

## **CHAPTER – IV**

### **SURVEY AND INVESTIGATIONS**

#### **4.0 Introduction**

The Kosi-Mechi Intra-State link envisages diversion of river Kosi water for extending irrigation in unirrigated areas of Mahananda basin lying between river Parman and Mechi by extending the existing Eastern Kosi Main Canal beyond its tail end RD 41.30 km and upto river Mechi for providing irrigation in unirrigated areas of Mahananda basin lying in Araria, Kishanganj, Purnea and Katihar districts of Bihar.

#### **4.1 Proposal at prefeasibility (PFR) stage**

The prefeasibility study report of Kosi-Mechi Intrastate Link Project in 2009. It was proposed to utilize the existing EKMC after its remodelling and extending it beyond its tail end RD 41.30 km and upto river Mechi for providing irrigation in new command lying between rivers Parman and Mechi and diverting balance Kosi flood water into river Mechi for future utilization by Government of Bihar. The total length of the link canal including the length of the existing EKMC was 120.15 km. Reach wise descriptions of link canal as per the PFR are given in following paragraphs.

##### **(i) R.D. 0.000 km to 41.300 km (Existing EKMC)**

The link canal was proposed to off take from left bank head regulator of Hanuman Nagar barrage on river Kosi near Hanuman Nagar town. In this reach the canal was proposed to utilize the existing EKMC after its remodeling. The full supply level of canal at offtake point was proposed as 73.5 m. The design discharge at offtake point was considered as 537 cumec with full supply depth and bed width of canal of 6.0 m and 55.00 m respectively. 12 number of various types of road bridges and 4 number syphon aqueducts were proposed in this reach. Syphon aqueducts were proposed at RD 1.300 km, 3.400 km, 12.100 km and 18.800 km on river Katiya Dhar, Haiya Dhar, Thalaha Dhar and Sursar Nadi respectively.

**(ii) R.D. 41.300 km to 120.150 km**

In this reach, link canal was proposed to run mainly in eastern direction. The bed width and depth of canal were proposed as 41 m and 6.0 m respectively with a design discharge of 410.69 cumec in this reach. The bed slope was proposed as 1 in 15000. The link canal was proposed to terminate at RD 120.15 km at its confluence with the Mechi river. The full supply level of canal at RD 41.300 km and RD 120.150 m were 69.097 m and 59.540 m respectively. The full supply depth and bed slope in this reach were proposed as 6.0 m and 1:15000 respectively. Design discharge of canal in the reach was proposed as 331.70 cumec. The bed width of canal was worked out to be 41.00 m and 32.00m at start and tail end respectively.

The total cost of the link project was estimated Rs. 4441.82 crore. The B C ratio and IRR of the link canal project was assessed as 1.51 and 15.99% respectively.

**4.1.1 Views of Government of Bihar on PFR**

To expedite the preparation of DPRs of intrastate river linking projects of Bihar, a meeting was held on January 18, 2010 between officers of WRD, Government of Bihar and NWDA. In the meeting, the Government of Bihar requested NWDA to prepare DPR of Kosi–Mechi link project as this scheme was found viable at the PFR stage. It was also decided that NWDA can go ahead with the preparation of DPR directly to save time instead of first preparing the feasibility report and then DPR. Accordingly, NWDA directly took up the work of preparation of DPR of this link project.

**4.2 Studies at Detailed Project Report stage**

**4.2.1 Reconnaissance survey**

The following observations were made during the reconnaissance survey of the link alignment of Kosi-Mechi link.

(i) There is an existing canal power house at RD 3.66 km of existing EKMC utilizing a fall of 3.96 m and having an installed capacity of 19.2 MW. The maximum tail water level of this power house is 70.104 m. The salient levels of canal were not considered in PFR. This fall was not

accounted at PFR stage. Due to consideration of this fall, the canal alignment has been shifted at lower levels at tail end point.

(ii) Most of the existing CD structures on EKMC were got damaged during Kosi flood in 2008, and the Government of Bihar is reconstructing these structures.

(iii) The river Kosi is one of the largest silt carrying river of the world and silt control is a challenging task in irrigation structures. The Water Resources Department, Government of Bihar is constructing a settling tank in the initial reach at RD 1.06 km. of existing EKMC at RD 4.57 km.

Recently, some more developments as described below have taken place:

(i) The EKMC was originally constructed for carrying a design discharge of 425 cumec, but it observed that a part of its designed command is still undeveloped and as per the information received from WRD, Government of Bihar, the EKMC is presently carrying a regular discharge of 284 cumec only throughout the year.

(ii) The Bihar Hydro Electric Power Corporation has proposed a hydro electric power station on river Kosi at Dagmara located about 31 km downstream of Hanuman Nagar barrage and recently submitted its DPR to CEA and CWC.

(iii) CWC has reassessed the existing demands as well as proposed requirements of Hanuman Nagar barrage for development of its full irrigation potential.

In view of the above, the planning of Kosi–Mechi intra state link is reviewed at DPR stage with the following considerations:

(i) The existing drop of 3.96 m at canal power house (At RD 3.66 m) is considered at DPR stage.

(ii) The water availability is reassessed by considering the increased barrage demands. As per the outcomes of the studies carried out, the proposal of augmentation of river Mechi is dropped at DPR stage.

Due to above modifications and considering the 3.96 m generating head of canal power house, the tail end point is shifted southwards as

compared to the proposal in PFR and now it is about 1.5 km upstream of confluence of river Mechi with river Mahananda .

As mentioned earlier, certain changes have been made in canal parameters at DPR stage for optimum utilisation of existing structures. The comparison between PFR stage and DPR stage is given in Table 4.1.

**Table: 4.1**  
**Comparison between PFR stage and DPR stage**

S. No.	Particulars	As per PFR	At DPR stage
1	Design discharge at head	537 cumec	573cumec
2	Full supply depth of canal		
(i)	Existing canal (RD 0.00 km to Rd 41.30 km)	6 m	4.250 m to 3.5 m
(ii)	New canal (RD 41.30 km to RD 117.50 km)	6 m	3.5 m to 2.0 m
3	Bed width		
(i)	At head	55 m	131.5 m
(ii)	At tail	32 m	15.00 m
4	Length of canal	120.15 km	117.50 km
5 (i)	Bed slope: RD 0.00 km to RD 41.30 km	As per table 1.1	1:11000
(ii)	RD 41.30 km to RD 117.50 km	1:15000	1:12000
6	Canal power house	Not considered	Considered
7	Location of outfall at Mechi river	15 km u/s of its confluence of river Mechi and Mahananda	1.50 km u/s of its confluence of river Mechi and Mahananda
8	Culturable command area	2.43 lakh ha	2.15 lakh ha
9	Water utilisation (MCM) for		
I	Irrigation	2265 MCM	1718 MCM
II	D&I requirements	14 MCM	Nil
III	Transmission losses	73 MCM	25 MCM
IV	Augmentation to Mechi river	4148 MCM	Nil
V	Total diversion including existing utilisation of EKMC of 6082 MCM and 71 MCM transmission losses for remodelled EKMC	12582 MCM	7896 MCM (1718+25+6082+71)

### **4.3 Topographical survey**

Various field investigation works like viz. topographical, geological, construction material survey, geotechnical investigations and borrow area survey for Kosi–Mechi link canal have been carried out as per the Guidelines for preparation of Detailed Project Reports of Irrigation and Multipurpose Projects 2010 of MoWR, Government of India. Brief particulars of the various topographical surveys carried out for different components of the project are given below:

#### **4.3.1 Survey for transferring GTS bench mark**

The topographical survey of link alignment of Kosi-Mechi intrastate link project was started in 2<sup>nd</sup> week of November 2011. The topographical survey was carried out with reference to the Bench Mark established by WRD, Government of Bihar at Hanuman Nagar barrage having a value of 78.78 m. The Government of Bihar has constructed all its canal structures with reference to this Bench Mark.

In the mean time, details of GTS Bench Mark, established by Survey of India at Bahadurganj in Bihar with value 54.141 m were also found and utilized for cross checking.

The work of establishing adequate number of Temporary Bench Marks at different locations by precision levelling was carried out departmentally by connecting the above GTS Bench Marks established by SOI. The GTS Bench Mark were connected to the link alignment by precision levelling using double tertiary levelling method. The locations of bench marks established by NWDA in and around the project site are given in Annexure-4.1. The details of link alignment and enroute structures are given in following paragraph.

#### **4.3.2 Firming of link alignment**

The Kosi-Mechi link canal will utilize entire length of existing EKMC after its remodelling and thereafter a new canal will follow upto Mechi river. The brief details of both the parts of the canal are as given below:

**(i) Existing Eastern Kosi Main Canal after remodelling**

The existing alignment of EKMC from RD 0.00 km to RD 41.30 km is proposed to be utilised unchanged with remodelling.

**(ii) New canal from EKMC RD 41.30 km to outfall Point in Mechi (RD 117.500 km)**

Beyond the EKMC tail end RD 41.30 km, the link canal traverses towards south–east direction upto RD 53.156 km. near village Sunmani. From RD 53.156 it turns towards north-east direction and traverse upto RD 62.160 km. near village Khesroil. In this reach it crosses some important rivers i.e. Tehri (Lat. 26° 20' 47" and Long. 87° 22' 00"), Lohandra and Bhalua. From RD 62.160 km. canal again turns towards south-east direction and cross a major road (Araria to Kuari) at RD 63.110 km near Kursakata village (Lat. 26° 21' 30" and Long. 87° 26' 39"). From RD 63.729 km alignment follows the path in north-east direction upto RD 68.761 km.

In this reach canal crosses a major river, Bakra at RD 65.925 km (Lat. 26° 21' 32" and Long. 87° 28' 18") and a small river Ghaghi at RD 68.630 km. From RD 68.761 km to 82.843 km canal runs in south-east direction. In this reach alignment crosses Pahara and Nona river at RD 71.900 km and 77.850 km respectively and an important road (Jokihat to Tehragach) at RD 80.600 km (Lat. 26° 18' 54" and Long. 87° 36' 16") near village Charbana. From RD 82.843 km to 91.200 km alignment traverses almost in east direction and crosses a major river Ratua/Gerua at RD 89.300 km. near village Suiha.

After RD 91.200 km it turns towards south east direction upto RD 98.400 km. In this reach it crosses the largest river of sub-basin i.e. Kankai/Kawal at RD 95.900 km near village Laucha (Lat. 26° 16' 58" and Long. 87° 44' 52"). The Kankai river originates from Nepal and carries a large quantum of silt.

The Kosi-Mechi link after RD 98.400 km to RD 112.250 km traverse towards east direction and crosses some important roads viz. Bahadurganj to Samesar road at RD 103.957 and Araria to Siliguri road (SH-63) at RD 104.905 km (Lat. 26° 16' 29" and Long. 87° 50' 15") it also cross old Kankai

river at RD 103.050 km, Kankai/Sarrah river at RD 107.725 km (near village Bharadhar) and Kankai river at RD 111.735 km near village Dala. In final reach from RD 112.250 km to RD 113.887 km it is aligned towards south-east direction and thereafter it turns towards east, it finally outfalls into Mechi river at RD 117.500 km near Makhanpur village (Lat.  $26^{\circ} 14' 27''$  N and Long.  $87^{\circ} 57' 23''$  E) about 1.50 km upstream of confluence of Mechi river with Mahananda river. Thus the total length of link canal from its offtake (Kosi barrage) to outfall (Mechi river) is 117.500 km including 41.30 km of EKMC and 2.9 km escape channel. The alignment passes through Supaul, Araria and Kishanganj districts of Bihar state. During topographical surveys, it was observed that existing canal was heavily silted up and the bed levels obtained were not representing the true bed levels of existing canal. Therefore, while preparing the L-section, the actual bed levels from original records of WRD, Government of Bihar have been used for showing FSL/canal bed level of existing canal. The link alignment marked on 1:50,000 scale maps and shown in Plate 4.1.1 to Plate 4.1.7 and L-section are shown in Plate 4.2.1 to Plate 4.2.59 in drawing volume.

### **(iii) Alternative alignment**

An alternate alignment has been investigated from RD 98.400 km to Mahananda river which can be used as an escape channel. There is no any major road and river crossing in between this alignment. The alternate alignment will be terminated in Kankai river at RD 114.140 km with FSL 53.757 m.

### **4.3.3 Link canal survey**

The topographical survey of link canal has been carried out for existing EKMC as well as of new canal as detailed below:

#### **a) Existing Eastern Kosi Main Canal (EKMC)**

The link alignment in its initial reach follows the existing EKMC from RD 0.00 km to RD 41.30 km. The cross sections of existing canal were taken at an interval of 100 m. The length of cross sections was extended upto 100 metres from either sides of the canal banks and upto meeting of natural ground levels whichever is more.

**b) New canal alignment from RD 41.30 km to 117.50 km**

Strip survey of 500 m width across link alignment (250 m on either side of centre line of the canal) was carried out from RD 41.30 km to 117.50 km. The FSL of link canal was fixed accounting for head losses for canal structures and natural slope for maintaining gravity flow. The alignment was first marked on the field with the help of fly levelling and bearings computed from toposheets RCC pillars of size 15x15x60 cm at 200 m interval were fixed along the link alignment. RCC Bench Marks pillars of size 40x40x110 cm were erected at every two km distance along the canal alignment and also at each turning point. Double levelling survey was carried out and the elevations of the link canal alignment at every 50 m interval were ascertained. Cross sections of link canal were taken at every 50 m interval by single levelling.

During the entire reach, the canal comes across 112 number of structures ( 9 canal syphons, 14 syphon aqueducts, 42 road bridges, 28 head regulators, 9 cross regulators, 9 hume pipe culverts and 1 settling basin). Details are given in Annexure 4.2.

**4.3.4 Grid survey of canal structures**

The link canal on its way crosses a number of rivers and streams besides national, state highways, district/village roads and railway lines. Keeping in view the technical aspects, following structures have been proposed.

1. Canal syphon	-	09
2. Syphon aqueduct	-	14
3. Road bridge	-	42
4. Cross regulator	-	09
5. Hume pipe culvert	-	09
6. Head regulator	-	28
7. Settling basin	-	01
Total	:	112 Nos.

Total 112 number structures were identified and surveyed. Grid survey at 50 m or less intervals depending on the slope of land was carried out at each canal structure site to cover an area up to 300 m on either side of



the centre line of the canal. Besides above, the Government of Bihar is constructing a silt settling tank in initial reach at RD 1.07 km.

Drainage survey have also been carried out with levelling at grid interval of 50 m or less depending on the slope of land for u/s and d/s of centre line of canal for adequate length as required for hydraulic calculations of canal structures.

#### **4.3.5 River survey**

##### **(A) Mechi River (The tail end river)**

The canal alignment was marked-up first on toposheets after considering the head losses due to enroute CD structures and bed slope. At DPR stage head loss due to existing fall of 3.96 m is also considered for canal power house. As a result the required FSL of out fall point at river Mechi was found suitable about 1.5 km upstream from its confluence with Mahananda.

The cross section of Mechi river were taken @ 50 m interval and levels have been taken at 50 m interval along the cross section of river. The river bed level and HFL of Mechi at tail end point of link canal are 47.881 m and 52.500 m respectively.

##### **(B) Survey of enroute rivers**

The specific feature of the rivers of the project area is their shallow depth. Most of the streams are having stable banks but some rivers are of meandering nature. The status of the enroute rivers as observed during the topographical survey is as under.

##### **(i) Parman river**

The grid survey for providing CD structure has been carried out at 50 meter interval extended 300 m on both sides from centre line. As per the physiographical conditions the river is having stable banks for a height of 2 to 3 m. No silt deposition was observed in the course. The WRD, Government of Bihar is constructing a hydro power house about 300 m upstream from the centre line of proposed canal at RD 44.200 km. A canal syphon aqueduct is proposed on this river. Considering all the factors, no extra river survey was required.

The river bed level and HFL was observed as 55.958 m and 60.465 m respectively, while the FSL and bed level of canal is worked out to 62.180 m and 58.680 m respectively. Therefore considering the hydraulic situation, canal syphon have been proposed. The plan, cross-section, L-section and catchment area plan is shown in Plate 4.3.1.

**(ii) Tehri river**

The Tehri river is a small river having stable banks of about 3.0 m. No silt deposition in the bed was observed. The grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A syphon aqueduct is proposed on this river. In view of the above topography, no extra river survey was carried out.

The river bed level and HFL were observed as 54.442 m and 58.497 m respectively, while the FSL and bed level of canal have been worked out to 61.111 m and 57.611 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed. The plan, cross-section, L - section and catchment area plan is shown in Plate 4.3.2.

**(iii) Lohandra river**

The Lohandra river is also a small river having stable banks of about 2.5 m. The grid survey for providing CD structures has been carried out at 50 m interval extended 300 m on both sides from centre line. No silt deposition in the bed was observed. A syphon aqueduct is proposed on this river. Due to stable banks, no extra river survey was carried out.

The river bed level and HFL were observed as 54.617 m and 57.811 m respectively, while the FSL and bed level of canal have been worked out to 60.906 m and 57.406 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

**(iv) Bhalua river**

The Bhalua river is also a small river having stable course without any silt deposition. The grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line.

A siphon aqueduct is proposed on this river. Due to stable banks, no extra river survey was carried out.

The river bed level and HFL were observed as 54.668 m and 58.925 m respectively, while the FSL and bed level of canal have been worked out to 60.559 m and 57.059 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

**(v) Bakra river**

The Bakra River is a medium size river of the project area. It is also having stable course without any silt deposition. Hence, only grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A syphon aqueduct is proposed on this river.

The river bed level and HFL were observed as 55.113 m and 58.488 m respectively, while the FSL and bed level of canal have been worked out to 59.872 m and 56.872 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

**(vi) Ghagi river**

The Ghagi river is also a small river having stable course without any silt deposition. The grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A siphon aqueduct is proposed on this river. Due to stable banks, no extra river survey was carried out.

The river bed level and HFL were observed as 54.037 m and 57.789 m respectively, while the FSL and bed level of canal have been worked out to 59.592 m and 56.952 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

**(vii) Pahara river**

Similar to above, the Pahara river is also a small river having stable course without any silt deposition. The grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A syphon aqueduct is proposed on this river. Due to stable banks, no extra river survey was carried out.

The river bed level and HFL were observed as 53.834 m and 58.266 m respectively, while the FSL and bed level of canal have been worked out to 59.264 m and 56.264 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

**(viii) Nona river**

Similar to above, this small river is also having stable course without any silt deposition. Therefore only grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A syphon aqueduct is proposed on this river.

The river bed level and HFL were observed as 54.129 m and 57.028 m respectively, while the FSL and bed level of canal have been worked out to 58.688 m and 55.688 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed. The plan, cross-section, L-section and catchment area plan is shown in Plate 4.3.3.

**(ix) Ratua/Gerua river**

The Ratua river is relatively large river. It was intimated by the local public that the river course is stable for last many years. No silt deposition was observed hence only grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line. A syphon aqueduct is proposed on this river.

The river bed level and HFL was observed as 53.124 m AND 55.609 m respectively while the FSL and bed level of canal is worked out to 57.613 m and 55.313 m respectively. Therefore considering the hydraulic situation, canal syphon aqueduct has been proposed. The plan, cross-section, L-section and catchment area plan is shown in Plate 4.3.4.

**(x) Kawal/Kankai river**

This is the largest enroute river flowing jointly with Kankai. The river course is shallow and high silt deposition was observed. The present bed between the firm banks is 1140 m wide. A bridge is being constructed on this river which is located about 500 m d/s from canal alignment. Hence no extra survey except grid survey for CD structure has been carried out. Grid survey for providing CD structure has been carried out at 50 m interval

extended 300 m on both sides from centre line. A syphon is proposed on this river.

The river bed level and HFL was observed as 52.513 m and 54.283 m respectively, while the FSL and bed level of canal is worked out to 56.524 m and 54.224 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed. The plan, cross-section, L-section and catchment area plan is shown in Plate 4.3.5.

#### **(xi) Other streams of Kankai river**

There are several streams in the name of Kankai. Most of them are small and having stable course. Therefore only Grid survey for providing CD structure has been carried out at 50 m interval extended 300 m on both sides from centre line.

One stream of Kankai has been surveyed in view of its utilisation as an alternative for flood diversion in Mahananda in case if the first alignment is not found suitable. The river survey as per the norms has been carried out.

The Kankai river at RD 111.735 km, bed level and HFL was observed as 50.451 m and 54.350 m respectively, while the FSL and bed level of canal is worked out to 54.749 m and 52.749 m respectively. Therefore considering the hydraulic situation, canal syphon/syphon aqueduct has been proposed.

The plan, cross section, L-section and catchment area plan are shown in Plate 4.3.6.

#### **4.3.6 Sample command area survey of the link**

The proposed command area is identified from the culturable area computed from the latest land use statistics for the period 2005-06 to 2010-11 of Araria, Kishanganj, Katihar and Purnea districts of Bihar. The gross command area under the new canal is worked out as 2,75,000 ha while the culturable command area works out to 2,14,812 ha. A representative sample command area survey of 9500 ha has been carried out.

For carrying out sample command area survey, four numbers of representative patches were selected in whole of the new command. The

grid surveys with 50 m X 50 m basis were carried out. The contour plans of these four patches and command area development for 100 ha are given as Plate 4.4.1 to Plate 4.4.5.

#### **4.3.7 Plant and colony layout area survey**

The present canal colonies of WRD, Government of Bihar located at Bhimnagar, Birpur and Bathnaha can be utilised for the construction and maintenance. In addition for construction and maintenance of new canal two more colonies are proposed near Kaliaganj and at Bahadurganj covering an area of 100 ha each. These sites are found reasonably good for plant and colony area. It is proposed that the above colony site will be finally converted into operational staff colonies, after the project construction is completed. Contour Plan of Plant and colony layout as given in Plate 4.5.1 to Plate 4.5.2.

#### **4.4 Other allied survey**

##### **4.4.1 Communication survey**

The major part of the project area is well connected by road networks and railways as detailed below:

##### **Connectivity:**

###### **Highways**

1. Birpur–Forbesganj road.
2. Purnea-Murliganj-Madhepura-Saharsa-Mahisi road.
3. Purnea-Dhamdaha-Rupauli-Bijayghat road.
4. Purnea-Korha-Kursella road.
5. Katihar–Korha–Farrakha road.
6. Pratapganj–Narpatganj–Forbesganj road (N.H.57).
7. Supaul–Pipara–Tribeniganj–Jadia road.
8. Jogbani–Forbesganj–Araria.
9. Kursela–Mirganj–Sarsi–Raniganj–Forbesganj road.

###### **Railways (North Eastern Railway):-.**

1. Purnea–Murliganj–Madhepura–Saharsa station (M.G.)
2. Supaul–Saharsa–Mansi section (B.G. AND M. G.)
3. Supaul–Narpatganj–Forbesganj section (M.G.)

4. Banmankhi–Bihariganj section (M.G.)
5. Katihar–Barauni section (B.G.)
6. Katihar–Purnea–Jogbani section (North East Frontier Railway)

The nearest railway stations from offtake point are Bathnaha and Forbesganj located at about 38 km and 42 km respectively from Hanuman Nagar Barrage site. Bagdogara is the nearest airport located about 200 km from Hanuman Nagar barrage and about 125 km from tail end point of canal.

All the villages in the vicinity of Hanuman Nagar barrage site and existing canal are electrified.

The new canal is passing through interior rural areas and at present there is no any suitable road communication. However, the existing NH-57 is being developed into a 4 lane express highway connecting Kosi bridge to Kishanganj town and one state highway connecting Araria to Bagdogra would be very useful for the project purposes during construction. Recently, the Seema Surksha Bal has planned to construct a two lane road along the Indo – Nepal boarder, which is almost parallel to the link alignment from river Parman to Kursakata at RD 63 km. The construction work is in progress. This road will be very useful for execution of link canal project.

#### **4.4.2 Drainage survey**

The drainage status of the existing command of EKMC (Kosi catchment) and of new command (Mahananda catchment) is described in following.

##### **(i) Existing command of EKMC**

Extensive studies were carried out by Government of Bihar for EKMC command. The main reasons of water logging and drainage congestions have been identified as given below:

- i. In the lower Kosi basin, the river in the process of shifting from east to west has left large tracts of the undulating sandy tracts.

ii. During the earthquake of 1934, the configuration of the Kosi belt underwent considerable change, when some of the natural drainage channels got choked up in major portion of their length and in certain reaches got depressed altogether.

As per the studies, in view of the pre Kosi-Mechi link project conditions, it can be concluded that, in EKMC command, the water logging and drainage problems are due to obstruction arising in the way of drainage and heavy siltation in the river bed after construction of embankment and such locations are mainly concentrated in the command along Kosi river and some part along the EKMC due to heavy seepage from unlined canal.

**(ii) New command**

In the new command of link canal, the catchment area of all the western tributaries of Mahananda flowing in the link command are of leaf shape with a less drainage density. The banks of most of the rivers like river Parman, Tehri, Lohandra, Balua, Bakra, Ghaghi, Pahara, Nona, Ratua, Gerua, Sarrah etc have stable course, No report regarding flood damage is available due to these rivers. The ground water is in safe category and the ground water level varies between 2.5 m bgl to 6.8 m bgl. Hence no water logging is found in the command. The drainages are well shaped and free from any obstruction. However, during the command areas survey, it is observed that some parts lying along river Mahananda and river Ganga are affected with water logging and drainage congestion. The reason in most of the cases is the encroachment of river courses by the cultivators and thus there is an inadequate waterway for the drainages which is responsible for water logging. Such water logging can be minimized by improving the drainage water way. Adequate provisions are being made in cost estimate for reclamation of such water logged areas. After construction of Kosi-Mechi link canal project, a part of the water logging and drainage congestion along the existing canal is expected to be improved. It is proposed that the remodeled section of EKMC as well as new canal will be a lined section to minimize the seepage losses resulting prevention for water logging along the link canal. Adequate waterways for enroute drainages at



CD structures will be provided. Thus, there will be considerable improvement in drainage and water logging problems.

#### **4.4.3 Soil conservation**

The main purpose of this link is to extend irrigation in un-irrigated areas of Mahananda basin in districts of Araria, Kishanganj and Purnea. The river Kosi carry huge quantity of silt from Nepal portion of its catchment and same is getting deposited in the river course. As such, possibility of soil erosion is minimal.

#### **4.4.4 Archaeological survey**

As reported by Archaeological Survey of India, the Kosi-Mechi intra state link does not pertain to restricted /regulated area of the centrally protected monuments/sites. The report of Archaeological Survey of India is appended in Annexure 4.3.

#### **4.4.5 Minerals survey**

No minerals (useful or harmful) of any significance are found in the project area.

#### **4.4.6 Geology and seismic investigations**

The geological investigations and mapping along the link canal alignment and important CD/CM structures has been carried out by GSI, Kolkata. The proposed Kosi-Mechi link is the extension of Existing Kosi Mechi Canal (EKMC) of 41.3 km length offtaking from the left head regulator of Hanuman Nagar barrage. Therefore, the foundation investigation of head works and EKMC were not necessary in this reach. But beyond RD 41.30 km upto the tail end links into Mechi river, the geotechnical investigations along link canal and various Cross Drainage (CD/CM) structures have been carried out by GSI. However, exploratory drilling work along the link canal and various canal structures, if necessary, may be taken up at next stage of the project. The main objectives of engineering geological investigation of the project assigned to GSI are (i) to identify the spots where deep open excavation for the canal may lead to slope failure and suggest protection measures for cut slope and (ii) geotechnical investigation to evaluate foundation strata of CD/CM structures.

The project area lies in the seismic zone IV as per the seismic zoning map of India as incorporated in IS Code Criteria for Earthquake Resistant Design of Structures [IS: 1893-(Part I) 2002]. As the Kosi-Mechi intrastate link project does not involve the construction of a reservoir etc, no seismic studies are proposed.

#### **4.4.7 Geotechnical investigations/borrow area survey/construction material survey**

The main objectives of studies are as under:

- (i) To ascertain the state of foundation competence as well as suitability of soil as construction material, the field and laboratory soil investigations for borrow area survey for the project by way of collection of soils samples from trial pits to be excavated for construction of the proposed structures.
- (ii) To carry out the construction materials survey, collection of rock and sand samples and laboratory testing to ascertain the suitability for use as coarse aggregate and fine aggregate in concrete for structures of the link projects.

The consultancy work of geotechnical investigations/borrow area survey/construction material survey of the project has been carried out by CSMRS, New Delhi.

##### **4.4.7.1 Geotechnical investigation**

The geotechnical investigations for the foundations of the important CD/CM structures at various locations along the link canal have been got done through CSMRS, New Delhi and report received. The results of the study have been used while carrying out the design of various structures. The investigation report received from CE HQs is furnished as Appendix 4.1 in Appendix Volume.

##### **4.4.7.2 Borrow area survey**

To ascertain the suitability of soil as construction material, the field and laboratory investigations for borrow area survey for the project by way of collection of soils samples from trial pits have been carried out by CSMRS, New Delhi. A total no. of 9 disturbed and 4 undisturbed soil

samples along the link canal have been collected from trial pits of size 3mX3mX3m at various locations along the link canal.

#### 4.4.7.3 Construction material survey

The main objective of the studies is to carry out the construction material survey, collection of rock and sand samples and laboratory testing to ascertain their suitability for use as coarse aggregate and fine aggregate to be used in concrete for various structures of the link project.

Since in north Bihar, no quarries are available, the quarries identified for coarse and fine aggregates for Burhi Gandak-Noon-Baya-Ganga link are proposed to be utilized in this project also. The quality of materials available in various quarries have been tested by CSMRS and found suitable for utilizing as construction material.

The list of quarries identified by the CSMRS is given in Table 4.2.

**Table 4.2**  
**List of quarries in the vicinity of project**

Sl. No.	Coarse aggregate
1	Village Bazidpur, District Shekhpura, Bihar
2	Village Katani Kol, District Shekhpura, Bihar
3	Village Pachna, District Shekhpura, Bihar
4	Village Khadigram, District Jamuai, Bihar
5	Village Parsoti, Govindpur, District Nabada, Bihar
6	Village Khakanwa, District Nabada, Bihar
7	Village Manpur, District Gaya, Bihar
8	Village Daksthan, District Gaya, Bihar
9	Village Budhgare, District Mirzapur, Bihar
	Fine aggregate
1	Satnamaghat, Distt. Lakhi sarai
2	Sarmaghat, Distt. Lakhi sarai
3	Bindolghat, Distt. Patna, Bihar
4	Pharhantpuraghat, Distt. Ara, Bihar

The locations of the quarries for rock and sand are shown at Plate 4.6 appended in Drawing Volume. The interim report of construction material survey has been appended as Appendix-III in appendix volume.