EXECUTIVE SUMMARY

1.0 National Perspective for Water Resources Development

The Ministry of Water Resources (then Union Ministry of Irrigation) and Central Water Commission formulated a National Perspective Plan (NPP) for water resources development in 1980, comprising of following two components:

a) The Himalayan Rivers Development, and

b) The Peninsular Rivers Development

The distinctive feature of the National Perspective Plan is that the transfer of water from surplus basin to deficit basin would essentially be by gravity and only in small reaches; it would be by lifts not exceeding 120 metres. These two components are briefly outlined in the following paragraphs.

(a) Himalayan Rivers Development

Himalayan Rivers Development envisages construction of storage reservoirs on the principal tributaries of the Ganga and the Brahmaputra in India, Nepal and Bhutan, along with inter-linking canal systems to transfer surplus flows of the eastern tributaries of the Ganga to the west, apart from linking of the main Brahmaputra and its tributaries with the Ganga and Ganga with Mahanadi and augmentation of flow at Farakka.

(b) Peninsular Rivers Development

This component is divided into four major Parts:

(i) Interlinking of Mahanadi-Godavari-Krishna-Pennar-Cauvery rivers and building storages at potential sites in these basins

(ii) Interlinking of west flowing rivers, north of Mumbai and south of the Tapi

(iii) Interlinking of Ken-Chambal Rivers

(iv) Diversion of other west flowing rivers

National Water Development Agency (NWDA) has identified 14 links under Himalayan Component and 16 links under Peninsular

Component for preparation of Feasibility Reports/Detailed Project Reports. Third part of Peninsular link of NPP was firmed as two links viz, Ken-Betwa link and Parbati-Kalisindh-Chambal link.

2.0 Memorandum of Understanding (MOU) amongst Centre and concerned States for preparation of DPR and Inter-State Aspects

Ken-Betwa Link is one of the 16 links under Peninsular Component of National Perspective Plan for Water Resources Development for which feasibility report was prepared by NWDA in the year 1995 and circulated among all concerned. Since then efforts were being made by NWDA, CWC and Ministry of Water Resources to arrive at consensus between two beneficiary States of Uttar Pradesh (UP) and Madhya Pradesh (MP). Finally consensus was arrived at among Centre and concerned States and a tripartite Memorandum of Understanding was signed by Madhya Pradesh, Uttar Pradesh and the Union Government on 25th August 2005 for preparation of Detailed Project Report (DPR) of Ken-Betwa link.

Subsequently, the work of preparation of DPR was entrusted to NWDA by Ministry of Water Resources in January 2006. NWDA prepared the DPR with active cooperation of the concerned state Governments, Central Water Commission (CWC), Central Electricity Authority (CEA) and other Central Government Organizations like Central Soil and Material Research Station (CSMRS), National Institute of Hydrology (NIH), Geological Survey of India (GSI), National Remote Sensing Agency (NRSA), Indian Institute of Technology (IIT) etc. The comprehensive Environmental Impact Assessment (EIA) and Resettlement and Rehabilitation (R&R) studies have been carried out by AFC Ltd, as per the terms and conditions approved by Ministry of Environment and Forest. Ministry of Water Resources had constituted a Committee headed by Chairman, CWC to monitor and supervise the overall work of preparation of DPR of Ken-Betwa Link. Engineer-in-Chiefs of both the States of UP and MP were also represented in the said Committee to give their views from time to time. A Steering Committee headed by Secretary, Ministry of Water Resources also reviewed the progress of work from time to time.

The Detailed Project Report (DPR) of Ken-Betwa Link Project was completed by NWDA in December, 2008. During the Secretary level meeting held on February 3, 2009, it was decided that DPR of Ken-Betwa Link Project will be prepared in two phases. In Phase-I, Daudhan Dam and its appurtenant works, two tunnels, two power houses and link canal will be included. The Phase-II will comprise projects proposed by Government of M.P. in Betwa Basin.

The Detailed Project Report (DPR) of Ken-Betwa Link Project, Phase-I was completed by NWDA in April, 2010 after incorporating the inputs as received from Govt. of M.P. and U.P. and circulated to concerned State Governments.

Further, during the meeting held under the Chairmanship of Secretary (WR), Govt. of India with the representatives of Govts of M.P. and U.P. on August 4, 2010 at New Delhi, it was decided that survey and investigations (S&I) works of proposed projects in Betwa Basin including Lower Orr major dam and preparation of Detailed Project Report (DPR) of Ken-Betwa Link Project, Phase-II will be taken up by NWDA.

It was further mentioned in the said meeting that after ascertaining the feasibility of these projects within six months, NWDA will take up the detailed survey and investigations and preparation of DPR of Phase-II. The survey and investigations and preparation of Detailed Project Report of Phase-II was taken up by NWDA in January, 2011.

3.0 Aims and Objective of the Project and Description of works

The main objective of the Ken-Betwa link project, Phase-II is to make available water to water deficit areas of upper Betwa basin through substitution from the surplus waters of Ken basin. As per NWDA study, the Ken river basin upto the Greater Gangau dam site was found to be water surplus. As per Feasibility Report prepared in 1995, it was found that the proposal is techno- economically viable. The proposal comprised of a dam at Daudhan across the Ken river upstream of the existing Gangau Weir and a link canal for transferring the surplus waters from Ken river to Betwa river. It is proposed to transfer 1074 MCM of Ken water through link canal, out of which 591 MCM of water will be delivered to Betwa river and the

link project has made various Upper Betwa Projects feasible by way of substitution which were earlier not feasible due to shortage of water.

After firming up the feasibility of the projects in close association of the officials of Water Resources Department, Govt. of M.P., NWDA carried out the Surveys and Investigations works of the Lower Orr major dam and Babnai, Tharr medium dam and five barrages namely Neemkhera, Parariya (Madhopur), Narkheraghat, Kotha and Bijrotha (Rajkhera) under Ken-Betwa Link Project Phase-II. In addition, the Barari and Kesari barrages proposed in Upper Betwa basin and surveyed during preparation of DPR of Phase-I of Ken-Betwa Link Project were also included in Phase-II of the project.

Further the Central Water Commission (CWC) team headed by Chief Engineer, Design (NW&S) and officers of NWDA inspected the proposed dam/barrages sites under Ken-Betwa Link Project, Phase-II during the November 20-22, 2013 to review the design features and feasibility of the dam/barrages.

As per the recommendations of CWC team it was decided to prepare DPR of Ken-Betwa Link phase-II with one major project namely Lower Orr dam and four barrages i.e Neemkheda, Barari, Kesari and Kotha.

4.0 Methodology Adopted

DPR of phase-II has been prepared by NWDA utilizing the services of Government Departments like CWC, CWPRS, CSMRS, NIH, GSI and reputed educational institutions/other Govt. Organizations like NRSC Hyderabad and Agricultural Finance Corporation (AFC) Limited, Hyderabad. Topographical surveys of dam axis, canals, tunnels, barrage axis, command area surveys, etc. were done departmentally by NWDA. However, private parties were engaged where Government agencies were not available for completing the work in time bound manner like drilling work and submergence area survey.

The DPR of the Project is in 5 volumes. The main Report of the DPR is contained in Volume-I. The detailed reports of various expert agencies associated with the work are contained in Volume-II and

Volume-III as Annexure. The relevant drawings are furnished in Volume-IV and V of the Report.

4.1 Data Collection

The preparation of DPR of the Ken-Betwa link Project Phase – II required various data / information. Data / information required by Design Organisation of CWC was collected during field surveys. Rainfall and meteorological data were collected from IMD, Pune whereas hydrological observation data and ground water data were collected from CWC and CGWB respectively and supplied to NIH, Roorkee for Hydrological Studies and IMO, CWC for Irrigation Planning Studies. Data regarding cropping pattern, yield of crop per ha, cost of produce, cost of cultivation etc. were collected from State Agriculture Departments and made available to CWC. Report of Lower Orr Project was collected from Water Resources Department, MP. Test results/outputs given by CSMRS, GSI, CWPRS formed inputs for designers of the project. Thus there were many inter-dependent activities, apart from normal data collection. All these activities were successfully managed by NWDA Officers and various data required by the Consultants were supplied to them for the preparation of this Report.

4.2 Planning and Layout

A joint visit of the Upper Betwa region / river course, by senior officers of NWDA and Water Resources Department, Govt. of Madhya Pradesh was carried out for finalization of project sites in the Upper Betwa region. L – section survey of Betwa river was also carried out by NWDA, to finalize the location of storage/diversion structures on Betwa river. The details of the projects proposed under Ken – Betwa Link Phase –II are given below:

4.2.1 Lower Orr dam

The proposed dam site is proposed across Orr river which is a tributary of Betwa river near the village Didauni in the tehsil of Khaniadana on the border of Shivpuri and Ashok Nagar districts of Madhya Pradesh. The total catchment area of Orr river upto dam site is 1843 sq km and the yield at the site on 75% dependability works out to 362.53 MCM based on Basoda gauge and discharge (G&D) site data. The Full Reservoir Level

(FRL) of the dam is kept as 380.0 m and the submergence area is 2723 ha. The gross and live storage capacities at FRL work out to 371.802 MCM and 328.173 MCM respectively. The project will provide annual irrigation to 67570 ha with an intensity of irrigation of 150 %, a total 6 MCM water will be provided for drinking water supply to the enroute villages and towns in the vicinity of the canal. There is no power generation from the project.

4.2.2 Neemkheda Barrage

The Neemkheda barrage site is proposed across Betwa river near village Neemkheda in Goharganj tehsil of Raisen district of Madhya Pradesh. The total catchment area of Betwa river upto proposed barrage site is 1976 sqkm and the yield at the site on 75% dependability works out to 328.61 MCM. The pond level of the barrage is kept as 426.0 m and the submergence area is 484 ha. The gross storage capacity at pond level works out to 11.06 MCM. The project will provide annual irrigation to 3066 ha with an intensity of irrigation of 100 %.

4.2.3 Barari barrage

The proposed barrage site is located on Betwa river near the village Barrighat in the tehsil of Vidisha/Gyaraspur district Vidisha of Madhya Pradesh. The total catchment area of Betwa river upto proposed barrage site is 5474 sqkm and the yield at the site on 75% dependability works out to 1078.32 MCM based on Basoda G&D site data. The pond level of the barrage is kept as 407.72 m and the submergence area is 597 ha. The gross storage capacity at pond level works out to 14.00 MCM. The project will provide annual irrigation to 4444 ha with an intensity of irrigation of 100 %.

4.2.4 Kotha Barrage

The proposed barrage site is located on Betwa river near the village Kotha in the tehsil of Basoda of Vidisha district of Madhya Pradesh. The total catchment area of Newan river upto proposed barrage site is 8711 sq km and the yield at the site at 75% dependability works out to 1593.99 MCM. The pond level of the barrage is kept as 396.0 m and the submergence area is 2210 ha. The gross storage capacity at pond level

works out to 104.60 MCM. The project will provide annual irrigation to 21696 ha with an intensity of irrigation of 125 %.

4.2.5 Kesari Barrage

The proposed barrage site is located on River Keotan, a tributary of Betwa, near village Ditholi in the Basoda tehsil of district Vidisha of Madhya Pradesh. The total catchment area of Keotan river upto proposed barrage site is 506 sqkm. The pond level of the barrage is kept as 403.9 m and the submergence area is 362 ha and the yield at the site at 75% dependability works out to 120.66 MCM based on Basoda G&D site data. The gross storage capacity at pond level works out to 10.0 MCM. The project will provide annual irrigation to 2070 ha with an intensity of irrigation of 140 %.

4.3 Surveys and Investigations

After the joint visit by senior officers of NWDA and Water Resources Department, Govt. of Madhya Pradesh, NWDA adopted two pronged strategy for preparation of DPR of Ken-Betwa Link Project Phase–II. Major part of the detailed surveys and investigations of the project for which in house capability was available, has been done by NWDA itself whereas other specialized surveys and investigations along with technical studies like construction material survey, borrow area survey, geological survey etc. were outsourced, mostly to other Government Agencies like CSMRS, GSI etc.

5.0 Climate

The climate of the upper Betwa basin is characterized by hot summer and mild winter. The temperature in the upper reach sometimes goes beyond 40°C. The maximum and minimum values of mean monthly relative humidity are reported to be 83% (August) and 20.5% (April) respectively. The wind velocities in the upper reaches (varying between 6.6 km/h to 18.9 km/h) of the basin are generally higher than that of the lower reaches in the basin (varying between 2.9 km/h to 13 km/h). The cloud cover remains higher in upper part of the basin as compared to lower parts. The region receives more than 90% of its total rainfall during the south-west monsoon period (June to October). The upper part of the region receives

about 1100 mm of rainfall annually whereas in the lower part, the average annual rainfall is between 800 to 900 mm.

6.0 Topography and Physiography

Upper Betwa sub-basin consists of the Vindhyan ranges running east-west in the upper reaches with around 500m or above elevation and the Malwa plateau in the middle and lower reaches consisting of scrap lands, barren lands and cultivated lands. The lower Betwa sub-basin consists of Shivpuri plateau at an elevation of about 400 m and lower reaches of the region are mostly plain areas.

7.0 Population

The human population in Vidisha, Raisen, Shivpuri, Ashok Nagar and Sagar districts of Madhya Pradesh will be benefited due to the assured irrigation supply, domestic and industrial water supply. The total population as per 2011 census in the catchment of Upper Betwa sub- basin are 32.70 lakh. Lower Orr reservoir will affect 12 villages 5 partial and 7 full for which due care has been taken in Environmental management plan. As the proposed barrages are within the gorge portion of the river therefore no village is coming under the submergence of barrages. Also sizeable population depending on agriculture in the command areas will be benefitted due to increased agricultural activities.

8.0 Geology, Geotechnical and Seismic aspects

8.1 Geology

Geology of region comprises of the vindhyan sandstones which are of pre-cambrian age occupying an area of 3900 sq. km. It is exposed at two widely apart localities, one forming a linear ridge trending North – West to South – East in the north and the other forming ridges and hillocks around Vidisha, Raisen and Lalamnagar located south of Bhopal. The different geological formations occurring in the region include: Alluvium, Lateritic and Deccan traps. The lower part of the basin consists of quartzite, sandstone, conglomerate and limestone. The coarse-grained Bundelkhand gneiss overlying granite basement formations are found in the basin.

8.2 Geotechnical Investigations

In view of the presence of pink, coarse grained, inherently hard and compact, fresh, massive and foliated granite in the river bed and at left abutment hill and at shallow depth along the axis of the dam, the proposed dam site of Lower Orr Project is considered to be geotechnically suitable for centrally located spillway. The location and alignment of the entire structure are considered to be geotechnically favourable in view of the absence of significant tectonic features.

In view of the presence of fresh, inherently hard, massive / dense sandstone in the river bed, the location and alignment of the structure for the proposed barrage sites of Neemkheda, Kotha and Kesari are considered to be geo-technically favorable in view of the absence of significant tectonic disturbance.

At Barari barrage site, the bedrock is anticipated to be at deeper levels in view of the presence of thick soil/alluvium cover and permanent ponding of water, which may pose construction problems. GSI therefore, suggested the shifting of barrage axis in either direction having bed rock at or near the river bed level may be contemplated.

8.3 Seismicity

The project area is practically devoid of active lineament, fault or shear. As per the seismic zoning map of India (1990), the proposed layout of the Ken-Betwa link scheme including storage dams/barrages in Upper Betwa falls under seismic zone-II which signifies low seismic events not exceeding magnitude 3 and hence seismo-tectonic hazards could be considered as minimum.

According to the Site specific ground motion seismic study carried out by CWPRS, Pune, the proposed Lower Orr dam site lies in the Bundelkhand gneissic terrain of Archaean-Proterozoic age and is bounded by the tectonic features associated with very low level of Seismicity and lies in Zone II of the Seismic zoning map of India (IS : 1893, part-1, 2002). The site-specific horizontal and vertical design seismic coefficient are found to be 0.029 g and 0.023 g for the Lower Orr dam and 0.055 g and 0.051 g for the spillway of Lower Orr dam respectively.

The site-specific design parameters of Lower Orr dam is approved by National Committee on Seismic Design Parameter (NCSDP) in its 23rd meeting held on 20th November 2012.

9.0 Hydrology and Water Assessment

Hydrological studies of Lower Orr dam and four barrages Neemkhera, Barari, Kotha and Kesari considered at present under Ken-Betwa Link project Phase-II have been carried out by National Institute of Hydrology, Roorkee.

The net 75% dependable yield as assessed by NIH, Roorkee at the proposed dam / barrage sites are summarized as below:

SI. No.	**Name of the project**	**Yield at 75% dep. (MCM)**
1	Lower Orr dam	362.53
2	Neemkheda barrage	328.61
3	Barari barrage	1078.32
4	Kotha barrage	1593.99
5	Kesari barrage	120.66

10.0 Flood Control and Drainage

No flood cushion has been provided in the projects proposed in Ken-Betwa link Phase – II. However, storage of waters in Lower Orr and its regulated release downstream will provide benefit of flood moderation in downstream areas of Orr river. Since topography of area is having mild slopes, drainage problem is not expected.

11.0 Reservoir and Power

One reservoir namely Lower Orr dam and four barrages namely Neemkheda, Barari, Kotha and Kesari are proposed in the project.

The Gross storage capacity of all these structures proposed under Ken-Betwa Link Phase-II are summarized below:

SI. No.	Name of the project	FRL/Pond level in m.	Storage capacity in MCM
1	Lower Orr dam	380	371.8
2	Neemkheda barrage	426	11.06
3	Barari barrage	407.72	14.02
4	Kotha barrage	396	104.60
5	Kesari barrage	403.9	10.00

No powerhouse has been proposed in the Ken-Betwa, Phase–II project.

12.0 Irrigation and Command Area Development

The Upper Betwa Sub basin (upto Rajghat Dam) is having a geographical area of 1686100 ha, out of which culturable land is 1087569 ha. The simulation of all these projects has been carried out by NIH, Roorkee. As per availability of water a total 98847 ha area will be irrigated annually by utilizing 489 MCM water. Intensity of irrigation in case of Neemkheda and Barrari barrage is 100 % where as in respect of Lower Orr, Kotha and Kesari barrage, the proposed intensity of irrigation is more than 100 %. So far as the cropping pattern in the command of upper Betwa projects is concerned it has been adopted as per the suggestion of State Agriculture Department. Major crops of the command areas of the Project are Soyabeen, Wheat (Ordinary and HYV) and Gram. The project wise details of CCA under the Phase - II, irrigation intensity, annual irrigation and utilization are furnished below:

S. no	Name of Project command	CCA (ha)	Irrigation intensity (%)	Annual irrigation (ha)	Annual Utilisation (MCM)
1	Lower Orr dam	45046	150	67570	329.67
2	Neemkheda	3066	100	3066	16.61
3	Barari barrage	4444	100	4444	24.53
4	Kotha barrage	17357	125	21697	107.77
5	Kesari barrage	1479	140	2070	10.03
	Total	71392		98847	488.61

13.0 Navigation and Tourism

Keeping in view the availability of water in the canals no provision for development of navigation aspect has been kept in the project.

The projects has full potential so far as the development of tourism is concerned. All the reservoirs to be constructed in Phase – II can be developed as tourist spots including boating as well as for pisciculture. However, in the report, the development of pisciculture has been considered in the Lower Orr project only.

14.0 Design Features

The design features of proposed five structures (one dams and four barrages) are summarized below:

S. No.	Name of Structure	Height of structure above deepest level (m)	FRL/ Pond level (m)	Length of Dam/ barrage (m)	Length of canal (km)
1	Lower Orr dam	45.0	380.00	2218	91.26
2	Neemkheda barrage	10.65	426.00	182	-
3	Barari barrage	6.8	407.72	440	4.5
4	Kotha barrage	13.5	396.00	576.5	83.0
5	Kesari barrage	7.0	403.90	181	12.5

15.0 Construction Materials

The requirement of construction materials for the Project can be met from the nearby quarries. The quality of the materials available in these quarries has been tested by CSMRS, New Delhi and found suitable for usage as construction materials. Further, the requirement of construction materials like cement, steel, etc. can be brought to the respective nearest railheads i.e. Lalitpur, Mungaoli, Khurai, Ganj Basoda, Bhopal and Vidisha.

16.0 Accessibility and Infrastructure

The Locations of the structures proposed in the Project are approachable by rail from nearby railway stations namely Bhopal, Vidisha, Basoda and Lalitpur. The project area of all the five structures is also approachable by dry weather motorable roads. All these roads are maintained by Public Works Department, Govt. of Madhya Pradesh and can be used for project purpose after necessary widening for which necessary provision is kept in the cost estimate. Similarly the command area of these dam/barrages are also having good net work of roads which facilitate transport of heavy machinery and construction materials to the various locations.

Various infrastructure facilities like buildings for offices, residences, stores, workshops, laboratories, hospital, schools, etc. would be provided near the project site to ensure smooth implementation, operation and maintenance of the project.

17.0 Construction and Equipment Planning

A total period of 5 years has been considered for completion of the Project. The infrastructural development, pre-construction surveys and investigations, preparation of design/ specifications and tender documents are proposed to be taken up during the first year. In case the works are to be executed through award of contract, it is planned to award contracts for all major works by the end of 1st year. However, some of the works like river diversion, spillway channel and main canal may have to be undertaken from the 4th quarter of the 1st year itself and therefore award of work for these works may be planned accordingly. The work on infrastructure facilities like project colonies, approach roads, workshop, haul roads, stores, office

buildings etc. will also start during the 1st year itself. Some of these activities will continue for some time during the second year also. The construction of all civil structures is proposed to be completed by the end of 4th quarter of 5th year.

A total construction period of 48 months have been earmarked for completion of main canal including branch canals, distributaries and other canal structures like aqueducts, super passages, siphons, pipe culverts, road bridges and railway crossings. The total requirement of important construction equipments as assessed by Construction Management Organisation, CWC is furnished below:

Major construction plants and equipments required for construction of Lower Orr Dam

S. N0.	Equipments	Size/capacity	Quantity
1	Hydraulic excavator	2.0 cum	23
2	Crawler dozer	180 hp	12
3	Crawler dozer	90 hp	8
4	Front End Loader	2.5 cum	10
5	Front End Loader	1.5 cum	2
6	Crawler/wagon drill	600 cfm	11
7	Jack hammer	120 cfm	49
8	Rear dumper	18/20t	135
9	Tippers	4.5 cum	12
10	Hydraulic Rock breaker		-
11	Tower Crane, traveling type	10t@30m	4
12	Aggregate processing plant	350 tph	1
13	Aggregate processing plant	120 tph	4
14	Batching and mixing plant	150 cum/hour	1
15	Batching and mixing plant	45 cum/hour	4
16	Mobile Batching and mixing plant	18 cum/hour	6
17	Transit mixers	4.5 cum	68
18	Concrete pump with 25m boom	38 cum/hour	7
19	Concrete Vibrator (electrical/pneumatic)	10 t	65

20	Vibratory compactor pad foot, smooth drum	10 t	12
21	Compressed air	cfm	6000
22	Grout pump	20 kg/m^2	12
23	Trucks	8/10 ton	32
24	Water sprinklers	8000 L	32
25	Air requirement	Cfm	6000
26	Filter processing plant	500 tPh	2
27	Mobile crane	20t	4

Major construction plants and equipments required for construction of Barrages

S. N0.	**Equipments**	**Size/ capacity**	**Quantity**
1.	Hydraulic excavator	2.0 cum	13
2.	Crawler dozer	180 hp	8
3.	Crawler dozer	90 hp	5
4.	Front End Loader	1.5 cum	6
5.	Crawler/wagon drill	600 cfm	4
6.	Jack hammer	120 cfm	20
7.	Rear dumper	18/20t	65
8.	Tippers	4.5 cum	14
9.	Aggregate processing plant	100 tph	4
10.	Batching and mixing plant	45,18 cum/hour	4
11.	Transit mixers	4.5 cum	18
12.	Concrete pump with 25m boom	15cum/hour	5
13.	Concrete pump with 25m boom	25cum/hour	2
14.	Concrete Vibrator (electrical/pneumatic)		26
15.	Compressed air	cfm	4800
16.	Grout pump	20 kg/m^2	8
17.	Trucks	8/10 ton	8
18.	Vibratory compactor (pad foot)	10t	4
19.	Vibratory compactor (smooth drum)	10t	4
20.	Water sprinklers	8000 L	8

Suitable provisions for the above construction equipments have been kept in the estimate.

18.0 Environmental and Ecological Aspects of the Project

The objective of EIA study is to identify the possible beneficial and adverse environmental impacts due to Project and to suggest measures to minimize, to the extent possible, the anticipated adverse impacts. These studies for Lower Orr dam have been carried out by M/S WAPCOS Ltd., New Delhi and studies for other 4 barrages have been carried out by M/S AFC Ltd., Hyderabad on the following lines:

(A) Base line study and EIA study

The baseline environmental data like study area, climate, rainfall, water, land, biological environments, socio-economic and public health, geology, etc. were collected and the likely impacts due to the project during construction and operation phases have been studied on the following aspects like land, water and air environments in addition to aquatic and terrestrial ecology, socio-economic, air and noise pollution, impact on public health, risk on failure of dam structures, fire hazards in power plants, unprecedented floods, etc.

(B) Flora and Fauna

The impacts on flora and fauna like increased pressure on aquatic ecology due to indiscriminate fishing, reduced productivity due to increase in turbidity, migratory fish species, spawning and breeding grounds, degradation of riverine ecology and increased potential for reservoir fishes have also been studied. In addition, impact on rare, endangered and threatened species, access to food and shelter for animals, increased pressure on wood and timber due to labour force, migratory labour population, terrestrial flora, wildlife movement specially in tiger reserve, wildlife habitat, diversity and productivity of flora, economically/ genetically/biologically important plant species, compensatory afforestation, reservoir rim treatments, etc. were also studied.

(C) Land use pattern

The land use pattern in the catchment area, submergence area, command area of proposed projects under Ken-Betwa link project, Phase–II have been studied. The cropped area in the Upper Betwa basin is found as 64.5% of the local area. The soils in the command area are characterized with good surface drainage. The water holding capacity is low to medium except in some clay patches. No water logging problem is anticipated due to the provision of sufficient field channels and drains.

(D) Environmental Management Plan (EMP)

Aspects like catchment area treatment, land management Plan, command area management, bio-diversity management, fisheries development plan, surface and groundwater management, public health management, environmental monitoring programme, dam break analysis and disaster management Plan, implementation schedule have been considered and suitable provisions have been kept in the estimate.

As a result of implementation of this Project, a large new area of Upper Betwa basin (98847ha. of MP) will come under assured irrigation which will increase agricultural production and productivity in the area. No major adverse impact due to the Project is anticipated on environmental and ecological angle. No significant rich mineral deposits have been identified in the catchment and hence no acidification of the reservoirs is anticipated. Necessary minimum flows in the Betwa, Keotan and Newan rivers during lean season will flush the untreated sewage and hence no impact is forthcoming on river water quality. The flooding of previously forested and agricultural land in the submergence area will increase the nutrients resulting from decomposition of vegetative matter. Enrichment of impounded water with organic and inorganic nutrients will be main water quality problem which will last for a short duration of few years from the filling up of the reservoirs. No eutrophication problem is anticipated due to controlled use of fertilizers in the commands. The ground water level will increase in the adjoining area due to assured water supply to the fields. No possibility of leakage in the bed of the reservoirs is anticipated as it is covered by semi quartzitic sand stone which is compact and hard. Hence,

reservoirs can be considered as water tight. The water samples tests indicate that organic and heavy metal components in the water are within permissible limits.

No historic monuments of archaeological importance will come under submergence in the reservoirs. A provision of Rs. 14149 Lakh crore has been kept in the estimate towards Environment Management Plan.

19.0 Socio-economic aspects

Socio-economic Impact Assessment Studies and R&R Plan of Lower Orr project has been carried out by Department of Sociology, Hamidia college, Bhopal and that for 4 barrages by M/s AFC Limited, Hyderabad.

The details of socio-economic aspects of the Lower Orr reservoir are furnished below. No submergence is proposed under 4 barrages.

S. No.	Item	Lower Orr dam
1.	Submergence area at FRL	2723 ha
2.	No. of villages affected	12
3.	No. of households affected	870
4.	Total population	2939
	Males	1587
	Females	1352
5.	Sex ratio(females : males)	849:1000
6	Literacy rate	67.49%
	Male	71.42%
	Female	54.21%
7	SC and ST households	
	SC	79
	ST	314
8	Landuse in submergence area	2723
	Area sown with agrl. Crops	853.287ha
	Area under dense forest	968.243ha
9.	Total live stock population affected	9249

S. No.	Item	Lower Orr dam
10.	Houses affected	
	Semi pucca houses	150
	Kutcha houses	487
	Pucca houses	233
11.	Children upto 6 years	241
12.	Population above 60 years and above	167
13.	Young and Old persons	2531
14.	Occupational distribution	
	Agricultural labourers	1251
	Cultivators	1420
	Trade and commerce	29
	Industry	27
15	Sources of income	
	Agricultural based activities	77.83%
	Selling of Minor forest produce	0%
16	Expenditure pattern	
	Expenditure on food	41.03%
	Recurring cost on agricultural and livestock	18.17%
	Expenditure on health	8.58%

20.0 Resettlement and Rehabilitation Plan

The cost of relief, resettlement and rehabilitation of the affected households under the Project is worked out in accordance with the Rehabilitation and Resettlement Policy guidelines of the Government of India -2007 as well as R&R Policy of Govt. of Madhya Pradesh. The issue has three major components : i) land compensation; ii) resettlement and economic rehabilitation of displaced persons; and iii) economic rehabilitation of PAFs who have lost only land but not house / house site.

i) Land Acquisition

According to the Socio-economic survey (SES), the total land acquisition required for the project is estimated to be 3727 ha for Lower Orr dam and 1713 ha for four barrages. The displaced persons will be settled in colonies near the areas where the affected persons are currently staying. Necessary provision has been made for housing plots, infrastructure like schools and other civic amenities. The total compensation for land acquisition is estimated to be Rs 185.96 crores (Rs. 137.22 crores for Lower Orr dam and Rs.48.74 crores for 4 barrages) considering voluntary as well as involuntary acquisition costs of irrigated/ unirrigated lands from PAFs, solatium (30%), standing crop loss, interest, demarcation, legal and establishment charges, etc.

(ii) Resettlement

The implementation of the Project results in the involuntary displacement of 944 families as their houses get submerged under the reservoir. The establishment of colonies including assistance for house construction, schools and other infrastructure, etc. to the families is estimated to cost Rs. 34.72 crores.

(iii) Economic Rehabilitation

The economic rehabilitation package for 944 PAF households identified under the SES is estimated to be about Rs. 9.62 crore.

(iv) Compensation for Properties

Under the Rehabilitation and Resettlement, compensation for loss of 59 cattle sheds, 725 productive trees and 46 farm houses has also been made. The total cost for compensation for properties works out to Rs. 0.45 crore.

Total Financial Requirement

The total financial requirement for the implementation of Resettlement and Economic Rehabilitation Plan including training to staff and land for colonies would be about Rs. 213.11 crore. Socio-economic condition of the people living in command areas as well as in near vicinity of the projects will improve in general.

No major adverse impacts are anticipated due to the Project on the socio-economic front. In fact, positive impacts due to provision of assured water supply for irrigation to the fields will increase the production of crops which in turn will improve the social set up of farmers/ cultivators, etc. The impact on occupational pattern will be low to medium. Tourism will develop in the project area.

21.0 Cost estimate

Unit-I: The cost of head works like Lower Orr dam, Neemkhera, Barari, Kotha, and Kesri barrages including spillway, outlet works, energy dissipation devices, regulator including intake structures and diversion works etc. have been worked out under this head and estimated as Rs. 1482.84 crore at 2012-13 price level.

Unit-II: The cost of canals proposed in Lower Orr dam and Neemkheda, Barrari, Kotha and Kesari barrages, branches, distributaries, channels upto strata works inclusive of all pucca works, fold embankments, drainage works, etc. has been worked out and is estimated as Rs.752.40 crore at 2012-13 price level.

Unit-III: No Power House is proposed in the project.

Unit-IV: The cost of command area development like land leveling etc, have been worked out to be Rs.16.53 crore at 2012-13 price level.

Thus, the total cost of the project has been estimated as Rs. 2282.94 crore. Rs. 1456.35 crores cost of Head works will be booked under irrigation component and Rs. 26.50 crores shall be under water supply component.

S. No.	Item	Estimated cost Rs. in crore
1.	Unit-I Headworks	1482.85
2.	Unit-II Canals and Conveyance system	752.40
3.	Unit-III Hydraulic installations	31.16
4.	Unit-VI Command Area Development	16.53
	Total cost of the project	**2282.94**

21.1 Economic and Financial Evaluation

The economic and financial evaluation is tabulated below:

S. No.	Description	Rs. (lakh)
1.	**Net return from agricultural produce**	
	Pre-project	7402.59
	Post-project	44547.52
	Total net return from agricultural produce	37144.93
2.	Revenue from Water supply @ Rs. 2.60 lakh per MCM for 6 MCM	15.60
3.	Revenue from Fisheries	53.88
4.	Revenue from tourism	Nil
	Total Revenue	**42548.53**
5.	Annual cost like interest, depreciation, charges of operation and maintenance (O&M) for command area and head works, power plants, etc.	**27190.70**
6.	**Benefit cost ratio**	**1.56**
7.	**Internal Rate of Return**	**14.87**

23.0 Clearances Required

The Ken-Betwa Link Project (Phase–II) will require the following clearances from the Agencies indicated against each:

Sl.no.	Clearance	Agency
(i)	Techno-economic	Central Water Commission/TAC MOWR
(ii)	Forest	Ministry of Env. and Forests
(iii)	Environmental	Ministry of Env. and Forests
(iv)	Wildlife	Central Empowered Committee, MOEF
(v)	R&R Plan of Tribal Population	Ministry of Tribal Affairs

Investment clearance will be accorded by Planning Commission based on the clearances by above mentioned Agencies.

24.0 Database

Action is being taken to prepare data base at field level as well as headquarters to keep all the data and information collected during the preparation of DPR.