

# Final Report On

## Development of Digital Elevation Model and Delineation of Catchment Boundaries (DEM) for Polder 29 and Polder 30 of Blue Gold Program

Khulna O&M Division



Submitted To



### Blue Gold Program

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# 1. Introduction

## 1.1 Background of the Study

The coastal region of Bangladesh is regarded as a zone of multiple vulnerabilities. About 38% of the population in this region live below the poverty line and face high vulnerabilities in terms of insecurity of food, income, water and health. Water is the blessings as well as curse for the coastal population. Management of this natural resource is very crucial for achieving wellbeing of the coastal population. Participatory water resources management is successfully operating in coastal area of Bangladesh by BWDB, where Government of the Netherlands (GoN) participates as a development partner. Blue Gold is a collaboration program between the Government of the Netherlands (donor) and the Government of Bangladesh which is undertaken to uplift the socio-economic status of households living in coastal polders and its surroundings.

Blue gold is such a project of GoN and GoB which emphasizes active involvement of rural communities concerned and other stakeholders. Under the Blue Gold project the consultant Euroconsult Mott MacDonald assigned CEGIS to prepare Digital Elevation Model (DEM) and catchment boundaries for seven polders in Patuakhali and Khulna Districts. Under this project CEGIS has been assessed certain parameters, (topography, hydrology, drainage system, interventions and cropping practice) that usually govern overall drainage and hydrological dynamics within the polders.

## 1.2 Study area

The study area of Polder 29 and Polder 30 are situated in South-West hydrological region of Bangladesh. It covers about 143.87 sq. km (Figure 1.1 and 1.2). Specific locations of the Polders, governing rivers and areas of the polders are mentioned in the following Table 1.1.

**Table 1.1: Specific location of the Polders**

SL	Polder Name	Location (union)	Major River/Khal	Area (ha)
01	Polder 29	Bhandarpara, Sahas and Sarappur union of Dumuria Upazila and Surkhali union of Batiaghata union	Bhadra River, Salta River and Ghengrail River	7,937 ha
02	Polder 30	Botiaghata, Gangarampur and Surkhali union of Botiaghata upazila	Kazi Bacha River, Jhap Jhapia River, Salta River and Solmari River	6,450 ha

### **1.3 Objectives**

The overall objective is to assess the existing condition of topography, hydrology, drainage system, interventions and existing cropping practice of selected polders coastal areas of Bangladesh.

#### **Specific objectives:**

The specific objectives of the study are:

- To identify detail topographic features, landforms and elevation;
- To assess the drainage pattern and tidal dynamics within the delineated catchment boundary;
- To identify the present condition of cropping pattern;

### **1.4 Scope of works**

The scope of works as per the ToR is as follows:

- Digital Elevation Model development based on contour and point data from FINNMAP/BWDB Maps.
- Catchment area delineation including updated water management infrastructure layout along with roads and culverts/bridges.
- Tidal dynamics assessment around the polders and suggest drainage plans.

### **1.5 Deliverables and outcomes**

As per the ToR and Scope of works a number of deliverables and outcomes identified. The major deliverables and outcomes are stated bellows:

- DEM preparation & Elevation Mapping
- Catchment area delineation and detail mapping.
- Drainage pattern/direction maps
- Technical Report

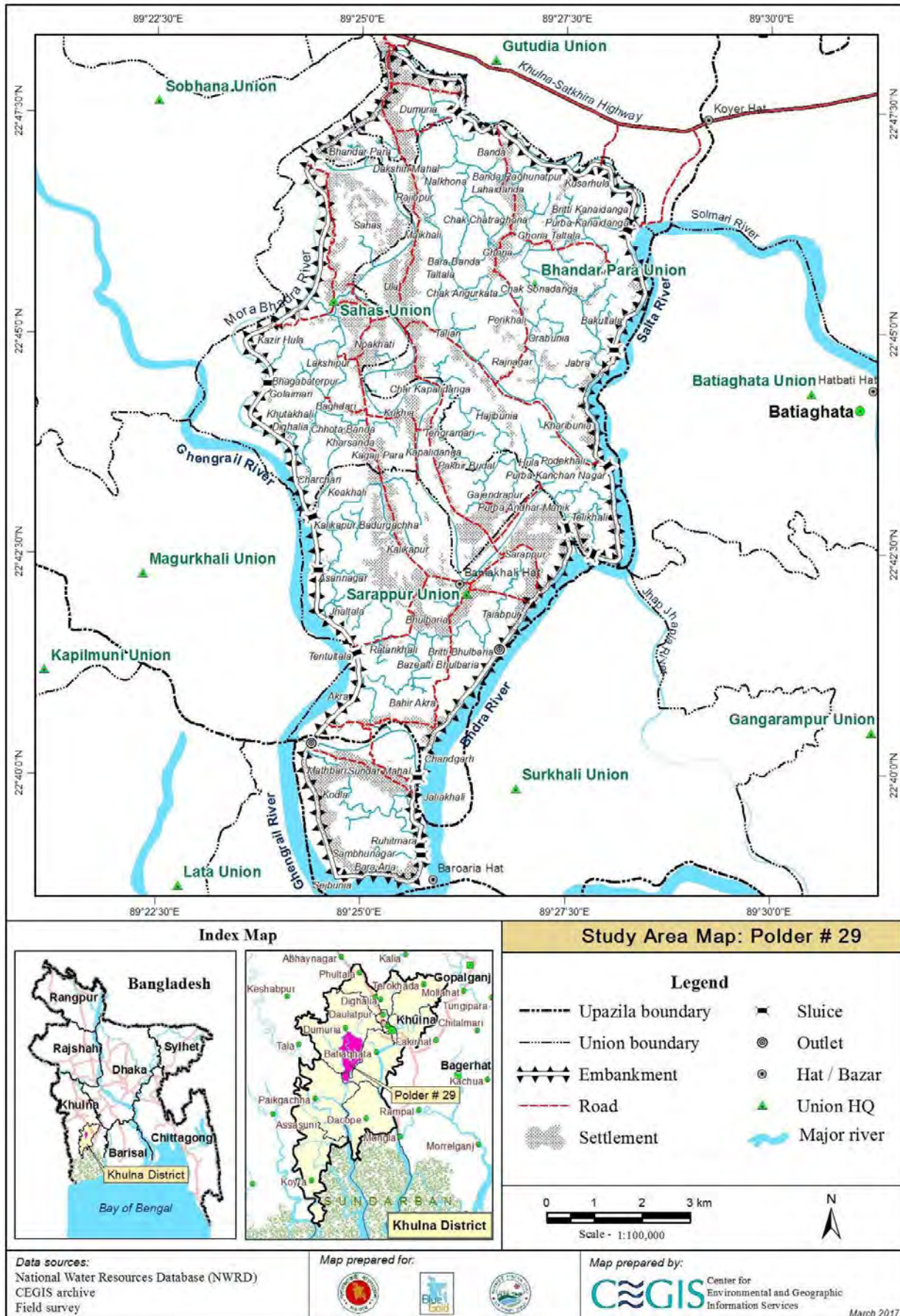


Figure 1.1: Study area of Polder 29

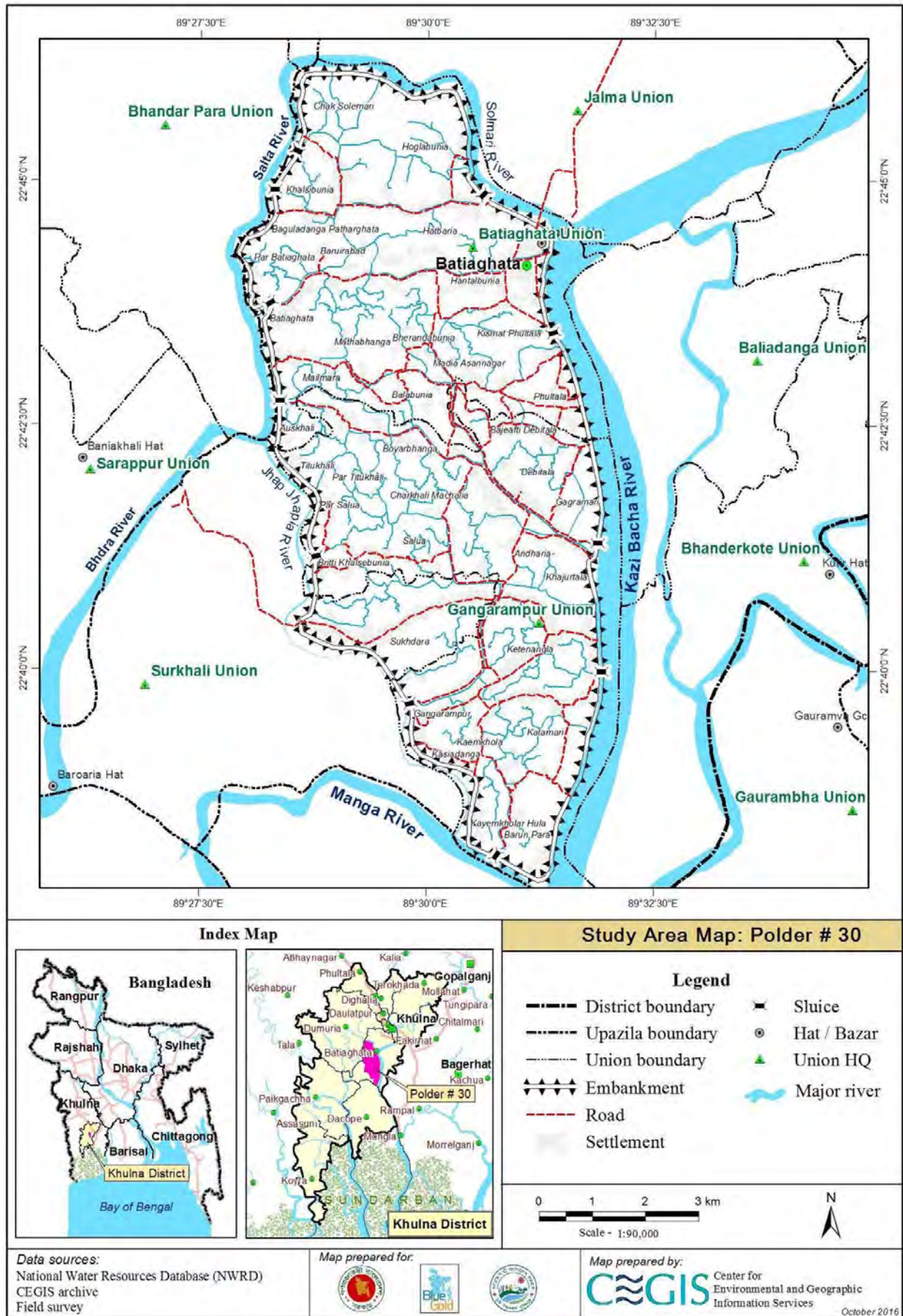


Figure 1.2: Study area of Polder 30

## 2. Approach and Methodology

### 2.1 Initial consultation meeting

At the inception phase all works have been identified and a step-by-step approach and methodology has been developed. The major activities are presented in Figure 2.1 and described in the following sections.

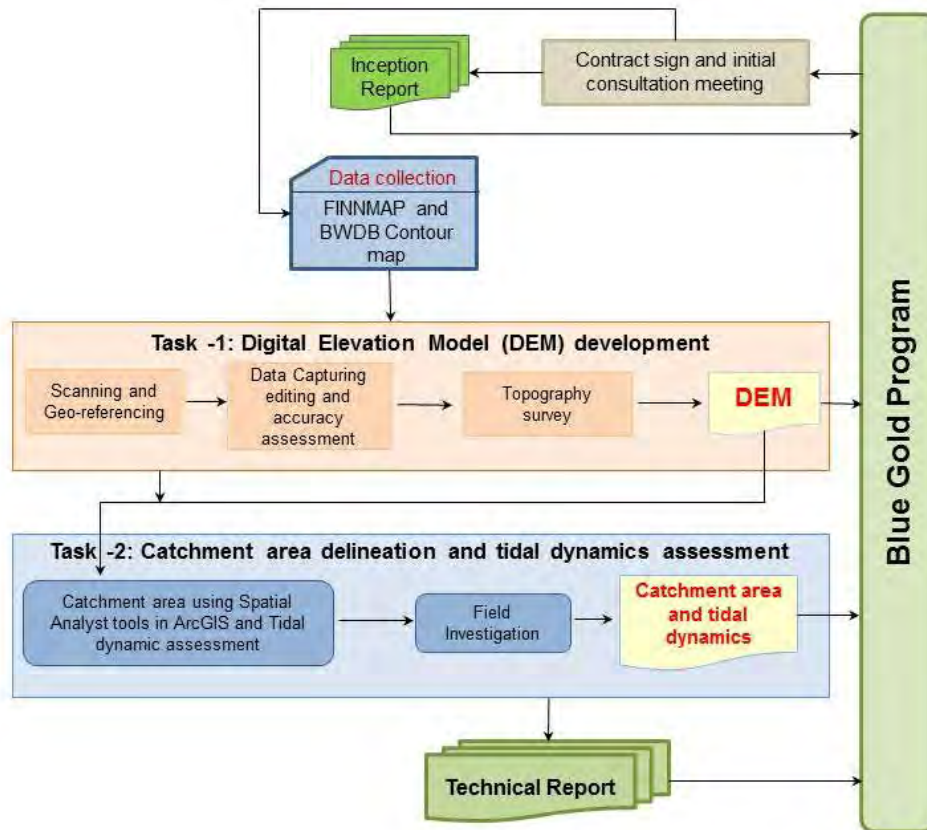


Figure 2.1: Overall methodology of the activities

### 2.2 Contract Signing

The contract was signed between Euroconsult Mott MacDonald and Center for Environmental and Geographic Information Services (CEGIS). Mr. Guy Jones, Team Leader, Blue Gold Project and Engr. Md. Waji Ullah, Executive Director, CEGIS signed the contract.

### 2.3 Initial consultation meeting

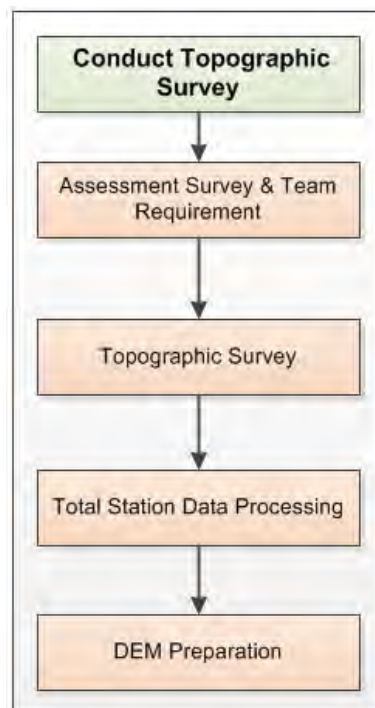
After signing of the contract an initial consultation meeting was organized with the officials and relevant professionals of the client on 4<sup>th</sup> September 2016 to finalize the understanding of the requirements; identify the data sources, data format, spatial resolution, coordinate system, probable outcomes and priorities.

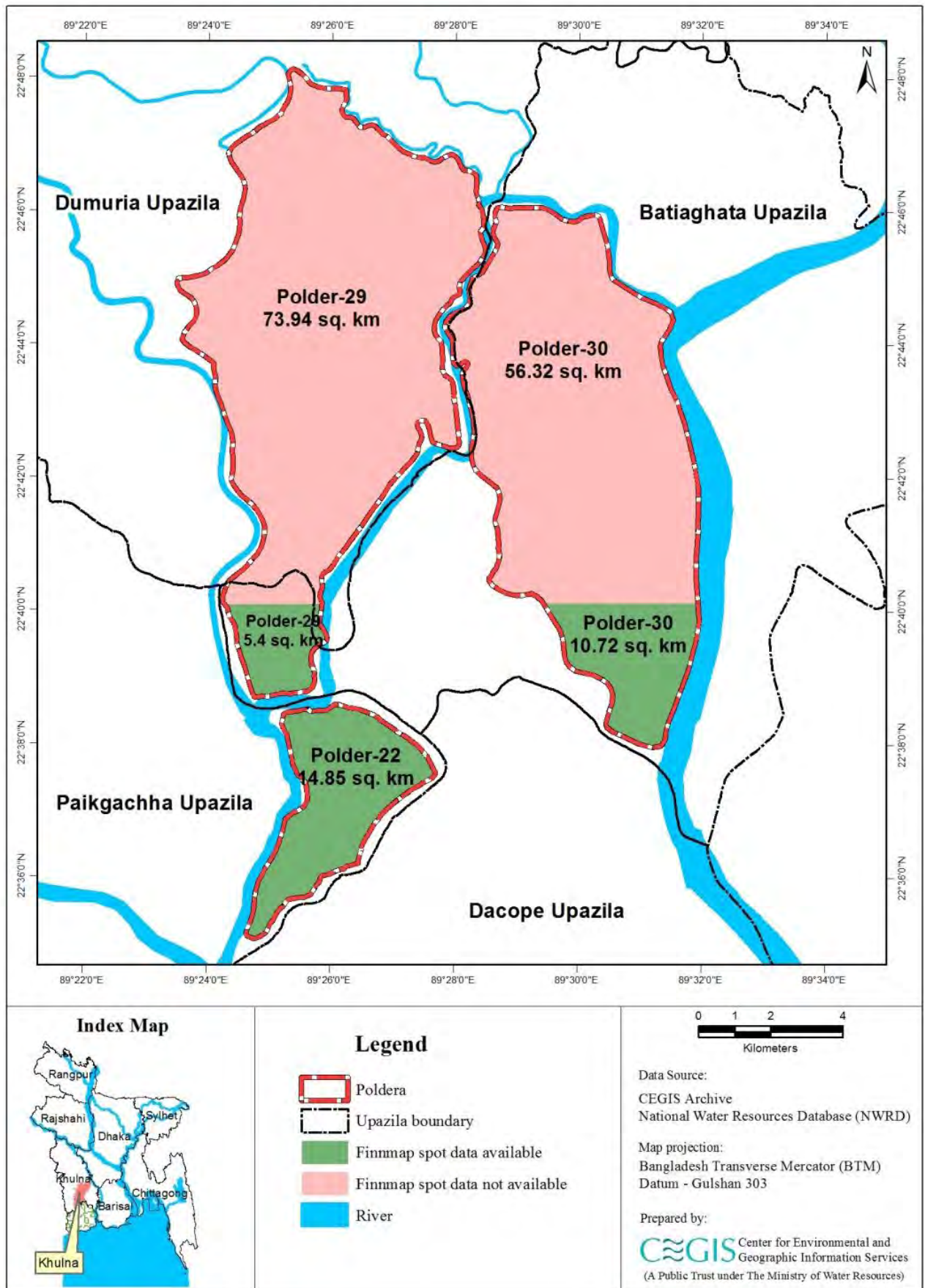


## 2.4 Topographical survey

Polder-29 and polder-30 is located at Dumuria and Batiaghata upazila of khulna district. FINNMAP survey data at the upper part of polder 29 and polder 30 is unavailable. Besides, BWDB topographic maps (Irrigation Map) in these areas are also unavailable at BWDB office. Figure 2.2 shows available FINNMAP of the study area. Therefore, to develop accurate DEM, about 130.26 sq. km topographic survey is required.

The topographic survey has been conducted following several sub activities. They are (i) assess the survey team requirement, (ii) team formation and mobilization (iii) conduction topographic survey using total station. The brief description of these sub activities are given below:





January 2016

Figure 2.2: FINNMAP available area

### ***Assess survey team requirement***

Considering the survey area and survey time, the requirement of the survey team has been assessed carefully. Survey team formation, training, team mobilization, conducting survey, GCP collection has been done just after the commencement of the project. A total number of 8 professionals/surveyors would carry out the survey activity under the supervision of an experienced Civil Engineer.

### ***Team formation and mobilization***

After assessing the survey requirement, the survey team has been formed. It is to be mentioned that CEGIS has a pool of experienced field staffs who work under different relevant projects. Those staffs were involved in the topographic survey within the stipulated timeframe. Necessary number of teams has been formed and each team was consisted with one surveyor, one survey assistant and two staff-men. Civil Engineer was engaged to monitor the overall topographic survey.

### ***Conducting topographic survey***

Topographic survey has been conducted using state-of-the-art survey techniques and equipment such as, GPS and Total Station (TS). The survey activities included collecting the land elevations, drainage divides and canals, homesteads, water bodies etc. This survey has been done taking the spot heights at 50 ~ 60 meter interval (closer spacing at major structure locations, at high and low points) and other important features.



### ***Total Station Data processing***

Data processing has been carried out after downloading the surveyed data from Total Station. Using ArcGIS software the downloaded data was converted to shape file format which has been used to prepare Digital Elevation Model.

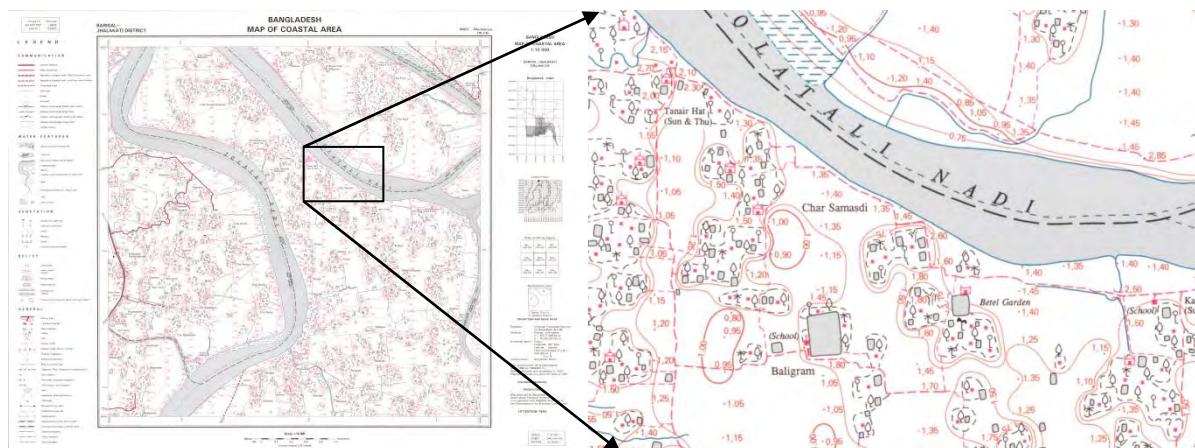
## 2.5 Data collection

About 16.12 sq.km contours and spot elevations have been collected from FINNMAP. The FINNMAPs were published by Bangladesh Inland Water Transport Authority (BIWTA) in 1998 at 1:10000 scale. Available four (04) numbers of sheets have been collected under this study. The collected FINNMAPs are shown in Table 2.1.

Table 2.1: FINNMAP collection from BIWTA

SL No.	FINNMAP	Number of Sheet
1	2505 – 440, 435	2
2	2500 – 450, 445	2
<b>Total</b>		<b>4</b>

The contour intervals of FINNMAP is 0.25 m. East-west spacing of spot elevation is about 300 m and spacing in north-south direction is about 100m. Rivers and khal networks will be digitized from these maps.



## 2.6 Digital Elevation Model (DEM) development

### 2.6.1 Scanning and geo-referencing

All the collected FINNMAP sheets have been scanned using a high precision scanner at 300 dpi in JPG file format. The maps are scanned in such a way, that all the features are clearly visible and digitization done accurately. Geo-referencing was done using ArcGIS software. Bangladesh Transverse Mercator (BTM) projection has been preferred by the client and used to geo-reference those images.

#### *Projection parameters*

Bangladesh Transverse Mercator (BTM) projection parameters will be used to geo-reference those images. The parameters of BTM projection are:

Projection Type	Bangladesh Transverse Mercator
Datum Name	Everest
Scale Factor at central meridian	0.99960000
Longitude of central meridian	90:00:00.000000E

Latitude of origin of projection	0:00:00.000000N
False easting	500000.000000 meters
False northing	-2000000.000000 meters

### 2.6.2 Data capturing

FINNMAP Maps are very reliable source for providing contour lines, spot height with fine details and accuracy. These data were captured from geo-referenced FINNMAP Maps. Settlement, detail roads network, rivers, khals, water bodies and water management infrastructure (Drainage and flushing regulators) were captured from these maps. The features were identified considering size, shape, pattern, texture and description available in the map.

### 2.6.3 Data editing and accuracy assessment

The good quality of the report was ensured from data accuracy, authentic source of information and inclusion of necessary parameters of accuracy. Data editing and accuracy assessment were carried out for quality output. The accuracy assessment was done through visual inspection and interpretation by comparing with the original FINNMAP maps. The contour values for each digitized map sheet were checked visually. GIS Expert and Quality Control Specialist were involved in accuracy assessment.

### 2.6.4 Develop Digital Elevation Map (DEM)

From the objectives it is clear that the study is deemed to be assessing topographic features, landforms, elevation, drainage patterns and tidal dynamics within the delineated catchment areas. As per the undulating nature of the landform the drainage systems are governed. To get ideas about the landform variation within the study area appropriate Digital Elevation Maps were prepared.

All the surveyed spot heights has been transferred to PWD datum. Roads and embankments are elevated based on the surrounding elevations. The rivers, khals and other water bodies were lowered considering lowest elevation. Road were considered as dominant factor where khal are closed. Digital Terrain Model (DTM) were prepared using Spatial Analyst tool of ArcGIS. The DEM are prepared with 25m X 25m spatial resolution.

## 2.7 Field Investigation

After data capturing and initial assessment based on secondary data (FINNMAPs, Topo Sheet, Google Images and development of initial DEM) a field investigation were conducted to verify the collected ground information of flow pattern and structure with parameters. The field office of Blue Gold Project has identified consult to identify the available information and location of features in the field.

- Collection of detail information on Hydraulic structures (Drainage sluices, Outlets, Bridge and Culvert) in the study area.
- Flow direction and pattern assessment through visual inspection in stream and public consultation with local people for overland flow.

- Identify man made obstruction/barrier on the khal through visual inspection and satellite image
- Identify the location name, hat-bazars etc. through physical visit and public consultation.
- Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection were incorporated. These parameters are considered in DEM and catchment delineation.

Considering all these collected information and knowledge gained from the BWDB officials, Blue Gold professionals, local people and direct field inspection are incorporated. These parameter are considered in DEM and catchment delineation.

## **2.8 Catchment Area and tidal dynamics assessment**

Catchment/watershed delineation is one of the most commonly performed activities in hydrologic analysis. A catchment of an outlet or pour point is the upslope area which drains its accumulated runoff through that point. Watershed delineation was performed with the Spatial Analyst Tools of ArcGIS using the Developed Digital Elevation Model (DEM) and rivers/khals network as inputs. All the watershed delineation steps such as filling sink, defining flow direction and accumulation will be done in ArcGIS using SWAT (Soil and Water Assessment Tool) hydrological model. Catchment wise drainage pattern and area elevation curves were derived from the DEM and watersheds.

CEGIS team installed Eight (08) water level gauge stations to understand the tidal water level variations in and around the study area. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) has been collected during monsoon. This water level data has been used to analyses the tidal dynamics. Figure 2.3 shows Water level gauge stations around the Study area.

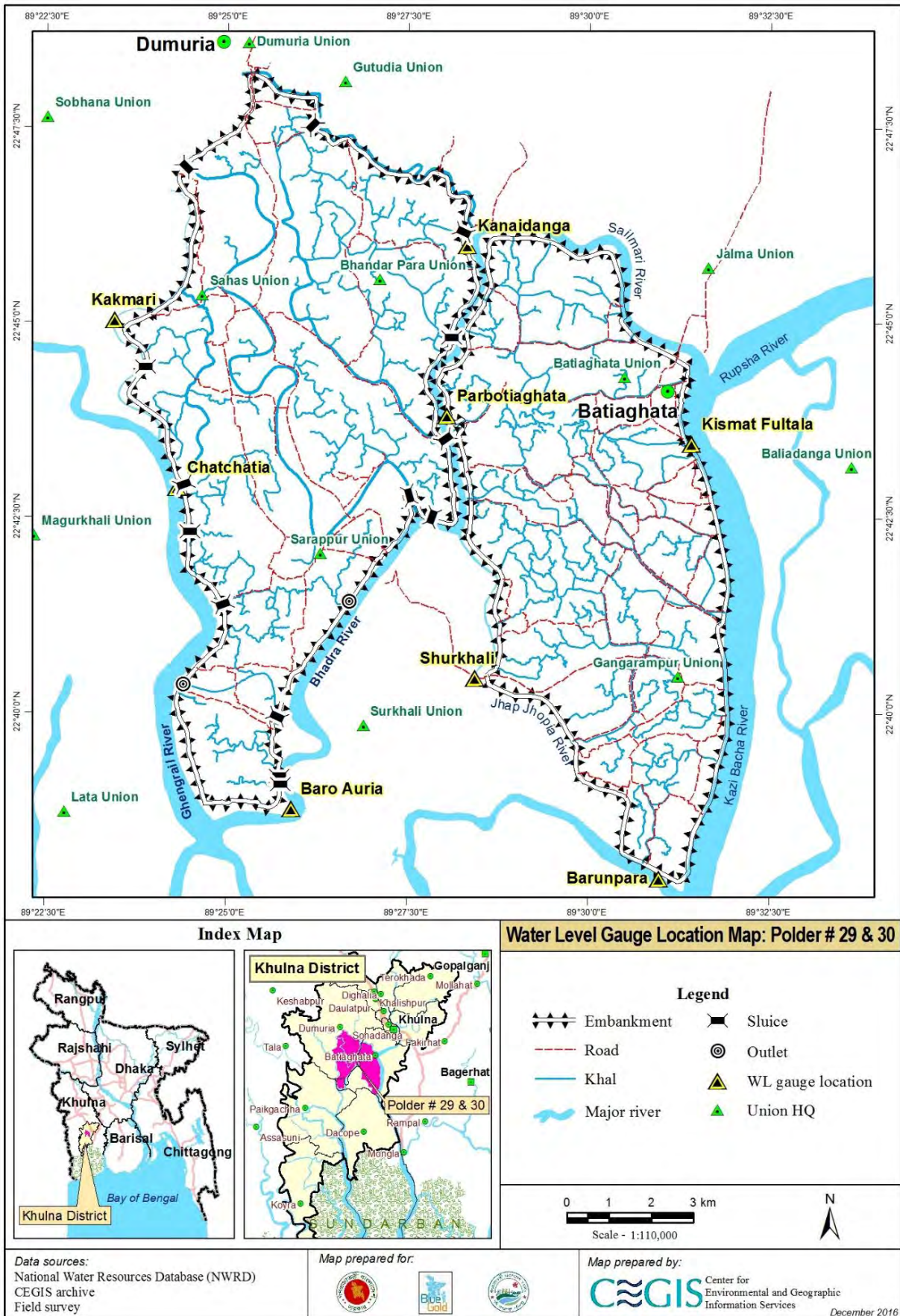


Figure 2.3: Water level gauge stations around the Study area

## 2.9 Catchment of Polder 29

In this study, for polder 29, Catchment has been delineated for ten (10) drainage outlets. The drainage outlets were selected at ten (10) hydraulic structure locations. Figure 2.4, 2.5 and 2.6 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 29. Area of each catchment boundary has been presented in Table 2.2. From the Figure 2.5 and Table 2.2 shows that catchment of Telikhali Sluice is the largest catchment which is about 2538 ha.

**Table 2.2: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 29**

### **Description of Catchment 1**

<b>Catchment Name</b>	Cat – 1 (Katakhali catchment)
<b>Location</b>	Banda (121 ha), Sitarampur (33 ha), Nalghona (25 ha), Lahaidanda (5 ha) of Bhandar Para union, Arazi Sajara (5 ha), Dumuria (143 ha) of Dumuria union and Chingra (10 ha) of Sobhana union.
<b>Catchment area (ha)</b>	342 ha
<b>Drainage Outlet</b>	Katakhali Sluice at Ch. 2+319 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Katakhali khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.54 Min: 0.06
<b>Length of Stream within catchment (Km)</b>	6.54
<b>Drainage Density (m/ha)</b>	19.11
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Moderately Silted up</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Partially silted up</b></li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b> (usually takes 3-4 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b> (Lt Aman and sesame affected by drainage congestion)</li> <li>• Water Scarcity: <b>Not found</b></li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially functional</b> (Vertical lift gate is corroded)</li> <li>• Sluice repairing is required</li> </ul> </li> </ul>







Figure: C/S of Katakhal Sluice



Figure: Katakhal khal

### Description of Catchment 2

<b>Catchment Name</b>	Cat – 2 (Kanaidanga Catchment)
<b>Location</b>	Kusarhula (56 ha), Purba Kanaidanga (86 ha), Britti Kanaidanga (89 ha), Ghona Taltala (23 ha), Dhanibunia (49 ha) of Bhandar Para union.
<b>Catchment area (ha)</b>	303 ha
<b>Drainage Outlet</b>	Kanaidanga Sluice at Ch. 7+895 km (1V- 0.9 m X1.2 m)
<b>Main Drainage Canal</b>	Kata khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.23 Min: 0.03
<b>Length of Stream within catchment (Km)</b>	7.07 km
<b>Drainage Density (m/ha)</b>	23.33
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately</b> silted up</li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found</b>.</li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b> (Lt Aman and sesame affected by drainage congestion)</li> <li>• Water Scarcity: <b>Observed</b>, Britti Kanaidanga area is affected by water scarcity during winter season (mainly affects Rabi crops).</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>• <b>Re-excavation of Kata khal, Aura/Taner khal</b> and its connecting branch khal will available irrigation water for Rabi crops.</li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially functional</b> (Vertical lift gate is corroded)</li> <li>• Sluice repairing is required</li> </ul> </li> </ul>
	
Figure: C/S of Kanaidanga Sluice	Figure: R/S of Kanaidanga catchment

### Description of Catchment 3

<b>Catchment Name</b>	Cat – 3 (Bakultola Catchment)
<b>Location</b>	Sitarampur (70 ha), Banda Raghunatpur (60 ha), Lahaidanda (20 ha), Ghona Taltala (34 ha), Ghona (26 ha), Dhanibunia (146 ha), Chak Sonadanga (67 ha), Bakultala (91 ha), Jabra (66 ha) of Bhandar Para union.
<b>Catchment area (ha)</b>	580 ha
<b>Drainage Outlet</b>	Bakultola Sluice at Ch. 10+748 km (1V- 1.38 m X1.22 m)
<b>Main Drainage Canal</b>	Bakultola khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.42 Min: 0.03
<b>Length of Stream within catchment (Km)</b>	12.36
<b>Drainage Density (m/ha)</b>	21.31
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately</b> Silted up</li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b> (usually takes 3-4 days to properly drain out rain water)</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>• <b>Re-excavation of Bakultala Khal</b> will reduce the drainage congestion problem and available irrigation water for Rabi crops</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> <li>• Crop damage: <b>Moderate</b> (Lt Aman, HYV Aman and sesame affected by drainage congestion)</li> <li>• Water Scarcity: <b>Observed</b>, Chak Sonadanga area is affected by water scarcity during winter season (mainly affects Rabi crops).</li> </ul> <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> <li>• <b>Partially Functional</b></li> <li>• Gates are corroded and rubber seals are damaged</li> <li>• Embankment has piping issue, which caused leakage.</li> <li>• Sluice repairing is required</li> </ul>
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Figure: C/S of Bakultola Sluice



Figure: Outfall of Bakultola catchment

#### **Description of Catchment 4**

<b>Catchment Name</b>	Cat – 4 ( Kanchannagar Catchment)
<b>Location</b>	Banda (8 ha), Nalghona (122 ha), Dakshin Mahal (19 ha), Lahaidanda (65 ha), Rajibpur (18 ha), Chak Chatraghona (85 ha), Maikhali (43 ha), Ghona (37 ha), Ula (37 ha), Taltala (72 ha), Barabhandh (22 ha), Chak Sonadanga (62 ha), Chak Angarkata (26 ha), Rajnagar (147 ha), Perikhali (130 ha), Jabra (96 ha), Talian (25 ha), Orabunia (56 ha), Hajibunia (86 ha), Kharibunia (85 ha), Podekhali (31 ha), Purba Kanchan Nagar (13 ha) of Bhandar Para union and Dumuria (63 ha) of Dumuria union.
<b>Catchment area (ha)</b>	1348 ha
<b>Drainage Outlet</b>	Kanchannagar Sluice at Ch. 13+625 km (2V- (1V- 1.38 m X1.22 m)
<b>Main Drainage Canal</b>	Kanchannagar / Hazibunia Khal

Land elevation of Catchment (m PWD)	Max: 3.18 Min: 0.01
Length of Stream within catchment (Km)	29.98
Drainage Density (m/ha)	22.24
Catchment Description	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately silted up</b></li> <li>• Branch khal: <b>Moderately silted up</b></li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b> (Lt Aman, HYV Aman and sesame affected by drainage congestion)</li> <li>• Water Scarcity: <b>Partially observed</b>, Rajnagar, Perikhali and Chak Angurkata area is affected by water scarcity during winter season (mainly affects Rabi crops).</li> <li>• <b>Re-excavation of Kanchannagar / Hazibunia Khal</b> with water retention provision will ensure water availability for irrigation.</li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially functional</b></li> <li>• Loose Apron both R/S and C/S is damaged</li> <li>• Block pitching work in ongoing</li> </ul> </li> </ul>



Figure: C/S of Kanchannagar Sluice



Figure: Outfall of Kanchannagar catchment

**Description of Catchment 5**

<b>Catchment Name</b>	Cat – 5 (Telikhali Catchment)
<b>Location</b>	Bhandar Para (72 ha), Dakshin Mahal (15 ha), Rajibpur (17 ha), Maikhali (17 ha), Ula (214 ha), Talian (13 ha), Hajibunia (267 ha), Podekhali (66 ha), Purba Kanchan Nagar (22 ha), Pakhribadal (21 ha), Hula (31 ha), Telikhali (106 ha), Purba Andhar Manik (30 ha) of Bhandar Para union, Dumuria (83 ha) of Dumuria union, Sahas (398 ha), Noakhati (121 ha), Kukhia (123 ha), Char Kapalidanga (16 ha), Kapalidanga (157 ha), Kagaji Para (32 ha), Tengramari (15 ha), Gajendrapur (247 ha) of Sahas union and Kalikapur (245 ha), Sarappur (178 ha), Britti Bhulbaria (14 ha) Bhulbaria (17 ha) of Sarappur union.
<b>Catchment area (ha)</b>	2538 ha
<b>Drainage Outlet</b>	Telikhali Sluice at Ch. 17+144 km (2V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Bhadra Nadi
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.67 Min: -0.08
<b>Length of Stream within catchment (Km)</b>	49.0
<b>Drainage Density (m/ha)</b>	19.30
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Bhadra River</b> Condition: <b>Partially active</b>; Telikhali new sluice was constructed about 700m away from Bhadra river. Therefore, Telikhali khal is silted up during post monsoon period.</li> <li>• Construction of temporary cross band at the outfall of Telikhali khal may reduce the siltation problem.</li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately silted up</b></li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b> (usually takes 3-4 days to properly drain out rain water)</li> <li>• Joykhali (4V-1.5m X 1.8m) sluice is fully damaged, as such, this catchment area has changed and drains into Telikhali catchment.</li> <li>• <b>Re-excavation of Telikhali Khal, Bhadra Nadi</b> and its connecting branches khal will reduce the drainage congestion problem and available irrigation water for Rabi crops.</li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Moderate</b> (Lt Aman, HYV Aman and sesame affected by drainage congestion)</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>• Water Scarcity: <b>Partially observed</b>, Telikhali, Noakati, Gajendrapur, Sahas and Pakhirbadal area is affected by water scarcity during winter season (mainly affects Rabi crops).</li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially Functional</b></li> <li>• Vertical lift gate are corroded</li> <li>• Sluice repairing is required</li> </ul> </li> </ul>
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Figure: C/S of Telikhali Sluice



Figure: Outfall of Telikhali catchment



Figure: Telikhali (Old) sluice



Figure: Abandon Joykhali Sluice

**Description of Catchment 6**

<b>Catchment Name</b>	Cat – 6 (Jaliakhali Catchment)
<b>Location</b>	Akra (162 ha), Bahir Akra (9 ha), Chandgarh (23 ha) of Sarappur union and Sundar Mahal (138 ha) of Surkhali union.
<b>Catchment area (ha)</b>	332 ha
<b>Drainage Outlet</b>	Jaliakhali Sluice at Ch. 23+668 km (1V- 0.9 m X1.2 m)
<b>Main Drainage Canal</b>	Mora Bhadra Nadi
<b>Land elevation of</b>	Max: 3.12 Min: 0.08

<b>Catchment (m PWD)</b>	
<b>Length of Stream within catchment (Km)</b>	6.18
<b>Drainage Density (m/ha)</b>	18.63
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Bhadra River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately silted up</b></li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found</b></li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially Functional</b></li> <li>• Loose Apron both R/S and C/S is damaged</li> <li>• Sluice repairing is required</li> </ul> </li> <li>➤ <i>Erosion</i> <ul style="list-style-type: none"> <li>• Around 1100m embankment at Chandghar and Sundar Mahal mauza is vulnerable to river bank erosion and tidal flooding. At the end of July 2015, around 300m of embankment was breached at Chandgarh area consequently about 90 to 100 ha area of Sundar Mahal, Akra and Chandghar mauza were frequently inundated by diurnal tide from July 2015 to July 2016.</li> <li>• In July 2016, BWDB has constructed an earthen retired embankment inside the actual polder alignment, which prevents tidal water from entering the polder.</li> <li>• Around 20 ha lands have been eroded from the floodplain portions of Jaliakhali area. Mora Badra Nadi and agricultural land at Sundar Mahal and Chandgarh was silted up.</li> <li>• Permanent bank protection works are required at the vulnerable locations.</li> </ul> </li> </ul>



Figure: C/S of Jaliakhali Sluice



Figure: Outfall of Jaliakhali catchment

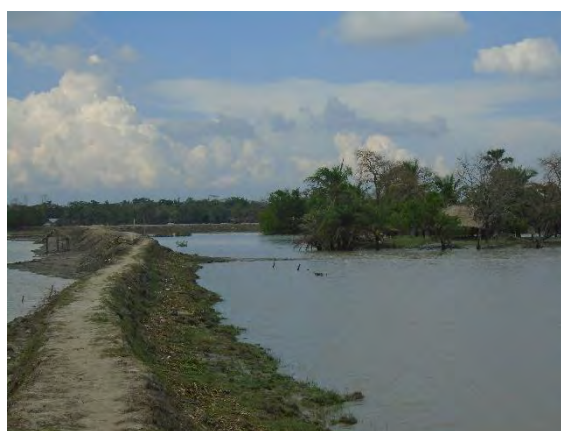
Figure: Retired embankment at  
Chadghar/Jalilakhali

Figure: Erosion at Chadghar/Jaliakhali

### Description of Catchment 7

<b>Catchment Name</b>	Cat – 7 (Ruhitmara Catchment)
<b>Location</b>	Sundar Mahal (150 ha), Mathbari (9 ha), Kodla (61 ha), Ruhitmara (86 ha), Sambhunagar (58 ha), Bara Aria (60 ha) of Surkhali union.
<b>Catchment area (ha)</b>	424 ha
<b>Drainage Outlet</b>	Ruhitmara Sluice at Ch. 25+444 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Ruhitmara Khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 4.59 Min: 0.60
<b>Length of Stream within catchment (Km)</b>	7.69
<b>Drainage Density (m/ha)</b>	18.14
	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>● Outfall Khal: <b>Bhadra River</b></li> </ul> </li> </ul>



<p><b>Catchment Description</b></p>	<p>Condition: <b>Active</b></p> <ul style="list-style-type: none"> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Partially silted up</b></li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: Partially observed, Ruhitmara and Bara Aria area is affected by water scarcity during winter season (mainly affects Rabi crops)</li> <li>• Re-excavation of Ruhitmara khal with water retention provision will ensure water availability for irrigation.</li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• Ruhitmara catchment has two drainage/ pour points namely Ruhitmara sluice and Kudlar khal pipe sluice, which are closer to each other. Kudlar khal pipe sluice is a <b>damaged</b> old hydraulic structure, while Ruhitmara sluice is a <b>fully functional</b> newly constructed structure.</li> <li>• Kudlar khal accumulates major portion of this catchment's water which is drained out through the damaged pipe sluice while the remaining smaller portion of water of this catchment is accumulated in Ruhitmara khal, which is drained out through the fully functional Ruhitmara sluice.</li> <li>• As the Kundlar khal pipe sluice is damaged, drainage congestion occurs in the area during monsoon season which may be prevented by letting the water accumulated in Kudlar khal to pass through the nearby Ruhitmara sluice. This can be achieved by constructing a connecting canal from Kundlar khal to Ruhitmara khal at a nearby the outlet location. A major rehabilitation or dismantling of the Kudlar khal sluice is also required.</li> <li>• Kodla Motbari area is affected by water logging during monsoon period. Hence, construction of Kodla Motbari drainage Sluice (1V- 0.9m X 1.2m) is required to reduce this problem.</li> </ul> </li> <li>➤ <i>Erosion</i> <ul style="list-style-type: none"> <li>• Around 500m embankment at Baro Aria is vulnerable to river bank erosion and tidal flooding. This location is situated at the common confluence of Badhra and Gengrail river which is unstable and is being eroded for some 8~10 years. Around 100 ha of lands have been eroded from the Baro aria point in last 26 years.</li> <li>• BWDB has constructed retired embankment at Baro Aria, however, the setback distance is decreasing</li> </ul> </li> </ul>
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every year. Permanent bank protection works by placing geo-bags with launching apron are required at the vulnerable locations.



Figure: C/S of Ruhitmara Sluice



Figure: Outfall of Ruhitmara catchment



Figure: C/S of Kudlar khal Sluice (damaged)



Figure: R/S of Kudlar khal Sluice



Figure: Retired embankment at Baro Auria



Figure: Embankment Erosion at Baro Auria

**Description of Catchment 8**

<b>Catchment Name</b>	Cat – 8 (Ratankhali Catchment)
<b>Location</b>	Kalikapur (88 ha), Britti Bhulbaria (186 ha), Jhaltala (64 ha), Bhulbaria (44 ha), Bazeafti Bhulbaria (36 ha), Ratankhali (135 ha), Akra (25 ha), Bahir Akra (53 ha), Chandgarh (16 ha), Taiabpur (60 ha) and Sarappur (100 ha) of Sarappur union.
<b>Catchment area (ha)</b>	807 ha
<b>Drainage Outlet</b>	Ratankhali Sluice at Ch. 32+903 km (1V- 1.38 m X1.22 m)
<b>Main Drainage Canal</b>	Sitalmari Khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.69 Min: 0.08
<b>Length of Stream within catchment (Km)</b>	10.21
<b>Drainage Density (m/ha)</b>	23.98
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Gangrail River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Partially silted up</b></li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not Found</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Partially observed</b>, Britti Bhulbaria and Ratankhali area is affected by water scarcity during winter season (mainly affects Rabi crops)</li> <li>• <b>Re-excavation of Jhaltola khal</b> and its connecting branch khals with water retention provision will ensure water availability for irrigation</li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially functional</b></li> <li>• Vertical lift gate is collapsed and rubber seals are damaged which caused leakage</li> <li>• Barrel wall and railing is damaged</li> <li>• Major repairing is required</li> </ul> </li> </ul>





Figure: R/S of Ratankhali Sluice



Figure: C/S of Ratankhali Sluice

### Description of Catchment 9

<b>Catchment Name</b>	Cat – 9 (Asannagar Catchment)
<b>Location</b>	Keakhali (50 ha), Kalikapur (203 ha), Kalikapur Badhurghachha (47 ha), Asannagar (92 ha), Jhaltala (34 ha) of Sarappur union.
<b>Catchment area (ha)</b>	426 ha
<b>Drainage Outlet</b>	Asannagar Sluice at Ch. 35+002 km (1V- 1.07 m X1.35 m)
<b>Main Drainage Canal</b>	Asannagar Khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.49 Min: 0.10
<b>Length of Stream within catchment (Km)</b>	10.21
<b>Drainage Density (m/ha)</b>	23.98
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Gangrail River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Active</b> (about 3.5 km Asannagar keyakhali khal was re-excavated under Bluegold program in 2015)</li> <li>• Branch khal: <b>Partially</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not Found</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found</b></li> </ul> </li> <li>➤ <i>Hydraulic structure condition</i> <ul style="list-style-type: none"> <li>• <b>Partially functional</b></li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>• Gates are corroded and rubber seals are damaged which caused leakage</li> <li>• Sluice repairing is required</li> </ul>
	
Figure: R/S of Asannagar Sluice	Figure: C/S of Asannagar catchment

### **Description of Catchment 10**

<b>Catchment Name</b>	Cat – 10 (Chotchotia Catchment)
<b>Location</b>	Sahas (199 ha), Kazir Hula (41 ha), Noakhati (63 ha), Lashmipur (48 ha), Bhagabatipur (97 ha), Golaimari (35 ha), Dighalia (36 ha), Baghdari (41 ha), Khutakhali (39 ha), Chhota Banda (57 ha), Kharsanda (69 ha), Kagaji Para (21 ha), Charchari (51 ha) of Sahas union and Keakhali (41 ha) of Sarappur union.
<b>Catchment area (ha)</b>	838 ha
<b>Drainage Outlet</b>	Chatchatia Sluice at Ch. 36+114 km (2V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Ramakhali Khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.22 Min: -0.49
<b>Length of Stream within catchment (Km)</b>	16.31
<b>Drainage Density (m/ha)</b>	19.46
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Gangrail River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately silted up</b></li> <li>• Branch khal: <b>Moderately silted up</b></li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b>, usually takes 3-4 days to properly drain out rain water</li> <li>• Bed level of Mora Bhadra River is higher than the invert level of Golaimari sluice. As such, Golaimari</li> </ul> </li> </ul>

	<p>catchment area was changed and drains into Chatchotia sluice through Ramakhali khal.</p> <ul style="list-style-type: none"> <li>• <b>Re-excavation of Ramakhali Khal, Aro khal, Hogolbunia khal</b> and its connecting branches khal will reduce the drainage congestion problem and available irrigation water for Rabi crops.</li> <li>• Permanent Water logging: <b>Not Found</b></li> </ul> <p>➤ <i>Agricultural condition</i></p> <ul style="list-style-type: none"> <li>• Crop damage: <b>Moderate</b> (Lt Aman, sesame and Sun-flower affected by drainage congestion)</li> <li>• Water Scarcity: <b>Partially observed</b>; Golaimari, Dighalia, Baghdari, Khutakhali and Chhota Banda area is affected by water scarcity during winter season (mainly affects Rabi crops)</li> </ul> <p>➤ <i>Hydraulic structure condition</i></p> <ul style="list-style-type: none"> <li>• <b>Damaged</b> <ul style="list-style-type: none"> <li>▪ Loose apron are damaged both C/S and R/S.</li> <li>▪ Gates are corroded and collapsed</li> <li>▪ Hoisting arrangement of vertical lift gate is damaged</li> </ul> </li> <li>• Sluice repairing is required</li> </ul>
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Figure: C/S of Chatchatia Sluice



Figure: Outfall of Chatchatia catchment



Figure: Siltrated up Offtake of Golaimari Sluice



Figure: C/S of Golaimari Sluice

## 2.10 Tidal dynamics assessment of polder 29

CEGIS team installed five (05) water level gauge stations (**Kakmari, Chatchotia, Baro Auria, Parbotiaghata and Kanaidanga**) outside the polder 29 (shown in Figure 2.12) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 01<sup>st</sup> October 2016 to 15<sup>th</sup> October 2016 has been collected presented in Table 2.3. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Kakmari, Chatchotia, Baro Auria, Parbotiaghata and Kanaidanga stations are shown in Figure 2.7 to 2.11 respectively.

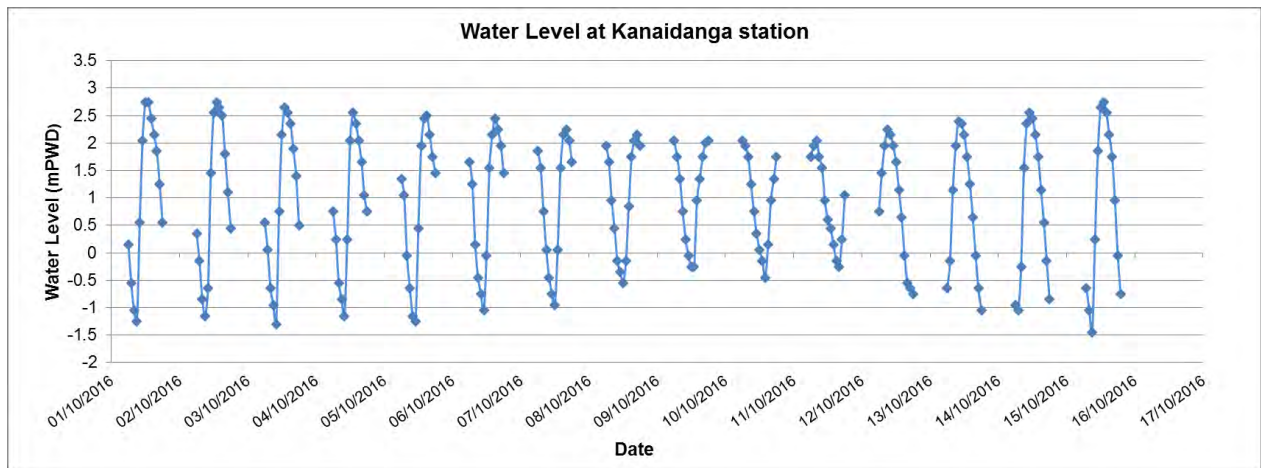


Figure 2.7: Water level analysis at Kanaidanga station

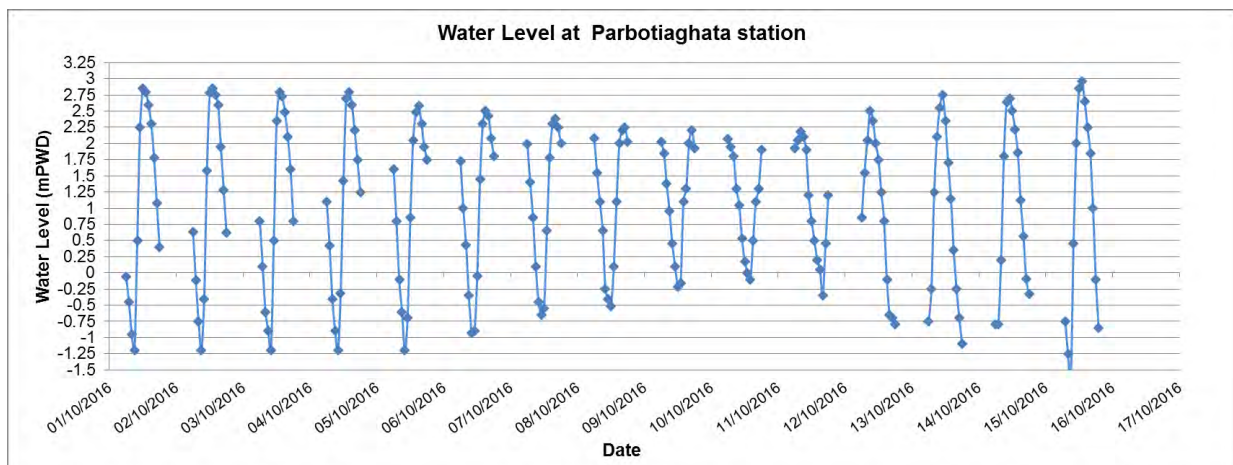


Figure 2.8: Water level analysis at Parbotiaghata station

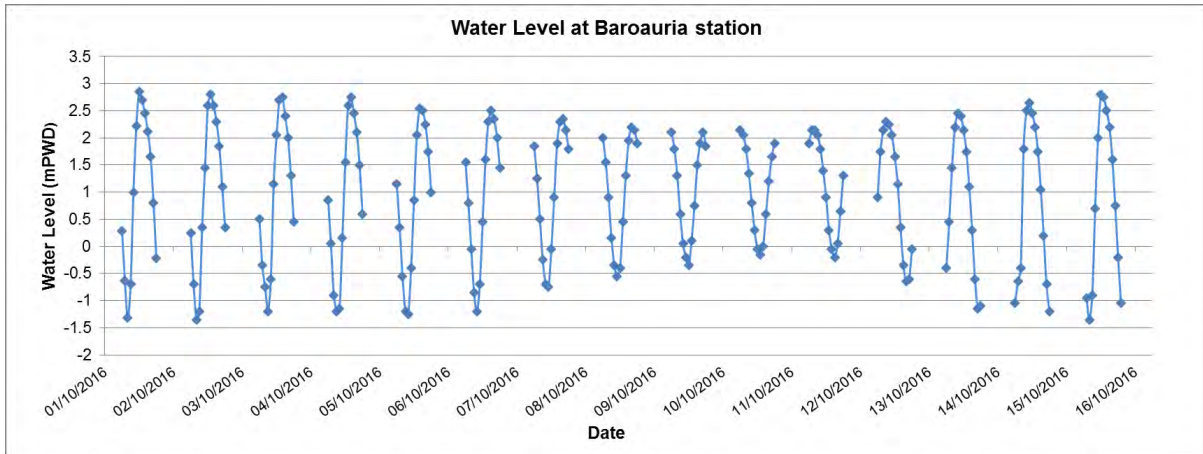


Figure 2.9: Water level analysis at Baroauria station

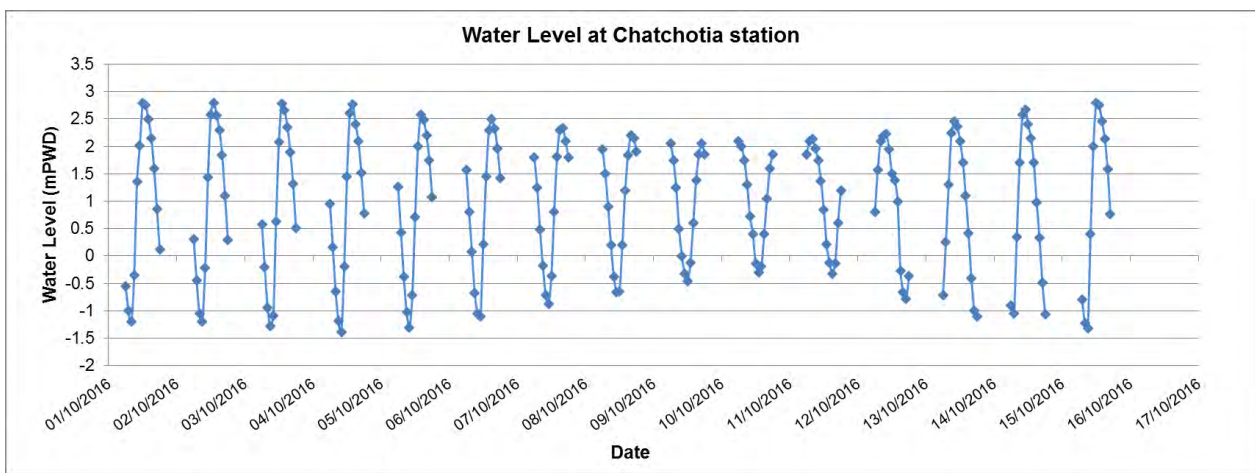


Figure 2.10: Water level analysis at Chatchotia station

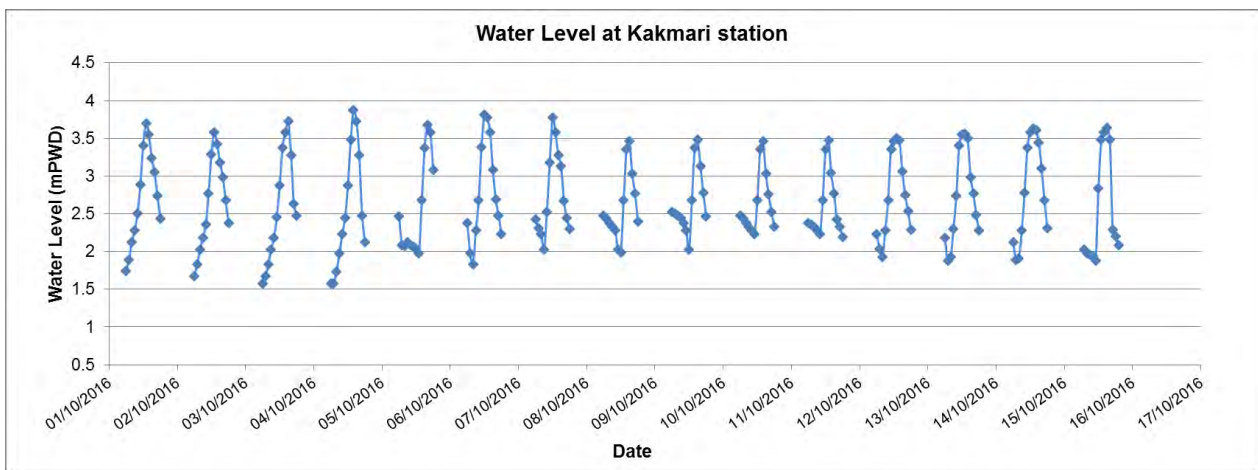


Figure 2.11: Water level analysis at Kakmari station



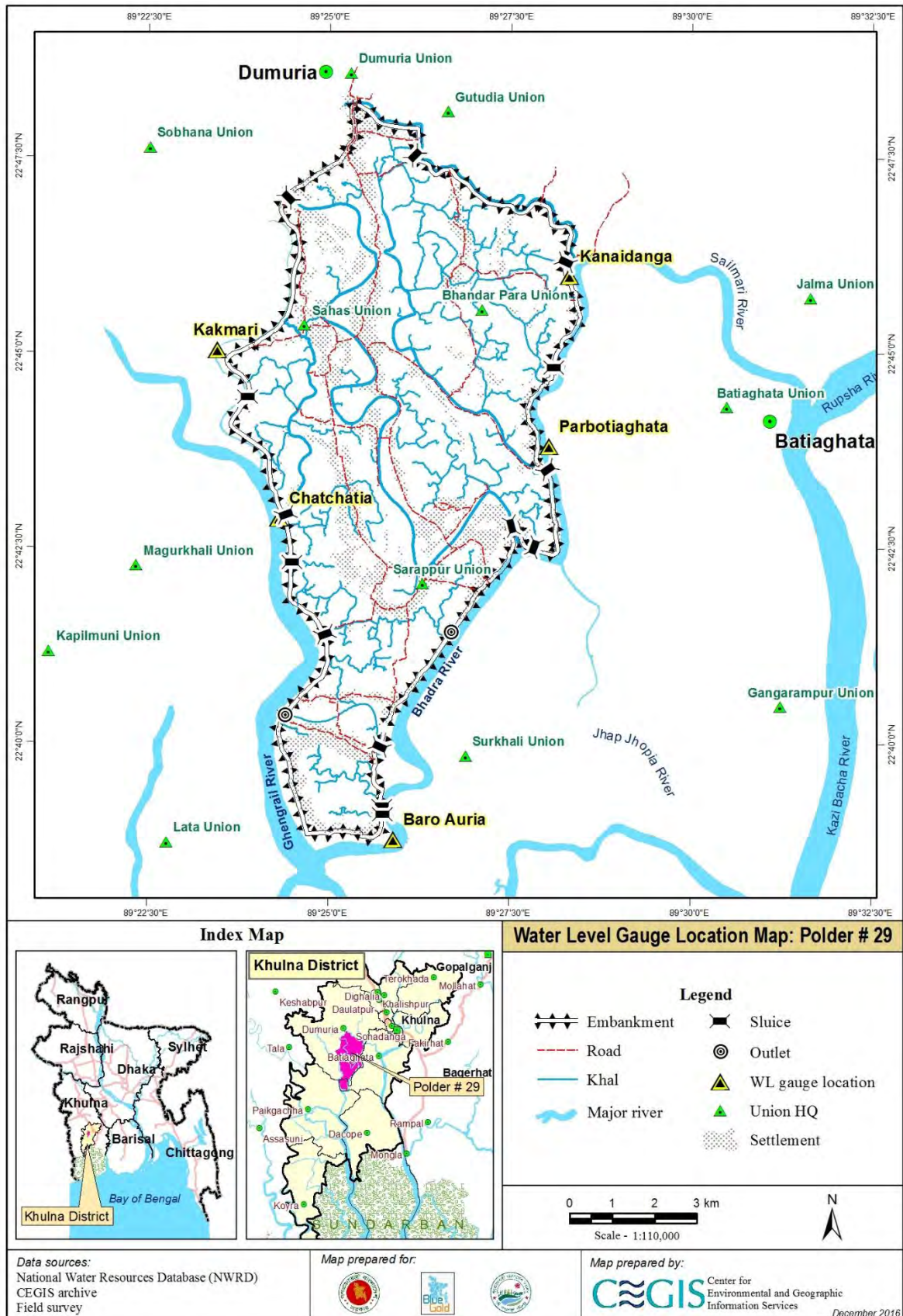


Figure 2.12: CEGIS installed gauge location at Polder 29

**Table 2.3: Water level gauge data from 01/10/2016 to 15/10/2016**

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
01/10/2016	06:00	0.15	-0.06	0.28	-0.55	1.74(LTL)
	07:00	-0.55	-0.45	-0.63	-1	1.89
	08:00	-1.05	-0.95	-1.32(LTL)	-1.2(LTL)	2.13
	9:00	-1.25(LTL)	-1.2(LTL)	-0.7	-0.35	2.28
	10:00	0.55	0.5	1	1.35	2.51
	11:00	2.05	2.25	2.22	2.02	2.89
	12:00	2.75	2.8	2.85 (HTL)	2.8(HTL)	3.41
	13:00	2.75(HTL)	2.85 (HTL)	2.7	2.75	3.70(HTL)
	14:00	2.45	2.6	2.45	2.5	3.55
	15:00	2.15	2.3	2.12	2.15	3.24
	16:00	1.85	1.78	1.65	1.6	3.05
	17:00	1.25	1.08	0.8	0.86	2.74
	18:00	0.55	0.4	-0.22	0.12	2.44

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
02/10/2016	06:00	0.35	0.63	0.25	0.31	1.68(LTL)
	07:00	-0.15	-0.12	-0.7	-0.45	1.83
	08:00	-0.85	-0.75	-1.35(LTL)	-1.05	2.03
	9:00	-1.15(LTL)	-1.2(LTL)	-1.2	-1.2(LTL)	2.18
	10:00	-0.65	-0.4	0.35	-0.22	2.36
	11:00	1.45	1.58	1.45	1.44	2.77
	12:00	2.55	2.78	2.6	2.58	3.29
	13:00	2.75(HTL)	2.85(HTL)	2.8(HTL)	2.8(HTL)	3.58(HTL)
	14:00	2.65	2.75	2.6	2.57	3.43
	15:00	2.5	2.6	2.3	2.3	3.18
	16:00	1.8	1.95	1.85	1.84	2.99
	17:00	1.1	1.28	1.1	1.1	2.68
	18:00	0.45	0.62	0.35	0.29	2.38

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
03/10/2016	06:00	0.55	0.8	0.5	0.58	1.58(LTL)
	07:00	0.05	0.1	-0.35	-0.2	1.68
	08:00	-0.65	-0.6	-0.75	-0.94	1.83
	9:00	-0.95	-0.9	-1.2(LTL)	-1.28(LTL)	2.03
	10:00	-1.3(LTL)	-1.2(LTL)	-0.6	-1.09	2.18
	11:00	0.75	0.5	1.15	0.63	2.46
	12:00	2.15	2.35	2.05	2.08	2.88
	13:00	2.65(HTL)	2.8(HTL)	2.7	2.78(HTL)	3.38
	14:00	2.55	2.73	2.75(HTL)	2.66	3.58
	15:00	2.35	2.48	2.4	2.35	3.73(HTL)
	16:00	1.9	2.1	2	1.9	3.28
	17:00	1.4	1.6	1.3	1.31	2.63
	18:00	0.5	0.8	0.45	0.51	2.48

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
04/10/2016	06:00	0.75	1.1	0.85	0.95	1.58(LTL)
	07:00	0.25	0.42	0.05	0.16	1.58
	08:00	-0.55	-0.4	-0.9	-0.65	1.73
	9:00	-0.85	-0.9	-1.2(LTL)	-1.19	1.98
	10:00	-1.15(LTL)	-1.2(LTL)	-1.15	-1.39(LTL)	2.23
	11:00	0.25	-0.31	0.15	-0.19	2.45
	12:00	2.05	1.42	1.55	1.45	2.88
	13:00	2.55(HTL)	2.7	2.6	2.6	3.48
	14:00	2.35	2.8	2.75(HTL)	2.77	3.88(HTL)
	15:00	2.05	2.6	2.45	2.41	3.73
	16:00	1.65	2.2	2.1	2.1	3.28
	17:00	1.05	1.75	1.5	1.52	2.48
	18:00	0.75	1.25	0.6	0.78	2.13

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
05/10/2016	06:00	1.35	1.6	1.15	1.26	2.47
	07:00	1.05	0.8	0.35	0.43	2.09
	08:00	-0.05	-0.1	-0.55	-0.38	2.08
	9:00	-0.65	-0.6	-1.2	-1.02	2.13
	10:00	-1.15	-1.2(LTL)	-1.25(LTL)	-1.3(LTL)	2.09
	11:00	-1.25(LTL)	-0.7	-0.4	-0.72	2.07
	12:00	0.45	0.85	0.85	0.71	2.04
	13:00	1.95	2.05	2.05	2	1.98(LTL)
	14:00	2.45	2.48	2.55(HTL)	2.58(HTL)	2.68
	15:00	2.5(HTL)	2.58(HTL)	2.5	2.48	3.38
	16:00	2.15	2.3	2.25	2.2	3.68(HTL)
	17:00	1.75	1.95	1.75	1.75	3.58
	18:00	1.45	1.75	1	1.07	3.08

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
06/10/2016	06:00	1.65	1.72	1.55	1.57	2.38
	07:00	1.25	1	0.8	0.81	1.98
	08:00	0.15	0.43	-0.05	0.08	1.83(LTL)
	9:00	-0.45	-0.35	-0.85	-0.67	2.28
	10:00	-0.75	-0.93(LTL)	-1.2(LTL)	-1.05	2.68
	11:00	-1.05(LTL)	-0.9	-0.7	-1.1(LTL)	3.39
	12:00	-0.05	-0.05	0.45	0.22	3.82(HTL)
	13:00	1.55	1.45	1.6	1.45	3.78
	14:00	2.15	2.3	2.3	2.3	3.58
	15:00	2.45(HTL)	2.5(HTL)	2.5(HTL)	2.5(HTL)	3.08
	16:00	2.25	2.43	2.35	2.32	2.69
	17:00	1.95	2.08	2	1.96	2.48
	18:00	1.45	1.8	1.45	1.43	2.23

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
07/10/2016	06:00	1.85	1.99	1.85	1.8	2.43
	07:00	1.55	1.4	1.25	1.25	2.31
	08:00	0.75	0.85	0.5	0.48	2.23
	9:00	0.05	0.1	-0.25	-0.18	2.03(LTL)
	10:00	-0.45	-0.45	-0.7	-0.71	2.53
	11:00	-0.75	-0.65(LTL)	-0.75(LTL)	-0.88(LTL)	3.18
	12:00	-0.95(LTL)	-0.55	-0.05	-0.36	3.78(HTL)
	13:00	0.05	0.65	0.9	0.8	3.58
	14:00	1.55	1.78	1.9	1.81	3.28
	15:00	2.15	2.3	2.3	2.3	3.13
	16:00	2.25(HTL)	2.38(HTL)	2.35(HTL)	2.34(HTL)	2.67
	17:00	2.05	2.25	2.15	2.1	2.45
	18:00	1.65	2	1.8	1.8	2.30

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
08/10/2016	06:00	1.95	2.08	2	1.95	2.48
	07:00	1.65	1.55	1.55	1.5	2.44
	08:00	0.95	1.1	0.9	0.9	2.38
	9:00	0.45	0.65	0.15	0.2	2.33
	10:00	-0.15	-0.25	-0.35	-0.38	2.28
	11:00	-0.35	-0.4	-0.55(LTL)	-0.66(LTL)	2.03
	12:00	-0.55(LTL)	-0.52(LTL)	-0.4	-0.65	1.99(LTL)
	13:00	-0.15	0.1	0.45	0.2	2.68
	14:00	0.85	1.1	1.3	1.2	3.36
	15:00	1.75	2	1.95	1.84	3.46(HTL)
	16:00	2.05	2.2	2.2(HTL)	2.2(HTL)	3.03
	17:00	2.15(HTL)	2.25(HTL)	2.15	2.15	2.77
	18:00	1.95	2.03	1.9	1.91	2.40

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
09/10/2016	06:00	2.05	2.03	2.1	2.05	2.53
	07:00	1.75	1.85	1.8	1.75	2.51
	08:00	1.35	1.38	1.3	1.25	2.48
	9:00	0.75	0.95	0.6	0.5	2.45
	10:00	0.25	0.45	0.05	0	2.38
	11:00	-0.05	0.1	-0.2	-0.32	2.28
	12:00	-0.25(LTL)	-0.22(LTL)	-0.35(LTL)	-0.46(LTL)	2.03(LTL)
	13:00	-0.25	-0.16	0.1	-0.12	2.68
	14:00	0.95	1.1	0.75	0.61	3.38
	15:00	1.35	1.3	1.5	1.38	3.48(HTL)
	16:00	1.75	2	1.9	1.85	3.13
	17:00	2	2.2(HTL)	2.1(HTL)	2.05(HTL)	2.78
	18:00	2.05(HTL)	1.92	1.85	1.85	2.47

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
10/10/2016	06:00	2.05(HTL)	2.07(HTL)	2.15(HTL)	2.1(HTL)	2.48
	07:00	1.95	1.95	2.05	2	2.44
	08:00	1.75	1.8	1.8	1.75	2.38
	9:00	1.25	1.3	1.35	1.3	2.33
	10:00	0.75	1.05	0.8	0.72	2.28
	11:00	0.35	0.53	0.3	0.4	2.23(LTL)
	12:00	0.05	0.18	-0.05	-0.14	2.68
	13:00	-0.15	0	-0.15(LTL)	-0.3(LTL)	3.36
	14:00	-0.45(LTL)	-0.1(LTL)	0	-0.19	3.46(HTL)
	15:00	0.15	0.5	0.6	0.4	3.03
	16:00	0.95	1.1	1.2	1.05	2.76
	17:00	1.35	1.3	1.65	1.6	2.53
	18:00	1.75	1.9	1.9	1.85	2.33

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
11/10/2016	06:00	1.75	1.92	1.9	1.85	2.38
	07:00	1.95	2.05	2.15(HTL)	2.1	2.36
	08:00	2.05(HTL)	2.18(HTL)	2.15	2.13(HTL)	2.33
	9:00	1.75	2.1	2.05	1.96	2.28
	10:00	1.55	1.9	1.8	1.75	2.23(LTL)
	11:00	0.95	1.2	1.4	1.37	2.68
	12:00	0.6	0.8	0.9	0.85	3.36
	13:00	0.45	0.5	0.3	0.21	3.47
	14:00	0.15	0.2	-0.05	-0.12	3.04
	15:00	-0.15	0.05	-0.2(LTL)	-0.32(LTL)	2.77
	16:00	-0.25(LTL)	-0.35(LTL)	0.05	-0.14	2.43
	17:00	0.25	0.45	0.65	0.6	2.33
	18:00	1.05	1.2	1.3	1.19	2.19

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
12/10/2016	06:00	0.75	0.85	0.9	0.8	2.23
	07:00	1.45	1.55	1.75	1.57	2.04
	08:00	1.95	2.05	2.15	2.1	1.93(LTL)
	9:00	2.25(HTL)	2.5	2.3(HTL)	2.19	2.28
	10:00	2.15	2.35(HTL)	2.25	2.23(HTL)	2.68
	11:00	1.95	2	2.05	1.95	3.36
	12:00	1.65	1.75	1.65	1.5	3.46
	13:00	1.15	1.25	1.15	1.38	3.50(HTL)
	14:00	0.65	0.8	0.35	1	3.47
	15:00	-0.05	-0.1	-0.35	-0.27	3.06
	16:00	-0.55	-0.65	-0.65(LTL)	-0.66	2.75
	17:00	-0.65	-0.7	-0.6	-0.78(LTL)	2.54
	18:00	-0.75(LTL)	-0.8(LTL)	-0.05	-0.37	2.29

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
13/10/2016	06:00	-0.65	-0.75	-0.4	-0.71	2.18
	07:00	-0.15	-0.25	0.45	0.25	1.88(LTL)
	08:00	1.15	1.25	1.45	1.3	1.93
	9:00	1.95	2.1	2.2	2.25	2.30
	10:00	2.4(HTL)	2.55	2.45(HTL)	2.46(HTL)	2.74
	11:00	2.35	2.75(HTL)	2.4	2.37	3.41
	12:00	2.15	2.35	2.15	2.1	3.55
	13:00	1.75	1.7	1.75	1.71	3.56(HTL)
	14:00	1.25	1.15	1.1	1.1	3.50
	15:00	0.65	0.35	0.3	0.41	2.99
	16:00	-0.05	-0.25	-0.6	-0.4	2.77
	17:00	-0.65	-0.7	-1.15(LTL)	-0.99	2.49
	18:00	-1.05(LTL)	-1.1(LTL)	-1.1	-1.1(LTL)	2.28

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
14/10/2016	06:00	-0.95	-0.8(LTL)	-1.05(LTL)	-0.9	2.13
	07:00	-1.05(LTL)	-0.8	-0.65	-1.05	1.89(LTL)
	08:00	-0.25	0.2	-0.4	0.35	1.91
	9:00	1.55	1.8	1.8	1.7	2.28
	10:00	2.35	2.64	2.5	2.58	2.78
	11:00	2.55(HTL)	2.7(HTL)	2.65(HTL)	2.68(HTL)	3.38
	12:00	2.45	2.5	2.45	2.4	3.58
	13:00	2.15	2.22	2.2	2.15	3.63(HTL)
	14:00	1.75	1.86	1.75	1.71	3.61
	15:00	1.15	1.12	1.05	0.98	3.45
	16:00	0.55	0.57	0.2	0.33	3.10
	17:00	-0.15	-0.09	-0.7	-0.48	2.68
	18:00	-0.85	-0.33	-1.2(LTL)	-1.06(LTL)	2.31

Date	Time	Kanaidanga	Parbotiaghata	Baroauria	Chatchotia	Kakmari
15/10/2016	06:00	-0.65	-0.75	-0.95	-0.8	2.03
	07:00	-1.05	-1.25	-1.35(LTL)	-1.22	1.98
	08:00	-1.45(LTL)	-1.65(LTL)	-0.9	-1.32(LTL)	1.96
	9:00	0.25	0.45	0.7	0.4	1.94
	10:00	1.85	2	2	2	1.88(LTL)
	11:00	2.65	2.85	2.8(HTL)	2.8	2.84
	12:00	2.75(HTL)	2.96(HTL)	2.75	2.75(HTL)	3.48
	13:00	2.55	2.65	2.5	2.46	3.58
	14:00	2.15	2.25	2.2	2.14	3.64(HTL)
	15:00	1.75	1.85	1.6	1.58	3.48
	16:00	0.95	1	0.75	0.76	2.29
	17:00	-0.05	-0.1	-0.2	0	2.20
	18:00	-0.75	-0.85	-1.05	-0.8	2.09

## 2.11 Catchment of Polder 30

In this study, for polder 30, Catchment has been delineated for ten (10) drainage outlets. The drainage outlets were selected at ten (10) hydraulic structure locations. Figure 2.13, 2.14 and 2.15 shows the Base map, Intervention with catchment and Digital Elevation Model (DEM) map of Polder 30. Area of each catchment boundary has been presented in Table 2.4. From the Figure 2.14 and Table 2.4 shows that catchment of Khorias Catchment is the largest catchment which is about 1327 ha.

**Table 2.4: Drainage outlet/ hydraulic Structure wise drainage catchment for polder 43/2F**

### ***Description of Catchment 1***

<b>Catchment Name</b>	Cat – 1 (Kismat Fultala Catchment)
<b>Location (mauza wise)</b>	Hetalbunia (152 ha), Kismat Phultala (148 ha), Bherandabunia (51 ha), Madia Asannagar (108 ha) of Batiaghata union.
<b>Catchment area (ha)</b>	459
<b>Drainage Outlet</b>	Kismat Fultala Sluice at Ch. 1+933 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Kismat Fultala khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.49 Min: 0.62
<b>Length of Stream within catchment (Km)</b>	11.96
<b>Drainage Density (m/ha)</b>	26.05
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Kazi Bacha River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Partially</b> silted up</li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b> (usually takes 3-4 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Moderate</b> (Lt Aman, sesame, watermelon and Sun-flower affected by heavy rainfall &amp; drainage congestion)</li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b></li> </ul> </li> </ul>



Figure: C/S of Kismat Fultala Sluice



Figure: Outfall of Kismat Fultala Sluice



Figure: Bank protective work at Botiaghata

### **Description of Catchment 2**

<b>Catchment Name</b>	Cat – 2 (Khorias Catchment)
<b>Location (mauza wise)</b>	Hetalbunia (1 ha), Mathbhanga (30 ha), Kismat Phultala (60 ha), Bherandabunia (14 ha), Madia Asannagar (50 ha), Phultala (151 ha), Balabunia (145 ha) of Batiaghata union and Debitala (260 ha), Boyarbhanga (190 ha), Bajeafti Debitala (45 ha), Gagaramari (78 ha), Charkhali Machalia (216 ha), Salua (61 ha), Andharia (13 ha), Khajurtala (13 ha) of Gangarampur union.
<b>Catchment area (ha)</b>	1327
<b>Drainage Outlet</b>	Khorias Sluice at Ch. 6+040 km (2V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Khorias khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.78 Min: 0.62
<b>Length of Stream within catchment (Km)</b>	38.43
<b>Drainage Density (m/ha)</b>	28.96



### Catchment Description

- *Outfall*
  - Outfall Khal: **Kazi Bacha River**  
Condition: **Active**
- *Condition of Drainage Khal*
  - Main drainage Khal: **Moderately** silted up
  - Branch khal: **Moderately** silted up
- *Drainage Congestion*
  - Drainage congestion problem: **Moderate** (usually takes 3-4 days to properly drain out rain water)
  - Re-excavation of Khorla khal and its connecting branches khal will reduce the drainage congestion problem and available irrigation water for Rabi crops.
  - Permanent Water logging: **Not found.**
- *Agricultural condition*
  - Crop damage: **Moderate** (about 15- 20% area of Lt Aman, sesame, watermelon and Sun-flower crops are damaged by heavy rainfall & drainage congestion)
  - Water Scarcity: **Partially observed.**
- *Structure Condition*
  - **Functional**
  - C/S block pitching and gate repairing (mechanical) work has been done by BWDB in 2015.



Figure: C/S of Khorla Sluice



Figure: Outfall of Khorla catchment

**Description of Catchment 3**

<b>Catchment Name</b>	Cat – 3 (Katianangla Catchment)
<b>Location (mauza wise)</b>	Katianangla (178 ha), Katamari (56 ha), Gangarampur (3 ha), Kaemkhola (4 ha) of Gangarampur union.
<b>Catchment area (ha)</b>	241 ha
<b>Drainage Outlet</b>	Katianangla Sluice at Ch. 8+533 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Katianangla khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.27 Min: 0.85
<b>Length of Stream within catchment (Km)</b>	6.27
<b>Drainage Density (m/ha)</b>	26.02
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Kazi Bacha River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Active</b></li> <li>• Branch khal: <b>Partially</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b> (R/S loose apron is damaged)</li> <li>• C/S block pitching and gate repairing (mechanical) work has been done by BWDB in 2015.</li> </ul> </li> </ul>



Figure: R/S of Katialangla Sluice



Figure: C/S of Katialangla Sluice

**Description of Catchment 4**

<b>Catchment Name</b>	Cat – 4 (Mashiardanga Catchment)
<b>Location (mauza wise)</b>	Katianangla (11 ha), Katamari (279 ha), Gangarampur (5 ha), Kaemkhola (79 ha), Kasiadanga (17 ha), Barun Para (162 ha), Kayemkholar Hula (73 ha) of Gangarampur union.
<b>Catchment area (ha)</b>	626 ha
<b>Drainage Outlet</b>	Mashiardanga Sluice at Ch. 13+660 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Mashiardanga khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 4.38 Min: 0.76
<b>Length of Stream within catchment (Km)</b>	13.142
<b>Drainage Density (m/ha)</b>	20.99
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Manga River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Active</b></li> <li>• Branch khal: <b>Partially</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b> (R/S loose apron is damaged)</li> <li>• C/S block pitching and gate repairing (mechanical) work has been done by BWDB in 2015</li> </ul> </li> <li>➤ <i>Erosion</i> <ul style="list-style-type: none"> <li>• Around 250m embankment at Barun para is vulnerable to river bank erosion and tidal flooding.</li> <li>• Temporary bank protection work has been done by installing bamboo fencing and placing geo-bags at the vulnerable locations.</li> </ul> </li> </ul>



Figure: C/S of Moisher Danga Sluice



Figure: Outfall of Moisher Danga catchment



Figure: River bank Erosion at Barunpara

### Description of Catchment 5

<b>Catchment Name</b>	Cat – 5 (Amtola Catchment)
<b>Location (mauza wise)</b>	Charkhali Machalia (33 ha), Salua (56 ha), Britti Khalsebunia (72 ha), Andharia (58 ha), Khajurtala (93 ha), Sukhdara (453 ha), Katianangla (264 ha), Gangarampur (96 ha), Kaemkhola (18 ha), Kasiadanga (18 ha) of Gangarampur union and Sukhdara (453 ha) of Surkhali union.
<b>Catchment area (ha)</b>	1162 ha
<b>Drainage Outlet</b>	Amtola Sluice at Ch. 17+645 km (2V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Amtola khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 3.35 Min: 0.69
<b>Length of Stream within catchment (Km)</b>	27.83
<b>Drainage Density (m/ha)</b>	23.96

### Catchment Description

- *Outfall*
  - Outfall Khal: **Jhop Jhopia River**  
Condition: **Highly Silted up**
- *Condition of Drainage Khal*
  - Main drainage Khal: **Moderately** silted up
  - Branch khal: **Moderately** silted up
- *Drainage Congestion*
  - Drainage congestion problem: **Severe** (usually takes 7-10 days to properly drain out rain water)
  - The Amtola khal drain the internal water to the Jhop Jhopia River. Siltation in Jhop Jhopia River has raised the bed level by 1.5~2.0 m above the sill level of the Amtola regulator. As such, during ebbing water cannot drain out properly, which results severe drainage congestion.
  - The Jhop Jhopia River (about 10.5 km) is highly silted up and required maintenance dredging to keep it functional. Therefore, properly drain out rain water, a new (3V – 1.5m X 1.8m) drainage cum flushing sluice at Khejurtala and re-excavation of Amtola khal and Khejurtala-Amtola- kolatola khal linking to new sluice will be required to divert the major portion of Amtola catchment.
  - Permanent Water logging: **Not found.**
- *Agricultural condition*
  - Crop damage: **Major** (Lt Aman, sesame, watermelon and Sun-flower crops are damaged by heavy rainfall & severe drainage congestion)
  - Water Scarcity: **Not found.**
- *Structure Condition*
  - **Partially Functional**
  - Loose Apron both R/S and C/S is damaged
  - Gates are corroded and damaged
  - Sluice repairing is required



Figure: R/S of Amtola Sluice



Figure: R/S of Amtola Sluice

**Description of Catchment 6**

<b>Catchment Name</b>	Cat – 6 (Aushkhali Catchment)
<b>Location (mauza wise)</b>	Mathbhanga (10 ha), Mailmara (80 ha), Balabunia (41 ha), Aushkhali (48 ha) of Batiaghata union and Boyarbhangra (147 ha), Titukhali (61 ha), Par Titukhali (71 ha), Charkhali Machalia (42 ha), Par Salua (102 ha), Salua (61 ha), Britti Khalsebunia (65 ha) of Gangarampur union.
<b>Catchment area (ha)</b>	726 ha
<b>Drainage Outlet</b>	Aushkhali Sluice at Ch. 25+115 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Aushkhali khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.42 Min: 0.54
<b>Length of Stream within catchment (Km)</b>	22.59
<b>Drainage Density (m/ha)</b>	31.11
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately</b> silted up</li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Severe</b> (usually takes 5-6 days to properly drain out rain water)</li> <li>• The Kalatala-Narikeltala khal drains the internal water to the Jhop Jhopia River. The Jhop Jhopia River is highly silted up and raised the bed level by 1.5~2 m above the invert level of the kolatola regulator. Therefore, Kolatola catchment area was diverted/changed and shared with Aushkhali and Khorla catchment through Kalatala-Narikeltala khal. The capacity of Aushkhali Sluice is inadequate for efficient drainage (726 ha), which cause severe drainage congestion.</li> <li>• During heavy rainfall, water pumping provision at Kalatala sluice is required to reduce drainage congestion problem.</li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: Crop damage: <b>Major</b> (Lt Aman, sesame, watermelon and Sun-flower crops are damaged by heavy rainfall &amp; severe drainage congestion)</li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional.</b></li> </ul> </li> </ul>



Figure: C/S of Aushkhali Sluice

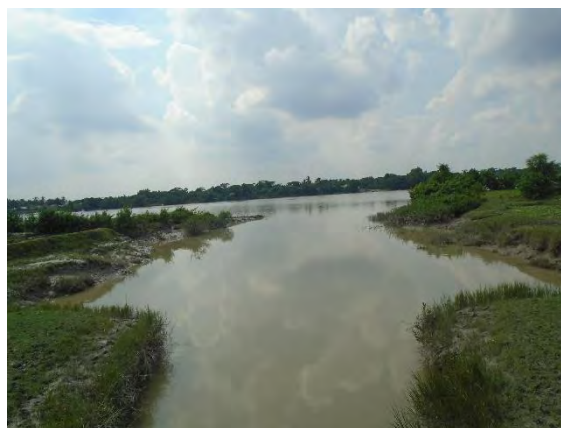


Figure: R/S of Aushkhali Sluice

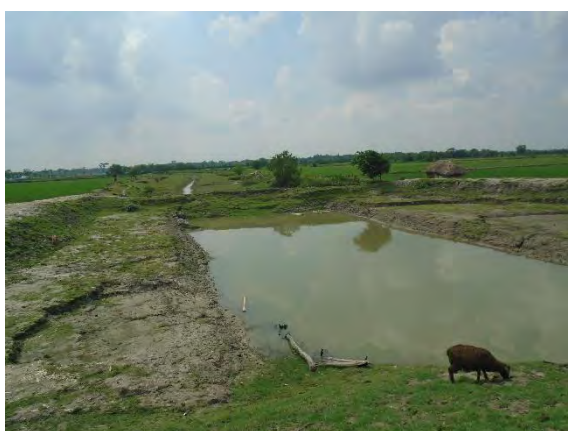


Figure: cross bund on the outfall of kolatola Sluice



Figure: C/S of kolatola Sluice

### **Description of Catchment 7**

<b>Catchment Name</b>	Cat – 7 (Parbotiaghata Catchment)
<b>Location (mauza wise)</b>	Baguladanga Patharghata (47 ha), Hatbati (Baro) (315 ha), Parbatiaghata (137 ha), Baruirabad (38 ha), Hetalbungia (53 ha), Batiaghata (78 ha), Mathbhanga (168 ha), Mailmara (54 ha) of Batiaghata union.
<b>Catchment area (ha)</b>	892 ha
<b>Drainage Outlet</b>	Parbotiaghata Sluice at Ch. 27+102 km (2V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Parbotiaghata khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.51 Min: 0.17
<b>Length of Stream within catchment (Km)</b>	23.84
<b>Drainage Density (m/ha)</b>	24.08
	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b></li> <li>Condition: <b>Active</b></li> </ul> </li> </ul>

### Catchment Description

- *Condition of Drainage Khal*
  - Main drainage Khal: **Partially** silted up
  - Branch khal: **Moderately** silted up
- *Drainage Congestion*
  - Drainage congestion problem: : **Moderate** (usually takes 3-4 days to properly drain out rain water)
  - Re-excavation of Botiaghata-Baruirabad khal, Uzukhali khal, Citibunia khal and its connecting branches khal will reduce the drainage congestion problem and available irrigation water for Rabi crops.
  - Permanent Water logging: **Not found.**
- *Agricultural condition*
  - Crop damage: **Moderate** (about 15- 20% area of Lt Aman, sesame, watermelon and Sun-flower crops are damaged by heavy rainfall & drainage congestion)
  - Water Scarcity: **Partially observed.** Hatbati and Baruirabad area are affected by water scarcity during March to April (mainly affects Watermelon and other Rabi crops)
- *Structure Condition*
  - **Damaged**
  - Loose apron are damaged both C/S and R/S.
  - One C/S vertical lift gate and both R/S flap gate are corroded and rubber seals are damaged
  - Hoisting arrangement of vertical lift gate is damaged
  - Replacement of gates and other necessary major repairing works is required.



Figure: C/S of Parbotiaghata Sluice



Figure: Outfall of Parbotiaghata catchment



**Description of Catchment 8**

<b>Catchment Name</b>	Cat – 8 (Kholishabunia Catchment)
<b>Location (mauza wise)</b>	Khalsibunia (74 ha), Baguladanga Patharghata (31 ha), Hatbati (Baro) (5 ha) of Batiaghata union.
<b>Catchment area (ha)</b>	207 ha
<b>Drainage Outlet</b>	Kholishabunia Sluice at Ch. 30+080 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Kholishabunia khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.06 Min: 0.46
<b>Length of Stream within catchment (Km)</b>	4.26
<b>Drainage Density (m/ha)</b>	20.61
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Active</b></li> <li>• Branch khal: <b>Partially</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b></li> <li>• Block pitching and gate repairing (mechanical) work has been done by BWDB in 2015</li> </ul> </li> </ul>



Figure: C/S of Kholishabunia Sluice



Figure: Kholishabunia khal

**Description of Catchment 9**

<b>Catchment Name</b>	Cat – 9 (Beeler khal Catchment)
<b>Location (mauza wise)</b>	Chak Solemari (172 ha), Batiaghata Hogolbunia (43 ha), Batiaghata Khalsibunia (48 ha) of Batiaghata union.
<b>Catchment area (ha)</b>	263
<b>Drainage Outlet</b>	Beeler khal Sluice at Ch. 30+935 km (1V- 0.9 m X1.2 m)
<b>Main Drainage Canal</b>	Beeler khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.29 Min: 0.29
<b>Length of Stream within catchment (Km)</b>	5.6
<b>Drainage Density (m/ha)</b>	21.29
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Salta River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Active</b></li> <li>• Branch khal: Hanira Khal is <b>Moderately</b> silted up, (<i>Hanira khal is proposed for re-excavation under Bluegold program</i>)</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Minor</b> (usually takes 2-3 days to properly drain out rain water)</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Minor</b></li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b></li> </ul> </li> <li>➤ <i>Erosion</i> <ul style="list-style-type: none"> <li>• Around 500m embankment at Chak Sholmari is vulnerable to river bank erosion and tidal flooding. About 30m of land area was eroded in last 5 years and Setback distance is reducing every year.</li> <li>• Low cost/Temporary bank protection works would be required by installing bamboo fencing and placing geo-bags at the vulnerable locations.</li> </ul> </li> </ul>



Figure: C/S of Beeler khal Sluice



Figure: Outfall of Beeler khal catchment



Figure: Chalk Sailmari Erosion

**Description of Catchment 10**

<b>Catchment Name</b>	Cat – 10 (Hogolbunia Catchment)
<b>Location (mauza wise)</b>	Chak Solemari (53 ha), Hogolbunia (369 ha), Khalsibunia (4 ha), Hatbati (Baro) (120 ha) of Batiaghata union.
<b>Catchment area (ha)</b>	546 ha
<b>Drainage Outlet</b>	Hogolbunia Sluice at Ch. 37+515 km (1V- 1.5 m X1.8 m)
<b>Main Drainage Canal</b>	Hogolbunia khal
<b>Land elevation of Catchment (m PWD)</b>	Max: 2.17 Min: 0.41
<b>Length of Stream within catchment (Km)</b>	12.11
<b>Drainage Density (m/ha)</b>	22.18
<b>Catchment Description</b>	<ul style="list-style-type: none"> <li>➤ <i>Outfall</i> <ul style="list-style-type: none"> <li>• Outfall Khal: <b>Sailmari River</b> Condition: <b>Active</b></li> </ul> </li> <li>➤ <i>Condition of Drainage Khal</i> <ul style="list-style-type: none"> <li>• Main drainage Khal: <b>Moderately</b> silted up</li> <li>• Branch khal: <b>Moderately</b> silted up</li> </ul> </li> <li>➤ <i>Drainage Congestion</i> <ul style="list-style-type: none"> <li>• Drainage congestion problem: <b>Moderate</b> (usually takes 3-4 days to properly drain out rain water)</li> <li>• Re-excavation of Hogolbunia khal and connecting branch khal will reduce the drainage congestion problem</li> <li>• Permanent Water logging: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Agricultural condition</i> <ul style="list-style-type: none"> <li>• Crop damage: <b>Moderate</b> (about 10- 15% area of Lt Aman, sesame, watermelon and Sun-flower crops are damaged by heavy rainfall &amp; drainage congestion)</li> <li>• Water Scarcity: <b>Not found.</b></li> </ul> </li> <li>➤ <i>Structure Condition</i> <ul style="list-style-type: none"> <li>• <b>Functional</b></li> </ul> </li> <li>➤ <i>Erosion</i> <ul style="list-style-type: none"> <li>• Around 650m embankment at Hogolbunia is vulnerable to river bank erosion and tidal flooding.</li> <li>• Low cost/Temporary bank protection works would be required by installing bamboo fencing and placing geo-bags at the vulnerable locations. A small launching apron will be prepared with the geo-bags in place and bamboo fencing would be provided along the toe of the embankment.</li> </ul> </li> </ul>



Figure: R/S of Hogolbunia Sluice



Figure: Hogolbunia khal



Figure: Hogolbunia Erosion

## 2.12 Tidal dynamics assessment of polder 30

CEGIS team installed five (05) water level gauge stations (**Kismat Fultala, Barunpara, Surkhali, Parbotiaghata and Kanaidanga**) outside the polder 30 (shown in Figure 2.10) to understand the tidal water level variations. Daily water level data at one (01) hour interval (from 6:00 AM to 6:00 PM) for 1 tide cycle (15 days) from 01<sup>st</sup> October 2016 to 15<sup>th</sup> October 2016 has been collected presented in Table 2.3. All water level data was collected in mPWD datum.

Daily water level data were collected on an hourly basis. Water level hydrographs were plotted as water level versus time. The water level hydrograph at Kismat Fultala, Barunpara, Surkhali, Parbotiaghata and Kanaidanga stations are shown in Figure 2.7 to 2.9 respectively.

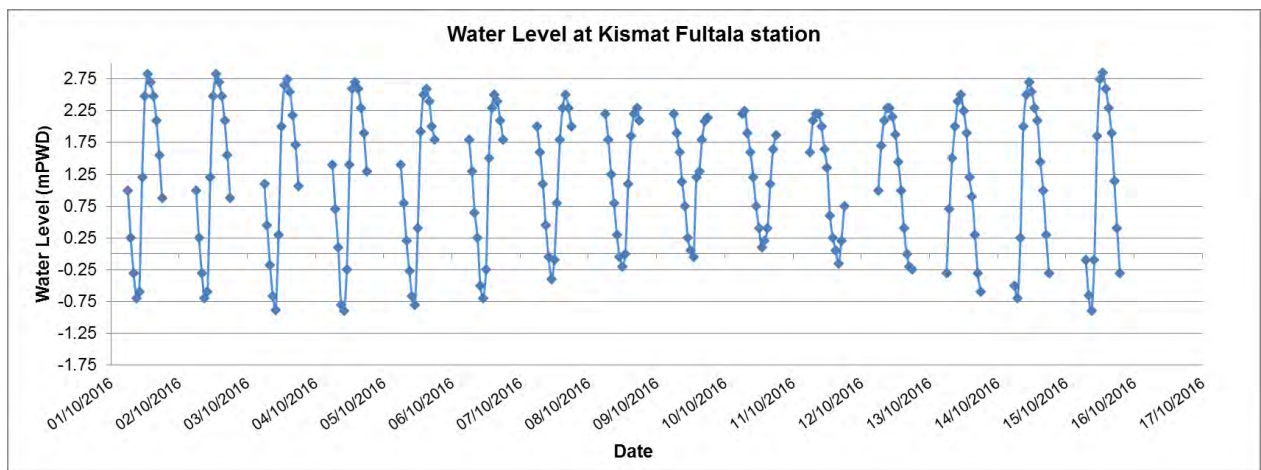


Figure 2.16: Water level analysis at Kismat Fultala station

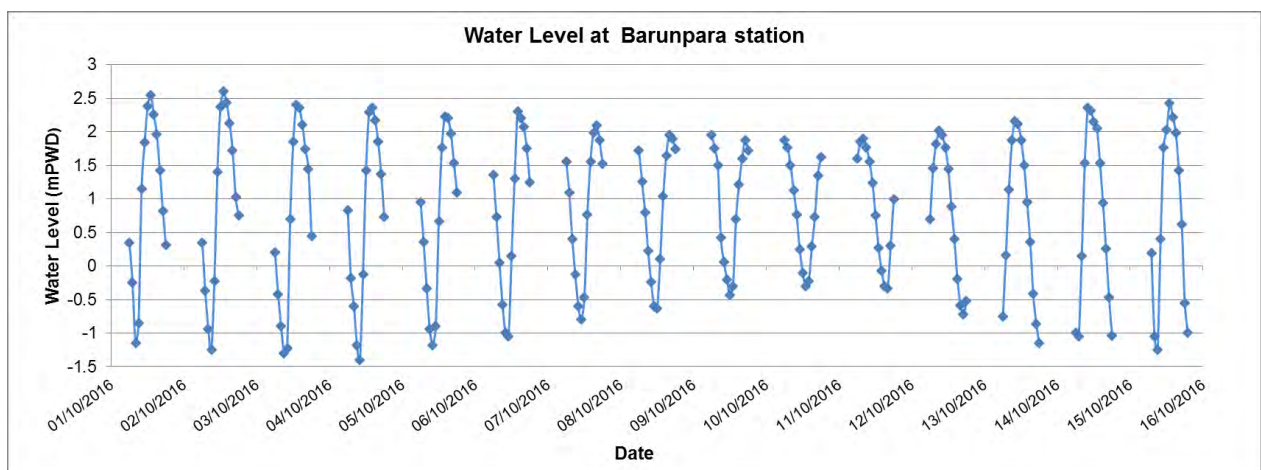


Figure 2.17: Water level analysis at Barunpara station

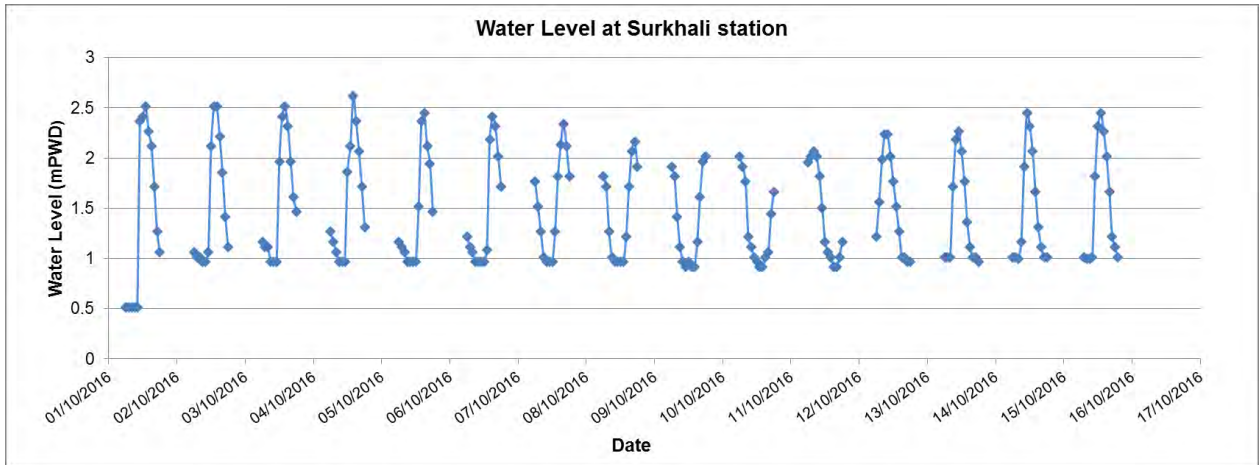


Figure 2.18: Water level analysis at Surkhali station

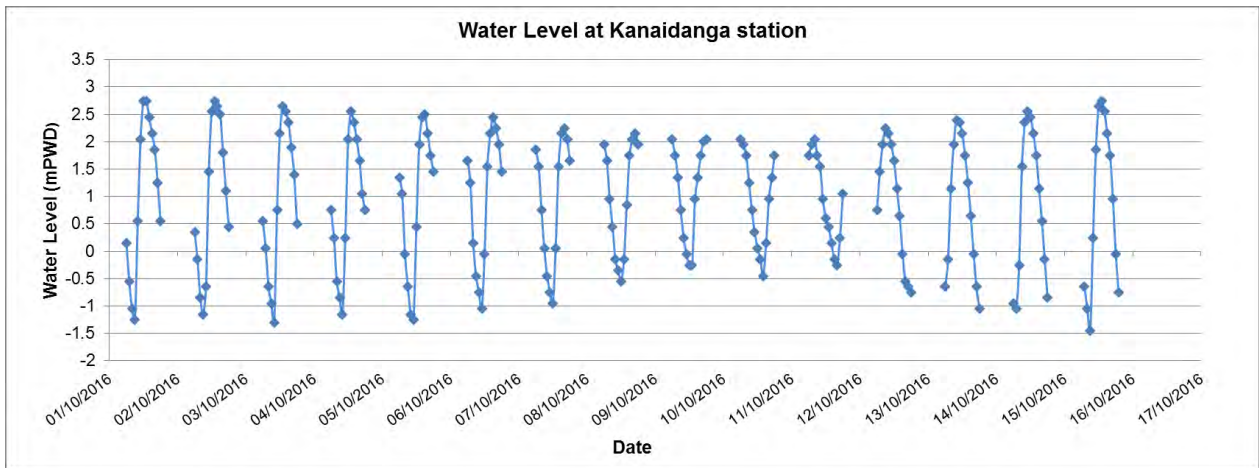


Figure 2.19: Water level analysis at Kanaidanga station

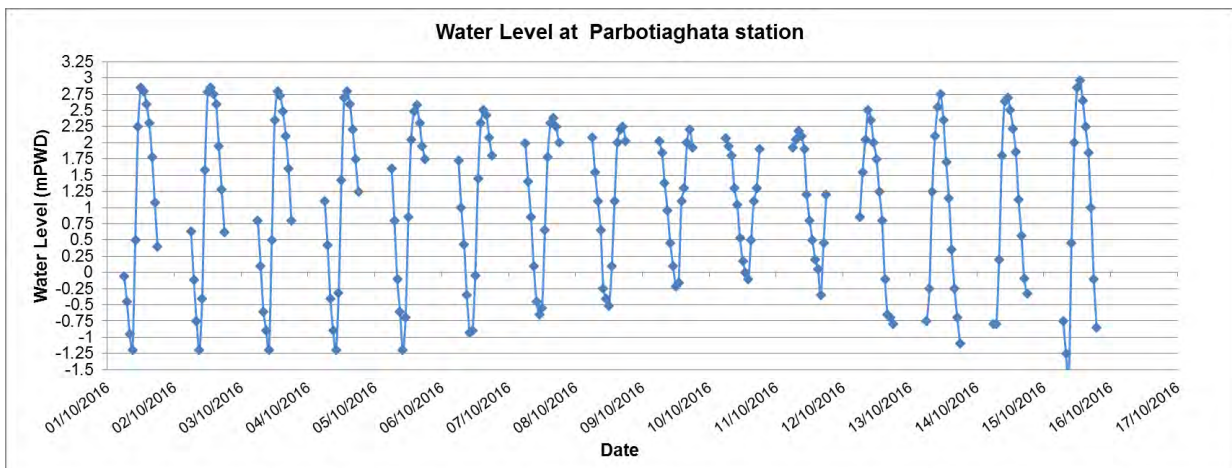


Figure 2.20: Water level analysis at Parbotiaghata station

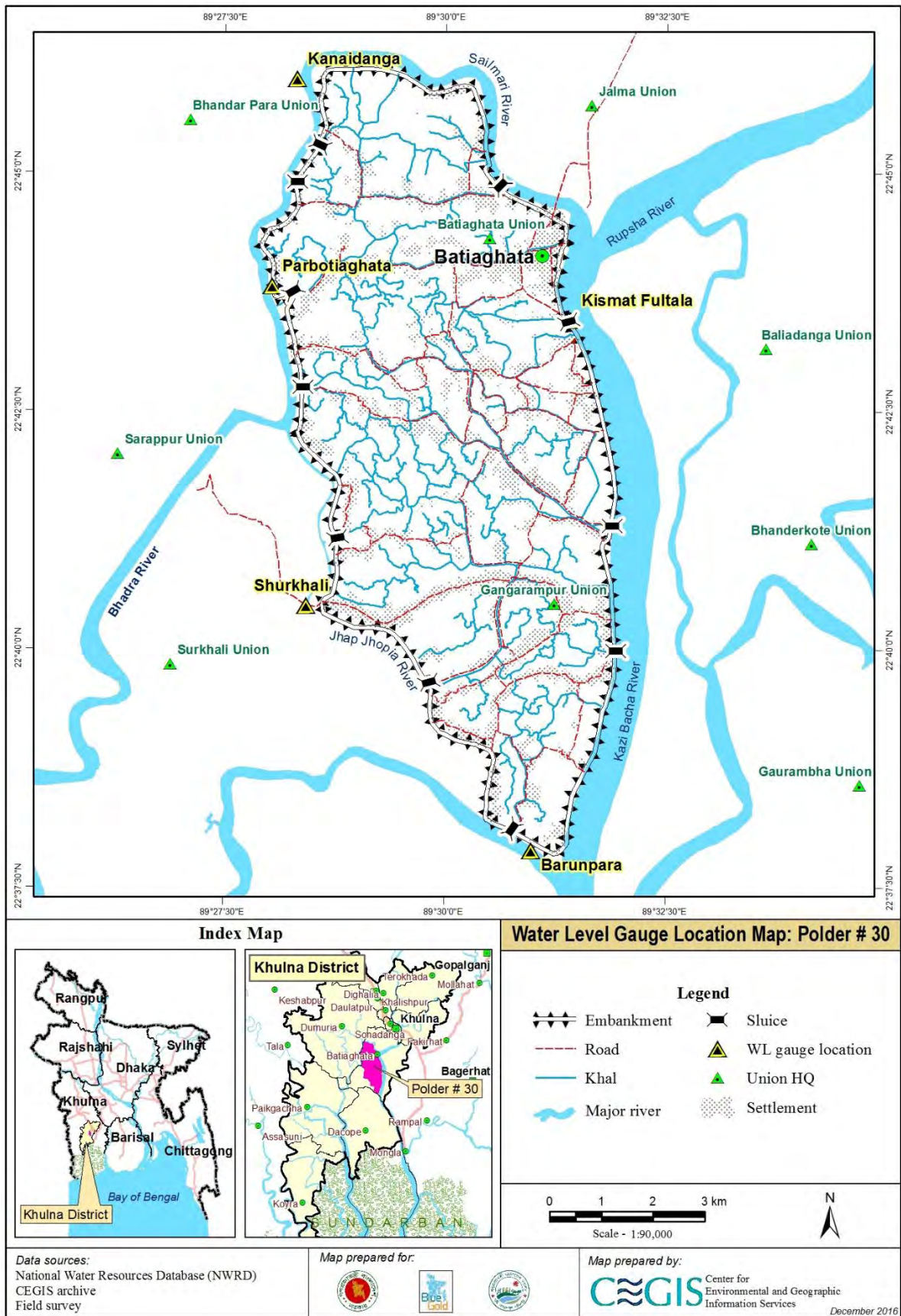


Figure 2.21: CEGIS installed gauge location map



**Table 2.5: Water level gauge data from 01/10/2016 to 15/10/2016**

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
01/10/2016	06:00	0.1	0.35	1.10	0.15	0.63
	07:00	-0.35	-0.25	1.06	-0.55	-0.12
	08:00	-1	-1.15(LTL)	1.05	-1.05	-0.75
	9:00	-1.1(LTL)	-0.85	0.95	-1.25(LTL)	-1.2(LTL)
	10:00	0.85	1.15	0.92(LTL)	0.55	-0.4
	11:00	2	1.84	2.37	2.05	1.58
	12:00	2.7	2.38	2.42	2.75	2.78
	13:00	2.8(HTL)	2.55(HTL)	2.52(HTL)	2.75(HTL)	2.85(HTL)
	14:00	2.5	2.26	2.27	2.45	2.75
	15:00	2.05	1.96	2.12	2.15	2.6
	16:00	1.55	1.42	1.72	1.85	1.95
	17:00	1.15	0.82	1.27	1.25	1.28
	18:00	0.4	0.31	1.07	0.55	0.62

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
02/10/2016	06:00	1	0.35	1.07	0.35	0.63
	07:00	0.25	-0.37	1.02	-0.15	-0.12
	08:00	-0.3	-0.94	1.02	-0.85	-0.75
	9:00	-0.7(LTL)	-1.25(LTL)	0.97(LTL)	-1.15(LTL)	-1.2(LTL)
	10:00	-0.6	-0.22	0.97	-0.65	-0.4
	11:00	1.2	1.4	1.07	1.45	1.58
	12:00	2.48	2.37	2.12	2.55	2.78
	13:00	2.83(HTL)	2.6(HTL)	2.52	2.75(HTL)	2.85(HTL)
	14:00	2.7	2.44	2.52(HTL)	2.65	2.75
	15:00	2.48	2.13	2.22	2.5	2.6
	16:00	2.1	1.72	1.86	1.8	1.95
	17:00	1.55	1.03	1.42	1.1	1.28
	18:00	0.88	0.75	1.12	0.45	0.62

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
03/10/2016	06:00	1.1	0.2	1.17	0.55	0.8
	07:00	0.45	-0.42	1.12	0.05	0.1
	08:00	-0.18	-0.9	1.12	-0.65	-0.6
	9:00	-0.67	-1.3(LTL)	0.97	-0.95	-0.9
	10:00	-0.88(LTL)	-1.22	0.97(LTL)	-1.3(LTL)	-1.2(LTL)
	11:00	0.3	0.7	0.97	0.75	0.5
	12:00	2	1.85	1.97	2.15	2.35
	13:00	2.66	2.4(HTL)	2.42	2.65(HTL)	2.8(HTL)
	14:00	2.75(HTL)	2.36	2.52(HTL)	2.55	2.73
	15:00	2.55	2.11	2.32	2.35	2.48
	16:00	2.18	1.74	1.97	1.9	2.1
	17:00	1.71	1.45	1.62	1.4	1.6
	18:00	1.06	0.45	1.47	0.5	0.8

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
04/10/2016	06:00	1.4	0.83	1.27	0.75	1.1
	07:00	0.7	-0.18	1.17	0.25	0.42
	08:00	0.1	-0.6	1.07	-0.55	-0.4
	9:00	-0.8	-1.18	0.97	-0.85	-0.9
	10:00	-0.9(LTL)	-1.4(LTL)	0.97(LTL)	-1.15(LTL)	-1.2(LTL)
	11:00	-0.25	-0.13	0.97	0.25	-0.31
	12:00	1.4	1.42	1.87	2.05	1.42
	13:00	2.6	2.29	2.12	2.55(HTL)	2.7
	14:00	2.7(HTL)	2.36(HTL)	2.62(HTL)	2.35	2.8(HTL)
	15:00	2.6	2.17	2.37	2.05	2.6
	16:00	2.3	1.85	2.07	1.65	2.2
	17:00	1.9	1.37	1.72	1.05	1.75
	18:00	1.3	0.73	1.32	0.75	1.25

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
05/10/2016	06:00	1.4	0.95	1.17	1.35	1.6
	07:00	0.8	0.36	1.12	1.05	0.8
	08:00	0.2	-0.34	1.07	-0.05	-0.1
	9:00	-0.27	-0.94	0.97	-0.65	-0.6
	10:00	-0.67	-1.18(LTL)	0.97(LTL)	-1.15	-1.2(LTL)
	11:00	-0.8(LTL)	-0.9	0.97	-1.25(LTL)	-0.7
	12:00	0.4	0.67	0.97	0.45	0.85
	13:00	1.92	1.77	1.52	1.95	2.05
	14:00	2.5	2.23(HTL)	2.37	2.45	2.48
	15:00	2.6(HTL)	2.2	2.45(HTL)	2.5(HTL)	2.58(HTL)
	16:00	2.4	1.97	2.12	2.15	2.3
	17:00	2	1.53	1.95	1.75	1.95
	18:00	1.8	1.1	1.47	1.45	1.75

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
06/10/2016	06:00	1.8	1.36	1.22	1.65	1.72
	07:00	1.3	0.73	1.12	1.25	1
	08:00	0.65	0.05	1.07	0.15	0.43
	9:00	0.25	-0.58	0.97	-0.45	-0.35
	10:00	-0.5	-1	0.97(LTL)	-0.75	-0.93(LTL)
	11:00	-0.7(LTL)	-1.05(LTL)	0.97	-1.05(LTL)	-0.9
	12:00	-0.25	0.15	0.97	-0.05	-0.05
	13:00	1.5	1.3	1.09	1.55	1.45
	14:00	2.3	2.3(HTL)	2.19	2.15	2.3
	15:00	2.5(HTL)	2.2	2.42(HTL)	2.45(HTL)	2.5(HTL)
	16:00	2.4	2.07	2.32	2.25	2.43
	17:00	2.1	1.75	2.02	1.95	2.08
	18:00	1.8	1.25	1.72	1.45	1.8

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
07/10/2016	06:00	2	1.56	1.77	1.85	1.99
	07:00	1.6	1.1	1.52	1.55	1.4
	08:00	1.1	0.4	1.27	0.75	0.85
	9:00	0.45	-0.13	1.02	0.05	0.1
	10:00	-0.05	-0.6	0.97	-0.45	-0.45
	11:00	-0.4(LTL)	-0.8(LTL)	0.97(LTL)	-0.75	-0.65(LTL)
	12:00	-0.1	-0.47	0.97	-0.95(LTL)	-0.55
	13:00	0.8	0.76	1.27	0.05	0.65
	14:00	1.8	1.56	1.82	1.55	1.78
	15:00	2.3	1.99	2.14	2.15	2.3
	16:00	2.5(HTL)	2.1(HTL)	2.34(HTL)	2.25(HTL)	2.38(HTL)
	17:00	2.3	1.87	2.12	2.05	2.25
	18:00	2	1.52	1.82	1.65	2

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
08/10/2016	06:00	2.2	1.72	1.82	1.95	2.08
	07:00	1.8	1.26	1.72	1.65	1.55
	08:00	1.25	0.8	1.27	0.95	1.1
	9:00	0.8	0.23	1.02	0.45	0.65
	10:00	0.3	-0.24	0.97	-0.15	-0.25
	11:00	-0.05	-0.6	0.97(LTL)	-0.35	-0.4
	12:00	-0.2(LTL)	-0.63(LTL)	0.97	-0.55(LTL)	-0.52(LTL)
	13:00	0	0.1	0.97	-0.15	0.1
	14:00	1.1	1.04	1.22	0.85	1.1
	15:00	1.85	1.64	1.72	1.75	2
	16:00	2.2	1.95(HTL)	2.07	2.05	2.2
	17:00	2.3(HTL)	1.9	2.17(HTL)	2.15(HTL)	2.25(HTL)
	18:00	2.1	1.74	1.92	1.95	2.03

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
09/10/2016	06:00	2.2(HTL)	1.95(HTL)	1.92	2.05	2.03
	07:00	1.9	1.75	1.82	1.75	1.85
	08:00	1.6	1.5	1.42	1.35	1.38
	9:00	1.13	0.42	1.12	0.75	0.95
	10:00	0.75	0.06	0.97	0.25	0.45
	11:00	0.25	-0.2	0.97	-0.05	0.1
	12:00	0.05	-0.43(LTL)	0.97	-0.25(LTL)	-0.22(LTL)
	13:00	-0.05(LTL)	-0.3	0.92(LTL)	-0.25	-0.16
	14:00	1.2	0.7	0.92	0.95	1.1
	15:00	1.3	1.22	1.17	1.35	1.3
	16:00	1.8	1.6	1.62	1.75	2
	17:00	2.08	1.87	1.97	2	2.2(HTL)
	18:00	2.14	1.72	2.02(HTL)	2.05(HTL)	1.92

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
10/10/2016	06:00	2.2	1.88(HTL)	2.02(HTL)	2.05(HTL)	2.07(HTL)
	07:00	2.25(HTL)	1.77	1.92	1.95	1.95
	08:00	1.9	1.5	1.77	1.75	1.8
	9:00	1.6	1.13	1.22	1.25	1.3
	10:00	1.2	0.7	1.12	0.75	1.05
	11:00	0.75	0.2	1.02	0.35	0.53
	12:00	0.4	-0.1	0.97	0.05	0.18
	13:00	0.1(LTL)	-0.3(LTL)	0.92(LTL)	-0.15	0
	14:00	0.2	-0.23	0.92	-0.45(LTL)	-0.1(LTL)
	15:00	0.4	0.29	1.02	0.15	0.5
	16:00	1.1	0.73	1.07	0.95	1.1
	17:00	1.65	1.35	1.45	1.35	1.3
	18:00	1.87	1.62	1.67	1.75	1.9

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
11/10/2016	06:00	1.6	1.6	1.96	1.75	1.92
	07:00	2.1	1.85	2.02	1.95	2.05
	08:00	2.2	1.9(HTL)	2.07(HTL)	2.05(HTL)	2.18(HTL)
	9:00	2.2(HTL)	1.77	2.02	1.75	2.1
	10:00	2	1.56	1.82	1.55	1.9
	11:00	1.65	1.24	1.51	0.95	1.2
	12:00	1.35	0.75	1.17	0.6	0.8
	13:00	0.6	0.27	1.07	0.45	0.5
	14:00	0.25	-0.07	1.02	0.15	0.2
	15:00	0.05	-0.3	0.92(LTL)	-0.15	0.05
	16:00	-0.15(LTL)	-0.33(LTL)	0.92	-0.25(LTL)	-0.35(LTL)
	17:00	0.2	0.3	1.02	0.25	0.45
	18:00	0.75	1	1.17	1.05	1.2

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
12/10/2016	06:00	1	0.7	1.22	0.75	0.85
	07:00	1.7	1.46	1.57	1.45	1.55
	08:00	2.1	1.82	1.99	1.95	2.05
	9:00	2.3	2.02(HTL)	2.24	2.25(HTL)	2.5
	10:00	2.3(HTL)	1.95	2.24(HTL)	2.15	2.35(HTL)
	11:00	2.15	1.76	2.02	1.95	2
	12:00	1.88	1.45	1.77	1.65	1.75
	13:00	1.45	0.89	1.52	1.15	1.25
	14:00	1	0.4	1.27	0.65	0.8
	15:00	0.4	-0.19	1.02	-0.05	-0.1
	16:00	0	-0.59	1.02	-0.55	-0.65
	17:00	-0.2	-0.72(LTL)	0.97(LTL)	-0.65	-0.7
	18:00	-0.25(LTL)	-0.52	0.97	-0.75(LTL)	-0.8(LTL)

Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
13/10/2016	06:00	-0.3	-0.75	1.02	-0.65	-0.75
	07:00	0.7	0.16	1.02	-0.15	-0.25
	08:00	1.5	1.14	1.02	1.15	1.25
	9:00	2	1.88	1.72	1.95	2.1
	10:00	2.4	2.16(HTL)	2.19	2.4(HTL)	2.55
	11:00	2.5(HTL)	2.12	2.27(HTL)	2.35	2.75(HTL)
	12:00	2.25	1.88	2.07	2.15	2.35
	13:00	1.9	1.5	1.77	1.75	1.7
	14:00	1.2	0.95	1.37	1.25	1.15
	15:00	0.9	0.36	1.12	0.65	0.35
	16:00	0.3	-0.41	1.02	-0.05	-0.25
	17:00	-0.3	-0.86	1.02	-0.65	-0.7
18:00	-0.6(LTL)	-1.15(LTL)	0.97(LTL)	-1.05(LTL)	-1.1(LTL)	

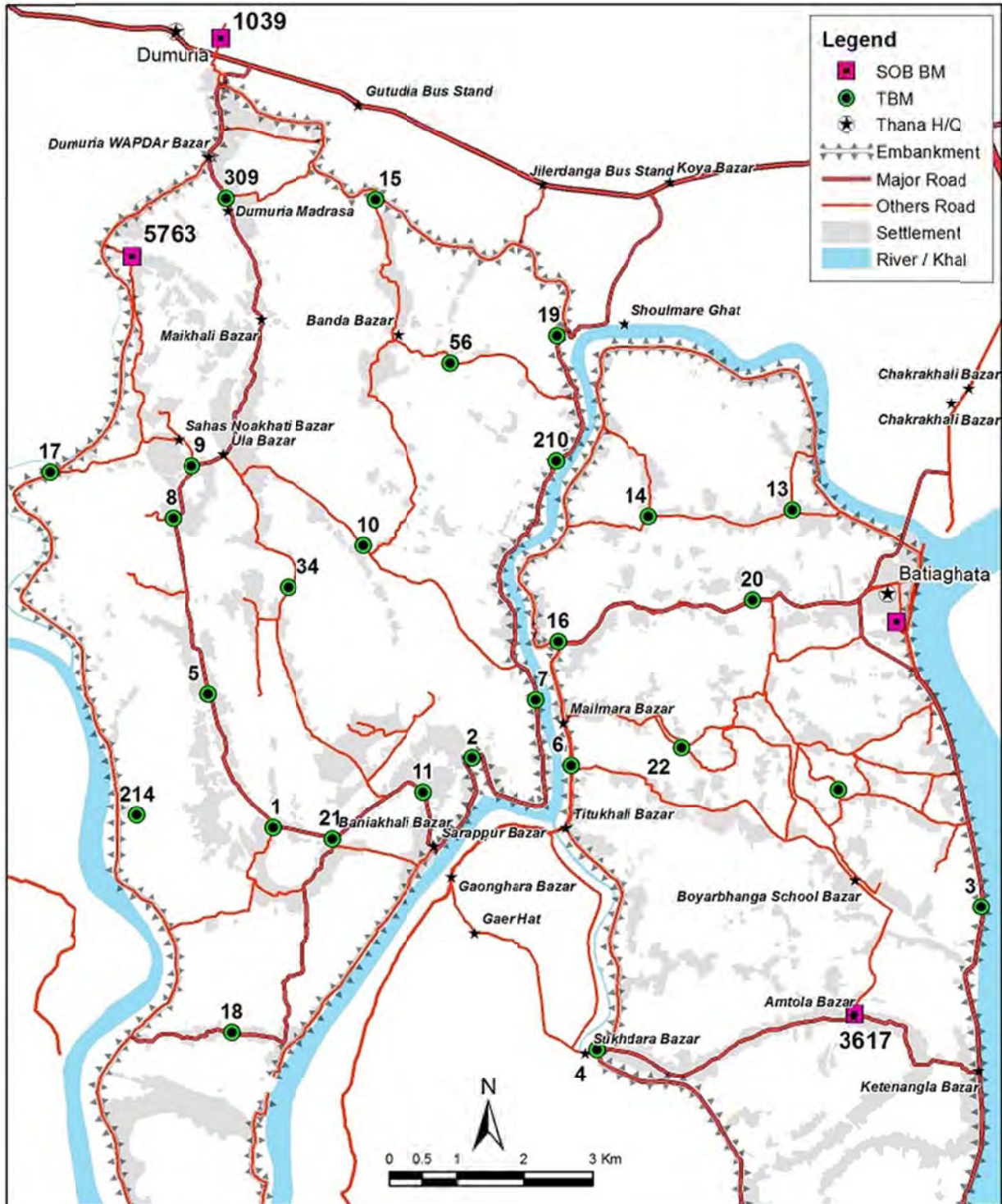
Date	Time	Kismat Fultala	Barunpara	Shurkhali	Kanaidanga	Parbotiaghata
14/10/2016	06:00	-0.5	-1	1.02	-0.95	-0.8(LTL)
	07:00	-0.7(LTL)	-1.05(LTL)	1.02	-1.05(LTL)	-0.8
	08:00	0.25	0.15	1.00(LTL)	-0.25	0.2
	9:00	2	1.54	1.17	1.55	1.8
	10:00	2.5	2.36(HTL)	1.92	2.35	2.64
	11:00	2.7(HTL)	2.32	2.45(HTL)	2.55(HTL)	2.7(HTL)
	12:00	2.55	2.15	2.32	2.45	2.5
	13:00	2.3	2.05	2.07	2.15	2.22
	14:00	2.1	1.54	1.67	1.75	1.86
	15:00	1.45	0.94	1.32	1.15	1.12
	16:00	1	0.26	1.12	0.55	0.57
	17:00	0.3	-0.47	1.02	-0.15	-0.09
18:00	-0.3	-1.04	1.02	-0.85	-0.33	

Date	Time	Baroauria	Chatchotia	Kakmari	Kanaidanga	Parbotiaghata
15/10/2016	06:00	-0.1	0.19	1.02	-0.65	-0.75
	07:00	-0.65	-1.05	1.00(LTL)	-1.05	-1.25
	08:00	-0.9(LTL)	-1.25(LTL)	1.00	-1.45(LTL)	-1.65(LTL)
	9:00	-0.1	0.4	1.02	0.25	0.45
	10:00	1.85	1.77	1.82	1.85	2
	11:00	2.75	2.03	2.32	2.65	2.85
	12:00	2.85(HTL)	2.42(HTL)	2.45(HTL)	2.75(HTL)	2.96(HTL)
	13:00	2.6	2.22	2.27	2.55	2.65
	14:00	2.3	1.99	2.02	2.15	2.25
	15:00	1.9	1.43	1.67	1.75	1.85
	16:00	1.15	0.62	1.22	0.95	1
	17:00	0.4	-0.56	1.12	-0.05	-0.1
18:00	-0.3	-1	1.02	-0.75	-0.85	

**Annex- I : Area Elevation Curve**  
**Polder 29 & Polder 30**

## **Annex- II : TBM List & MAP**

# TBM List & MAP



Map showing the BM & TBM location under Polder 29 & 30



**List of BM and TBM with description:**

<i>Id</i>	<i>BM/TBM</i>	<i>Location Description</i>	<i>Latitude</i>	<i>Longitude</i>
134	GPS-134	SOB BM, GPS-134, 2001, Batiaghata High School	22° 43' 56.762" N	89° 31' 0.219" E
1039	BM-1039	SOB BM-1039, 2001, Dumuria	22° 48' 35.256" N	89° 25' 10.304" E
3617	BM-3617	SOB BM-3617, 2006, Near Amtola Union Parishad and Amtola Primary School, Batiaghata	22° 40' 48.700" N	89° 30' 39.300" E
5763	GPS-5763	SOB BM GPS-5763, 2010 at Shahash Joykhali, Dumuria	22° 46' 50.600" N	89° 24' 24.700" E
1	TBM-1	Delvita Bazar Moor, On the Plinth of Biswajit Ray's Shop, Near Baniakhali	22° 42' 17.460" N	89° 25' 38.677" E
2	TBM-2	Telikhali SluiceGate	22° 42' 51.254" N	89° 27' 21.287" E
3	TBM-3	On Canal Slub, Salinity Management and Research Center, Batiaghata, Khulna	22° 41' 40.781" N	89° 31' 44.795" E
4	TBM-4	Floor level of a shop, Sukhdara	22° 40' 31.512" N	89° 28' 26.079" E
5	TBM-5	On the Abatment of a Bridge, North side of Bashundia danga Bazar	22° 43' 21.248" N	89° 25' 5.118" E
6	TBM-6	Aushkhali Sluice Gate	22° 42' 47.888" N	89° 28' 12.472" E
7	TBM-7	On the metaled road Infront of Brickfield, near Kanchannagar, Koya-Sarappur Road	22° 43' 19.000" N	89° 27' 54.400" E
8	TBM-8	On the Bottom of a Mile Post ( Dumuria=8 km, Baroaria=18 km), Near a Moszid, Noakati	22° 44' 45.481" N	89° 24' 46.451" E
9	TBM-9	TBM-9, on the Bottom of Name Plate of Monsur Ali Road, Near Shahash Noakati Playground	22° 45' 10.650" N	89° 24' 56.285" E
10	TBM-10	On a brick solling road near Rajanagar.	22° 44' 32.700" N	89° 26' 24.700" E
11	TBM-11	On the brick soling road, Battola, inside of Sarappur village	22° 42' 34.833" N	89° 26' 56.367" E
12	TBM-12	South-west Corner of a Bridge on earth road near Bazeafti Debitala	22° 42' 36.619" N	89° 30' 30.441" E
13	TBM-13	On a bridge at Hoglebunia	22° 44' 50.577" N	89° 30' 6.182" E
14	TBM-14	On a bridge at Boro Hatbaria village	22° 44' 47.310" N	89° 28' 52.121" E
15	TBM-15	On the Ghutudia-Bandha metaled road, near embankment	22° 47' 18.467" N	89° 26' 30.289" E
16	TBM-16	On Sluice Gate over Batiaghata Khal	22° 43' 47.223" N	89° 28' 5.812" E
17	TBM-17	On brick solling road near Qazirhula	22° 45' 7.441" N	89° 23' 43.062" E
18	TBM-18	In front of School, Bahir Akra	22° 40' 39.360" N	89° 25' 17.833" E
19	TBM-19	On Koya-Sarappur metaled road near Purba Kanaidanga	22° 46' 13.565" N	89° 28' 4.376" E
20	TBM-20	In front of School, Hetalbuniya Primary School	22° 44' 7.231" N	89° 29' 46.055" E
21	TBM-21	Plinth level of Baniakhali Maddhyamic School	22° 42' 12.036" N	89° 26' 9.310" E

22	TBM-22	Corner of a bridge on Deanir Khal, Mailmara-Balbunia Earth Road	22° 42' 56.500" N	89° 29' 9.600" E
34	TBM-34	On the Ulla Bazar-Sarappur Road metaled road, near Kukhia	22° 44' 12.580" N	89° 25' 46.000" E
56	TBM-56	North-West corner of small culvert near Ghona Taltala	22° 46' 0.260" N	89° 27' 9.247" E
210	TBM-210	On the metaled road Koya-Sarappur Road	22° 45' 13.797" N	89° 28' 4.225" E
214	TBM-214	At Aoannagar village	22° 42' 23.236" N	89° 24' 28.344" E
309	TBM-309	On the Baniakhali-Dumuria metaled road, near Dumuria Madrasa	22° 47' 19.014" N	89° 25' 13.200" E