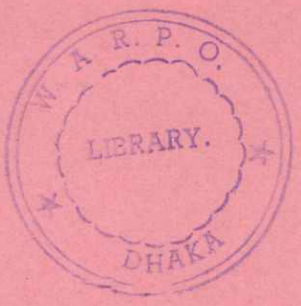
Government of the People's Republic of Bangladesh
Ministry of Water Resources
Bangladesh Water Development Board
Water Resources Planning Organization



# COMPARTMENTALIZATION PILOT PROJECT, TANGAIL



## A STUDY ON THE HYDROLOGICAL IMPACT ASSESSMENT OF THE JAMUNA BYPASS AND RAILROAD IN CPP AREA




November 1997

**LAHMEYER INTERNATIONAL GMBH**, Germany

in Association with

**Haskoning - Consulting Engineers & Architects**, The Netherlands
**Consultants for Development Programmes (CDP),** The Netherlands
**Development Design Consultants Ltd. (DDC),** People's Republic of Bangladesh

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# 1. INTRODUCTION

The CPP is presently testing the idea of compartmentalization which is based on an innovative concept of controlled flooding and controlled drainage. The concept will be tested in permitting floods to depths which are permissible for an increased agricultural production and not disruptive to settlements or infrastructures; furthermore it allows beneficial flooding and seeks to prevent flood water rising above these beneficial level.

A full compartmentalization process would have a series of compartments along a flood plain with a flow of water between compartments closely coordinated to create the optimum overall distribution of water between the different areas and facilitate the ready flow of flood water through the area with the least possible damage or disruption.

The concept of CPP is simple in vision and straightforward in engineering terms. The key to compartmentalization is not the construction of the compartments, it is their operation and coordination. This in turn requires an effective management capacity to open and close regulators in line with clear, predetermined management options. It also requires a knowledge of the input of these management options on different types of land owners and different places. The controlled flooding and controlled drainage will create winners and loosers. The most important test of the functional and beneficial water management system of the compartments is how they reconcile or arbitrate between these sets of different interests.

To minimize the differences between chawks and make the water management system more beneficial, CPP constructed planned structures in these chawks through which the proposed Jamuna bypass and railroads passes. The surveys of the alignment of the Jamuna bypass and railroad to the Jamuna bridge have been carried out by the JMBA during the period of 1995 and 1996. Both the alignment of the bypass and railroad passes through the CPP area as shown in Map 2 which would affect the future water management of the area. Because the alignment will cross a number of beels, khals and rivers affecting the hydrology of the area, particularly a change in overland flow will take place. As the water management infrastructure constructed by CPP for controlled drainage is in place within the affected area, it is of utmost important that the infrastructure is kept functional to the highest possible level and to take necessary measures so that testing of the structures is not hampered. Based on the request from WARPO, the CPP consultant made a report on "Study into impact of Tangail by-pass and railroad" published in July 1996 utilizing the detailed layout of the road (MoC, November 1995) and the tentative alignment of the rail (Sofrerail, Anarail). In that report, a first assessment of the impact of the interventions was carried out and a number of recommendations were presented. During a discussion with the Ministry of Communication officials held on October 7, 1997, it become known that the detailed layout of the road published in November 1995 remained as it was. At the same time, the detail layout of the railroad is available, which was published on August 1997. Based on the recent available bypass and railroad alignment, a study has been made to assess the possible water management impacts due to the proposed Jamuna bypass and railroad alignment through the CPP area.

## 2. OBJECTIVE OF THE STUDY

The objective of this study is to

- assess the impacts on water management due to the proposed bypass and railroad
- check the adequacy of the proposed structures on the bypass and railroad alignment provided by R & H and JBRLP respectively and
- mitigate the water management impacts by providing additional structures, if so required

## 3. ALIGNMENT OF THE JAMUNA BYPASS AND RAILROAD IN CPP AREA

The alignment of the Jamuna railroad enters the CPP boundary at Karatia road whose chainage is 55.420 km and ends at the embankment (from Rasulpur to Selina) whose chainage is 67.560 km. The alignment of the Jamuna bypass is divided into two parts namely Karatia bypass and the Tangail bypass. The Karatia bypass starts at chainage 0.000 km (ch. 52.682 km from Joydevpur) and ends at 2.915 km (ch. 56.118 km from Joydevpur). While the Tangail bypass starts near the western side of BADC Horticulture Centre at Nagar Jalfai whose chainage is 0.000 km (ch. 58.672 km from Joydevpur) and ends at Costapara in front of Rupali Flour Mill along the Tangail-Mymensingh road whose chainage is 5.820 km (ch. 65.286 km from Joydevpur) (see Map 1: CPP project area and Jamuna Bypass and Railroad alignment).

The CPP consists of a total of 16 sub-compartments (SC) among which sub-compartments 2, 3, 4, 5, 6 and to a very minor extent 7 and 15 are affected by the Jamuna bypass and railroad. Each of the sub-compartment is again divided into a number of chawks as shown in Map 3. The Jamuna bypass and railroad pass through a total of 20 chawks (Table 1).

Table 1 Chawk nos. through which Jamuna bypass and railroad passes

| SC # | Chawk nos. under railroad | Chawk nos. under bypass |
|---|---|---|
| 2 | 17B, 17A, 16C | × |
| 3 | 19E, 20A, 19D | × |
| 4 | 22C, 22A, 22B | 22C, 22B |
| 5 | 12B, 12A | 12B, 12A |
| 6 | 11J, 11H, 11G, 11D, 11B | 11J |
| 7 | × | 10L, 10K |
| 15 | × | 31E, 32A |

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# 4. PRESENT HYDROLOGICAL FEATURES: FINDINGS OF THE CHAWK DRAINAGE INVENTORY

An extensive field investigation has been carried out to assess the present hydrological features of the chawks through which the Jamuna bypass and railroad passes within CPP area. The field investigations were necessary to obtain a more detailed picture of the actual drainage patterns, which ultimately will help to understand the hydrology of the area in order to improve water management. The flow direction of each chawk during post monsoon is shown in Map 4. Based on field investigations, water management situation for each affected chawk is described below:

**Chawk 17B**

The railway alignment passes through the southwest corner of this chawk. Within the chawk boundary, there are five structures including one outlet at Paschim Pauli (code 30103) in the southern boundary which covers a command area of 210 ha comprising the chawks 17A, 17B and 18A (partly). In the northwest boundary (Dapnazar road), there are one bridge and two box culverts. In the southern boundary, there is one pipe culvert near the Paschim Pauli WCS. The Basail road in the southern part splits the chawk into two parts. In that road there are five box culverts. The Muchibari khal enters into the southwest corner of the chawk and goes parallely along the southern boundary. This khal is not functional at present due to a closer at the entrance and also construction of some cross roads over the khal by public for their movement.

Rainfall is the main source of water in this chawk. Also the chawk receives water partly from the chawks 17A and 18A as a rainfall runoff which accumulates and crosses the Basail road through the five box culverts and ultimately drains through the Paschim Pauli outlet.

**Chawk 17A**

The railway alignment passes through the middle of this chawk. There is no defined boundary at the northern side of the chawk. The eastern boundary is a metalled road over which there are one bridge and one box culvert. The western boundary is a earthen road over which there is one bridge and one box culvert. The southern boundary (part of the Basail road) is a metalled road in which there are two box culverts.

The chawk receives water from chawk 16C through a bridge at the northwest corner of the chawk and drains in the same way. But during high water level in the chawk, water also drains into chawk 17B through the box culvert and bridge in the eastern boundary and into chawk 18A through two box culverts in the Basail road.

**Chawk 16C**

The railway alignment passes over the chawk close to the southern boundary. Within the chawk boundary there are two bridges, two pipe culverts and there is one WCS located at Namder Kumulli Dakhinpara in the western boundary. The two vent pipe culvert in the western boundary is not functioning well due to partly closing of the opening of the pipes by earth to make it as a bank of a pond.

The chawk receives major water through Namder Kumulli WCS (code no. 30312) from chawk 19E and a minor quantity of water from chawks 16A and 18B (partly) through the

pipe culverts in the northern boundary and through a breach at the extreme southwest corner respectively and drains into chawk 19E and finally falls into the Lohajang river via Bhatkura khal through Bhatkura regulator.

**Chawk 19E**

The railway alignment passes over this chawk which divides the chawk into two parts. One part is approx. 1/3rd of the area falls in the south side of the chawk. Within the chawk boundary, there are seven structures among which three WCS in the eastern boundary namely Namder Kumulli Dakhinpara (code no. 30312), Namder Kumulli Madhypara (code no. 30306) and Birnali WCS (code no. 30304) and one WCS at the northwest corner of the chawk known as Hatila WCS (code no. 30309). There are two box culverts in the northern boundary namely Hatila box culvert and Gosaijoir box culvert. Also there is one pipe culvert in the southeast corner of the chawk which is not functioning due to the bank of a pond just at the u/s of the pipe culvert and partly filled up by earth. There are two beels within this chawk namely Hatila beel and Kachna beel.

The chawk receives water from the combined flow of Suruj and Golabari khal via chawk 19C through Hatila and Gosaijoir box culverts. Also rainfall runoff accumulated in this chawk from chawks 15A, 16A and 16C through the WCS's already described in the eastern boundary and from chawk 19D through Hatila WCS in the western boundary. All these water accumulated in the Hatila and Kachna beel and finally drains into the Lohajang river via Bhatkura khal through Bhatkura regulator.

**Chawk 20A**

The railway alignment enters into this chawk through the eastern boundary and crosses the northern boundary. Within the chawk boundary, there are two structures namely Poila WCS (code no. 30310) in the northwest corner and Hatila bridge close to the southeast corner of the chawk. But Hatila bridge is not functioning due to the settlement of the d/s side of the bridge. It is noted here that there is no defined chawk boundary between this chawk and chawk 19D.

The chawk receives major quantity of water from chawk 22C through Poila WCS and also a small quantity of water from chawk 19D by overland flow. All this water accumulates with rainfall runoff and finally drains into chawk 22C through the Poila WCS. Besides this, some water also enters into this chawk through Hatila WCS and drains in the sameway.

**Chawk 19D**

The railway alignment passes over the southwest corner of the chawk. Within the chawk boundary, there are three structures among which two WCS namely Dharat WCS (code no. 30314 ) in the northern boundary and Hatila WCS (code no. 30309) in the eastern boundary and one pipe culvert in the western boundary. Besides these, there are two more pipe culverts installed locally in the eastern boundary. There is no defined chawk boundary between this chawk and chawk 20A.

The chawk receives water from chawk 19B through Dharat WCS and from chawk 22C through Poila WCS. The chawk also receives water from chawk 19E through Hatila WCS. Most of the chawk water drains through the Poila WCS. The chawk also drains into chawk 19E through Hatila WCS when the Bhatkura regulator remains open.

### Chawk 22C

Both the bypass and the railroad passes over this chawk and divides the chawk into three parts. The railroad alignment passes through the northeast corner of the chawk. The alignment of the Tangail bypass starts at the southern boundary and passes approximately straight through the northern boundary. There are ten structures in the chawk boundary and there is one bridge in the chawk. In the southern boundary there are two bridges and there is one box culvert along the Dhaka-Tangail road and one arch culvert (not functional). In the eastern boundary, there are two pipe culverts and there is one WCS (Poila WCS). In the northwest boundary, there is one pipe culvert and there are two box culverts.

The chawk receives flood water directly from the Gharinda-Jalfai khal and also from the Darun beel (chawk 22B) through Darun box culvert. During post monsoon, this chawk also receives water from chawk 19D and 20A through Poila WCS and from chawk 22D through a pipe culvert. All this water accumulates with the rainfall runoff and drains into the Jalfai khal through one box culvert and two bridges along the Dhaka-Tangail road which ultimately falls into the Lohajang river through Jalfai regulator (chawk 22E). It is noted here that the Gharinda-Jalfai khal crosses the Nagar Jalfai box culvert at the extreme left in the southern boundary along the Dhaka-Tangail road (ch. 59.000 km from Joydevpur). As the sill level of this box culvert is too high than the bed level of the Gharinda-Jalfai khal, the water can not drain fully through this box culvert. Therefore drainage congestion occurs in the chawk 22C.

### Chawk 22A

The railway alignment passes through the southwest corner of the chawk. Two internal road divided the chawk into three parts. In the chawk boundary, there is a bridge over the Gharinda-Jalfai khal at the extreme northwest corner and one pipe culvert in the southern boundary at Sarutia. Also there are two pipe culverts on the internal roads. The western boundary of the chawk is Gharinda-Jalfai khal.

The chawk receives flood water from the Gharinda-Jalfai khal and also a small quantity of water from chawk 22C through Sarutia pipe culvert. This water accumulates with rainfall runoff. The lower two parts of the chawk drains into chawk 22C through Sarutia pipe culvert and the upper part of the chawk drains into the Gharinda-Jalfai khal.

### Chawk 22B

Both the bypass and railroad passes through this chawk. The western part of the chawk area is densely populated and is under the Tangail Pourashava. The Tangail-Suruj road is located in the northern boundary. In the northern boundary, there are three bridges and there is one WCS known as beel Gharinda WCS (code no. 20304). In the southeast boundary, there are three bridges and two box culverts. Two bridges in the southern boundary are not effective for water management, but the others are effectively used for water management such as Darun box culvert over Darun beel, Sarutia box culvert and Gharinda bridge over Gharinda-Jalfai khal. There is one bridge over the Tangail drain in the western boundary. There is one bridge and one pipe culvert inside the chawk.

The chawk receives water from chawk 12B through the bridges and WCS along the Tangail-Suruj road in the northern boundary, directly from the Gharinda-Jalfai khal and also from Tangail Town via Tangail drain through a box culvert. It is noted here that the construction of the Tangail drain (R.C.C drain) is at completion stage. After completion of

the Tangail drain, the storm and sewerage water of Tangail Town will fall into the Darun beel. This accumulated water drains into the chawk 22C via Darun box culvert and Sarutia box culvert.

**Chawk 12B**

Both the bypass and railroad crosses this chawk. There are two bridges and there is one WCS known as beel Gharinda WCS along the Tangail-Suruj road in the southeast boundary. There are two box culverts, one pipe culvert (not functioning) and one bridge (over Katakhali khal) in the northern boundary. There is one box culvert in the western boundary (not functioning).

The chawk receives flood water directly from Sadullahpur khal via Katakhali link canal through Kandila bridge (under construction). The chawk also receives water from the major part of chawk 12A through a box culvert located between the boundary of chawks 12A and 12B. This accumulated water drains into the chawk 22B through beel Gharinda WCS and a bridge towards the west side of beel Gharinda WCS. The box culvert between the boundary of chawks 12A and 12B would be completely obsoleted due to the alignment of railroad.

**Chawk 12A**

The railway alignment passes approximately through the middle of the chawk. But the bypass just crosses at the extreme southwest corner of the chawk. There is one box culvert and one pipe culvert (not functioning) in the southern boundary of the chawk. An internal earthen road from Kandila to Bamankushia divided this chawk into two parts from north to south.

The chawk receives water from chawk 12B through a box culvert over the Kandila-Gharinda road in the southern boundary. This water accumulates with local rainfall and drains into chawk 12B through the same box culvert. The box culvert in the southern boundary would be completely obsoleted due to the alignment of railroad.

**Chawk 11J**

Both the bypass and the railroad pass through this chawk. There are two pipe culverts and there is one bridge, namely Bartha pipe culvert, Barshila pipe culvert and Burai Lake bridge in the northern boundary. There are three bridges in the western boundary among which one is at the Tangail-Mymensingh road over Sadullahpur khal (Boilla khal) and the other two are over the Shibpur-Bethoir road. There is one bridge at the Beltiabari and three breachs in the southern boundary.

There are two water bodies within this chawk, namely the Barshila beel towards the west and the Burai lake towards the east. There is a strip of high land in between the two water bodies (over which Jamuna railroad passes) which divided the chawk into two parts. Due to the presence of this high land, the hydrological characteristics differs significantly from each other.

The western part of the chawk receives flood water from Sadullahpur khal through a bridge over Tangail-Mymensingh road and directly from chawk 10L via Shibpur khal and one link canal from Shibpur to Barshila beel through two bridges in the western boundary. Also a small quantity of water receives from chawk 11H through Barshila pipe culvert. This water

accumulates with the local rainfall and drains into the Sadullahpur khal (partly) in the southern boundary by overland flow.

The eastern part of the chawk receives water from chawk 11H via Burai Lake through Burai Lake bridge and through the Bartha pipe culvert. This water accumulates with rainfall and drains into the Sadullahpur khal like the western part through a breach.

**Chawk 11H**

The railway alignment passes through the southwest corner of the chawk. In the chawk boundary, there is one WCS known as Agbethur WCS (code no. 20305), there are three pipe culverts, among which two pipe culverts are located in the southern boundary and the other one is located in the internal road close to the eastern boundary and there is one bridge over Burai Lake in the southern boundary. In this chawk there are two water bodies known as Khaladbari beel and Burai Lake.

The only source of flood water received by the chawk is the Agbethur WCS. This water accumulates with rainfall and drains through the Burai Lake bridge and other two culverts in the southern boundary.

**Chawk 11G**

The railway alignment crosses at the northeast corner of the chawk. The chawk is densely populated. There is a bridge in the northern boundary and a pipe culvert in the northwest corner of the chawk. A link canal enters into this chawk which originates from Rasulpur khal d/s of Agbethur WCS.

The chawk receives water through the link canal and drains in the same way.

**Chawk 11D**

The railway alignment divides the chawk into approximately two equal parts. In the western boundary, there are three bridges over Tangail-Mymensingh road among which two bridges over the Rasulpur khal. There are four pipe culverts, two bridges and one WCS known as Agbethur WCS in the southern boundary of the chawk. The Selina regulator (code no. 20302) is located in the northern boundary. The eastern boundary is covered by the embankment along the bank of the Pungli river and the chawk boundary between 11H and 11D. There is a irrigation pass through the embankment in the eastern boundary. A beel known as Kum beel exists inside the chawk near the eastern boundary. The Agbethur khal originates within this chawk and goes along the eastern boundary and passes through the Agbethur WCS. Other two khals known as Pass Bikramhati and Tarabari khal originates from the Rasulpur khal and ends within this chawk.

The chawk receives water directly from the Rasulpur khal, Pass Bikramhati khal and Tarabari khal through bridges in the western boundary. Also it receives water from chawks 11B and 11A (partly) through Selina regulator. Again, it receives some water from chawk 11C through a bridge over the Tangail-Mymensingh road in the western boundary. This water accumulates with rainfall and drains through the Agbethur WCS via Kum beel.

**Chawk 11B**

The railway alignment passes the chawk approximately parallel to the western boundary (Tangail-Mymensingh road). There are two structures in the chawk boundary, one in the western boundary (Tangail-Mymensingh road) and the other is the Selina regulator (code no. 20302) in the southwest corner of the chawk.

The chawk receives water from chawk 11A through the bridge over the Tangail-Mymensingh road as a rainfall runoff together with the flood water through Pauli GPC (code no. 20316), from chawk 11D through Selina regulator and accumulates with local rainfall and also drains into chawk 11D through Selina regulator.

**Chawk 10L**

The Tangail bypass divided the chawk into approximately two equal parts. There are two bridges in the southeastern boundary over Shibpur khal and Shibpur-Barshila link canal. The Shibpur khal enters into the chawk through a breach in the northern boundary and bifurcates into two canals among which one goes to Barshil beel through a bridge in chawk 11J and the other joins to the Sadullahpur khal (Boilla khal) through a bridge in the southern boundary.

The chawk receives flood water directly from Shibpur khal through the breach in the northern boundary and drains into the Shibpur khal which finally falls into the Sadullahpur khal and Barshila beel through two bridges in the southeastern boundary.

**Chawk 10K**

The Tangail bypass crosses the chawk at the southwest corner. There are three bridges, two in the western boundary (one bridge is over the Rasulpur khal) and the other one in the northeastern boundary. The Shibpur khal originates within this chawk and goes into chawk 10L through the breach of approximately 30 m long in the southern boundary.

The chawk receives flood water from the Rasulpur khal through a bridge in the western boundary i.e.Tangail-Mymensingh road located at the extreme northwest corner of the chawk and a very small quantity of water from chawk 10E through a bridge also in the western boundary. All this water accumulates with rainfall and drains into Shibpur khal by overland flow.

**Chawk 32A**

The Karatia bypass crosses the extreme southeast boundary of the chawk. There is only one structure in the northern boundary known as Khagjana gated pipe culvert (GPC) (code no. 40407).

The chawk receives flood water directly from the Lohajang river through Khagjana GPC and drains in the same way.

## Chawk 31E

The Karatia bypass crosses at the northeast corner of the chawk. In the northern boundary, there is a breach of approximately 3 m long near the west. In the western boundary, there is one bridge, one pipe culvert and one breach of 10 m long. In the southern boundary, there are two box culverts and there is one breach of approximately 15 m long. Some internal roads splited the chawk into several parts. The bypass passes through north eastern corner of the eastern part. Again the area of the chawk at the right side of the bypass divided into two parts by an internal road. The Lohajang river is located outside the eastern boundary. There is a khal known as Birpushia khal originates from the Lohajang river and joins to the Birpushia beel inside the chawk and then further extends into the chawk.

The chawk receives flood water from the Lohajang river via Birpushia beel. The chawk also receive a significant quantity of rainfall runoff from chawk 31D. This water accumulates into the Birpushia beel and then drains into the Lohajang river.

# 5. POSSIBLE WATER MANAGEMENT IMPACTS OF JAMUNA BYPASS AND RAILROADS IN THE CPP AREA

## 5.1 General water management problems

The proposed bypass and railroad alignment splits the chawks into several parts causing change in overland flow which may result in drainage congestion of the chawks. The water bodies such as perennial and seasonal beels, ponds and ditches (which are important for fish cultivation) would also be split into smaller water bodies. Due to this splitting, the hydrology of the area would be changed considerably which will adversely affect on water management, for instance, raising the head difference between u/s and d/s of the chawks at the right side of the alignment, the command area of the water control structures would be reduced and some of the infrastructure would become obsolete. But CPP's water control structures were based on the present hydrological features including the specific command area. The change in the hydrology of the area will change the whole water management scenario. As a result, the water control structures could not be able to drain properly in time resulting in increased submergence at the eastern side of the alignment. Due to this submergence, sedimentation may take place resulting in increased bed level of the khals and beels which ultimately reduce the water carrying capacity.

There are Shallow Tubewells (STW) and Deep Tubewells (DTW) within the right of way of the railroad alignment which are used for irrigation. The farmers widely used ground water for irrigation while cultivating High Yielding Variety (HYV) rice during dry season. There is no surface water irrigation in the project area during dry season. As the irrigation schemes are within the right of way of the alignment, their command area would be partly or fully reduced. As a result some STW and DTW schemes would become obsolete.

Mitigation measures have been suggested Chapter 7.1 and 7.2.

## 5.2 Affected water management infrastructure and water bodies

The affected water management infrastructures due to the proposed bypass and railroad is given in Table 2.

Table 2: List of the affected water management infrastructure

| Sl. no. | Code no. | Name of the infrastructures and water bodies | SC # | Remarks |
|---|---|---|---|---|
| 1 | 20302 | Selina regulator | 6 | |
| 2 | 20305 | Agbethur WCS | 6 | |
| 3 | 20304 | Beel Gharinda WCS | 5 | |
| 4 | 30104 | Gharinda Regulator | 4 | planned structure |
| 5 | 30101 | Jalfai regulator | 4 | |
| 6 | 30309 | Hatila WCS | 3 | |
| 7 | 30310 | Poila WCS | 3 | |
| 8 | 30102 | Bhatkura regulator | 3 | |
| 9 | 30302 | Khudirampur WCS | 3 | |
| 10 | 30103 | Paschim Pauli outlet | 3 | |
| 11 | | Beel Gharinda Bridge | 5 | completely obsoleted due to bypass |
| 12 | | Box Culvert on Kandila-Gharinda road | 5 | completely obsoleted due to railroad |
| 13 | 20508 | Rasulpur khal (Tarabari khal) | 6 | cross by railroad |
| 14 | 20501 | Bamankushia khal (Sadullahpur khal) | 6 | cross by both the alignment |
| 15 | 30506 | Gharinda-Jalfai khal | 4 | cross by both the alignment |
| 16 | 30501 | Bhatkura khal | 3 | cross by railroad |
| 17 | | Shibpur khal | 6 | cross by bypass |
| 18 | | Kum beel | 6 | cross by railroad |
| 19 | | Beel Gharinda | 4 | both the alignment |
| 20 | | Darun beel | 4 | cross by bypass |
| 21 | | Kachna beel | 3 | cross by railroad |

# 6. PROPOSED INFRASTRUCTURE

## 6.1 Structures proposed by JBRLP on the railroad alignment

In Table 3, the structures proposed on the railroad alignment by Jamuna Bridge Rail Link Project (JBRLP) are given.

Table 3: Structures proposed on the railroad alignment by JBRLP

| Sl. No. | Structure no. | Chainage from Joydevpur, km | Type of Structure | Opening (cell*width), m | Structure falls under chawk |
|---|---|---|---|---|---|
| 1 | 80 | 55.420 | CB | 2×3 | 17B, CPP Tangail starts |
| 2 | 81 | 55.612 | CB | 2×3 | 17B |
| 3 | 82 | 56.080 | CB | 2×3 | 17A |
| 4 | 82-2 | 56.860 | CB | 2×3 | 16C |
| 5 | 83 | 58.000 | BR | 1×25 | 19E |
| 6 | 84 | 58.280 | CB | 2×3 | 19E |
| 7 | 84-2 | 58.670 | CB | 2×3 | 19E |
| 8 | 84-3 | 58.995 | BR | 1×15 | 19E |
| 9 | 85 | 59.340 | CB | 1×3 | 20A |
| 10 | 85-2 | 59.920 | BR | 1×15 | 20A |
| 11 | 86 | 60.190 | CB | 2×3 | 19D |
| 12 | 87 | 60.690 | CB | 1×3 | 22C |
| 13 | 88 | 61.760 | BR | 1×15 | 22A |
| 14 | 89 | 61.970 | CB | 2×3 | 22B |
| 15 | 89-2 | 62.160 | CB | 1×1 | 12B |
| 16 | 90 | 62.850 | CB | 1×1 | 12A |
| 17 | 91 | 63.310 | BR | 2×20 | 11J |
| 18 | 92 | 63.470 | CB | 1×3 | 11J |
| 19 | 93 | 64.090 | CB | 2×3 | 11H |
| 20 | 94 | 64.510 | CB | 2×3 | 11G |
| 21 | 95 | 64.720 | CB | 2×3 | 11D |
| 22 | 96 | 65.320 | BR | 4×20 | 11D |
| 23 | 97 | 66.750 | CB | 1×3 | 11B, CPP Tangail ends |
| 24 | 98 | 67.680 | BR | 6×25 | Pungli river |

CB: Concrete Box, BR: Bridge

## 6.2 Structures proposed by R & H on the Karatia and Tangail bypass

In Table 4, the structures proposed on the Karatia and Tangail bypass by R & H are given.

Table 4: Structures proposed on the Karatia and Tangail bypass by R & H

| Location | Chainage, km | Type of Structure | Opening | Name of the bypass | Structure falls under chawk |
|---|---|---|---|---|---|
| Madarjani khal | 0.360 | Bridge | 20 m long | Karatia | Southern adjacent area of CPP |
| Lohajang river | 1.300 | Bridge | 45 m long | Karatia | -do- |
| Lohajang river | 2.325 | Bridge | 60 m long | Karatia | Lohajang flood plain |
| Khudirampur khal | 2.833 | Box Culvert | 5.00 m × 5.00 m | Karatia | Lohajang flood plain |
| Gharinda-Jalfai khal | 0.416 | Box Culvert | 5.00 m × 5.00 m | Tangail | 22C |
| Darun beel | 2.335 | Box Culvert | 4.50 m × 4.00 m | Tangail | 22B |
| Sadullahpur khal | 4.008 | Bridge | 18 m long | Tangail | 11J |
| Shibpur khal | 5.085 | Bridge | 20 m long | Tangail | 11J |

# 7. ANALYSIS AND INTERPRETATION

The analysis and interpretation of the impacts of each chawk which are affected due to the proposed alignment would be discussed here based on the present hydrological characteristics and the land elevation. In the following, the impacts of the affected chawks along the alignment of bypass and railroad are discussed.

## 7.1 Detail analysis and interpretation of the chawks along the proposed railroad alignment

### Chawk 17B

Two structures (structure no. 80 and 81) are proposed by JBRLP on the railroad alignment of this chawk. The total horizontal opening of these two structures is 12 m. These structures are proposed considering the existing structures of the chawk so that the drainage which takes place through the existing water management infrastructure would not be disturbed. Analysis shows that the alignment of the proposed railroad with two structures will not hamper the water management system of the chawk.

### Chawk 17A

Only one structure is proposed (structure no. 82) by JBRLP on the railroad alignment which is close to the existing box culvert in the eastern boundary of this chawk. The horizontal opening of this structure is 6m. It is to be noted here that the proposed structure is located at the extreme eastern boundary but no other structure is proposed between the western boundary and the proposed structure. There is a low pocket towards the western boundary at ch. 56.600 km where there is a need of one more structure (2 cell $\times$ 3 m width) for proper drainage. Also this alignment passes over two irrigation canals at chainages 56.280 km and 56.510 km respectively where one 300 mm dia pipe culvert at each location should be provided.

### Chawk 16C

Only one structure (structure no. 82-2) is provided by JBRLP which is close to the eastern boundary of this chawk. The horizontal opening of this structure is 6m. The only structure proposed in this chawk which is located near the graveyard could only provide drainage facilities for bottom eastern part while the bottom western part of the chawk faces some water logging problem that could not be solved by providing any structure due to the presence of high land along the railroad alignment. The water logging in the bottom western part can be mitigated by removing earth from the existing 2 vent pipe culvert in the western boundary. Also the bank of the pond should be removed for proper drainage.

### Chawk 19E

Four structures (structure no. 83, 84, 84-2 and 84-3) are proposed by JBRLP on the railroad alignment of this chawk. The total horizontal opening of these structures is 52 m. The structure no. 83 is located just below the Kachna beel over the Bhatkura khal. In this large chawk, there are two beels namely Hatila and Kachna beel on which all the water stored and drains into the Lohajang river via Bhatkura khal through Bhatkura regulator. Considering the drainage requirment of this chawk, the openings provided on the alignment

are sufficient for proper drainage. The alignment passes over an irrigation canal at ch. 57.695 km where one 300 mm dia pipe culvert should be provided.

**Chawk 20A**

Two structures (structure no. 85 and 85-2) are proposed by JBRLP on the railroad alignment of this chawk. The total horizontal opening of these two structures is 18 m. Considering the drainage requirment of this chawk, the opening provided are sufficient for proper drainage. The railroad alignment passes over an irrigation canal at ch. 59.340 km which coincides with the structure no. 85. As per analysis no more structure is required.

**Chawk 19D**

Only one structure (structure no. 86) is proposed by JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 6m. The opening provided is sufficient for drainage based on the consideration of drainage requirment. The railroad alignment passes over four irrigation canals at chainages 60.060 km, 60.265 km, 60.357 km and 60.445 km respectively where one 300 mm dia pipe culvert at each location should be provided.

**Chawk 22C**

Only one structure (structure no. 87) is proposed by JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 3 m. Based on the drainage requirment of this chawk, the opening provided is sufficient for drainage. The railroad alignment passes over two irrigation canals at ch. 60.790 km and 60.955 km respectively where one 300 mm dia pipe culvert at each location should be provided.

**Chawk 22A**

Only one structure (structure no. 88) is proposed by JBRLP on the railroad alignment of this chawk. This structure is located over the Gharinda-Jalfai khal in the western boundary. The horizontal opening of this structure is 15 m. Two internal road divides the chawk into three parts and the bottom parts again splited into two parts by the proposed alignment. Due to splitting, the left part of the alignment goes under permanent drainage congestion. To eliminate this, it is required to provide an additional structure of small opening (1cell $\times$ 1m width) at chainage 61.250 km.

**Chawk 22B**

Two structures (structure no. 88 and 89) are proposed by JBRLP on the railroad alignment of this chawk. But structure no. 88 is located over the Gharinda-Jalfai khal which is the common structure for the chawks 22A and 22B. The total horizontal opening of these two structures is 21 m. Considering the drainage requirment of this chawk, the opening provided are sufficient for drainage.

**Chawk 12B**

Only one structure (structure no. 89-2) is proposed by JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 1 m. The Tangail Railway Station is located at ch. 62.700 km within this chawk. Based on the drainage requirment of this chawk, the opening provided is sufficient for drainage. The alignment passes over an irrigation canal at ch. 62.510 km where one 300 mm dia pipe culvert should be provided.

**Chawk 12A**

Only one structure (structure no. 90) is proposed by JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 1 m. The existing box culvert over which the alignment passes has an horizontal opening of 4 m. Considering the horizontal opening of the existing box culvert, the opening of the proposed structure should be 4 m for proper drainage. The alignment passes over an irrigation canal at ch. 63.065 km where one 300 mm dia pipe culvert should be provided.

**Chawk 11J**

Two structures (structure no. 91 and 92) are proposed by the JBRLP on the railroad alignment of this chawk among which structure no. 91 is over the Sadullahpur khal. The total horizontal opening of these structures is 43 m. The alignment passes over an irrigation canal at ch. 63.470 km which coincides the structure no. 92. As the alignment passes over a strip of high land and also there are sufficient ways to drain the chawk water at both sides of the alignment, the openings provided are sufficient for drainage.

**Chawk 11H**

Only one structure (structure no. 93) is proposed by JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 6 m. A large irrigation scheme is located near the proposed structure. In addition to this, there are three more irrigation canals on the right of way of the alignment where 300 mm dia pipe culvert at each location should be provided. Considering the drainage requirment of this chawk, the opening provided is sufficient for drainage.

**Chawk 11G**

Only one structure (structure no. 94) is proposed by the JBRLP on the railroad alignment of this chawk over the Burai Lake link canal. The horizontal opening of this structure is 6 m. Based on the drainage requirment of the chawk, the opening provided is sufficient for drainage.

**Chawk 11D**

Two structures (structure no. 95 and 96) are proposed by JBRLP on the railroad alignment of this chawk. The total horizontal opening of these two structures is 86 m. The alignment crosses the Rasulpur-Agbethur khal (locally known as Tarabari khal) at chainage 65.195 km which is under implementation. The land possession has already been received by CPP for implementation of the said khal. But it is found from the supplied map (Drawing no. AL 1047, August/97) that the acquired land from ch. 60.085 km to ch. 65.240 km is 25 m more at each side of the alignment than the normal land acquisition. The Tarabari khal falls in between the said chainage where no structure was proposed. The proposed structure no. 96 is located outside the chainage mentioned. Therefore, it is necessary to relocate the structure no. 96, over Tarabari khal (ch. 65.195 km).

**Chawk 11B**

Only one structure (structure no. 97) is proposed by the JBRLP on the railroad alignment of this chawk. The horizontal opening of this structure is 3 m. The land elevation of this chawk

is from north to south that facilitates overland flow quickly. Therefore, the opening provided is sufficient for drainage based on consideration of the drainage requirment.

## 7.2 Detail analysis and interpretation of the chawks along the proposed bypass

### 7.2.1 Karatia bypass

#### Chawk 31E

The northeastern part (right side of the bypass) is split into two parts by an internal road. These two parts are bounded by roads without any opening which would create water logging due to rainfall in that area. The upper part is high land where no opening is required. But in the lower part one small box culvert (2.0 m × 2.0 m) at ch. 1.60 km is required to remove water logging due to rainfall.

#### Chawk 32A

Due to the bypass, an approximately triangular close conduit would be created at the north east corner and there is no opening to remove the accumulated rain water from that area. But the alignment passes over the high land. As a result, the accumulated rain water would not be able to drain by overland flow into the Fusukia beel. If a structure is to be built in the bypass, it could not provide any benefit. Due to the proposed bypass, a borrow pit will be created. A link canal connecting the borrow pit with the Lohajang river can remove the drainage congestion due to rainfall. In this case, the bypass road would be treated as the compartment boundary, as the existing compartment boundary will be porous due to link canal.

### 7.2.2 Tangail bypass

#### Chawk 22C

Only one structure at chainage 0.416 km is proposed by R & H on the alignment of Tangail bypass. The size of the opening provided is 5.00 m × 5.00 m. But the bed width of the Gharinda-Jalfai khal at that location is 7 m. Therefore the horizontal opening of the box culvert should be 7 m. Again part of the Darun beel (lower edge) is located within the upper part of this chawk. The stored water in Darun beel drains into the Gharinda-Jalfai khal, but the bypass crosses in between the Darun beel and the Gharinda-Jalfai khal. Due to that a depression near the Darun beel would be isolated and would be no longer able to drain towards the Gharinda-Jalfai khal. It is to be noted here that the storm and the sewerage water from the Tangail drain from Tangail town would be disposed to the Darun beel which would create waste water hazards in the Darun beel as well as drainage congestion. To eliminate such drainage congestion, it is necessary to provide a box culvert (5.5 m × 5.5 m) near Darun beel at chainage 1.550 km.

#### Chawk 22B

Only one structure at chainage 2.335 km is proposed by R & H on the alignment of Tangail bypass over the upper edge of the Darun beel. The size of the opening provided is 4.50 m × 4.00 m. But water from the Darun beel will be drained into the Gharinda-Jalfai khal through the CPP constructed box culvert whose horizontal opening is 5.5 m. Therefore the horizontal opening of the box culvert should be 5.5 m instead of 4.5 m. Again an internal

earthen road has been built across the chawk towards Sarutia village at the northern bank of the Darun beel. As a result drainage congestion will take place at the northern part of the chawk. Gharinda beel is located at the right side of the bypass. A depression connects the western side of the northern part of the chawk with the Gharinda beel. Therefore, it is necessary to provide a box culvert (4.5 m *4.0 m) at chainage 2.700 km for proper drainage.

**Chawk 12B**

Due to the bypass, an existing bridge on the Tangail-Gharinda road would be completely obsolete. The western part of the bypass would be completely encircled by roads and no opening is provided for draining towards the Gharinda beel. Therefore, the western part of the bypass should be connected with the beel Gharinda WCS for proper drainage. Based on the drainage consideration, it is necessary to provide a box culvert (5.0 m * 5.0 m) at chainage 3.300 km.

**Chawk 11J**

Two structures are provided by R & H at chainages 4.008 km and 5.085 km over the Sadullahpur khal and Shibpur khal respectively in the southern and western boundary of the chawk. The land elevation of this chawk is from south to north (left to right part of the bypass). The area under the left part of the bypass would go permanent drainage congestion due to the high bank of the Sadullahpur khal and also due to the homestead as well as no opening provided over the bypass within the chawk. Therefore, to remove drainage congestion, it is required to provide two small box culvert (each 2.0 m $\times$ 2.0 m) at chainages 4.100 km and 4.830 km respectively.

**Chawk 10L**

The bypass goes over the high land of the chawk. Moreover there was a brick field with some ditches also. There is a small area of cultivable land at the left side of the bypass. According to the statement of local people, most of the area at the left side of the bypass is under acquisition of C & B. Though this area would suffer from drainage congestion, providing an opening over the bypass could not be helpful for water management. The borrow pit which will be created at the left side of the bypass during construction can be extended upto the Shibpur khal with the installation of a pipe culvert of 600 mm dia for draining.

**Chawk 10K**

There is a bridge over the Tangail-Mymensingh road at the left side of the bypass (just before the end of Tangail bypass). Earlier chawk 10E (partly) drains water into this chawk through that bridge which finally falls into Shibpur khal. Therefore it is required to provide a small box culvert at chainage 5.620 km (2.0 m $\times$ 2.0 m) to make a link between chawk 10E and Shibpur khal.

# 8. ISSUES FOR CONSIDERATION

The proposed bypass and railroad would split the flood plain and chawks into several parts which would affect the overland flow. The change in overland flow would have the largest impact on the existing water management systems. To minimize this impact, it is felt necessary to construct additional structures such as bridge/culverts along the proposed bypass and railroad alignment. Also as a matter of principle, the construction of bridge/culvert is always required in or near the beels. As the beels are important for fish cultivation and it is undesirable to split these beels into smaller water bodies. Due to the construction of the proposed bypass and railroad, borrowpits would be created. But the creation of a continuous borrowpit may affect the water management considerably. So special attention should be given in order to prevent continuous borrowpit. At least 15m wide cross bar will be kept in the borrowpit at the rate of 150 m apart. It was known from the JBRLP that during construction, only 25% of the required volume of earth to be taken along the alignment. Therefore, it is essential that the JBRLP would ensure it during construction. Besides this, the alignment passes over a large number of irrigation canals for which necessary pipe culverts (300 mm dia) should be installed. Sill level of the pipe culvert at the locations of irrigation canals should be same as the existing bed level of that particular irrigation canals.

Two structures (structure no. 95 and 96) are proposed by JBRLP on the railroad alignment of chawk 11D. The total horizontal opening provided of these two structures is 86 m. The alignment crosses the Rasulpur-Agbethur khal (locally known as Tarabari khal) at chainage 65.195 km which is under implementation. The land possession has already been received by CPP for implementation of the said khal. But it is found from the supplied map (Drawing no. AL 1047, August/97) that the acquired land from ch. 60.085 km to ch. 65.240 km is 25 m more at each side of the alignment than the normal land acquisition. The Tarabari khal falls in between the said chainage where no structure was proposed. The proposed structure no. 96 is located outside the chainage mentioned. Therefore, it is necessary to relocate the structure no. 96, over Rasulpur khal (Tarabari khal) at ch. 65.195 km.

Sill level (floor level) is an important factor for proper water management. Too high sill level creates water congestion which would affect the hydrology of the area and may change the water management possibilities considerably. Therefore, special attention should be paid regarding the sill levels during designing of box culverts and should be verified during execution.

The sill level for the proposed structures are given in Table 5 and Table 6 for bypass and railroad respectively.

Table 5: Sill level of the proposed structures on Karatia and Tangail bypass

| Sl No. | Location | Chainage km | Type of structure | Size (m×m) | Proposed sill level (m+PWD) | Name of the bypass | Structure proposed by | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1 | Madarjani khal | 0.360 | Bridge | 20 m long | - | Karatia | R & H | |
| 2 | Lohajang river | 1.300 | Bridge | 45 m long | - | Karatia | R & H | |
| 3 | Chawk 31E | 1.600 | Box Culvert | 2 m × 2 m | 9.25 | Karatia | CPP | |
| 4 | Lohajang river | 2.325 | Bridge | 60 m long | - | Karatia | R & H | |
| 5 | Khudirampur khal | 2.833 | Box Culvert | 5.0 m × 5.0 m | 8.00 | Karatia | R & H | |
| 6 | Gharinda-Jalfai khal | 0.416 | Box Culvert | 5.0 m × 5.0 m* | 6.48 | Tangail | R & H | size should be 7.0 m × 5.5 m |
| 7 | Chawk 22C | 1.550 | Box Culvert | 5.5 m x 5.5 m | 8.75 | Tangail | CPP | |
| 8 | Darun beel | 2.335 | Box Culvert | 4.5 m x 4.0 m* | 8.75 | Tangail | R & H | size should be 5.5 m × 5.5 m |
| 9 | Chawk 22B | 2.700 | Box Culvert | 4.5 m x 4.0 m | 8.75 | Tangail | CPP | |
| 10 | Chawk 12B | 3.300 | Box Culvert | 5.0 m x5.0 m | 8.75 | Tangail | CPP | |
| 11 | Sadullahpur khal | 4.008 | Bridge | 18 m long | - | Tangail | R & H | |
| 12 | Chawk 11J | 4.100 | Box Culvert | 2.0 m x 2.0 m | 9.50 | Tangail | CPP | |
| 13 | Chawk 11J | 4.830 | Box Culvert | 2.0 m x 2.0 m | 10.00 | Tangail | CPP | |
| 14 | Shibpur khal | 5.085 | Bridge | 20 m long | - | Tangail | R & H | |
| 15 | Chawk 10K | 5.620 | Box Culvert | 2.0 m x 2.0 m | 9.50 | Tangail | CPP | |

Table 6: Sill level of the proposed structures on railroad

| Sl. No. | Structure no. | Chainage from Joydevpur, km | Type of Structure | Size (*width), m | Proposed sill level (m+PWD) | Structure proposed by | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 80 | 55.420 | CB | 2×3 | 7.50 | JBRLP | |
| 2 | 81 | 55.612 | CB | 2×3 | 8.70 | JBRLP | |
| 3 | 82 | 56.080 | CB | 2×3 | 8.75 | JBRLP | |
| 4 | P1 | 56.600 | CB | 2×3 | 9.00 | CPP | |
| 5 | 82-2 | 56.860 | CB | 2×3 | 9.00 | JBRLP | |
| 6 | 83 | 58.000 | BR | 1×25 | 7.60 | JBRLP | |
| 7 | 84 | 58.280 | CB | 2×3 | 8.30 | JBRLP | |
| 8 | 84-2 | 58.670 | CB | 2×3 | 9.10 | JBRLP | |
| 9 | 84-3 | 58.995 | BR | 1×15 | 9.10 | JBRLP | |
| 10 | 85 | 59.340 | CB | 1×3 | 8.90 | JBRLP | |
| 11 | 85-2 | 59.920 | BR | 1×15 | 8.60 | JBRLP | |
| 12 | 86 | 60.190 | CB | 2×3 | 8.60 | JBRLP | |
| 13 | 87 | 60.690 | CB | 1×3 | 9.00 | JBRLP | |
| 14 | P2 | 61.250 | CB | 1×1 | 9.50 | CPP | |
| 15 | 88 | 61.760 | BR | 1×15 | 6.50 | JBRLP | |
| 16 | 89 | 61.970 | CB | 2×3 | 9.00 | JBRLP | |
| 17 | 89-2 | 62.160 | CB | 1×1 | 8.50 | JBRLP | |
| 18 | 90 | 62.850 | CB | 1×1* | 9.65 | JBRLP | size should be 1×4 |
| 19 | 91 | 63.310 | BR | 2×20 | 7.55 | JBRLP | |
| 20 | 92 | 63.470 | CB | 1×3 | 10.00 | JBRLP | |
| 21 | 93 | 64.090 | CB | 2×3 | 9.75 | JBRLP | |
| 22 | 94 | 64.510 | CB | 2×3 | 8.50 | JBRLP | |
| 23 | 95 | 64.720 | CB | 2×3 | 9.50 | JBRLP | |
| 24 | P3 | 65.192 | BR | 4×20* | 8.65 | CPP | see details at page 14 under chawk 11D |
| 25 | 96 | 65.320 | BR | 4×20 | 9.25 | JBRLP | |
| 26 | 97 | 66.750 | CB | 1×3 | 9.75 | JBRLP | |
| 27 | 98 | 67.680 | BR | 6×25 | - | JBRLP | |

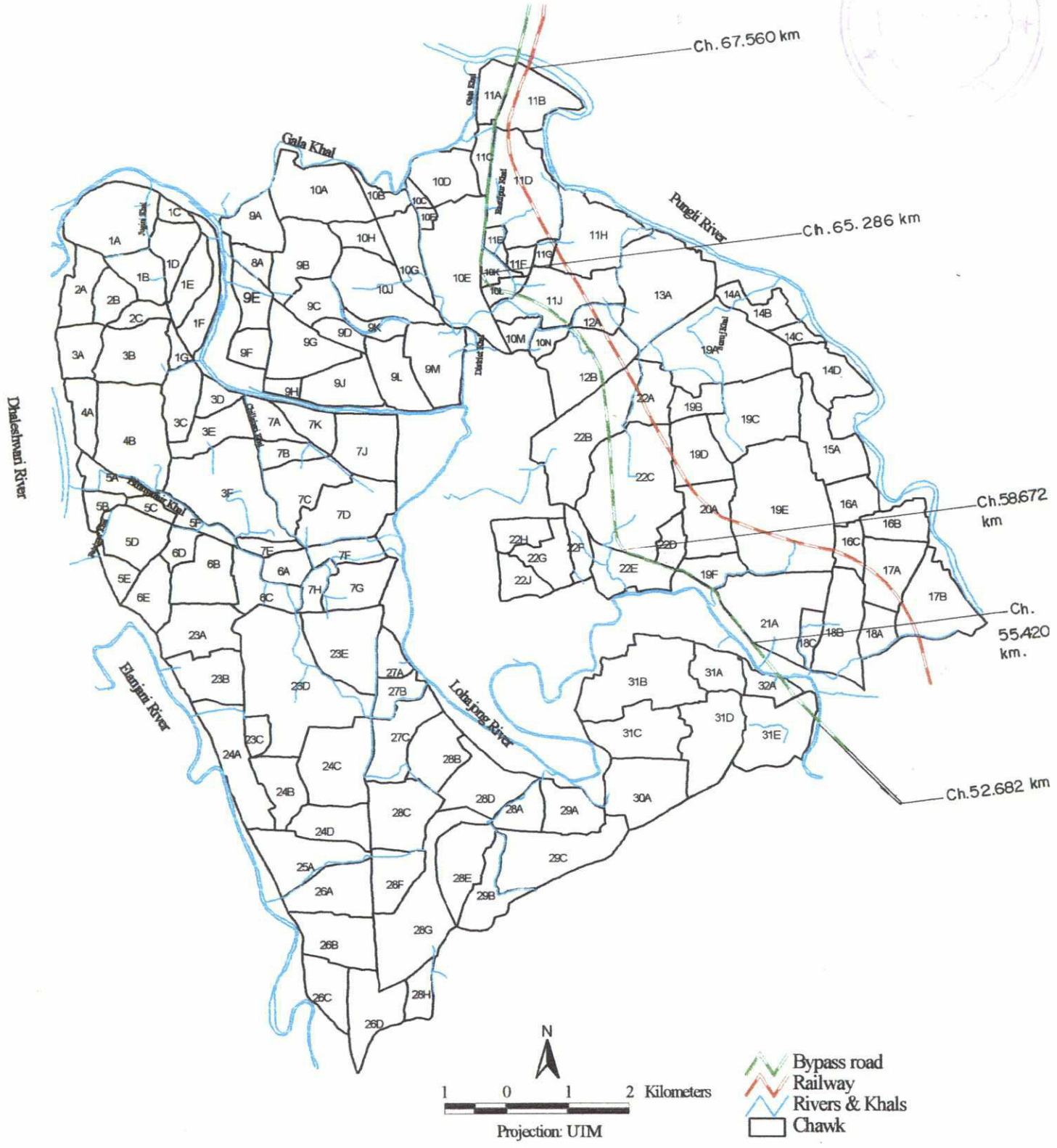
Map 1: CPP project area and Jamuna Bypass & Railroad alignment

Map 2: Alignment of the Jamuna Bypass and Railroad through CPP area (with proposed structural interventions)

Map 3: The chawks through which Jamuna Bypass and Railroad passes

Map 4: Flow direction of each chawk during post monsoon

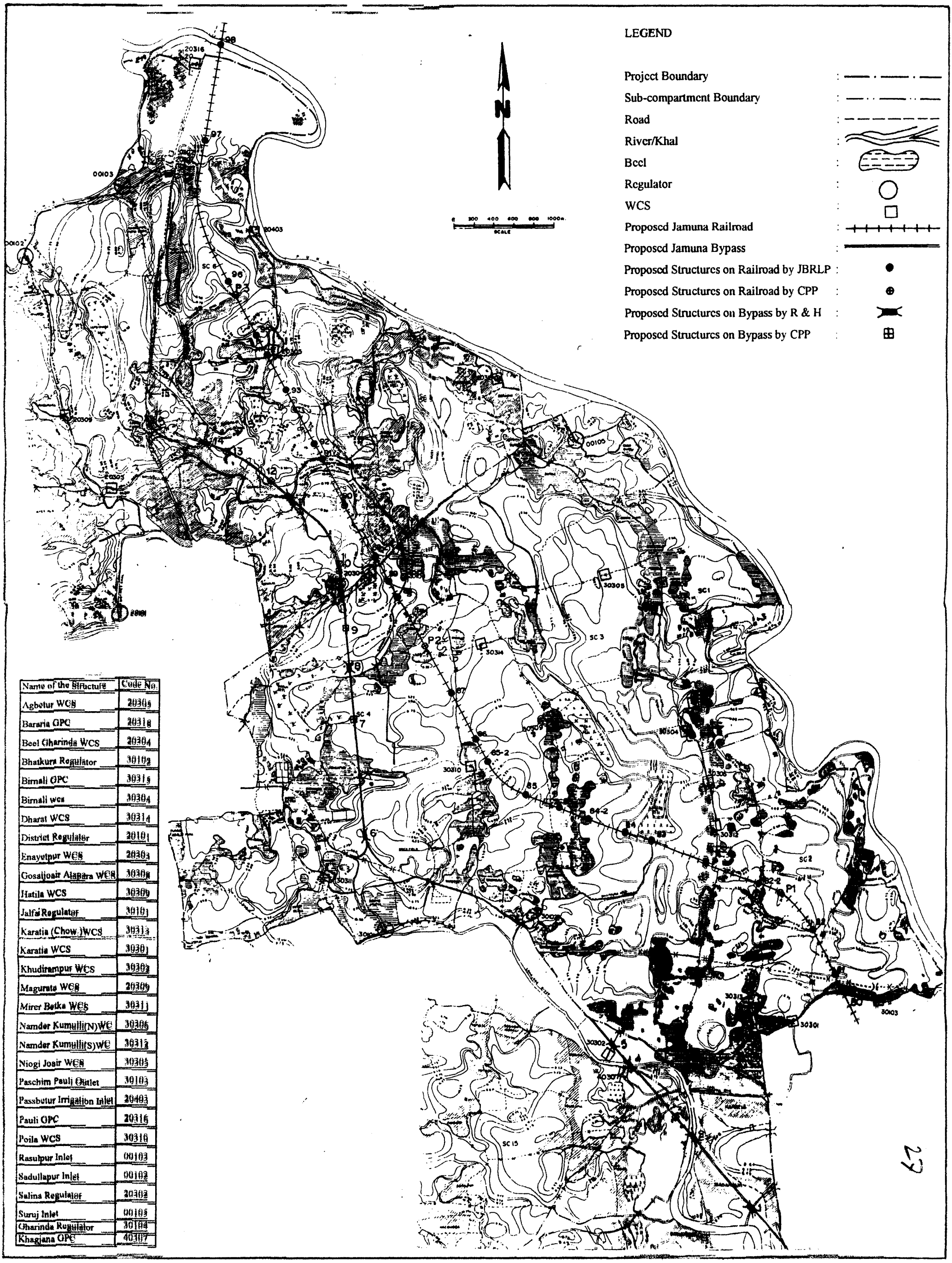
# Map 1: CPP project area and Jamuna Bypass & Railroad alignment





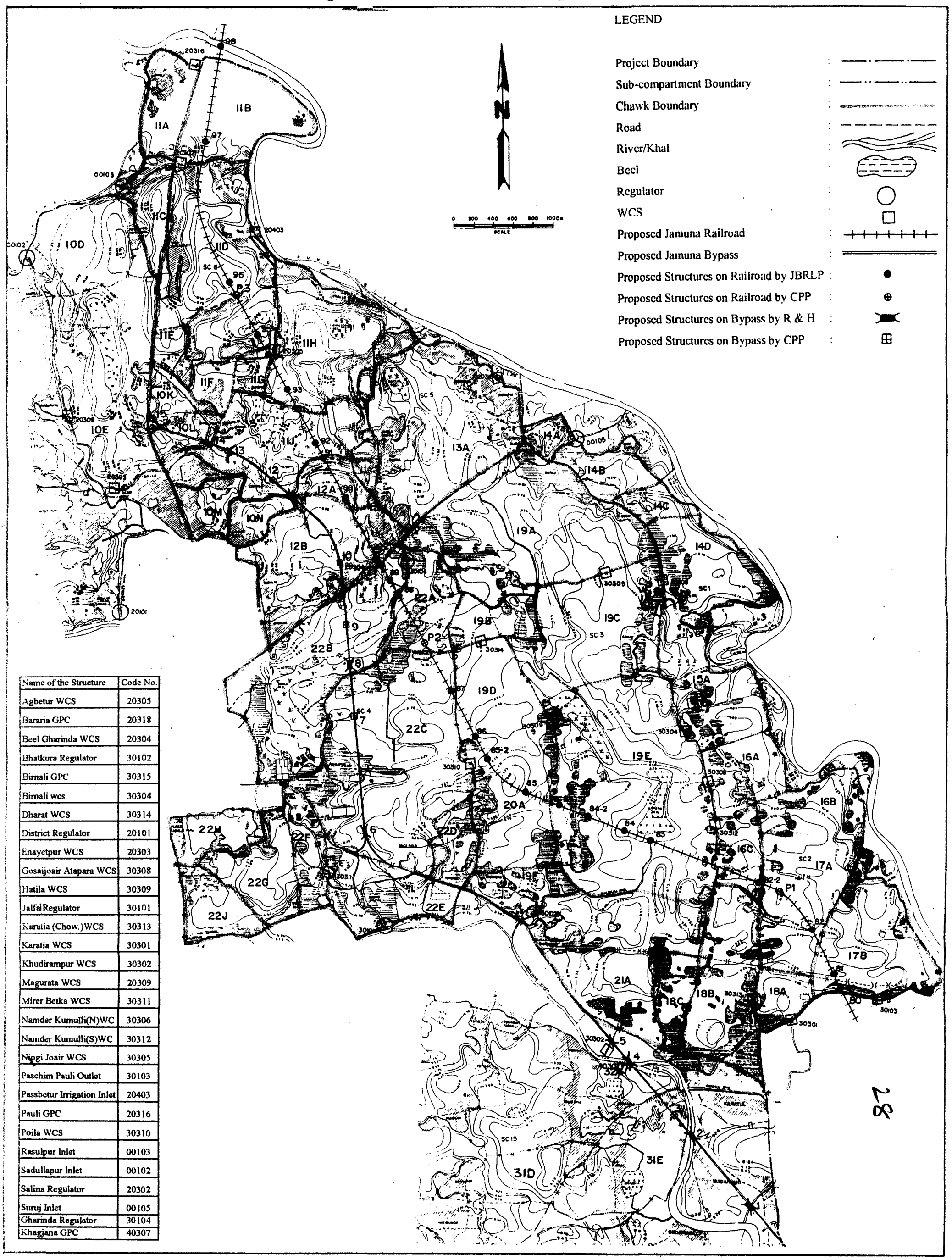

Compartmentalization Pilot Project Tangail

# Map 2 : Alignment of the Jamuna Bypass & Railroad through CPP area (with proposed structural interventions)



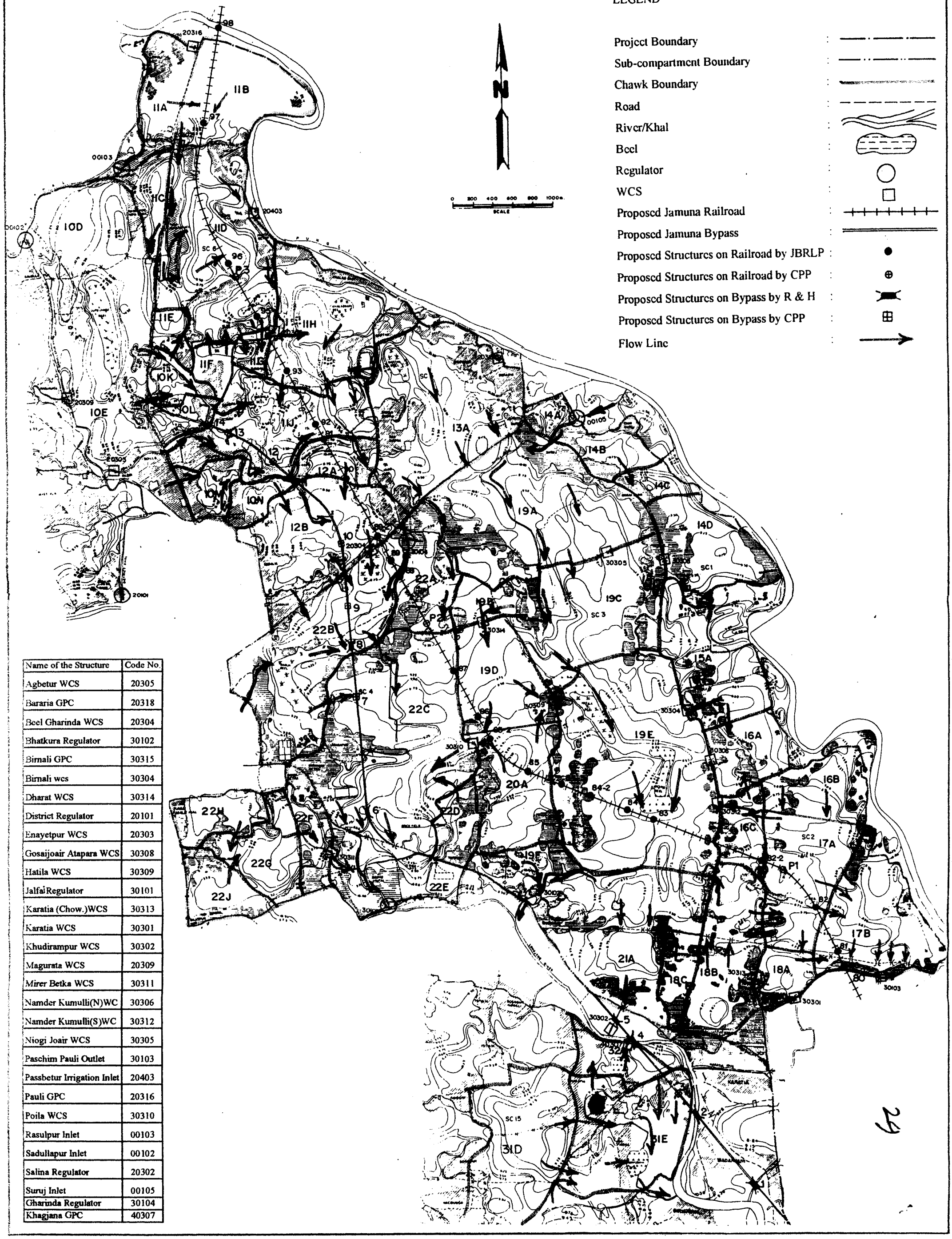

| Name of the Structure | Code No. |
|---|---|
| Agbetur WCS | 20305 |
| Bararia GPC | 20316 |
| Beel Gharinda WCS | 20304 |
| Bhatkura Regulator | 30102 |
| Birnali GPC | 30315 |
| Birnali wcs | 30304 |
| Dharat WCS | 30314 |
| District Regulator | 20101 |
| Enayetpur WCS | 20303 |
| Gosaijoair Alapara WCS | 30308 |
| Hatila WCS | 30309 |
| Jalfai Regulator | 30101 |
| Karatia (Chow.)WCS | 30313 |
| Karatia WCS | 30301 |
| Khudirampur WCS | 30302 |
| Magurata WCS | 20309 |
| Mirer Betka WCS | 30311 |
| Namder Kumulli(N)WC | 30306 |
| Namder Kumulli(S)WC | 30312 |
| Niogi Joair WCS | 30305 |
| Paschim Pauli Outlet | 30103 |
| Passbutur Irrigation Inlet | 20403 |
| Pauli GPC | 20316 |
| Poila WCS | 30310 |
| Rasulpur Inlet | 00103 |
| Sadullapur Inlet | 00102 |
| Salina Regulator | 20302 |
| Suruj Inlet | 00105 |
| Gharinda Regulator | 30104 |
| Khagjana GPC | 40307 |

# Map 3: The chawks through which Jamuna Bypass and Railroad passes




| Name of the Structure | Code No. |
|---|---|
| Agbetur WCS | 20305 |
| Bararia GPC | 20318 |
| Beel Gharinda WCS | 20304 |
| Bhatkura Regulator | 30102 |
| Birnali GPC | 30315 |
| Birnali wcs | 30304 |
| Dharat WCS | 30314 |
| District Regulator | 20101 |
| Enayetpur WCS | 20303 |
| Gosaijoair Atapara WCS | 30308 |
| Hatila WCS | 30309 |
| Jalfai Regulator | 30101 |
| Karatia (Chow.)WCS | 30313 |
| Karatia WCS | 30301 |
| Khudirampur WCS | 30302 |
| Magurata WCS | 20309 |
| Mirer Betka WCS | 30311 |
| Namder Kumulli(N)WC | 30306 |
| Namder Kumulli(S)WC | 30312 |
| Niogi Joair WCS | 30305 |
| Paschim Pauli Outlet | 30103 |
| Passbetur Irrigation Inlet | 20403 |
| Pauli GPC | 20316 |
| Poila WCS | 30310 |
| Rasulpur Inlet | 00103 |
| Sadullapur Inlet | 00102 |
| Salina Regulator | 20302 |
| Suruj Inlet | 00105 |
| Gharinda Regulator | 30104 |
| Khagjana GPC | 40307 |

# Map 4 : Flow direction of each chawk during post monsoon




| Name of the Structure | Code No. |
|---|---|
| Agbetur WCS | 20305 |
| Bararia GPC | 20318 |
| Beel Gharinda WCS | 20304 |
| Bhatkura Regulator | 30102 |
| Birnali GPC | 30315 |
| Birnali wcs | 30304 |
| Dharat WCS | 30314 |
| District Regulator | 20101 |
| Enayetpur WCS | 20303 |
| Gosaijoair Atapara WCS | 30308 |
| Hatila WCS | 30309 |
| Jalfai Regulator | 30101 |
| Karatia (Chow.)WCS | 30313 |
| Karatia WCS | 30301 |
| Khudirampur WCS | 30302 |
| Magurata WCS | 20309 |
| Mirer Betka WCS | 30311 |
| Namder Kumulli(N)WC | 30306 |
| Namder Kumulli(S)WC | 30312 |
| Niogi Joair WCS | 30305 |
| Paschim Pauli Outlet | 30103 |
| Passbetur Irrigation Inlet | 20403 |
| Pauli GPC | 20316 |
| Poila WCS | 30310 |
| Rasulpur Inlet | 00103 |
| Sadullapur Inlet | 00102 |
| Salina Regulator | 20302 |
| Suruj Inlet | 00105 |
| Gharinda Regulator | 30104 |
| Khagjana GPC | 40307 |