

Executive Summary

1.0 Introduction

The Government of Gujarat proposes to construct a barrage across river Narmada near village Bhadbhut in Bharuch district with the following objectives :

- Protection of water quality of Narmada river from salinity due to tidal influence and checking the problems of salinity ingress and deterioration of ground water quality in the upper reaches of Narmada river;
- Storage of the regulated release of water from SSP and runoff from free catchment for irrigation, domestic and industrial water supply;
- Flood protection of about 400 sq km low lying area covering 17 villages on the left bank of river Narmada; and
- Road connectivity between left and right banks, shortening route from Surat/Hajira to Dahej region

As per the feasibility report of the project prepared by M/s SECON Private Limited, Bangalore, the Bhadbhut barrage will be 1663 m long having top width of 30 m with 6-lane road, approach embankment of 12.82 km on RHS, 7.12 km on LHS and flood protection bund of 24.05 km on left bank. The water will get stored to the level of FRL (+) 7.50 m at the barrage. There are provisions for fish ladder for unobstructed migration of fishery species and ship lock-type arrangement for allowing boat passage between upstream and downstream of the barrage.

The salient features of the barrage are as follows:

1. Barrage		
River gorge width at Bhadbhut barrage location	:	1600 m
Bed material property	:	Silty sand
Type of barrage	:	Barrage on permeable foundation
Design flood (SPF)	:	1,05,000 cumecs
Discharge through barrage	:	77505 cumecs
Total Length of barrage	:	1663 m
Crest level of barrage bays	:	(-) 2.0 m
FRL of the storage	:	(+) 7.50 m
Clear span between piers	:	15.50 m
Nos. of gates	:	90
Top road bridge width	:	33 m
Road bridge top level	:	(+) 12.85 m
Size of gates	:	15.5 m x 9.5 m
2. Approach embankment		
Type of embankment	:	Earth embankment
Length of embankment	:	6.90 km on RHS + 7.31 km on LHS
Top width	:	30.0 m
Side slopes U/S and D/S	:	2.5 (H):1(V)
Average height	:	6.50 m
Protection of side slopes	:	Gabion pitching on both side

		slopes.
3. Left bank protective embankment		
Type of embankment	:	Earth embankment/RCC retaining wall
Length of embankment (Barrage to Golden bridge)	:	24.05 km
Top width	:	30 m
Side slopes U/S and D/S	:	2.5(H):1(V)
Average height	:	6.50 m
Protection of side slopes	:	Gabion considering tide level of 7.0 m from CD level on both sides.
3. Irrigation command area	:	Existing L.I Schemes 1. Angareshwar : 568 ha. 2. Zanor scheme: 568 ha. Total area: 1136 ha.

2.0 EIA study by NEERI

The Government of Gujarat retained National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur to prepare Environmental Impact Assessment (EIA) report of the Bhadbhut barrage project. NEERI has prepared the EIA report as per the Terms of Reference (ToR) given by the State Environmental Appraisal Committee (SEAC), Gujarat. An Environmental Management Plan (EMP) together with Risk Assessment and Disaster Management Plan have also been delineated for the pre-construction, construction and post-construction phases of the

project. Besides, a comprehensive Environmental Monitoring Programme for operational phase of the project has been formulated and included in the report with a view to minimizing negative impacts and maximizing beneficial impacts of the project. A detailed Corporate Social Responsibility plan dealing with the various facets socio-economic welfare of the community in the project impacted area together with appropriate budgetary provisions also form part of the EIA report.

3.0 Scope of EIA study

The scope of study included baseline data collection for air, noise, water, waste water, solid waste, marine biodiversity and ecology; impact assessment of anticipated impacts on various components of environment due to the project, delineation of an environmental management plan for preconstruction phase, construction phase and post construction phases as well as a post-project environmental surveillance and monitoring.

4.0 Baseline Environment Quality

The baseline environmental quality site has been assessed through field monitoring within the project impact zone. The methodology included reconnaissance, identification and quantification of environmental parameters air, noise, land, water, biological and socio-economic components. Micro-meteorological data (wind speed, wind direction) of the project region was also collected simultaneously through a weather station installed at the project site.

Air Environment

An area covering 10 km radial distance with Bhadbhut barrage site as centre was identified as the study area. Eleven representative locations were selected in the study area and concentration of compliance pollutants

namely PM_{10} , $PM_{2.5}$, Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_x) and industry specific pollutants like Hydrocarbons, VOCs, Ozone, HCl, NH_3 were monitored. The micro-meteorological data was also recorded at the project site.

The observed average PM_{10} and $PM_{2.5}$ concentrations for all the selected locations were found below the stipulated standards of CPCB during all the seasons (pre-monsoon, post-monsoon and summer) of the year. Similarly, mean concentrations of gaseous pollutants namely SO_2 , NO_x , ammonia and Ozone were also observed to be below the stipulated standards of CPCB at all the locations.

Noise Environment

Noise levels were measured (A-weighted) in the surrounding as well as some locations including human settlements in the vicinity of the proposed barrage during the day and night time. The noise levels varied between 52.3-62.3 dBA during day time and 42.3-53.7 dBA during night time in the residential zones. In the commercial zone, the noise level ranged between 67.2-68.7 dBA during day and 57.2-61.3 dBA at night time. Noise levels were also monitored in sensitive locations (schools, primary health center etc.) The noise levels varied from 60.2-68.7 dBA during day and 45.0-59.2 dBA during night time. The noise levels exceeded in commercial area and may be attributed to increased traffic and other human activities.

Water Environment

The water quality assessment was carried out for coastal as well as estuarine zone of Narmada river and also in the upstream areas up to 35 km along the river stretch during three seasons of the year by collecting samples from the selected locations. The results indicated the dominance of saline water throughout the stretch of Narmada estuary as evident from the

TDS values varying between 500 mg/l and 5000 mg/l even in the low tide, whereas in the coastal region the variation was from 34,000 and 39,000 mg/l in the samples collected from surface, middle and bottom locations.

The variations in average salinity values were observed to be 2.37 ‰ to 16.56 ‰ during tidal conditions during 1992 - 2010 in case of estuary, whereas in the coastal areas it varies from 24.6 ‰ to 34.6 ‰ respectively.

Dissolved Oxygen (DO) in water body, an essential requirement for survival of aquatic organisms varied from 5.5 mg/l to 7.1 mg/l and 5.0 mg/l to 7.0 mg/l (average values) during 1992 -2010, indicating seasonal changes in estuary and coastal water respectively.

water quality of Narmada river estuary and coastal region off villages Luvara / Lakhigam in Gulf of Khambhat , was also monitored for heavy metals, whose presence in more concentration is detrimental to aquatic life. The concentrations of Cr, Cd and Pb varied from ND to 0.34 mg/l, ND to 0.22 mg/l and ND to 0.308 mg/l respectively in estuarine water samples whereas in coastal water samples, these metals showed concentration from ND to 7.5 µg/l (Cr), ND to 3.8 µg/l (Cd) and ND to 45.8 µg/l (Pb) respectively.

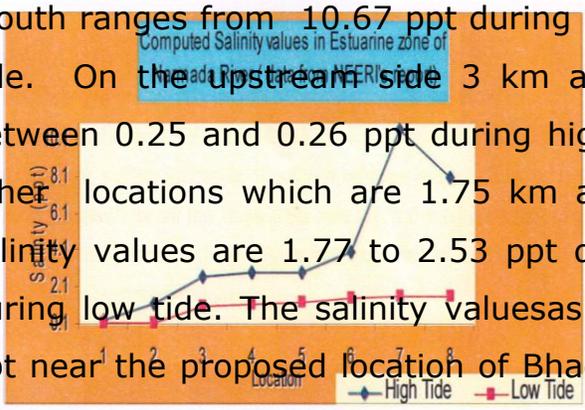
The barrage project due to its location in the estuarine zone of the river Narmada attracted provisions of CRZ Notification, 2011 of MoEF. Accordingly, Kalpasar department prepared a separate proposal for seeking CRZ clearance for the project. All the issues raised during the discussion with the CRZ Technical Committee Meeting on 25 March, 2013 have been appropriately addressed and complied and annexed in the EIA report (Annexure-2)

Salinity in the river Narmada

Additional data on water quality was collected by Kalpasar Department in 2011-12 from more sampling locations numbering 12 from Bhadbhut to Nand to ascertain the quality of river Narmada particularly in terms of salinity vis-a- vis the prescribed standards as prescribed in CRZ Notification, 2011. Earlier river water quality was also monitored by CSMCRI, Bhavnagar and NEERI.

The data provided by NEERI and CSMCRI was used by CWPRS to compute the salinity based on the chlorides at various locations, submitted to Kalpasar Dept in the form of a report by CWPRS. From the computed values it was observed that salinity is much lower particularly at the outfall of Narmada estuary where the tidal effect is presumed to be predominant. A comparison of the salinity values as observed from NEERI and CSMCRI data near outfall location, near the barrage and further upstream reach of the river indicated that the salinity values at the mouth are quite low and the salinity at the barrage location is well below 5 ppt.

It is observed that the salinity values at the two locations which are 24.5 and 28 km downstream of the proposed barrage and close to the river mouth ranges from 10.67 ppt during high tide to less than 2 ppt during low tide. On the upstream side 3 km away from the barrage the salinity is between 0.25 and 0.26 ppt during high and low tides respectively. At two other locations which are 1.75 km and 5.25 km downstream of barrage, salinity values are 1.77 to 2.53 ppt during high tide and 0.23 to 1.11 ppt during low tide. The salinity values as observed by NEERI are well below 5 ppt near the proposed location of Bhadbhut barrage during all stages of the tides and those reported by CSMCRI for Narmada estuary are 0.40 - 0.49, 1.31 - 1.52 and 0.09 - 0.22 ppt during pre-monsoon, winter and post-



monsoon seasons respectively. Thus salinity values reported by NEERI and CSMCRI near the barrage are found to be less than 5 ppt. With the construction of proposed barrage , the salinity values would further reduce at these locations and in the upstream reaches.

Studies on biological aspects of ecosystem in terms of plankton counts which are indicative of health of a riverl were undertaken by analyzing the representative water samples for phytoplankton and zooplankton counts per ml and expressed as Shannon Weiner Diversity Index (SWDI). Overall, SWDI for phytoplankton species indicates medium to low impact of pollution in the waterbody. Similarly the zooplankton count and the corresponding SWDI showed low impact of pollution in estuarine and coastal water.

The physico-chemical and biological characteristics of estuarine water indicated the following:

- water quality with respect to dissolved solids, chlorides and salinity is good excepting the increase in turbidity level due to tidal effect in the estuarine areas
- Quality of river water in the upstream reaches shows salinity below 5 ppt during dry season which are expected to go further down after the barrage construction.
- Presence of fecal coliforms was detected in surface as well as ground water indicating their contamination warranting need for chlorination before consumption.
- Samples collected from selected locations for surface and groundwater and analysed for zooplanktons and phytoplanktons

which are indicators of environmental stress showed that surface water quality is good but that of groundwater is poor.

Land Environment

Soil and sediment samples were collected from the barrage site, its immediate vicinity and the surrounding villages and analysed for physico-chemical parameters. Soil samples showed moderately good soil with high adsorptive capacity indicating good productivity medium fertility.

Information on land use / land cover pattern, existing cropping pattern, their types and yield of the crops was also collected from various sources including satellite imageries of the study area. The land use pattern in the different villages falling within 10 km radial distance from Bhadbhut shows that agriculture is the main occupation occupying more than 50 percent land under cultivation.

Sediment samples were collected from different locations in estuarine and coastal areas and analyzed for physico-chemical characteristics to know the transfer of pollution load from liquid to solid phase in terms of organic content, nutrients and heavy metals. The analysis indicated that lot of organic and nutrient load is being carried by the river Narmada and settle at the bottom along the stretch.

Biological Environment

The reconnaissance revealed that the land around the study area is covered with natural vegetation including little amount of mangroves. *Prosopis juliflora* (Jangali Babul) are observed to be dominant along the roadside and near the seashore. The areas near the seashore are mostly affected by tides and remain submerged for considerable time. Thus the seashore is inhabited by small salt tolerant plants (mangroves ecosystem) such as *Avicenia*, *Rhizophora* and *Prosopis juliflora* only on high lands. Aliabet,

an island near the mouth of Narmada, is also affected by the tidal fluctuations.

A total of 14 sampling locations were selected for study of biological environment based on topography, vegetation structure, pattern and distribution. The observations were taken from different villages along agricultural field, marshy land, wasteland, riverside vegetation and built up land. The details are presented in Chapter 3 of the EIA report.

Fisheries

Bharuch District is one of the coastal districts of the Gujarat State, contributing to the marine fish as well as inland water fish production. The study area has a large potential for inland fisheries including brackish water and fresh water fishes.

Existing Fishery Scenario

The Narmada estuary traverses through the bounds of Bharuch district. The estuary, which is about 1.6 km wide at the barrage site downstream of village Bhadbhut, gets further widened at the Gulf mouth. This estuary is reckoned as the largest estuary in the State of Gujarat..

The total number of fishermen's families residing in 21 villages is 2520 with a population of 12638. On an average, a family comprises of 5 fishermen, having 2-3 active fishermen. Thus, out of the total fishermen population of 12638, about 50 % is actively engaged in the fishery activities. While each fishermen family has about 50 units of nets, ownership/access of mechanized/non-mechanized boats is limited to a small number of families, about 20 % families.

Fish Production

Fish production in Gujarat comprises inland fish and marine fish, of which the former is minor constituent. In contrast, Bharuch district has the

inland fish production as a major constituent accounting for 27.80 % of the total inland fish production in the State, with marine fish production being a minor constituent accounting for only 0.94 % of the total marine fish production in the State.

Fishery scenario is apparently sub-optimal with respect to fishermen's employment, fishery infrastructure and fishing practices.

Agriculture

The agricultural fields are interrupted by pastures, fallows and waste land. The crops grown are Bajari, Sugarcane, Jowar, Moong, Tuar, Kapas etc. The villages are very close to the coast (towards east) and have no ascent to agriculture, as the water is saline by frequent inundation of sea water during high tides. Thus, the area of intertidal zone is not suitable for agriculture purpose. Major crops grown in the area are Bajra, jowar, Til, cotton and Soyabean.

Threatened Species

The species enlisted in the study area are not mentioned/recorded in Red Data Book published by BSI and ZSI.

Socio-economic Environment

There are a total 49 villages in the study area falling in Ankleshwar, Vagara, Bharuch, Hansot and Jhagadia Talukas of Bharuch district. The parameters selected for collection of the baseline information on socio-economic component were demographic structure, infrastructure base in the area, economic structure, health status, cultural attributes, socio-economics status in relation to quality of life and public awareness and public concern about the project. Relevant information was collected from randomly selected villages in the study area.

Demographic Structure

The salient features of demographic details such as residential households, sex ratio, percentage of scheduled caste, scheduled tribes and literate population are described below:

- Total Population of the region as per the 2001 censuses is 119521 out of which 61303 are male and 58218 are female.

- Total number of residential households within the study area are 23530
- Scheduled caste and Scheduled tribe population is 6315 (5.28%) and 33078 (27.67%) respectively
- Literacy rate in the study area is 63.95%
- Sex ratio (number of females per thousand males) is 949 which indicates that females are less in number than their male counterparts in the study area
- Total main worker population is 41196 (34.46%), 7861 (6.57%) falls under marginal worker category while the non-workers population is about 70464 (58.95%)

Infrastructure Resource Base

The infrastructure resources base of the study area with reference to education and medical facilities, water supply, post and telegraph, transportation, communication facility and power supply etc. is studied. The infrastructure resources details have been abstracted from Village Directory CD 2001 of Gujarat State and detailed in the main report.

In general, the study area has all the basic infrastructure facilities which with the implementation of the proposed project, are expected to get upgraded. The project is expected to improve the quality of life of the people through improved socio-economic status in terms of income, employment, educational facilities and also better availability of basic needs, viz. food, clothing, and housing.

5.0 Anticipated impacts & Mitigation Measures

The environmental impacts due to Bhadbhut barrage project have been anticipated during pre-construction, construction and post-construction phases. During the pre-construction phase, the impact will be limited to the acquisition of a small land area for approach road and flood protective embankment while during construction phase, the impacts will be on air environment mainly due to vehicular emissions and, noise generation due to transportation activity. During the post-construction phase, the impacts would be on water environment by way of quality improvement of surface and ground waters; land environment through improvement in land ecology due to improvement of groundwater quality, availability of fresh river water to the urban and rural population, flood protection of low lying area of 400 sq km housing 17 villages on the left bank of river Narmada, and creation of new road connectivity (through alternate shorter route) between left and right banks; biological environment in terms of fishery development and socio-economic environment through improvement in quality of life of the people in the project region. The occupation of the people residing in this area is mainly agriculture. Almost entire agriculture is having relatively low yield due to the variation in rainfall during monsoon. The only means of irrigation over a very small area is from river in which crops like groundnuts, cotton etc. are grown. If the irrigation facilities are provided to this area, it could increase its agriculture produce. Besides increase in agriculture production, it will also result in development of infrastructure and agriculture including agro industries.

The implications of the barrage on the fishery activities along the barrage influenced domain of the Narmada river encompass three types of fishery habitat viz. fresh water, brackish water and sea water. After

construction of the barrage, there can be apprehension that the inter-habitat movement of the fishermen as also of the fishery species (Hilsa, fresh water and prawn fish) may be obstructed. However, the fresh water storage in upstream of the barrage will provide a favourable environment for intensive fresh water fishery and provision of fish ladder with shiplocks would enhance the fishery activities and fetch greater economic benefits to the people.

6.0 Environmental Management Plan (EMP)

An environmental management plan is delineated for preconstruction, construction and post-construction phases. During the post-construction phase, the environmental problems are related to various natural hazards that the state is subject to like earthquake, cyclone, storm, surge, tsunami, flood, etc. However, these issues have been factored in the design of the barrage and other project components. The most significant risk perceived in the Bhadbhut barrage project is the flood for which the barrage is appropriately designed for 1 in 1000 year flood. A considerable scope of flood disposal would be, however, possible by gates that have been provided in the barrage operation during the tidal situation. Understandably, by prudent operation of the gates, the flood can be managed without any effectual damage.

Beside the above strategies of flood management, flood protection measures are planned. A flood protection embankment of 30 m top width above the HFL is to be constructed on left bank area so as to provide full flood protection of the low lying areas on this bank. On the right bank which is at the higher level, provision would be made for plugging of depressed area.

As a matter of abundant precaution, provision will also be made for adoption of safety measures against flood disaster as per flood warning

transmitted on the basis of observed flood level at Garudeshwar gauging station. For this purpose, the Flood Memorandum will be adopted as existing at present or with appropriate modification as per needs.

7.0 Barrage Risk Analysis & Disaster Management Plan

A Disaster Management Plan (DMP) has been outlined for the project as a reference document containing salient information about actions to be taken at the time of disaster. The disaster management plan include an emergency response organization, emergency response system & control, emergency communication & alert system and health & medical response system. In addition, training of personnel, mock drill& demonstration exercise as well as public information system will be part of the DMP. As a preventive measure, it is suggested to constitute an emergency response organisation, which will take charge of the overall planning, execution and co-ordination of all the activities of the Disaster Management Plan. Some of the vital activities of the organisation may include demarcating emergency zones, carrying out emergency actions like extending relief, first aid, human assistance, carrying out evacuation, if necessary and organisation of rehabilitation centers.

It is pertinent to mention that due to construction of Bhadbhut barrage, there will be increase in surface water availability and ground water table because of creation of impoundment. This would not only increase water availability but also improve its quality by way of reduction in salinity (TDS) and make it fit for agricultural (irrigation) human consumption for the surrounding population as well for industrial and other allied purposes. Further, increase in water availability would also increase watershed area and help in increase in agriculture productivity and vegetation cover.

It may be worthwhile to mention that the proposed barrage project has been a result of demand of the local people as well as their representatives in various forum apart from feasibility based on scientific and engineering parameters. The project assumes special importance due to its objectives which have significant and far-reaching consequences to the benefits of the local people. The major one being solving the problem of salinity ingress and creating a source of fresh water for domestic, irrigation and industrial needs coupled with multi-sector development of the region and socio-economic prosperity to people and promote their quality of life. The project will not have any significant adverse repercussion on the environmental quality in the surrounding region, if the suggested mitigation measures as described in the EMP are implemented.