of Roypara Main Road, West side of Musalman Para Road, West side of Tetultala Road, Nirala Road No. 7, East side of Road No. 1	Purbo Nirala Khal at the place of Nirala Graveyard	M-P12
M-P12-P1	Dolkhula More	West side of Islampur Road, North side of Baniakhamar Main Road, West side of Bagmara Main Road	Purbo Nirala Khal at the place of Bagmara Bridge	M-P12
M-P12-P3	Nirala 1 No More	South side of Sher - E - Bangla Road	Nirala Khal through Printik Khal	M-P12

There are a good number of culverts found in Ward 24. Most of the existing culverts require repair and reconstruction. Proposed number of culverts for reconstruction and new construction are 71 and 31 respectively (**Table- 4.95**).

Table- 4.96: Proposed Culvert in Ward 24

Culvert	New	OK/Repair	Reconstruction	Total
Number	31	112	71	**214**



Map: 4.24
DRAINAGE PLAN MAP IN WARD NO. 24
SCALE
1:13,500
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Nobinagar Khal
Tomijuddin Khal
North Khal
Mander Khal
Mayur Khal
Hatia River
Horintana Khal
Nirala Khal
Hatia Khal
Chari Chora Khal
Biscuit Factory
Extended Area
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
SHELTECH (PVT.) LTD.

4.1.25 Detailed Drainage Plan of Ward 25

Ward 25 is located on the western part of the Khulna City. It is physically located between the Ward 19, Ward 18 and Ward 26. The minimum spot height is about 1.16m PWD where maximum spot height is found about 2.99m PWD and the average spot height is about 1.85m PWD. The natural slope maintains from Sher-E- Bangla Road to Mayur Khal.

There is 22,810m pucca drains in this Ward. All the drains are connected to natural canals. There is 2941m natural canal in Ward 25. Details have been presented in the **Table-4.97**.

Table- 4.97: Existing Drainage Network in Ward 25

Drainage Category	Existing Length (m)
Natural Canal	2,941.34
Pucca Drain	22,809.71
Total	**25,751.05**

Total 30,974m drainage network have been proposed by the Consultant in Ward 25 (**Table-4.98**). Out of this total network, about 7,203m drains have been newly proposed. About 2,836m, 6,586m, 1,7841m and 3,710m primary, secondary, tertiary and quaternary drains have been proposed respectively. Proposed drainage network of Ward 25 has been presented in **Map- 4.25**.

Reconstruction of 2,836m and construction of 26m new primary drains have been proposed. About 3,660m and 223m secondary drains have been proposed for reconstruction and new construction respectively. Recommended tertiary drains in Ward 25 is about 1,7841m, where construction of 5,453m new drains have been proposed.

Table- 4.98: Proposed Drainage Network in Ward 25

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	26.16	23.59	5,452.51	1,701.00	**7,203.26**
OK/Repair	3.18	2,902.67	9,391.82	1,790.86	**14,088.53**
Reconstruction	2,806.90	3,660.01	2,997.16	217.87	**9,681.95**
Total	**2,836.25**	**6,586.27**	**17,841.49**	**3,709.73**	**30,973.74**

Primary drains have been proposed, these are M-P11S, M-P11E and M-P11E-P2 and fall in to same outfall drain. The primary drain named “M-P11S” starts from KDA Avenue, passing along the south-eastern side of Hazi Ismail Road, south side of Hazi Ismail Cross Road/Hazi Ismail Link Road, and falls into outfall canal “M” through Mander Khal. The proposed primary drain “M-P11E” starts from B.K.Roy Road, passing along the south-eastern side of B.K.Roy Road, southwestern side of KDA Avenue, west side of Sher- E-Bangla Road, Baroda Datta Lane and falls into outfall canal “M” through North Khal. The drain naming “M-P11E-P2” starts from west side corner of Tabliq Mosque passing along the north side of Sher-E- Bangla Road, beside the Lions School boundry, Khorshed Ahmed Sarak and falls into outfall drain “M-P11E” (North Khal). All secondary and tertiary drains are connected to these primary drains (**Table- 4.99, Map- 4.25**).

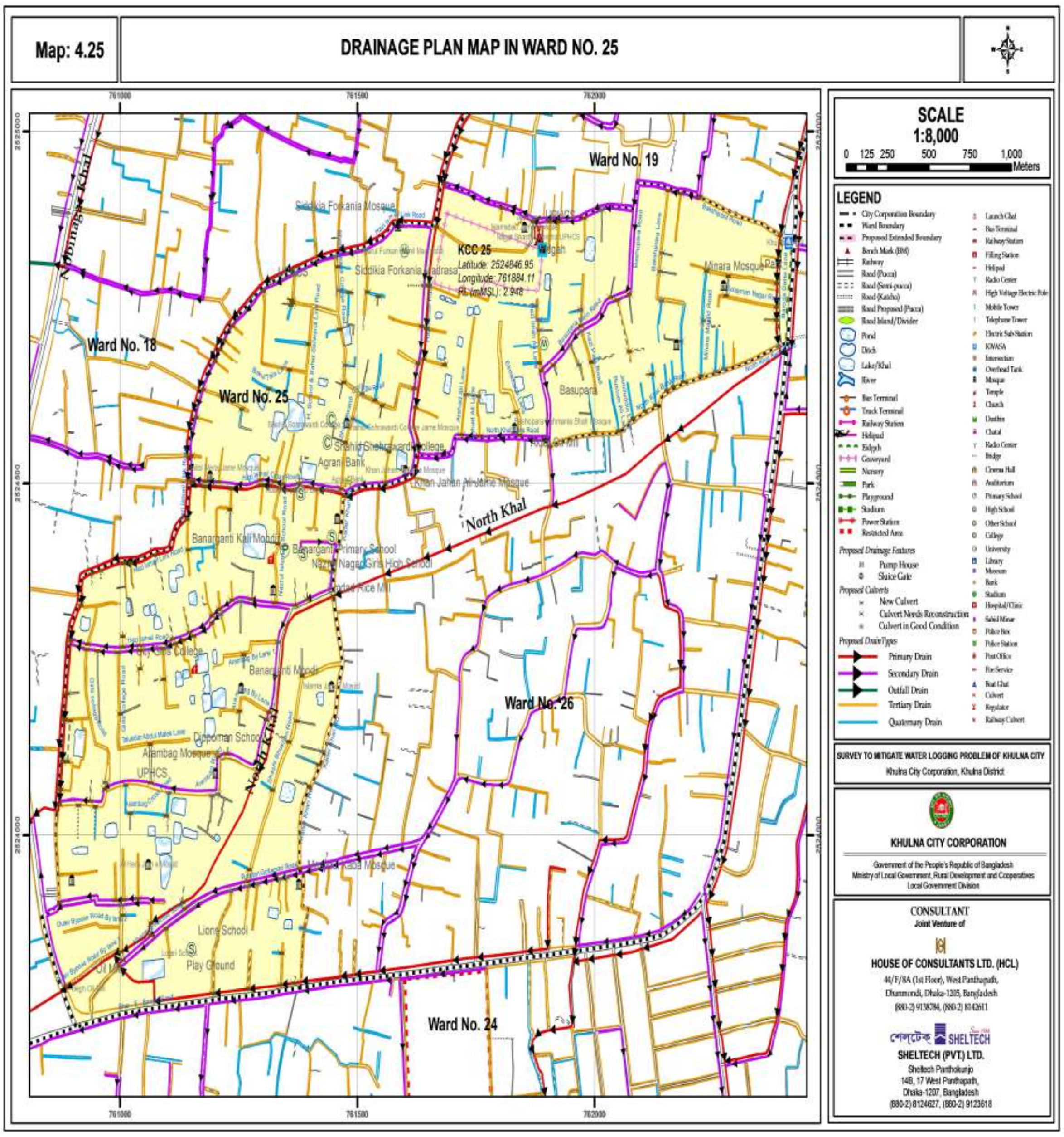
Table- 4.99: Proposed Primary Drainage System in Ward 25

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P11S	KDA Avenue	Southeastern side of Hazi Ismail Road, South side of Hazi Ismail Cross Road, South side of Hazi Ismail Link Road	Mander Khal	M
M-P11E	B. K. Roy Road	Southeastern side of B. K. Roy Road, Southwestern side of KDA Avenue, West side of Sher - E - Bangla Road, Baroda Datta Lane	North Khal	M
M-P11E-P2	West side corner of Tablik Mosque	North side of Sher - E - Bangla Road, Beside of Lions School boundry, Khorshed Ahmed Sarak	M-P11E (North Khal)	M

There exist 97 culverts in Ward 25. These culverts are not in good condition or not enough to meet the future requirement. Consultants have proposed for reconstruction of 51 and new construction of 16 culverts there (**Table- 4.100**).

Table- 4.100: Proposed Culvert in Ward 25

Culvert	New	OK/Repair	Reconstruction	Total
Number	16	46	51	**113**


Map: 4.25
DRAINAGE PLAN MAP IN WARD NO. 25
SCALE
1:8,000
Ward No. 19
Ward No. 18
Ward No. 25
Ward No. 26
Ward No. 24
North Khal
KCC 25
Latitude: 2524846.95
Longitude: 761884.11
Basupara
Minara Mosque
Siddikia Forkania Madrasa
Agrani Bank
Khan Jahan Ali Jame Mosque
Banarganti Primary School
Lions School
Play Ground
Alambag Mosque
UPHCS
LEGEND
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
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Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
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4.1.26 Detailed Drainage Plan of Ward 26

This ward is located beside Ward 25 and Ward 24. The minimum, maximum and average spot heights are 0.35m PWD, 2.99m PWD and 1.87m PWD respectively. The natural slope is from Sher-E-Bangla Road to North Khal.

The **Table-4.101** shows that there exist about 20,747m pucca drains in the ward. All the drains within this ward are connected with natural canals. It has 2,182m natural canals. Details presented in the **Table-4.101**.

Table- 4.101: Existing Drainage Network in Ward 26

Drainage Category	Existing Length (m)
Natural Canal	2,182.28
Pucca Drain	20,747.60
Total	**22,929.88**

Total drainage network proposed by the Consultant is 27,321m. In this ward, newly proposed drainage network is 6,396m.In total 2,555m, 4,959m, 15,395m and 4,413m primary, secondary, tertiary and quaternary drains have been proposed in this Ward respectively (**Table-4.102**). Proposed drainage network of Ward 26 has been presented in **Map- 4.26**.

Reconstruction of 1,964m and construction of 29m new primary drains have been proposed. About 2,938m and 210m drains have been proposed for reconstruction and new construction respectively. Recommended tertiary drains in ward 26 are 15,395m where construction of 4,660m new drains have been proposed.

Table- 4.102: Proposed Drainage Network in Ward 26

Drainage Category	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	28.70	10.96	4,660.29	1,695.99	**6,395.94**
OK/Repair	561.37	2,009.36	7,246.55	2,426.38	**12,243.66**
Reconstruction	1,964.56	2,938.77	3,488.12	290.28	**8,681.72**
Total	**2,554.63**	**4,959.09**	**15,394.95**	**4,412.65**	**27,321.32**

The proposed primary drain named “M-P11E” starts from south-eastern side of B.K.Roy Road, passing along the southwestern side of KDA Avenue, west side of Sher-E-Bangla Road, Baroda Datta Lane falls into outfall canal “M” through North Khal. The drain named “M-P11E-P2” started from west corner of Tabliq Mosque passing along the north side of Sher-E-Bangla Road, beside the Lions School boundry, Khorshed Ahmed Sarak falls into outfall drain “M” near “M-P11E” (North Khal). The drain “M-P12-P3-P1” starts from west side of Nazirhat Cross Road passing along the west side of Nazirhat Main Road falls into outfall drain “M-P12-P3” (Printik Khal) at Tabliq Mosque. All secondary and tertiary drains in this ward are connected to the primary drainage system. Details presented in **Table- 4.103 and Map- 4.26**.

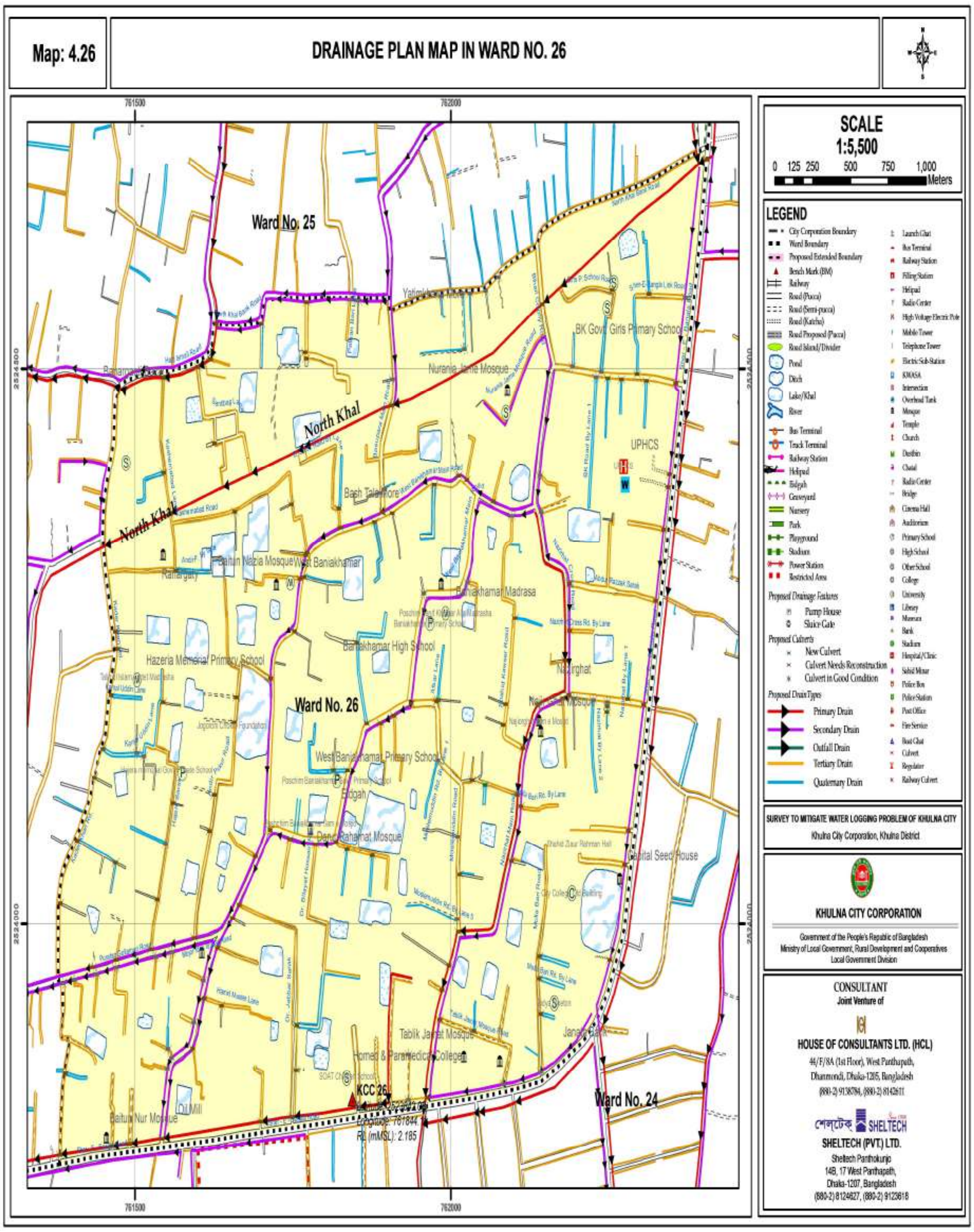
Table- 4.103: Proposed Primary Drainage System in Ward 26

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P11E	B. K. Roy Road	Southeastern side of B. K. Roy Road, Southwestern side of KDA Avenue, West side of Sher - E - Bangla Road, Baroda Datta Lane	North Khal	M
M-P11E-P2	West corner of Tablik Mosque	North side of Sher - E - Bangla Road, Beside of Lions School boundry, Khorshed Ahmed Sarak	M-P11E (North Khal)	M
M-P12-P3-P1	West side of Nazirhat Cross Road	West side of Nazirhat Main Road	Prantik Khal at Tablik Mosque	M-P12-P3

The consultants have proposed 12 new culverts in the ward in addition to 103 existing culverts. Most of the existing culverts needed repair (38 nos.) or reconstruction (65 nos.) (**Table- 4.104)**.

Table- 4.104: Proposed Culverts in Ward 26

Culvert	New	OK/Repair	Reconstruction	Total
Number	12	38	65	**115**


Map: 4.26
DRAINAGE PLAN MAP IN WARD NO. 26
SCALE
1:5,500
LEGEND
Ward No. 25
Ward No. 26
Ward No. 24
North Khal
BK Govt Girls Primary School
UPHCS
Hazeria Memorial Primary School
West Baniakhamar Primary School
Baniakhamar High School
Baniakhamar Madrasa
Nurania Jame Mosque
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
SHELTECH (PVT.) LTD.

4.1.27 Detailed Drainage Plan of Ward 27

Ward 27 is situated in the southern part of the Khulna City with Khanjahan Ali Road on the north, Chori Chora Khal on the south Ward 24 and 28 on the west and east side respectively. The minimum spot height is -0.63m PWD, maximum height 2.82m PWD and the average height is 1.82m PWD. The natural slope moves from Khanjahan Ali Road to Chori Chora Khal.

Length of existing pucca drains and natural canals in this ward are about 24,607m and about 2,883m respectively. All categories of drains are connected to the natural canals. Details presented in the **Table-4.105**.

Table- 4.105: Existing Drainage Network in Ward 27

Drainage Category	Existing Length (m)
Natural Canal	2,883.42
Pucca Drain	24,607.18
Total	**27,490.60**

In this ward, the Consultants have proposed about 33,618m different categories drainage network that includes 8676m new drains. About 2,721m, 6,775m, 19,675m and 3,128m primary, secondary, tertiary and quaternary drains have been proposed in this ward respectively (**Table-4.106**). Proposed drainage network of ward 27 has been presented in **Map- 4.27**.

There is proposal for reconstruction of 2,270m and construction of 7m new primary drains. A total of 6,775m secondary drains have been recommended. About 3,286m and 363m drains have been proposed for reconstruction and new construction respectively. Tertiary drain in Ward 27 is about 19,675m, where the drain proposed for new construction is 5,840m.

Table- 4.106: Proposed Drainage Network in Ward 27

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,318.62	6.75	362.87	5,839.35	1,148.87	**8,676.47**
OK/Repair	0.00	443.87	3,125.62	13,444.73	1,731.66	**18,745.87**
Reconstruction	0.00	2,270.65	3,286.41	390.36	247.78	**6,195.19**
Total	**1,318.62**	**2,721.27**	**6,774.90**	**19,674.44**	**3,128.31**	**33,617.54**

Only one primary drain named “M-P12” has been proposed. It start from Hotel Castle Salam, passing along the south side of KDA Avenue, east side of Islampur Road, south side of Baniakhamar Main Road, east side of Bagmara Main Road finally falls into the outfall canal (Purbo Nirala Khal) “M-P12” at Bagmara Bridge. There are also a number of proposed secondary drains. The secondary drains “M-P12-S1” and “L-S8” pass along both side of Mistripara Bazar Road finally falls into the Chori Chora Khal. The secondary drains “L-S6W” and “L-S6E”, passing along both side of Baniakhamar Main Road finally falls into the Chori Chora Khal through Pipe More Khal. Details have been presented in **Table- 4.107, Map-4.27**.

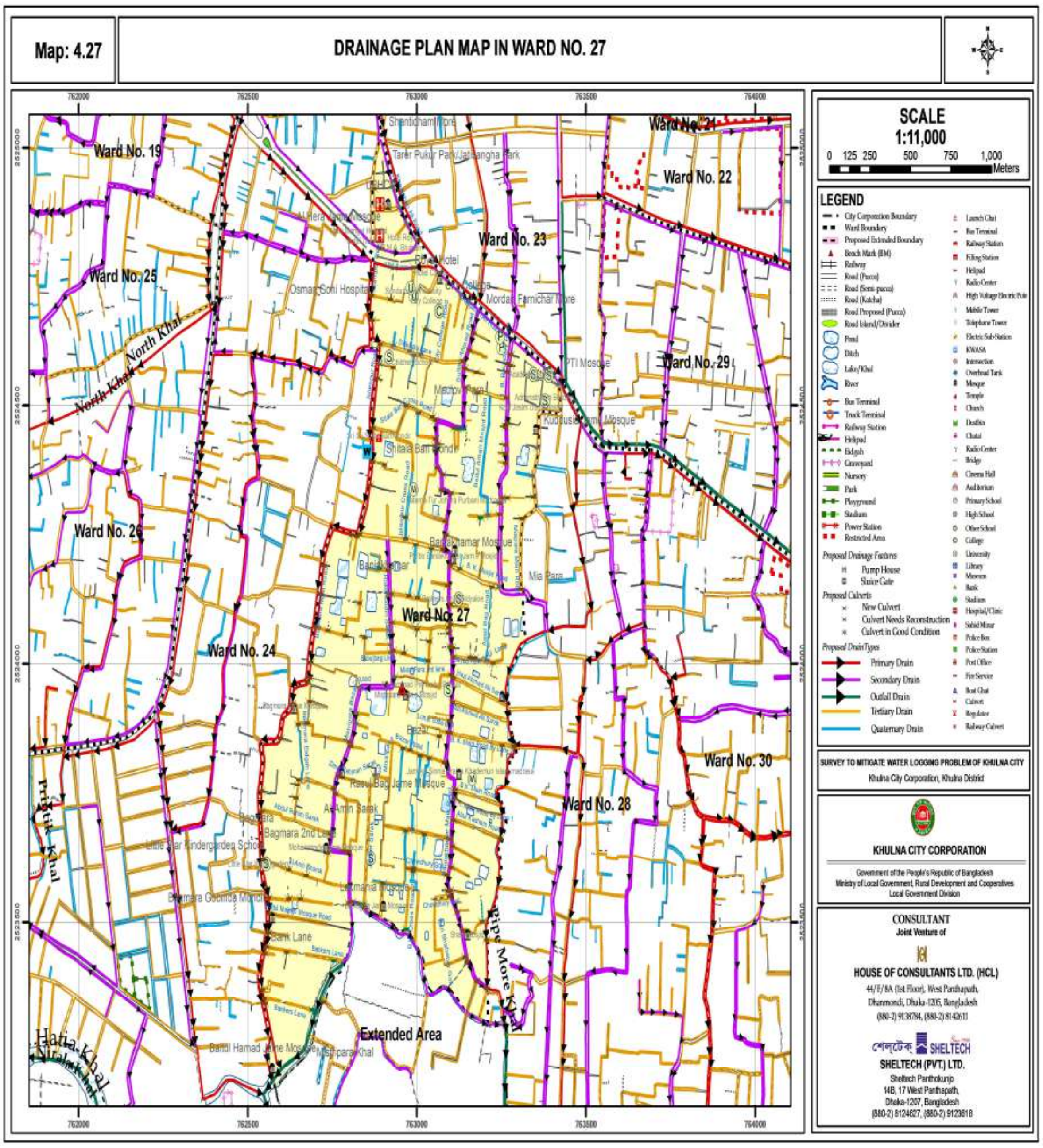
Table- 4.107: Proposed Primary Drainage System in Ward 27

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
M-P12	In front of Hotel Castle Salam	South side of KDA Avenue, East side of Islampur Road, South side of Baniakhamar Main Road, East side of Bagmara Main Road	Purbo Nirala Khal at Bagmara Bridge	M-P12

The existing number of culverts found in this ward is 97. These culverts need to be repaired and reconstruction for the future requirement. As per **Table-4.108**, proposed number of culverts for reconstruction and new construction are 49 and 19 respectively.

Table- 4.108: Proposed Culverts in Ward 27

Culvert	New	OK/Repair	Reconstruction	Total
Number	19	48	49	**116**



Map: 4.27
DRAINAGE PLAN MAP IN WARD NO. 27
SCALE
1:11,000
0 125 250 500 750 1,000 Meters
LEGEND
Ward No. 19
Ward No. 21
Ward No. 22
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
North Khal
Extended Area
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
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4.1.28 Detailed Drainage Plan of Ward 28

Ward 28 is situated in the southern part of the Khulna City. It is exactly located between Ward no 27 and 30 on the west and east side. The minimum spot height in this area is about -0.78m PWD where maximum spot height is found 2.97m PWD and the average height is 1.56m PWD. The natural slope is from Khanjahan Ali Road to Chori Chora Khal and Motia Khali Khal.

There exist about 20,647m pucca drains in this Ward. All the drains are connected to nearby natural canal around the Ward. There about 3,167m natural canals found in Ward 28. Details presented in the **Table-4.109**.

Table- 4.109: Existing Drainage Network in Ward 28

Drainage Category	Existing Length (m)
Natural Canal	3,166.82
Pucca Drain	20,647.48
Total	**23,814.30**

About 30,760m drainage network have been recommended by the Consultant in Ward 28, where about 8850m new drains are proposed there. About 3,611m, 7,077m, 16,118m and 2,716m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.110**). Proposed Drainage network of Ward 28 has been given in **Map- 4.28**.

Reconstruction of about 2,454m primary drains and about secondary 4,027m has been proposed in this ward. There recommended about 200m, 730m and 5,744m new drains for construction respectively. About 1,237m new outfall drains have also been proposed.

Table- 4.110: Proposed Drainage Network in Ward 28

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	1,237.39	200.17	729.54	5,744.10	938.81	**8,850.01**
OK/Repair	0.00	956.80	2,320.55	7,702.43	1,669.24	**12,649.01**
Reconstruction	0.00	2,453.71	4,027.29	2,670.99	108.45	**9,260.44**
Total	**1,237.39**	**3,610.68**	**7,077.37**	**16,117.52**	**2,716.50**	**30,759.46**

The consultants propsed 5 primary drains ward 28. The primary drain “L” starts from the east side of Ferry Ghat More (Khanjahan Ali Road) passing along the northeastern side of Khanjahan Ali Road, crossing the Khanjahan Ali Road at PTI more, then passing along the south side of Khanjahan Ali Road, Binodini Hospital Road, Miapara 2nd Lane finally falls into the Bhairab River by pump drainage system (Pump House 02) through Pipe More Khal, Chori Chora Khal and Labanchora 2 No Sluice Gate Khal. The drain “L-P2”, starts from West Tootpara Main Road, passing along the West Tootpara Road, B. K. Main Road by Lane 2 falls into the outfall drain “L” (Baniakhamar Khal). The primary drain naming “L-P4” starts from east side of West Tootpara Road passing along the east side of Tootpara Primary School Sarak, Dulal Sarok finally falls into the outfall drain “L” (Labanchora 2 No Sluice Gate Khal) through Motia Khali Khal, Khetra Khali Khal and Labanchora South Khal. The drains “L-P4-P1” and “L-P4-P2”, starts from Tootpara Main Road, passing along Tootpara Main Road and Tootpara South Circular Road finally falls into the outfall canal “L-P4” (Motia Khali Khal). All other drains like secondary and tertiary are connected to these primary drains. Details presented in **Table- 4.111 and Map- 4.28**.

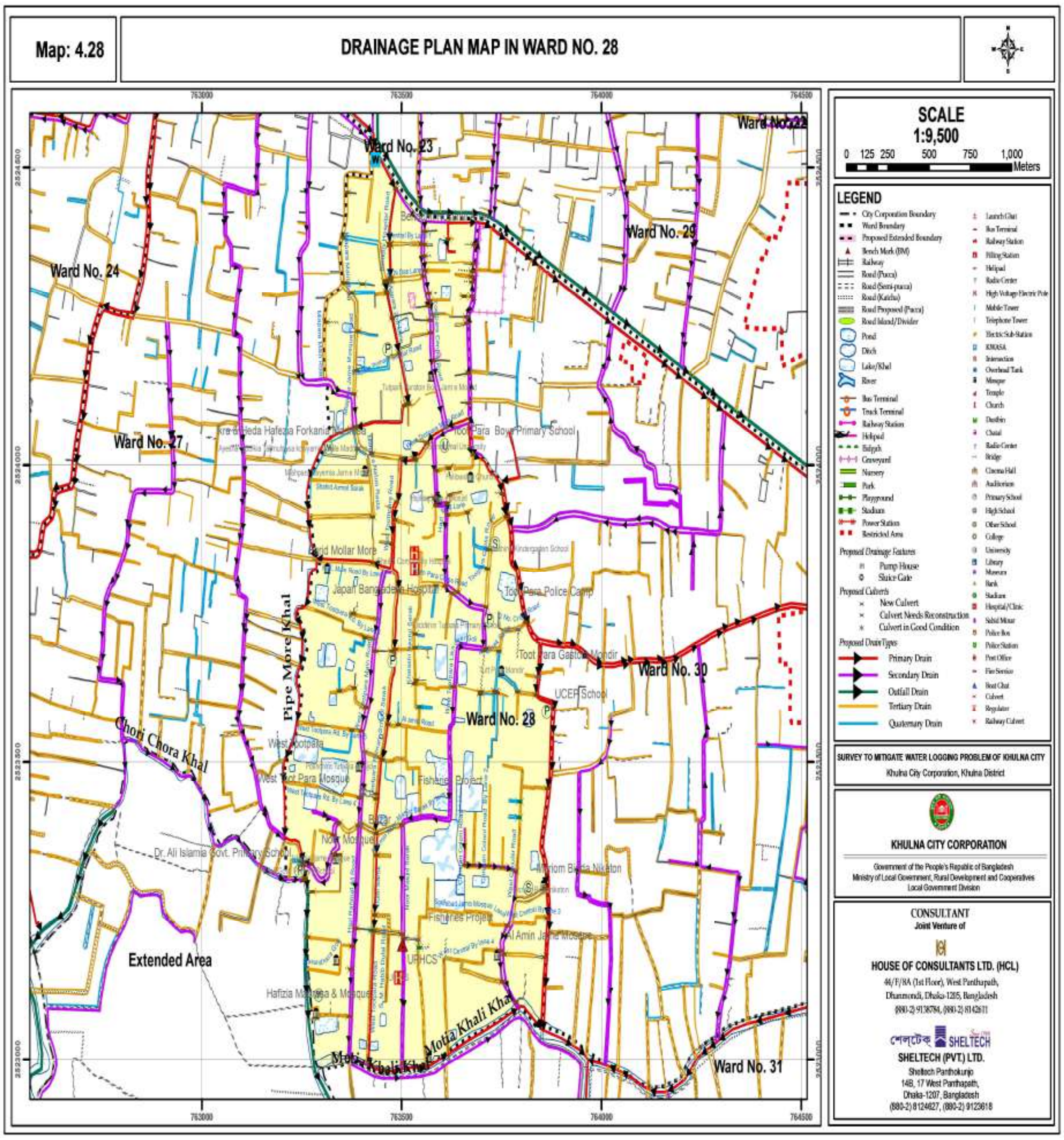
Table- 4.111: Proposed Primary Drainage System in Ward 28

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
L	East side of Ferry Ghat More (Khanjahan Ali Road)	Northeastern side of Khanjahan Ali Road, Binodini Hospital Road, Miapara 2nd Lane	Bhairab River through Pipe More Khal, Chori Chora Khal and Labanchora 2 No Sluice Gate Khal	Bhairab River
L-P2	West Tootpara Main Road	West Toothpara Road, B. K. Main Road By Lane 2	Baniakhamar Khal	L
L-P4	East side of West Tootpara Road	East side of Tootpara Primary School Sarak, Dulal Sarok	Labanchora 2 No Sluice Gate Khal through Motia Khali Khal, Khetra Khali Khal and Labanchora South Khal	L
L-P4-P1 & L-P4-P2	Tootpara Main Road	Tootpara South Circular Road	Motia Khali Khal	L-P4

There are 78 culverts in Ward 28. These culverts are not in poor condition. Proposed numbers of culverts recommended for reconstruction and new construction are 39 and 16 respectively (**Table- 4.112**).

Table- 4.112: Proposed Culverts in Ward 28

Culvert	New	OK/Repair	Reconstruction	Total
Number	16	39	39	**94**


Map: 4.28
DRAINAGE PLAN MAP IN WARD NO. 28
SCALE
1:9,500
LEGEND
Ward No. 23
Ward No. 24
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
Ward No. 31
Extended Area
Pipe More Khal
Chori Chora Khal
Motia Khali Khal
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4.1.29 Detailed Drainage Plan of Ward 29

This ward has Khanjahan Ali Road on the south, South Centeral Road on the north, Ward 23 on the west and 22 on the east respectively. The minimum spot height of the ward is 0.98m PWD, maximum height 2.59m PWD and the average spot height is 1.84m PWD. The natural slope is from South Central Road towards Khanjahan Ali Road.

There is 1,6161m pucca drains and about 1,867m natural canals in this Ward. All the existing drains are connected to n natural canals in and around the Ward. Details presented in the **Table-4.113**.

Table- 4.113: Existing Drainage Network in Ward 29

Drainage Category	Existing Length (m)
Natural Canal	1,867.36
Pucca Drain	16,160.88
Total	**18,028.24**

In this ward, about 213m, 5,632m, 11,623m and 814m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.114**). Recommended total drainage network is about 19,550m, in which about 3558m drains have been newly proposed. Proposed drainage network of Ward 29 has been presented in **Map- 4.29**.

There is no proposal for reconstruction or new construction of primary drains in this ward. About 2,332m and 647m secondary drains have been proposed for reconstruction and new construction respectively. Tertiary drains in Ward 29 is about 11,623m, where about 2,560m new drains have been proposed for constructions.

Table- 4.114: Proposed Drainage Network in Ward 29

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	8.17	0.00	646.85	2,559.46	343.54	**3,558.01**
OK/Repair	0.00	213.11	2,652.67	6,453.56	266.22	**9,585.56**
Reconstruction	1,259.20	0.00	2,332.77	2,609.79	204.48	**6,406.23**
Total	**1,267.36**	**213.11**	**5,632.29**	**11,622.80**	**814.24**	**19,549.80**

Only one primary drain proposed in ward 29. The proposed primary drain is named as “D4” that starts Govt. Coronation Girls School (Ahsan Ahmed Road), passing along the east side of Ahsan Ahmed Road, northeastern side of Khanjahan Ali Road finally falls into the Rupsha River by pump drainage system (Pump House 01) at Rupsha Ghat. There are a number of secondary drains “D4-S2W”, “D4-S2E”, “D4-S3W”, “D4-S3E”, “D4-S4W”, “D4-S4E” and “D4-S5” pass along different roads within this ward and finally falls into the primary drain “D4” All tertiary and quaternary drains are also connected to this primary drain. Details have been presented in **Table- 4.115 and Map- 4.29**.

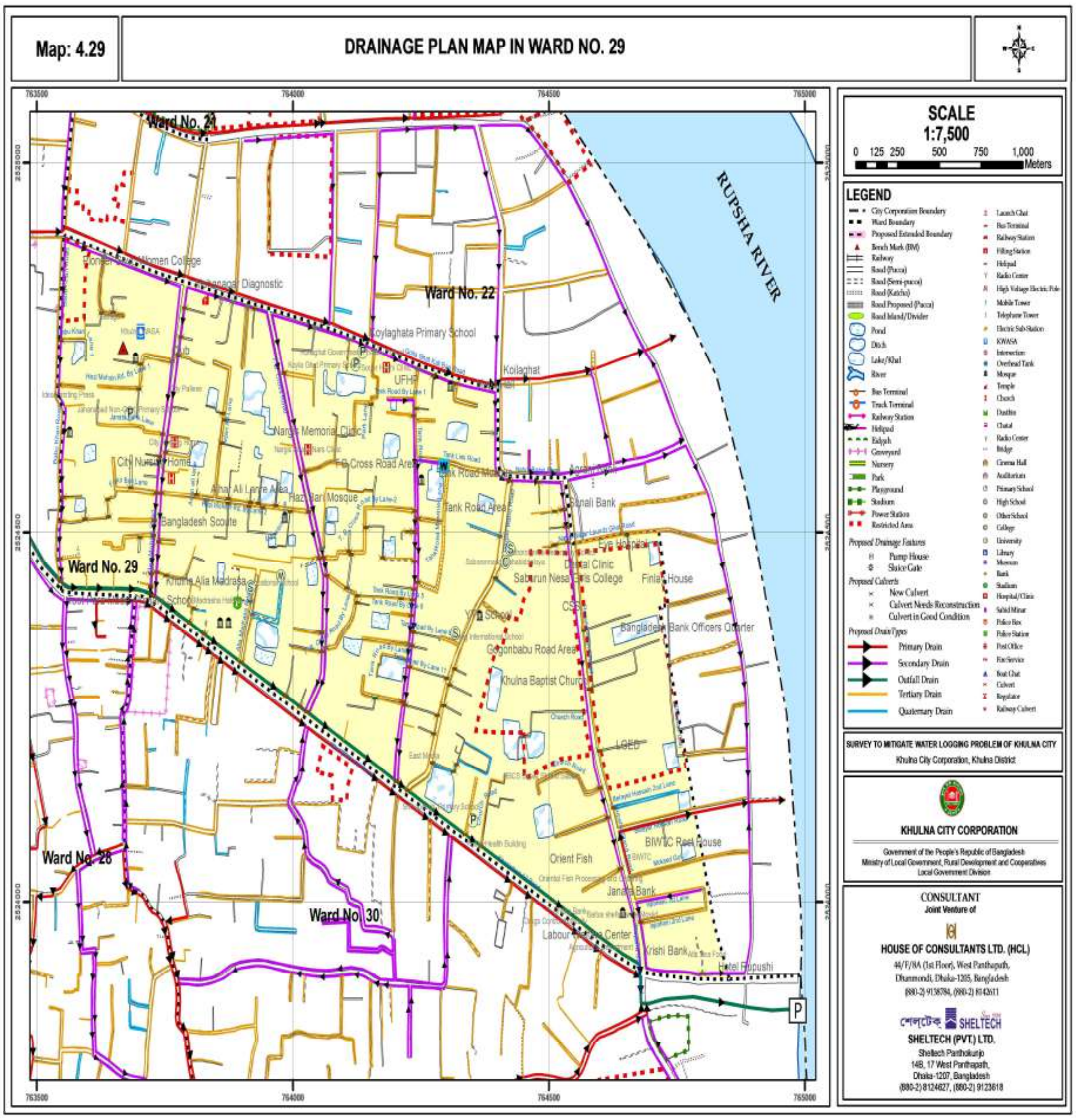
Table- 4.115: Proposed Primary Drainage System in Ward 29

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
D4	In front of Govt. Coronation Girls School	Ahsan Ahmed Road, Northeastern side of Khanjahan Ali Road	Rupsha Ghat	Rupsha River

Total number of proposed culverts is 81, including 74 existing culverts. Most of the existing culverts need repair or reconstruction. Consultants have proposed 38 and 07 culverts for reconstruction and new construction respectively (**Table- 4.116**).

Table- 4.116: Proposed Culvert in Ward 29

Culvert	New	OK/Repair	Reconstruction	Total
Number	7	36	38	**81**


Map: 4.29
DRAINAGE PLAN MAP IN WARD NO. 29
SCALE
1:7,500
0 125 250 500 750 1,000
Meters
LEGEND
RUPSHA RIVER
Ward No. 24
Ward No. 22
Ward No. 29
Ward No. 28
Ward No. 30
Koylaghata Primary School
Koilaghat
Nargis Memorial Clinic
FB Cross Road Area
Tank Road Area
Bangladesh Scoute
Khulna Alia Madrasa
Sonali Bank
Sabarun Nesa Girls College
Finlay House
Bangladesh Bank Officers Quarter
Gogonbabu Road Area
Khulna Baptist Church
LGED
BIWTC Rest House
Orient Fish
Janata Bank
Labour Welfare Center
Krishi Bank
Hotel Rupushi
Diagnostic
UFHP
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Ministry of Local Government, Rural Development and Cooperatives
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4.1.30 Detailed Drainage Plan of Ward 30

Ward 30 is in the eastern part of the Khulna city. It is surrounded by the Ward no. 28 on the west, Ward No. 31 on the south, the Rupsha River on the east and Khanjahan Ali Road on the north. This area is on the bank of the Rupsha River, where the minimum spot height is about 0.66m PWD, maximum height is 2.80m PWD and the average height is 1.82m PWD. The natural slope is towards Rupsha River.

Length of existing pucca drains and natural canals are 2,4495m and 3,373m respectively. All the drains are linked to natural canals within the Ward. Details have been presented in the **Table-4.117**.

Table- 4.117: Existing Drainage Network in Ward 30

Drainage Category	Existing Length (m)
Natural Canal	**3,373.05**
Pucca Drain	24,495.24
Total	**27,868.29**

About 37,018m total drainage network including 10,575m new drains have been proposed by the Consultant in Ward 30. About 4,034m, 8,375m, 20,239m and 3,997m primary, secondary, tertiary and quaternary drains have been proposed respectively (**Table-4.118**). Proposed drainage network of Ward 30 has been given in **Map- 4.30**.

Reconstruction of about 2,288m and construction of 143m new primary drains have been proposed. About 6,189m and 1,324m secondary drains have been proposed for reconstruction and new construction respectively. Proposal has been made for a number of tertiary drains, which includes about 6,978m new drains.

Table- 4.118: Proposed Drainage Network in Ward 30

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	29.66	143.18	1,323.66	6,977.89	2,100.75	**10,575.13**
OK/Repair	0.00	1,602.25	861.82	4,106.40	380.46	**6,950.93**
Reconstruction	343.40	2,288.66	6,189.23	9,154.97	1,515.84	**19,492.10**
Total	**373.05**	**4,034.09**	**8,374.71**	**20,239.26**	**3,997.05**	**37,018.16**

This area is densely habituated and formidably low land having serious drainage congestion. To mitigate the drainage problems, pump drainage system is proposed. The proposed primary drains “D4-P2” and “D4-P3” starts from Tootpara Jorakol Bazar, passing along both side of Tootpara Main Road finally falls into the outfall drain “D4” at Rupsha Swashan Ghat More. The primary drain named “D4-P1” starts Tootpara Graveyard, passing along the southwestern side of Khanjahan Ali Road finally falls into the outfall drain “D4” near Rupsha Bus Stand. All secondary, tertiary and other drains are connected to the primary drains. Details have been presented in **Table- 4.119 and Map- 4.30**.

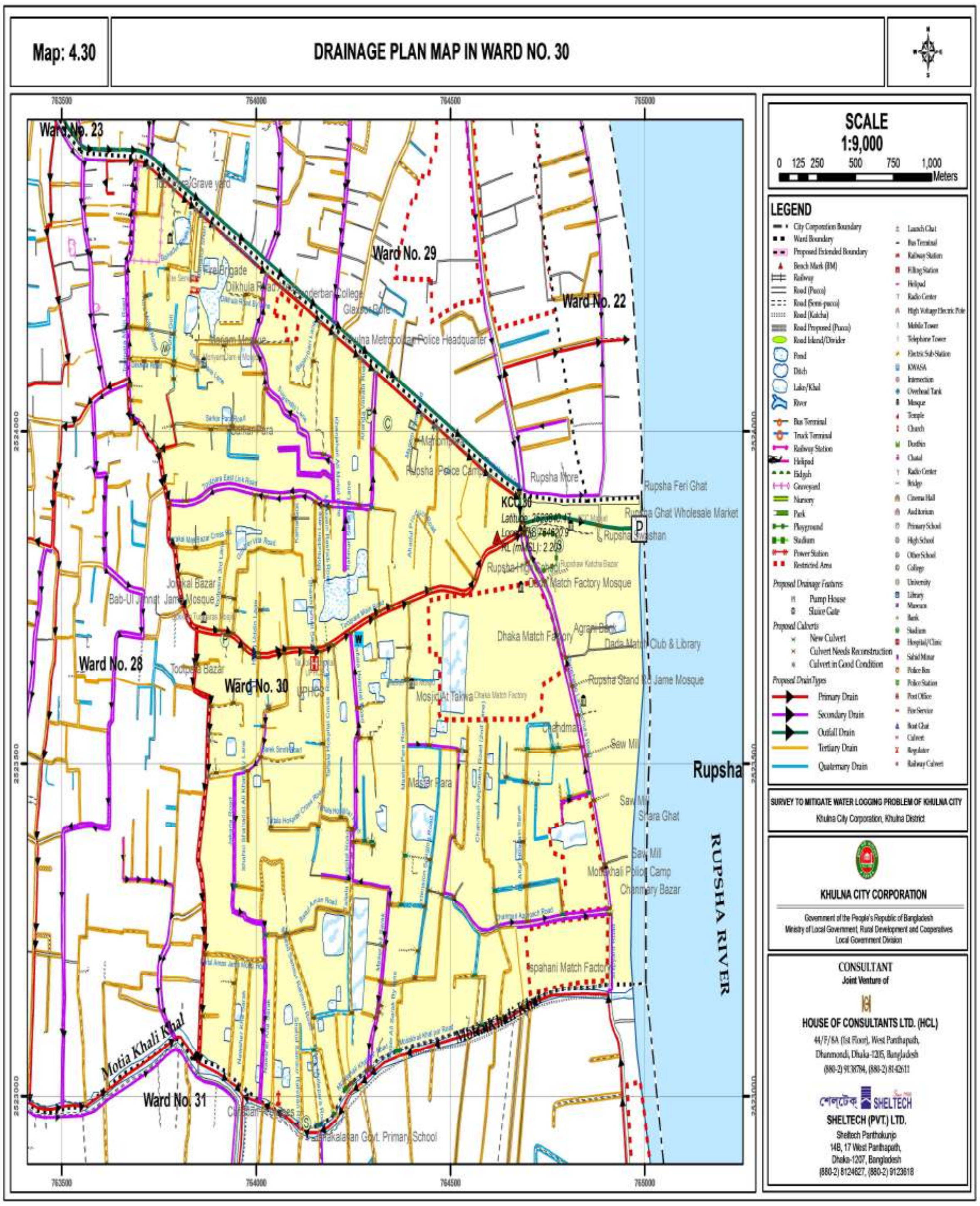
Table- 4.119: Proposed Primary Drainage System in Ward 30

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
D4-P2 & D4-P3	Tootpara Jorakol Bazar	Tootpara Main Road	Rupsha Swashan Ghat More	D4
D4-P1	Tootpara Graveyard,	Southwestern side of Khanjahan Ali Road	Rupsha Bus Stand	D4

There exist 75 culverts in Ward 30. Most of these culverts require reconstruction. According to the **Table-4.120**, proposed culverts for reconstruction and new construction are 61 and 30 respectively.

Table- 4.120: Proposed Culverts in Ward 30

Culvert	New	OK/Repair	Reconstruction	Total
Number	30	24	61	**115**



Map: 4.30
DRAINAGE PLAN MAP IN WARD NO. 30
SCALE
1:9,000
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 23
Ward No. 29
Ward No. 22
Ward No. 28
Ward No. 30
Ward No. 31
Rupsha
RUPSHA RIVER
Rupsha Feri Ghat
Rupsha Ghat Wholesale Market
Rupsha More
Dhaka Match Factory
Dhaka Match Factory Mosque
Ispahani Match Factory
Motia Khali Khal
Bab-Ul Jannat Jame Mosque
Joraikal Bazar
Toutpara Bazar
Master Para
Saw Mill
Chanmary Bazar
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
Tertiary Drain
Quaternary Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
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4.1.31 Detailed Drainage Plan of Ward 31

The ward is in the southern part of the Khulna City, located beside Ward 30 on the north and the Rupsha River on the east. This area is situated on the bank of the Rupsha River, where the minimum spot height is -1.74m PWD, maximum spot height is 3.77m PWD and the average spot height is 1.10m PWD. The natural slope is from north to south.

There exist 8,832m pucca drains within this ward. All categories of drains are connected with natural canals. Total 14,453m natural canals of have been proposed for RCC and Block lining. Details have been presented in the **Table-4.121**.

Table- 4.121: Existing Drainage Network in Ward 31

Drainage Category	Existing Length (m)
Natural Canal	14,453.20
Pucca Drain	8,831.64
Total	**23,284.84**

Total drainage network proposed by the Consultant is 72,243m in ward 31. Length of newly proposed drain is about 62,884m. About 336m, 8,311m, 46,407m and 2,544m primary, secondary, tertiary and quaternary drains have been proposed there respectively (**Table-4.122**). Proposed Drainage network of Ward 31 has been shown in **Map- 4.31**.

A few numbers of primary drains have been recommended in this ward. About 988m and 6,517m secondary drains have been proposed for reconstruction and new construction respectively. Proposed tertiary drains in ward 31 is 46,407m, where 39,208m new tertiary drains have been proposed for construction.

Table- 4.122: Proposed Drainage Network in Ward 31

Drainage Category	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total
New	14,645.41	331.85	6,517.18	39,207.89	2,181.76	**62,884.09**
OK/Repair	0.00	0.00	805.46	5,177.88	331.51	**6,314.86**
Reconstruction	0.00	3.92	988.20	2,020.88	30.31	**3,043.32**
Total	**14,645.41**	**335.77**	**8,310.84**	**46,406.66**	**2,543.58**	**72,242.26**

In this ward, only one primary drain system is proposed, named “L-P4-P3”. It starts from shipyard and passing along the west side of Shipyard Road finally falls into the Rupsha River through Motia Khali Khal. All secondary, tertiary and other drains are connected to this primary drain. Details presented in **Table-4.123 and Map- 4.31**.

This area is densely populated including a number of industries. Most of the land in this area is formidably low having serious drainage congestion. To mitigate the drainage problems, pump drainage is proposed. The Motia Khali Khal, Khetra Khali Khal, Ghora Khal, Labanchora no. 1 Sluice Gate Khal, Labanchora South Khal, Labanchora no. 2 Sluice Gate Khal and Khan-E-Sabur Bagan Bari Khal usually drain out rainfall runoff water of this area.

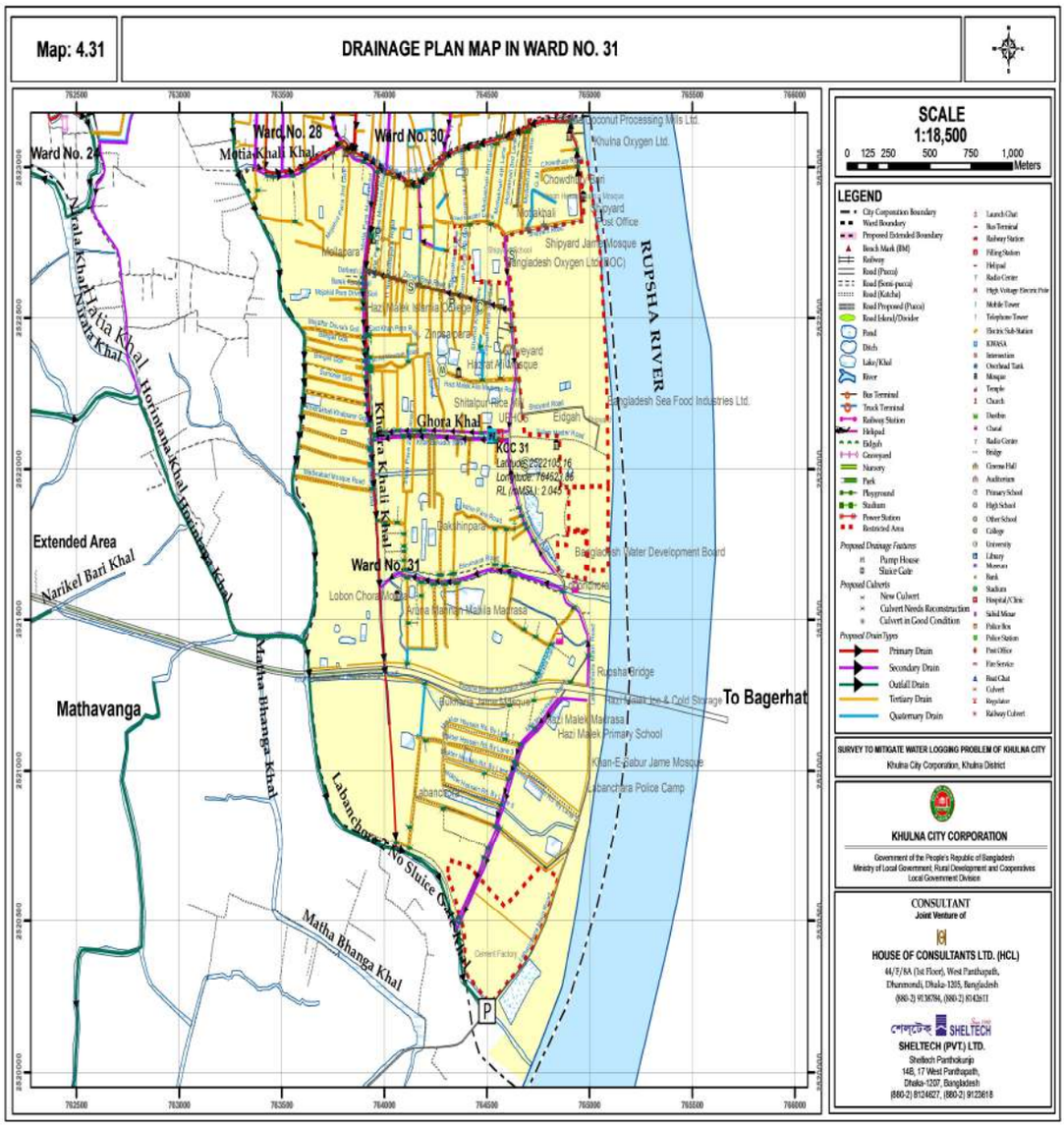
Table- 4.123: Proposed Primary Drainage System in Ward 31

Name of the Drain	Name of the Road			Outfall Drain
	Start	Passing Along	End	
L-P4-P3	In front of shipyard,	Shipyard Road	Motia Khali Khal	Rupsha River

There are 31 culverts in Ward 31. As per future requirement, the consultants have proposed 140 new culverts. Out of 31 existing culverts, 13 culverts are proposed for reconstruction (**Table- 4.124**).

Table- 4.124: Proposed Culverts in Ward 31

Culvert	New	OK/Repair	Reconstruction	Total
Number	140	18	13	**171**


Map: 4.31
DRAINAGE PLAN MAP IN WARD NO. 31
SCALE
1:18,500
0 125 250 500 750 1,000
Meters
LEGEND
Ward No. 28
Ward No. 30
Ward No. 24
Ward No. 31
Matia Khali Khal
Nirala Khal
Hatia Khal
Horintana Khal
Ghora Khal
Khalisa Khali Khal
Narikel Bari Khal
Matha Bhanga Khal
Labanchora Sluice Gate Khal
Extended Area
Mathavanga
To Bagerhat
RUPSHA RIVER
Khulna Oxygen Ltd.
Bangladesh Oxygen Ltd. (BOC)
Bangladesh Sea Food Industries Ltd.
Bangladesh Water Development Board
Rupsha Bridge
Hazi Malek Primary School
Khan-E-Babur Jame Mosque
Labanchora Police Camp
KCC 31
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
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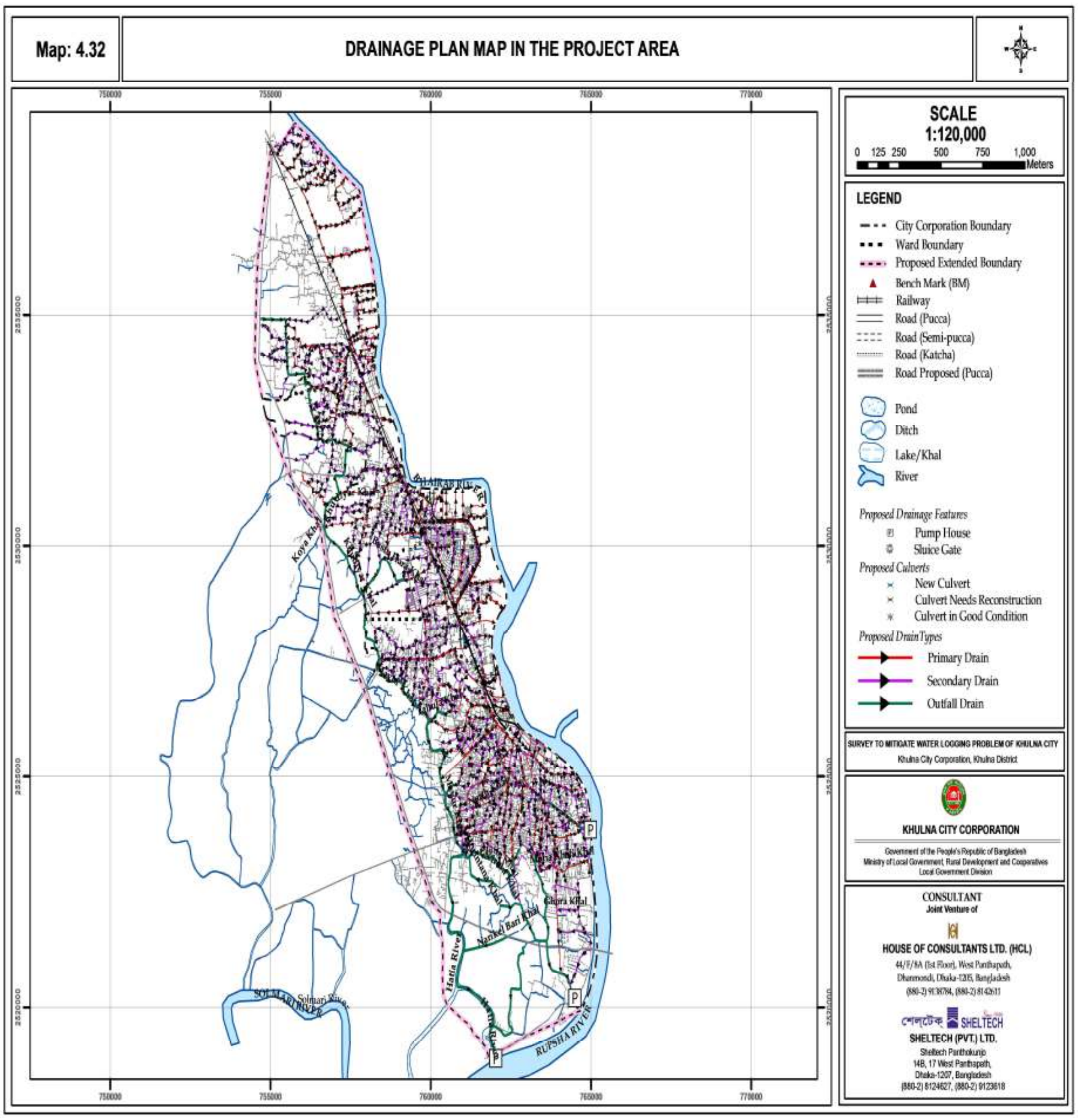
4.2 Summary of Drainage Network

In order to develop the drainage network systems for mitigating the water logging problem in the project area, a total of about 1,206 km drainage network have been proposed. About 172 km primary, 259 km secondary, 613km tertiary, 124km quaternary and 37 km outfall drains have been proposed in the entire KCC and extended area. Details have been presented in **Table- 4.125 and Map- 4.32**.

Table- 4.125: Total Drainage Network in the Project Area

Ward No	Outfall Drain	Primary Drain	Secondary Drain	Tertiary Drain	Quaternary Drain	Total	Total
	M	M	M	M	M	M	KM
Ward 01	489.39	6,939.92	13,439.67	22,949.01	4,054.18	47,872.17	**47.87**
Ward 02		15,655.86	4,823.22	10,420.72	2,282.68	33,182.47	**33.18**
Ward 03	1917.97	7,541.73	15,273.43	25,854.04	7,676.60	58,263.76	**58.26**
Ward 04	814.29	4,679.54	10,741.62	11,195.73	1,950.93	29,382.11	**29.38**
Ward 05		3,619.02	3,101.59	11,380.75	2,812.79	20,914.15	**20.91**
Ward 06		6,025.31	13,871.30	21,168.09	2,686.83	43,751.52	**43.75**
Ward 07		2,092.61	2,877.94	6,305.31	1,878.34	13,154.20	**13.15**
Ward 08		4,921.89	235.17	54.12		5,211.19	**5.21**
Ward 09	2500.36	5,247.03	16,192.01	365,13.53	9,858.92	70,311.85	**70.31**
Ward 10		4,013.45	7,539.47	206,03.66	5,604.99	37,761.58	**37.76**
Ward 11		1,828.19	1,404.84	42,10.21	1,961.31	9,404.54	**9.40**
Ward 12		4,357.07	3,538.73	178,16.97	2,490.87	28,203.64	**28.20**
Ward 13		5,151.66	1,223.92	38,17.73	1,583.70	11,777.01	**11.78**
Ward 14	1282.24	4,321.60	14,655.91	327,29.70	10,310.84	63,300.29	**63.30**
Ward 15		6,237.11	4,222.91	97,47.59	2,180.66	22,388.26	**22.39**
Ward 16	1858.58	5,219.43	15,531.85	310,70.70	10,460.75	64,141.31	**64.14**
Ward 17	1670.52	8,130.43	15,087.96	359,38.28	10,464.08	71,291.28	**71.29**
Ward 18	2306.67	6,190.50	7,805.11	265,19.22	5,656.20	48,477.70	**48.48**
Ward 19		2,490.85	4,935.30	111,17.70	2,388.29	20,932.16	**20.93**
Ward 20		2,871.30	4,346.88	113,71.67	1,361.86	19,951.71	**19.95**
Ward 21		8,022.83	4,348.78	143,00.39	1,514.09	28,186.09	**28.19**
Ward 22		2,070.81	3,818.62	100,96.17	591.34	16,576.94	**16.58**
Ward 23	503.86	2,464.94	3,433.15	86,10.94	1,195.27	16,208.16	**16.21**
Ward 24	717.64	7,005.08	9,762.58	331,83.08	8,964.13	59,632.51	**59.63**
Ward 25		2,836.25	6,586.27	178,41.49	3,709.73	30,973.74	**30.97**
Ward 26		2,554.63	4,959.09	153,94.95	4,412.65	27,321.32	**27.32**
Ward 27	318.62	2,721.27	6,774.90	196,74.44	3,128.31	32,617.54	**32.62**
Ward 28	237.39	3,610.68	7,077.37	159,40.55	2,716.50	29,582.49	**29.58**
Ward 29	1267.36	213.11	5,632.29	117,99.78	814.24	19,726.78	**19.73**
Ward 30	373.05	4,034.09	8,374.71	202,39.26	3,997.05	37018.16	**37.02**
Ward 31	4645.41	335.77	8,310.84	464,06.66	2,543.58	62,242.26	**62.24**
Extended Area	16497.30	28,600.25	28,998.25	489,85.75	2,911.15	125,992.70	**125.99**
Total (M)	**37400.65**	**172,004.19**	**258,925.67**	**6132,58.18**	**124,162.87**	**1205,751.56**	**1205.75**
Total (KM)	**37.40**	**172.00**	**258.93**	**613.26**	**124.16**	**1205.75**	



Map: 4.32
DRAINAGE PLAN MAP IN THE PROJECT AREA
SCALE
1:120,000
0 125 250 500 750 1,000
Meters
LEGEND
City Corporation Boundary
Ward Boundary
Proposed Extended Boundary
Bench Mark (BM)
Railway
Road (Pucca)
Road (Semi-pucca)
Road (Katcha)
Road Proposed (Pucca)
Pond
Ditch
Lake/Khal
River
Proposed Drainage Features
Pump House
Sluice Gate
Proposed Culverts
New Culvert
Culvert Needs Reconstruction
Culvert in Good Condition
Proposed Drain Types
Primary Drain
Secondary Drain
Outfall Drain
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
SHELTECH
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
RUPSHA RIVER
Hatia River

Chapter 5
COST ESTIMATE

5.1 Implementation Cost

5.1.1 Conditions for Cost Estimation

The project cost is estimated under the following conditions:

- The project cost is estimated on the basis of the LGED Rate Schedule of 2012 for the Khulna Region.
- The construction works will be done on contract basis. Civil works are to be done on the local contract basis, while mechanical and electrical works in the pumping stations are on the foreign contract basis.
- The unit prices of materials, labours and civil works are mainly based on "Schedule of Rates" of LGED, 2012 for the Khulna Region.
- The physical contingency is set at 10% to the construction and associated costs.
- The price escalation rate is predicted at 8% per year considering the recent tendency.

5.1.2 Cost Estimate

The Cost Estimate for different categories of drainage in the project areas is summarized below (**Table- 5.1**). Details are given separately in Volume IIIA, IIIB, IIIC.

Table- 5.1: Cost Estimates (Including Consultancy, Contingency, VAT & Tax)

Zone	Type	Cost (In core Tk.)
অ. ঝঁসসধহু ড়ভ ঈড়ংঃ ভড়ৎ উৎধরহধমব ডড়ৎশং		
Zone 1	Outfall	0.00
	Primary	248.51
	Secondary	59.64
	Tertiary	94.67
	Quaternary	9.75
Zone 3	Outfall	208.77
	Primary	249.30
	Secondary	224.66
	Tertiary	154.32
	Quaternary	22.80
Zone 4	Outfall	22.31
	Primary	10.19
	Secondary	32.37
	Tertiary	39.81
	Quaternary	4.01
Zone 5	Outfall	69.14
	Primary	77.66
	Secondary	82.38
	Tertiary	109.20
	Quaternary	12.59
Zone 6	Outfall	356.73
	Primary	215.13
	Secondary	157.67
	Tertiary	240.23
	Quaternary	41.13
Sub-total		**2742.92**
B. Summary of Cost of Pump House		

Zone	Type	Cost (In core Tk.)
Rupsha Ghat	Pump House 1	120.00
Labonchora	Pump House 2	420.00
Alutola	Pump House 3	840.00
Sub-total		**1380.00**
C. Cost of Effluent Treatment Plants (ETP)		
Rupsha Ghat	ETP Zone 1	10.00
Labonchora	ETP Zone 2	30.00
Alutola	ETP Zone 3	50.00
Others		50.00
Sub-total		**140.00**
D. Regulator		
Regulator	Regulator 10 Nos.	1.13.00
Sub-total		**1.13.00**
E. Transmission Line		
Transmission Line		30.00
Sub-total		**30.00**
Total		**4294.05**

5.1.3 Phasing of Costs

Year wise break up of costs for Drains, Regulator, Culverts, Pump House etc. in different phases has presented in **Table- 5.2**.

5.2 Operation and Maintenance (O&M)

5.2.1 Operation and Maintenance Works

Operation and Maintenance Works comprise of the following items.

a) Pump Stations

- Operation of pumps.
- Maintenance of machinery and electrical equipment.
- Dredging for outlet channel basins, head reach canals: Dredging is to be done for outlet channel and head reach at the beginning of the dry period by using portable sand pumps (150mm bore, 11kw).
- The Iron Frames Trash Racks and Gates are to be regularly cleaned and properly painted every three years.

b) Maintenance of Drainage Sluices

The floating debrises in front of the Gates are to be cleaned regularly so that these properly in operative conditions. The Gates are to be painted in every three years.

Table- 5.2.

c) Open Channels

The open channels are three types:

- **CC Block Facing and Pacca Channels:** Floating debrises- in these type of channels should be manually cleaned regularly. The sediments are to be cleaned by Portable Sand Pumps (150mm bore, 11kw).

- **Open Rectangular Pacca Drains:** Open drain are to be cleaned regularly and the floating debridges should be remove manually or by cranes.

- **Covered Drains:** The covered drains are also to be cleaned regularly. The floating debridses are initially to be prevented from the entrance points in the drains by providing gratings. There are some debridges, which are sometimes thrown by the local people into the drains through the open manholes. These are to be prevented by properly replacing the Leads and finally these are to be cleaned from the proposed Trash Racks at the outlets. The sediments are to be cleaned by Bamboo Splits inserting through the manholes or by send pumps.

d) Effluent Treatment Plants (ETPs)

The ETPs are to be cleaned regularly as per the direction of DPHE or when those are required to be cleaned as per specifications.

5.2.2 Cost for Operation and Maintenance (O&M)

The cost for O & M is shown in **Table-5.3**. This has been estimated as per standard practice of LGED. These are:

- Structures- 1.5%
- Earthen works- 3.0%

For Blocks we have taken 2% for ETP 3% and for pumps 5%. These are not available in the LGED standard.

Table- 5.3: Operation and Maintenance Cost

Work	Type	Total Cost	O& M	O & M Cost
		Crore Tk.	%	Cr. Tk/Yr
Drains	Structure	1366.40	1.5	20.50
	Earthen	73.70	3	2.21
	Block	388.49	2	7.77
Culverts	Structure	31.56	1.5	0.47
Regulators	Structure	0.75	1.5	0.01
PH	Structure	1035.00	1.5	15.53
	Earthen	345.00	3	10.35
	Pumps	650.00	5	32.5
ETP	Structure	1057.50	1.5	15.86
	Earthen	352.50	3	10.58
Total				**115.78**

Chapter 6
PLAN IMPLEMENTATION

6.1 Organization for Project Implementation

Khulna City Corporation (KCC), as principal implementation agency is fully responsible for planning and implementation of the drainage system, structures, the Pump Houses, ETPs etc. within its jurisdiction. KCC would also be responsible for development and execution of all drainage projects, operation and also maintenance of the completed projects.

It is proposed that a separated body be established for implementation of projects under a Project Director (PD) with the rank of Superintendent Engineer. PD will directly work under the existing Chief Engineer. There will be a Deputy Project Director (DPD), who will work under supervision of PD. Proposed organogram for project implementation is presented in **Figure-6.1**.

6.1.1 Manning Schedule

Detailed design for the project will take three years including topographical and geological surveys and loan procedure and tendering will take 8 months.

The Project Director will have a hierarchy of man power. From engineering side, there have been six Executive Engineers (XEN), 18 Assistant Engineer and 27 SAEs. Out of the six XEN's, one is for planning and design, one for mechanical works for the three Pump Houses and sluice gates, one for electrical works and the other three for civil engineering works. Under the XEN planning and design, there will be three Assistant Planning and Design Engineers. The XENElectrical will have three Assistant Electrical Engineers for the three Pump Houses and ETPs. The mechanical XEN will have three Assistant Mechanical Engineers for the three Pump Houses.

There will be a separate cell for Planning headed by a Town Planner assisted by three Junior Town Planners. Besides, there will be an Environmentalist and one Sociologist directly under the DPD. A tentative Manning Schedule for implementation of the plan is shown in **Figure-6.2**.

For smooth and successfully implementation of all the development projects, it is recommended to form a Project Management Committee (PMC) involving the following:

1. District Commissioner (DC), Khulna
2. Superintending Engineer, BWDB Khulna
3. Executive Engineer, LGED, Khulna
4. Head of Planning Discipline from Khulna University
5. Chief Planning Officer KDA
6. Head of Civil Engineering Department from KUET
7. Superintending Engineer, KWASA
8. Executive Engineer, DPHE, Khulna
9. Executive Engineer T&T Board, Khulna
10. Executive Engineer, PDB, Khulna
11. Executive Engineer, RHD, Khulna
12. Three Technical Expert of National level in the fields of Drainage/Hydrology, Environment and Sociology.

6.1.2 Financing

The major portion of the development project likely to be implemented by foreign currency that is expected to be financed by international or foreign financing organization. Some of the projects will be developed through local currency financed by the Government of Bangladesh or KCC's own fund.

6.1.3 Construction Mode

Qualified contractors will be selected through national/international biding procedures for all kinds of civil and mechanical works. Naturally, civil construction works will be selected by a local competitive bidding among local contractors. On the other hand, for supply of construction machinery and pump equipments, qualified foreign contractor will be selected by an international competitive bidding.

6.2 Implementation Phases

6.2.1 General

A huge amount of investment is required (about MTK 42,941.00) for implementation of Development projects to solve various problems and issues in the vast KCC area (75 km^2). As such the consultants proposed need based prioritization the project components and careful phasing out their implementation programmes. To start with, prioritization works and the sequences of development have been established. These are discussed below:

6.2.2 Prioritization of Works

- Recovery/Reclamation of the original ROW of existing open channels,
- Cleaning the existing Pacca Drains,
- Modification, repairing and reconstruction of the existing Pacca drains,
- Construction of new Pacca drains,
- Repairing/Reconstruction of all existing Regulators,
- Construction of PH 1 and ETP in zone 1 and Transmission lines,
- Construction of PH 2 ETP at Labanchora
- Construction of PH3 and ETP at Alutola

6.2.3 Phasing of Works

Based on the above, implementation of works have been developed **(Figure-6.3, Map- 6.1** Phasing) considering 32 years construction period spread over. The period has been divided into eight phases with a minimum of 5 years to a maximum of 8 year in a phase. These scheduling have been done keeping in view the priority of works. These are discussed below:

Phase 1: **Natural Drainage Channel Development**: Tamijuddin Khal, Taltola Khal, Nabinagor Khal, Chori Chora Khal, Purbo Nirala Khal, Nirala Khal, Labanchora 2, Sluice gate Khal, Motiakhali Khal, Khetra Khali Khal, Labanchora no. 1 Sluice gate Khal, Khudir Khal, Moyur river (both upto the present GL), Hatia river, Bastuhara Khal and Repairing of Regulator D1, D2 & D3.

Khuder Khal and Moyur River will be developed upto the existing GL under this Phase. These will then be raised up to the proposed land development level in the area under Phase 3.

The proposed development under this phase will help in improving partial drainage problems in most of the KCC area.

Phase 2: Under this phase all the existing/proposed primary, secondary drains but excluding those of Zone-3 are proposed to be developed. Zone 3 is proposed to be deferred as a portion of the area is still under-developed and the existing drainage system is being drained through the Koya Khal. In future this zone will be integrated with the pump drainage under zone 6 by the Alutola PH. At that time the opening through the Bypass road will be closed to prevent intrusion of water from outside within the pump drainage area. Those outside areas are expected to be developed by KDA and the ground formation level would be above flood level. These areas may then be drained by gravity through Koya river into the lower Sholmari River.

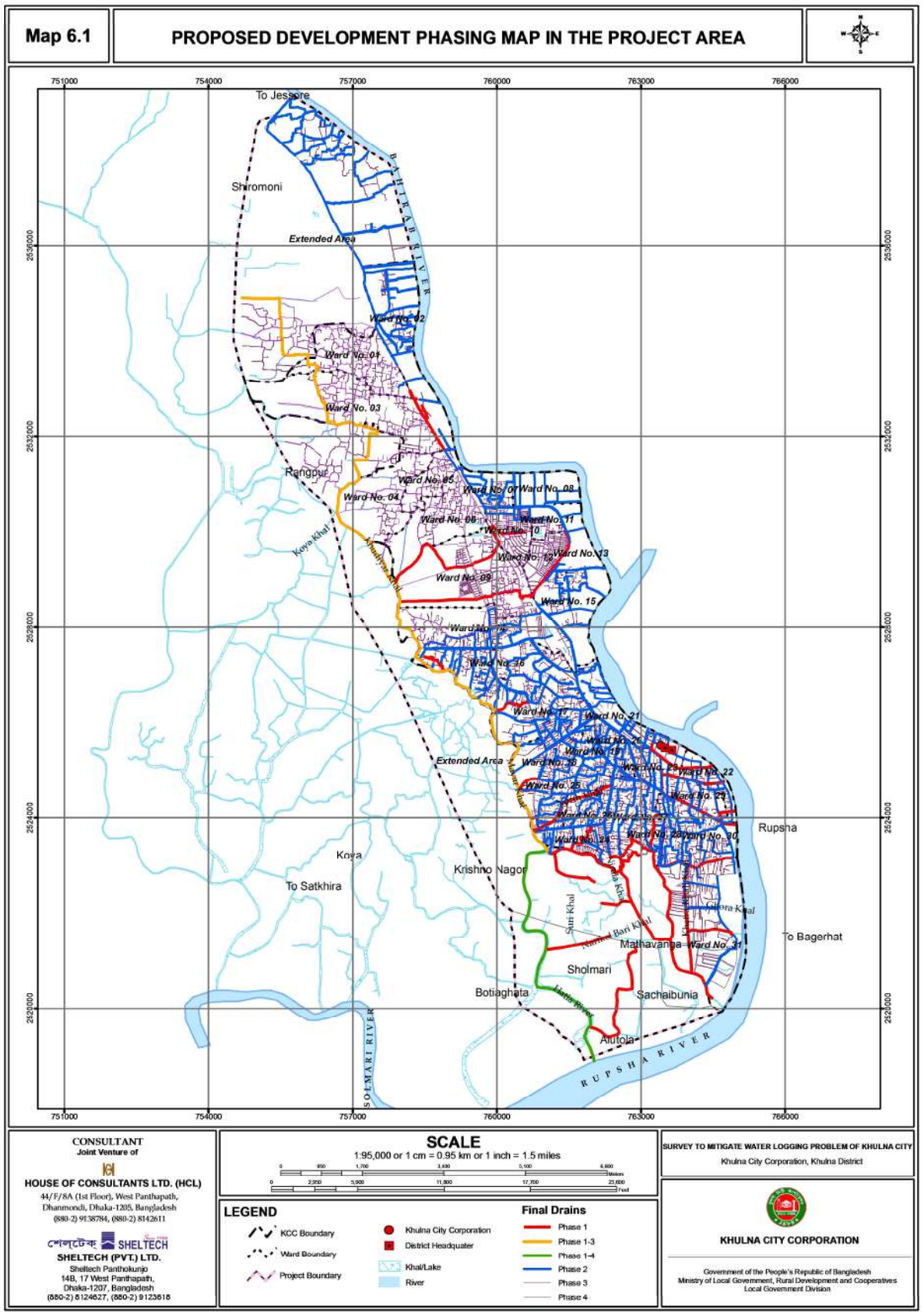

Map 6.1
PROPOSED DEVELOPMENT PHASING MAP IN THE PROJECT AREA
751000
754000
757000
760000
763000
766000
2536000
2532000
2528000
2524000
2520000
To Jessore
Shiromoni
Extended Area
BHAIRAB RIVER
Ward No. 02
Ward No. 01
Ward No. 03
Rangpur
Ward No. 05
Ward No. 04
Ward No. 06
Ward No. 07
Ward No. 08
Ward No. 11
Ward No. 10
Ward No. 12
Ward No. 13
Ward No. 09
Ward No. 15
Ward No. 16
Ward No. 17
Ward No. 21
Ward No. 18
Ward No. 19
Ward No. 20
Ward No. 22
Ward No. 23
Ward No. 24
Ward No. 25
Ward No. 26
Ward No. 27
Ward No. 28
Ward No. 29
Ward No. 30
Ward No. 31
Extended Area
Rupsha
Kaya
Krishno Nagor
To Satkhira
Sholmari
Mathavanga
To Bagerhat
Botiaghata
Sachaibunia
Alutola
SOLMARI RIVER
RUPSHA RIVER
CONSULTANT
Joint Venture of
HOUSE OF CONSULTANTS LTD. (HCL)
44/F/8A (1st Floor), West Panthapath,
Dhanmondi, Dhaka-1205, Bangladesh
(880-2) 9138784, (880-2) 8142611
SHELTECH (PVT.) LTD.
Sheltech Panthokunjo
14B, 17 West Panthapath,
Dhaka-1207, Bangladesh
(880-2) 8124627, (880-2) 9123618
SCALE
1:95,000 or 1 cm = 0.95 km or 1 inch = 1.5 miles
LEGEND
KCC Boundary
Ward Boundary
Project Boundary
Khulna City Corporation
District Headquater
Khal/Lake
River
Final Drains
Phase 1
Phase 1-3
Phase 1-4
Phase 2
Phase 3
Phase 4
SURVEY TO MITIGATE WATER LOGGING PROBLEM OF KHULNA CITY
Khulna City Corporation, Khulna District
KHULNA CITY CORPORATION
Government of the People's Republic of Bangladesh
Ministry of Local Government, Rural Development and Cooperatives
Local Government Division

Figure-6.2.

This phase includes reconstruction of BH-P31 and repair of BH-P295. Also Reconstruction of Regulator at the outfall of Motia Khali Khal and Labanchora 1 no Sluice gate Khal is needed.

Phase-3: This phase includes construction of the primary and secondary drain and the remaining works of Moyur River and Khudir Khal upto the proposed land development level, transmission line and PH1 at Rupsha khal.

Phase 4: All Tertiary and Quaternary drain of KCC and the remaining works of Hatia river upto the design level, i.e the full development level, are included under this phase.

Phase 5: Construction of transmission line from Rupsha Ghat to Labanchora and construction of PH2 at Labanchora and ETPs of Zone 1.

Phase-6: Construction of transmission line from Labanchora to Alutola and construction of the Alutola PH3

Phase-7: Construction of ETP at Rupsha Ghat and Labanchora.

Phase-8: Construction ETP at Alutola.

6.3 Organization for Operation and Maintenance

The KCC will be responsible for the operation and maintenance of the Drainage System, the Pump Houses and Regulators. It is proposed that the KCC establish an organization for operation and maintenance as shown in **Figure-6.4**.

The present organogramme for O&M appears to be adequate. However, one more Executive Engineer along with three assistant Engineers and nine SAE for the O&M of PH Civil work and one more Executive Engineer Mechanical with one Assistant Engineer (Mech.) and one Assistant Engineer Electrical) with three SAEs for AES will be added.

6.3.1 Equipment for O&M

Major equipments required for field works and office uses are listed in **Table-6.1** below. Minor equipments and office appliances like furniture etc. are considered at this stage.

Table- 6.1: List of Equipment for O&M

Sl. No.	Particular	Numbers
Field works Equipment		
1.	Sand Pumps (6", 11 KW)	5
2.	Dragline with Graps (10m Borni)	5
3.	Trucks ST	5
4.	4 WD vehicles	6
5.	Motor Cycles for AE & SAE 100 cc	40
Office Equipment		
1.	Computers	20
2.	Printers	5
3.	Scanner	2
4.	Photo Copier	2
5.	Ploter (Ao Size)	1
6.	Multimedia	1

Note: Other maintenance materials as per requirement.

Map- 6.1

Figure-6.3

Figure-6.4

Chapter 7
CONCLUSION AND RECOMMENDATION

7.1 Conclusion

Water logging is a major urban problem in most urban centers of the country. Conscious early efforts can help prevent inconveniences caused by the water logging. While a comprehensive drainage master plan is essential in all town and cities, side by side strict vigilance must be there to keep the natural drainage system operative. Because, they carry waste and storm water to the final destination. This is probably the first attempt to prepare a comprehensive drainage master plan for an urban centre in Bangladesh. This will help resolve water logging problems in Khulna City if the proposed development projects are implemented in time. Therefore, all preventive measures should be taken by KCC carefully and execute different projects efficiently.

7.2 Recommendations

The following recommendations have been made to mitigate water logging problems in Khulna City.

1. Under the existing peripheral hydraulic conditions, present practice of gravity flow drainage is not advantageous and can not relief drainage congestion even after lining the entire system due to tidal effect.

2. Areas having elevation above 2.40 meter SoB covering about 20% (Zone-1) on the eastern side of Khulna-Jessore Road can be drained out by the gravity flow. Remaining area (80%) needs pump drainage especially during the full monsoon (Jun-July).

3. The pumping area is recommended to be divided into 4 zones based on the present drainage pattern as follows.

    a. Zone-4: PH1 (Rupsha ghat)
    b. Zone-5: PH2 (Lobon Chora)
    c. Zone-3 & 6: Alutola

4. Routine maintenance, seasonal maintenance and emergency maintenance of all infrastructures should be carried out effectively and for this adequate manpower, equipment and budget provision should be provided.

5. Law should be enacted with punitive measures to prevent disposal of waste in drains.

6. Arrangement should be made to collect solid waste from door to door and their proper disposal.

7. The City drainage that is mostly done by pumping is isolated from external intrusion of water i.e. from polder 28 and 25 of BWDB on the western side of the bypass. These areas should be developed above flood level (2.40 m SOB) by other agencies like KDA.

8. Large size existing unlined drainage should be lined by cc blocks with trapezoidal cross sections to increase drainage capacity. The rest will be RCC lined rectangular channels.

9. Existing regulator and flap gates should be rehabilitated as per requirement and their operation and maintenance should be under direct control of KCC.

10. Submersible pump should be provided to minimize cost and easy operation and maintenance problem as far as possible. However Alutola PH being very large should be vertical type.
11. Implementation has been phased out according to the capacity of KCC but should be started immediately.

12. Land formation level for habitation should be specified. There should not be any construction below that level.

13. All the polluting industries should have their own effluent treatment plants to reduce pollution of drainage system.

14. All domestic latrines should have their individual septic tank with soak well and no sewage should be drained into the drainage system.

15. Plinth elevation for different types of buildings should be incorporated mandatorily in the prevailing Building Construction Rules under EBBC Act. This is necessary to prevent inconvenience out of water congestion during monsoon.