Chapter – 11
Environment Impact Assessment and Environment Management Plan

11.0 General

The water is an essential element in all the developmental activities of the mankind which is required throughout the year. Water is also required for sustenance of the surrounding environment. Precipitation is the only source of fresh water supply which is unevenly distributed both in space and time confined to mainly in monsoon season ie June to Sept only. As such building storage dams to store flood waters are necessary so that the availability of water could be ensured throughout the year for various requirements including drinking water. Though reservoirs increase the water availability leading to various developmental activities and prosperity in the area, but some adverse impacts on the environment are also inevitable. As such, it is necessary to identify the adverse impacts along with the positive benefits of the reservoirs to mitigate or ameliorate the anticipated adverse impacts on the environment.

To identify both positive and adverse environmental impacts due to the proposed Par-Tapi-Narmada link project and to suggest measures to mitigate or ameliorate the anticipated adverse impacts on the environment, the Environmental Impact Assessment study of this link project has been carried out through Water and Power Consultancy Services India Limited. Brief report of the study indicating baseline information on various environmental aspects, Environmental Impact Assessment of the project, Environmental Management Plan and Environmental Monitoring Plan along with the costs to implement the Environmental Management Plan are presented in the following paragraphs:

11.1 The Proposed Project

11.1.1 Project Background

Par-Tapi-Narmada Link Project has been planned to transfer surplus waters of West flowing Par, Auranga, Ambica and Purna river basins of South Gujarat and neighbouring Maharashtra to provide irrigation facilities to: the

areas on its enroute: tribal areas enroute right side of the link canal; tribal dominant districts of Dang and Valsad of Gujarat and Nasik district of Maharashtra; command area of five projects proposed by Government of Gujarat in its initial reaches to caters the water demands for irrigation and drinking purposes in its enroute; and take over the part command area of existing Miyagam Branch Canal of Narmada Canal System. The Narmada waters so saved in Sardar Sarovar Project would be utilized to provide irrigation facilities: in tribal areas of Naswadi, Kavant, Sankheda, Jetpur Pavi, Chhota Udepur talukas of Chhota Udepur district and Halol, Ghogamba and Kalol talukas of Panchmahal district by lift directly from Narmada Main Canal on substitution basis; and in drought affected Saurashtra region of Gujarat on substitution basis through Narmada Canal System to meet irrigation, domestic and other requirements. In addition to this, all possible Panchayat / village tanks coming in the vicinity of the project will be filled up. The project will also provide drinking water to tribal population in the vicinity.

The Union Ministry of Water Resources in the year 1980 had prepared a National Perspective Plan for Water Resources Development in the country, which comprises two components: Himalayan Rivers Development Component and Peninsular Rivers Development Component. The Par-Tapi-Narmada link is one of the 16 link proposals coming under the peninsular rivers development component of National Perspective Plan, involving the States of Maharashtra and Gujarat which will provide water for irrigation and drinking purposes as specified in preceedind para.

Par-Tapi-Narmada Link project envisages transfer of about 1330 Million Cubic metres (MCM) surplus water available in west flowing Par, Auranga, Ambica and Purna river basins of South Gujarat and Maharashtra to North Gujarat. The project envisages construction of 6 dams and 6 power houses involving submergence of about 6065 ha of land affecting about 2500 families in 61 villages in Gujarat and Maharashtra.

The earlier DPR of Par-Tapi-Narmada Link Project - Aug, 2015 has been revised based on decisions taken at various Meetings in light of the suggestions of Government of Gujarat to consider the water demands for

irrigation and drinking water purposes in the vicinity of the project as specified above. The following are the broad changes incorporated in the Revised DPR of Par-Tapi-Narmada Link Project..

1. An additional area of 45561 ha of five projects viz., Ugta, Sidhumber, Khata Amba, Zankhari and Khuntali is included in the PTN link project.
2. An area of about 36,200 ha benefitting the tribal areas on the right side of PTN link canal by lift is included.
3. Command area 12514 ha in the vicinity of six proposed reservoirs through lift directly from reservoirs in Dang and Valsad districts of Gujarat and Nasik district of Maharashtra.
4. An area of about 23750 ha and 10592 ha is included in the command area in Chhota Udepur and Panchmahal districts respectively by substitution through lift from Narmada Main Canal.
5. Out of a total Culturable Command Area of about 2.32 lakh ha, about 68% of the area (1.57 lakh ha) is now benefitting the tribal areas.
6. Provision is made for drinking water needs of all villages in Dangs district and villages in Dharmapur and Kaparada talukas of Valsad district.
7. Provision is made for filling up of all village tanks in the benefitted tribal areas.
8. Open channels has been replaced with closed pipeline system in the feeder canals (totalling about 37 km length) as well as in the distribution system in the command areas to reduce the land acquisition.

11.1.2 Project Justification

The rainfall in Saurashtra and Kutch regions of Gujarat is very scanty and the area is frequently affected by droughts. The annual normal rainfall (1951-2000) in Saurashtra and Kutch region is 507 mm and whereas the average annual Rainfall in Par, Auranga, Ambica and Purna river basins is assessed to be 2180, 2055, 1830 and 1472 mm respectively. The rivers in Saurashtra and Kutch region are mostly dry throughout the year. Whereas, sizable quantum of flows of Par, Auranga, Ambica and Purna rivers are going to sea unutilised every year. The water availability studies of these basins carried out by Central Water Commission indicates availability of

sizable surplus waters. The available surplus waters shall be stored in the reservoirs to be constructed on these rivers and diverted to Saurashtra and Kutch regions for meeting irrigation, drinking and other needs. However, before considering any water transfer from these basins the water requirements of the peoples in the vicinity of the proposed reservoirs and en-route of the link canal will be met on top priority basis. The Par-Tapi-Narmada link project is one of the viable options to divert the surplus flows of Par, Auranga, Ambica and Purna rivers to Provide irrigation benefits in Tribal areas as well as in drought prone Saurashtra and Kutch regions of Gujarat etc.

Accordingly, Preliminary Feasibility study to ascertain whether the project is feasible was carried out for the diversion of surplus waters of West flowing Par, Auranga, Ambica and Purna rivers of South Gujarat to provide the irrigation benefits in tribal areas as well as in the drought prone Saurashtra and Kutch regions of Gujarat etc. While working out the quantity of water that can be diverted through Par-Tapi-Narmada link, the in-basin requirements of water up-stream and down-stream of the proposed dams at the ultimate stage of development have been considered for justifying the diversion of water through the proposed Par-Tapi-Narmada link project.

11.1.3 Project Description

The Par-Tapi-Narmada link project envisages construction of the following components at the DPR preparation stage:

i) A 808.32 m long composite embankment (concrete face rock fill) cum concrete dam across river Par near village Jheri with FRL 246.00 m and corresponding gross storage capacity 206.03 MCM. The length of concrete face rock fill portion of the dam is 663.32 m and the length of concrete non-overflow section and spill way is 145.00 m. The dam axis is located at Latitude 20°22'25" N and Longitude 73°25'51" E.

ii) A 1431.85 m long composite embankment (concrete face rock fill) cum concrete dam across river Nar (a tributary of Par river) near village Paikhed with FRL 248.00 m and corresponding gross storage

capacity of 229.53 MCM. The length of concrete face rock fill portion of the dam is 1310.85 m and the length of concrete non-overflow section and spill way is 121.00 m. The dam axis is located at Latitude 20°27'42" N and Longitude 73°23'37" E;

iii) A power house of 9.0 MW installed capacity at the toe of Paikhed dam with 3 units each of 3 MW.

iv) A 2781.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Tan (a tributary of Auranga river) near village Chasmandva with FRL 214.00 m and corresponding gross storage capacity of 83.63 MCM. The length of concrete face rock fill portion of the dam is 2703.00 m and the length of concrete non overflow section and spill way is 78.00 m. The dam axis is located at Latitude 20°37'02" N and Longitude 73°22'36" E.

v) A power house of 2.0 MW installed capacity at the toe of Chasmandva dam with 2 units each of 1 MW.

vi) A 1887.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Ambica near village Chikkar with FRL 210.00 m and corresponding gross storage capacity of 141.99 MCM. The length of concrete face rock fill portion of the dam is 1736.00 m and the length of concrete non overflow section and spill way is 151.00 m. The dam axis is located at Latitude 20°42'00" N and Longitude 73°30'50" E.

vii) A power house of 2.0 MW installed capacity at the toe of Chikkar dam with 2 units each of 1 MW.

viii) A 1170.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Kapri (a tributary of Ambica river) near village Dabdar with FRL 169.00 m and corresponding gross storage capacity 222.38 MCM. The length of concrete face rock fill portion of the dam is 1035.00 m and the length of concrete non overflow section and spill way is 135.00 m. The dam axis is located at Latitude 20°48'58" N and Longitude 73°32'05" E.

ix) A power house of 3.2 MW installed capacity at the toe of Dabdar dam with 2 units each of 1.60 MW.

x) A 1330.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Purna near village Kelwan with FRL 164.00 m and corresponding gross storage capacity of 282.17 MCM. The length of concrete face rock fill portion of the dam is 1141.00 m and length of concrete non overflow section and spill way is 189.00 m. The main dam axis is located at Latitude 20°55'30" N and Longitude 73°32'00" E.

xi) A power house of 2.5 MW installed capacity at the toe of Kelwan dam with 2 units each of 1.25 MW.

xii) A power house of 2.0 MW installed capacity at the fall of feeder pipe line connecting Kelwan dam with main link canal with 2 units each of 1 MW.

xiii) A tunnel of about 12.70 km long with 3.00 m diameter (D shape) and bed slope of 1:875 connecting Jheri reservoir with Paikhed reservoir.

xiv) A 147.50 m long barrage in the downstream of Paikhed dam with crest level of 136.00 m.

xv) A 128.00 m long barrage in the downstream of Chasmandva dam with crest level of 123.00 m.

xvi) A 369.043 km long link canal off-taking from Paikhed barrage at FSL 142.80 m.

xvii) A 100 m long tunnel No.1 at RD 14.650 to 14.750 km; A 350 m long tunnel No.2 at RD 24.000 to 24.350 km; A 200 m long tunnel No.3 at RD 32.350 to 32.550 km; A 50 m long tunnel No.4 at RD 37.750 to 37.800 km; and A 450 m long tunnel No.5 at RD 51.500 to 51.950 km;

xviii) A 2.859 km feeder pipe line connecting main canal with Chasmandva barrage.

xix) A 14.342 km pipe line inter connecting Chikkar and Dabdar reservoirs.

xx) A 12.258 km feeder pipe line connecting main canal with Dabdar dam.

xxi) A 7.616 km feeder pipe line connecting main canal with Kelwan dam.

xxii) Cross Drainage / Cross Masonry works including Regulators, Escapes, Road / Railway bridges

11.2 Study Area

The study area to be considered for the Environmental Impact Assessment study and preparation of Environmental Management Plan for the proposed Par-Tapi-Narmada link project is given as under:

i) Area to be acquired for various project appurtenances including reservoir submergence.
ii) 10 km on either side of the canal.
iii) 10 km radius around the project area from the periphery of the project site.
iv) Catchment area intercepted at each dam site.
v) Command area of the project.

11.3 Legal Status of the Project

The Water Resources Project, when implemented provides the immense benefits to the society in the form of increased availability of water for irrigation, domestic, industrial and other uses. On the other hand, these projects have impacts, both positive and negative on the environment of the project area and in the near vicinity and also affect the socio-economic conditions of the population in the specific region. The project before implementation required statutory clearance from the Ministry of Environment and Forests and Climate Change. As stipulated in the Environmental Impact Assessment Notification of 14th Sept 2006, the Terms and Conditions for carrying out the Environmental Impact Assessment study

of Par-Tapi-Narmada link project were submitted to the Ministry for approval. The Ministry vide letter No.J-12011/55/2008-IA.I, dated 8th June 2009 (Annexure-1.10, Vol-II) accorded clearance for pre-construction activities at the proposed site as per the provisions of EIA Notification-2006 alongwith the TORs for preparation of EIA report.

The Par-Tapi-Narmada link project comprises of 6 dams, 2 barrages, 6 power houses and canal. This will involve the shifting of the families residing in the villages likely to be affected by these dams / reservoirs. These project affected families are required to be resettled at the new locations. Therefore, with a view to compensate the Project Affected Families ensuring that the proper facilities in the re-settlement colonies are provided, a Rehabilitation and Resettlement Plan has been evolved. While formulating the Rehabilitation and Resettlement Plan, the provisions of National Policy on Rehabilitation and Resettlement–2007 have been kept in view. Various provisions of Rehabilitation and Resettlement Policies of Gujarat and Maharashtra are compared with the provision of National Policy on Rehabilitation and Resettlement – 2007 and best of the provision have been adopted. The project is lying in the tribal area as such the Rehabilitation and Resettlement plan required clearance from Ministry of Tribal Affairs.

The Par-Tapi-Narmada link project is required about 4439 ha of forest land as such forest clearance under Forest (Conservation) Act, 1980 is required. A provision for afforestation in double the area in de-graded forests region has been kept as per the Forests (Conservation) Act, 1980. The project will also require Techno-economic clearance from Central Water Commissioner; investment clearance from Ministry of Water Resources, RD and GR; and Consent to Establish from Maharashtra and Gujarat Pollution Control Boards under Water (Prevention and Control of Pollution) Act 1974 and the Air (Prevention and Control of Pollution) Act 1981.

The Geological Survey of India (GSI), Jaipur vide their letter No. 171/G-1/EG/WR/GSI/08-09 dated 9th April, 2009 (Annexure 4.3, Vol-II) had indicated that the area of Par-Tapi-Narmada link project are occupied by the different basaltic flows and associated rocks belonging to the Deccan Traps.

No significant minerals have been reported from the area, except construction material and a few minor minerals like zeolites. Similarly, the Archaeological Survey of India, Vadodara vide their letter No. 36/10/MIS/08-09/4078 dated 19th June 2009 (Annexure 4.2.1, Vol-II) and Archaeological Survey of India, Aurangabad vide their letter No. 12/2009-10/Tech-3036 dated 17th Feb 2011 (Annexure 4.2.2, Vol-II) have submitted brief report on archaeological exploration and informed that no monuments or any remains of archaeological importance were noticed in the areas of the 6 reservoirs viz Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dams and none of the centrally protected monuments are located in the area likely to be submerged due to the construction of the 6 proposed dams in the area of Par-Tapi-Narmada link project. As such, No Objection Certificates from Ministry of Coal and Mines and Archaeological Survey of India are not required.

11.4 Baseline Environmental Data

It is essential that the baseline levels of environmental parameters which could be significantly affected by the implementation of the project are to be ascertained before implementation of the project. The baseline status shall involve both field work and review of data collected from secondary sources. A similar approach has been adopted for conducting comprehensive environmental impact assessment study for the proposed Par-Tapi-Narmada link project.

The baseline survey planning commenced with the short listing of impacts and identification of parameters for which the data needs to be collected. Baseline status has been ascertained for air environment, water environment, land environment, public health and biological (terrestrial and aquatic) environment. The baseline status has been divided into three categories: Physio-chemical aspects; Ecological aspects; and Socio-Economic aspects.

11.4.1 Air Environment

11.4.1.1 Ambient Air Quality

The sources of air pollution in the study area are vehicular traffic,

dust arising from unpaved village roads and domestic fuel burning. The prime objective of the baseline air quality study was to establish the existing ambient air quality of the area. The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The monitoring of ambient air quality has been done for summer and winter seasons. The Ambient Air Quality in the project area has been monitored at 24 locations. The parameters such as Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (PM_{10}), Sulphur dioxide (SO_2) and Oxides of Nitrogen (NO_x) have been monitored. List of ambient air quality monitoring stations is given at Table- 11.1.

Table- 11.1
Location of Ambient Air Quality Monitoring Stations

Station (s)	Sampling Location	Dam site	Direction wrt Site	Distance (km)
A1	Dharampur	Chasmandva	SW	23.4
A3	Ulhaspedi	Paikhed	NW	6.0
A5	Sadarvera	Paikhed	N	6.0
A6	Bopi	Chasmandva	SW	7.0
A7	Man Kuniya	Chasmandva	NE	10.0
A8	Khambhla	Dabdar	SW	4.0
A9	Ahwa	Chikkar	NE	11.0
A10	Davdahad	Dabdar	E	1.0
A11	Sarvar	Dabdar	N	2.0
A12	Bheshkatri	Kelwan	N	1.0
A13	Chikkar	Kelwan	W	0.5
A14	Dungarda	Dabdar	SW	0.5
A15	Jamlapada	Chikkar	N	0.5
A16	Dhangdi	Chikkar	SE	2.0
A17	Saputara	Chikkar	SE	20.0
A18	Surgana	Jheri	NE	16.0
A19	Manigam	Jheri	NE	10.0
A20	Bedse	Jheri	NE	5.0
A21	Ghodia	Link	W	1.0
A22	Navagam	Link	S	1.0
A23	Navapara	Link	W	1.0
A24	Katkuwa	Link	N	1.0
A25	Ukai	Link	E	1.0

A26	Dhanmodi	Link	E	1.0

The sampling procedure adopted for monitoring of various ambient air quality parameters is at Table- 11.2.

Table- 11.2
Testing Procedure for Various Ambient Air Quality Parameters

Para-meter	**Description**	**IS Code**	**Testing Procedure**
PM_{10}	Respirable Suspended Particulate Matter	IS:5182 (Part-23): 2006	Respirable Particulate Matter Sampler
SPM	Suspended Particulate Matter	IS:5182 (Part-4): 1999	High Volume Sampling Method
SO_2	Sulphur dioxide	IS:5182 (Part-2): 2001	Improved West and Geake Method
NO_x	Oxides of Nitrogen	IS:5182 (Part-6): 1975(Reaffirmed 1998)	Jacobs and Hochhelser's Method

The result of Ambient Air Quality monitoring observations on SO_2 and **NO_x** levels indicate that:

SO_2 Levels:

Sulphur dioxide (SO_2) values ranged from 6.2 to 13.5 $\mu g/m^3$ in summer season and 3.5 to 13.2 $\mu g/m^3$ in winter season, which are well below the permissible limit of 50 $\mu g/m^3$ specified for industrial, residential and rural areas. The absence of industrial sources, low vehicular density in the project area can be attributed to low SO_2 level.

NO_x Levels:

Average NO_x values ranged from 9.8 to 13.1 $\mu g/m^3$ in summer season and 6.7 to 19.4 $\mu g/m^3$ in winter season, which are well below the permissible limit of 40 $\mu g/m^3$ specified for industrial, residential and rural areas. The absence of pollution sources in the study area is the reason of low NO_x level.

Observations on Ambient Respirable Particulate Matter Levels:

Average RPM values ranged from 25.1 to 36.8 μg/m^3 in summer season and 24.4 to 34.2 μg/m^3 in winter season, which are well below the permissible limit of 60 μg/m^3 specified for industrial, residential and rural areas. The RPM level was marginally higher in summer season as compared to winter season because lower moisture content in soil and vegetal cover in summer season.

Conclusions:

Based on the findings of the ambient air quality survey conducted for the summer and winter seasons, it can be concluded that the ambient air quality is quite good in the area. The values of these parameters were well below the permissible limits specified for residential, rural and other areas. The absence of industries and low vehicular traffic has attributed for the good ambient air quality in the project area.

11.4.1.2 Noise Environment

Noise level was monitored at 9 locations: Dharampur, Sarvar, Dhangdi, Motikorwad, Davdahad, Mankuniya, Chikkar, Surgana and Dhankawal in the study area. Monitoring was conducted for two seasons namely summer (June 2010) and winter (December 2010). The noise levels were monitored continuously for 24 hours at each location and hourly equivalent noise level was measured.

At each station, hourly noise level was monitored. These values were then used to estimate the day time and night time equivalent noise levels.

The day time equivalent noise level at various sampling stations ranged from 37.23 to 58.88 and 47.40 to 58.70 dB(A) in summer and winter seasons respectively. The noise levels in residential areas are well within the permissible limit of 55 dB(A) specified for commercial area (65 dB(A)), industrial area (70 dB(A) and silence zone (50 dB(A)).The night time

equivalent noise levels at various sampling stations ranged from 28.62 to 40.70 dB(A) and 30.50 to 42.63 dB(A) in summer and winter seasons respectively, which are well within the permissible limit specified for various categories.

11.4.1.3 Meteorology

Climatologically, the calendar year in the project area can be categorized into:

- Winter — November to February
- Summer — March to May
- Monsoon — June to September
- Post-monsoon / Transition — October

Temperature: Mean maximum temperature is observed in Vadodara 39.9 ^{0}C and Surat 36.8 ^{0}C. The mean minimum temperature observed at Vadodara is 13.2 ^{0}C and Surat is 14.7 ^{0}C .

Rainfall: The monsoon rainfall occurs mainly during mid June to Sept. Maximum rainfall is received in months July and August. The annual average rainfall values observed at the India Meteorological Department stations of Vadodara and Surat are used for the command area and are 923 mm and 1209 mm respectively. Majority of the rainfall is received under the influence of south –west monsoons.

Humidity: Monthly mean maximum and minimum relative humidity recorded at Surat and Vadodara stations are 90% and 53% and 94% and 44% respectively.

11.4.2 Water Quality

11.4.2.1 Surface Water Quality Monitoring

As a part of the primary study, water samples were collected and analyzed for ascertaining the water quality status in the study area during the period of summer season (June 2010), winter season (Dec 2010) and monsoon (Aug 2011). The quality of surface water has been ascertained from the physico-chemical analyses of water samples collected from

different river bodies. Grab sampling method was used for the collection of water samples. Ground water samples were taken from the hand pumps. The methods adopted for water testing are given at Table-11.3 and water sampling locations are listed at Table-11.4(A) and 11.4(B).

Table- 11.3

Protocols Adopted for Analysis of Various Water Quality Parameters

Parameter	Unit	Protocol	Testing Procedure
pH @ 25 ^{o}C	-	IS :2488 Part – 1, 1966	Electrometric method
Temperature	(^{0}C)	APHA (21st Edition)-2550 B : Page 2-61	Thermometry method
Dissolved Oxygen (DO)	mg/l	IS – 3025 (Part–38): 1989	Wrinkler's method
Biological Oxygen Demand (BOD)	mg/l	IS – 3025 (Part–44): 1993 (Reaffirmed 1999) Edition 2.1 (2000 - 10)	Modified Wrinkler's method
Chemical Oxygen Demand (COD)	mg/l	APHA (21st Edition)-Open Reflux Method 5220 B Page 5-15	Dichromate Reflux Technique
Total Dissolved Solids (TDS)	mg/l	IS: 3025 (Part-16) 1984 (Reaffirmed 1996)	Water bath Evaporation method
Total Suspended Solids (TSS)	mg/l	IS: 3025 (Part-17) 1984 (Reaffirmed 2002)	Filtration and Water bath Evaporation
Calcium (Ca+)	mg/l	APHA (21st Edition) – 3500 – Ca B: Page 3-65	EDTA method
Calcium Hardness ($CaCO_3$)	mg/l	APHA (21st Edition) – 3500 – Ca B: Page 3-65	Calculation method
Magnesium (Mg+)	mg/l	APHA (21st Edition) – 3500 – Mg B: Page 3-84	Calculation method
Magnesium Hardness	mg/l	APHA (21st Edition) – 3500 – Mg B: Page 3-84	Calculation method
Total Hardness ($CaCO_3$)	mg/l	APHA (21st Edition) – 2340 C Page 2 - 37	EDTA method
Sodium (Na)	mg/l	APHA (21st Edition) –	Flame Photometric

Parameter	Unit	Protocol	Testing Procedure
		3500 – Na B: Page 3-98	method
Potassium (K)	mg/l	APHA (21st Edition) – 3500 – K B:	Flame Photometric method
Sodium Absorption Ration (SAR)	-	-	Calculation method
Nitrogen Ammonia (NH_3-N)	mg/l	APHA (21st Edition) – 4500 – NH_3 C	Titrimetric method

Table- 11.4(A)

List of Water Sampling Locations for Summer and Winter Seasons

Sl. No.	Under Project Dam	River	Village	Sample ID	Location
1	Kelwan	Geera	Saijupada	W1	1 km from Saijupada
		Purna	Purna Wild Life Century	W2	2 km before Bheshkatri Gam
			Tekpada Gam	W3	Tekpada
			Enginepada	W21	500 m from Enginepada
2	Paikhed	Nar	Aavdha	W4	Near Aavdha
		Nar	Tamchadi	W5	1 km from Dhamni Gam
		Nar	Paikhed	W6	Paikhed
3	Jheri	Par	Vadpada	W7	Vadpada
		Aamti	Talpada	W8	2 km before Surgana
4	Chasmandva	Kaveri	Khambhla Gam	W10	Khambhla Gam
		Tan	Bopi	W11	1 km from Bopi
		Bore well	Mankuniya	W13	Hand Pump
			Bopi	W14	Bopi Primary School
		Auranga	Pandavkhadak	W15	Near Pandavkhadak
5	Chikkar	Ambica	Nanivadhai	W18	Nanivadhai
6	Dabdar	Kapri	Dholakpada	W19	2 km from Dhodhlpada
		Kapri	Khudkas	W12	Near Kudkas Gram
		Kapri	Bhavannagar	W20	Bhavannagar
		Lake	Ahwa	W9	Baddara lake

Table- 11.4(B)
List of Water Sampling Locations for Monsoon Season

Sl. No.	Dam Site	Sample Location	Village	Taluka	District	Location Details
1	Jheri	Dam site	Jheri	--	--	W 1
		U/s	Gondka/Kankbari	--	--	W 2
		D/s	Khelda	Kaprada	Valsad	W 3
2	Paikhed	U/s	Tamachadi	Dharampur	Valsad	W 7
		D/s	Amada pulsan	Surgana	Nasik	W8
3	Chasmandva	D/s	Bopi	--	--	W 11
4	Chikkar	Dam site	Chikkar	--	--	W 12
		U/s	Dhanjudi	--	--	W 13
5	Dabdar	Dam site	Dabdar	--	--	W 15
		U/s	Davdhad	--	--	W 16
		D/s	Pungwda	--	--	W 17
6	Kelwan	Dam site	Mheskatri	--	--	W 18
		U/s	Kalibel	--	--	W 19
		D/s	Dhamandevi	--	--	W 20
7	Either side of link canal	Link	Amreshwar	Dabhoi	Vadodara	W21
		Link	Garudeshwar	Nr. Kevadia	Narmada	W22
		Link	Mangrol	Mangrol	Surat	W23
		Link	Nani Narol	Mangrol	Surat	W24
		Link	Amhia	Vyara	Tapi	W25
		Link	Bhurivel	Songadh	Tapi	W26

The result of Water Quality Monitoring indicates that:

i) The pH level in the study area ranged from 6.95 to 8.32 in summer season and 7.3 to 8.2 in winter season and 7.2 to 8.1 in monsoon season at the samples sites considered in the study area. The pH level indicates neutral nature of the water and is well within the permissible limit of 6.5 to 8.5 specified for meeting the drinking water quality requirements.

ii) The TDS level in summer, winter and monsoon seasons are ranged from 150 to 1010 mg/l, 56 to 340 mg/l and 72 to 220 mg/l. TDS level in

monsoon seasons for ground water are ranged from 108 to 304 mg/l. The TDS levels observed in some of the samples sites were above the permissible limit of 500 mg/l specified for the drinking water quality and also within the rejection limit of 1500 mg/l. For irrigation water, the permissible limit is 2250 μmhos/cm, which is equivalent to the TDS level of about 1600-1700 mg/l. As the TDS level was below this limit, the water quality is found suitable for meeting the irrigation requirements.

iii) The hardness level ranged from 50 to 230 mg/l, 20 to 110 mg/l and 52 to 120 mg/l in summer, winter and monsoon seasons respectively indicating soft nature and for ground water hardness level ranged from 54 to 160 mg/l indicating soft nature. The hardness level generally was well below the permissible limit of 200 mg/l specified for drinking water. In only one sample, hardness level was 230 mg/l, which is well within the cause for rejection limit of 600 mg/l. Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

iv) The concentration of various cations, viz sodium, calcium and magnesium was observed to be within the permissible limits. This is also reflected by the low SAR value, which ranged from 1.44 to 20.16 and 6.5 to 29.2 in summer and winter seasons respectively. Permissible limit SAR for irrigation purpose is 26. The DO level ranged from 5.1 to 8.8 mg/l at various sampling locations. The BOD values are well within permissible limit, which indicates that the organic pollution loading entering the water bodies is well within the carrying capacity. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load which enters the water bodies gets diluted.

11.4.2.2 Ground Water Quality Monitoring

The Ground water quality monitoring in the study area was done during monsoon season at 4 sampling locations. The analysis of the collected samples was carried out in the laboratory as per the standard respective protocols. The summary of summer and winter seasons ground water monitoring is given below:

pH level in the study area ranged from 6.95 to 7.34 in summer season and 7.30 to 7.80 in winter season which indicates the neutral nature of the water, and are within the permissible limit of 6.5 to 8.5 specified for meeting drinking water requirements; TDS level ranged from 240 to 525 mg/l in summer and 172 to 228 mg/l in winter season, which is well within the permissible limit of 500 mg/l specified for drinking water and also within the cause for rejection limit of 1500 mg/l; hardness level ranged 100 mg/l in summer season and 70 to 90 mg/l in winter season, indicating soft nature. The hardness level generally is well below the permissible limit of 200 mg/l specified for drinking water.

The concentration of various cations, viz sodium, calcium and magnesium was observed to be within the permissible limits. This is also reflected by the low SAR value, which ranged from 3.17 to 4.32 in summer season and 13.8 to 17.00 in winter season. Permissible limit of SAR for irrigation purpose is 26. The DO level ranged from 7.5 to 8.70 mg/l in summer season and 5.2 to 5.6 mg/l in winter season at various sampling locations. The BOD values are well within permissible limit, which indicates that the organic pollution loading entering the water bodies is well within the carrying capacity. The low COD values also indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load which enters the water bodies gets diluted.

11.4.3 Land Environment

11.4.3.1 Land Use

The land use and land cover information of the catchment area of the 6 dams has been mapped using the digital satellite data of IRS 1C-LISS III. Various major categories like Agricultural land, Wasteland, Water body, etc were identified and mapped. Area statistics is calculated for different Land use / Land cover categories and furnished at Table- 11.5 for the catchment area of the 6 dam sites:

Table- 11.5

Catchment Area of Dams – Land Use / Land Cover Statistics

Sl. No.	Description	Area (km^2)	%age Area
I	Jheri dam		

Sl. No.	Description	Area (km^2)	%age Area
1	Built-up Residential	4.42	1.04
2	Mine / Quarry	0.26	0.06
3	Agricultural Land	244.68	57.57
4	Dense scrub	0.14	0.03
5	Open scrub	2.20	0.52
6	Dense Forest	121.40	28.56
7	Open Forest	38.75	9.12
8	Scrub Forest	1.98	0.47
9	Lake / Pond	1.45	0.34
10	Reservoir	0.18	0.04
11	River	9.54	2.24
	Total	**425.00**	**100.00**
II	**Paikhed dam**		
1	Built-up Residential	2.78	0.88
2	Agricultural Land	211.74	67.22
3	Dense scrub	3.44	1.09
4	Open scrub	0.21	0.07
5	Dense Forest	78.96	25.07
6	Open Forest	7.10	2.26
7	Scrub Forest	1.52	0.48
8	Lake / Pond	0.54	0.17
9	River	8.71	2.76
	Total	**315.00**	**100.00**
III	**Chasmandva dam**		
1	Built-up Residential	0.68	0.76
2	Agricultural Land	55.15	61.96
3	Dense scrub	0.20	0.22
4	Open scrub	0.26	0.29
5	Dense Forest	27.76	31.19
6	Open Forest	2.77	3.11
7	Scrub Forest	0.91	1.03
8	Lake / Pond	0.07	0.08
9	River	1.21	1.36
	Total	**89.00**	**100.00**
IV	**Chikkar dam**		
1	Built-up Residential	2.52	0.78
2	Agricultural Land	135.38	41.91
3	Dense scrub	2.37	0.73
4	Open scrub	0.07	0.02
5	Dense Forest	162.55	50.32

Sl. No.	Description	Area (km^2)	%age Area
6	Open Forest	12.03	3.72
7	Scrub Forest	0.001	0.00
8	Lake / Pond	0.05	0.02
9	River	8.03	2.49
	Total	**323.00**	**100.00**
V	**Dabdar dam**		
1	Built-up Residential	3.99	0.83
2	Agricultural Land	151.01	31.33
3	Dense Forest	301.07	62.46
4	Open Forest	11.83	2.45
5	Scrub Forest	2.37	0.49
6	Lake / Pond	0.32	0.07
7	Reservoir	0.17	0.03
8	River	11.25	2.33
	Total	**482.00**	**100.00**
VI	**Kelwan dam**		
1	Built-up Residential	2.88	0.39
2	Agricultural Land	269.04	36.70
3	Dense scrub	0.003	0.02
4	Open scrub	0.09	0.01
5	Dense Forest	290.75	39.67
6	Open Forest	135.99	18.55
7	Scrub Forest	15.62	2.13
8	Lake / Pond	0.21	0.03
9	Reservoir	0.04	0.01
10	River	18.35	2.50
	Total	**733.00**	**100.00**

11.4.3.2 Mineral Deposits

The Geological Survey of India, Western Region, Jaipur had informed vide their letter No. 171/G-1/EG/WR/GSI/08-09 dated 9th April 2009 (Annexure 4.3, Volume-II) that, the area covered under Par-Tapi-Narmada link project in Valsad and Dangs districts of Gujarat and partly Nasik district of Maharashtra are occupied by the different basaltic flows and associated rocks belonging to the Deccan Traps. No significant minerals have been reported from the area, except construction material and a few minor minerals like zeolites.

11.4.3.3 Historic / Archaeological Monuments

The Archaeological Survey of the project area has been carried out by Archaeological Survey of India, Aurangabad Circle during May, 2009 and Dec, 2010. The Archaeological Survey of India, Vadodara vide their letter No. 36/10/MIS/08-09/4078 dated 19th June 2009 (Annexure 4.2.1, Volume-II) have submitted a brief report on archaeological exploration and informed that no monuments or any remains of archaeological importance were noticed in the areas of 5 reservoirs viz., Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dams and none of the centrally protected monuments are located in the area likely to be submerged due to construction of proposed dams in the area of Par-Tapi-Narmada link project. Similarly, the Superintending Archaeologist, Archaeological Survey of India, Aurangabad Circle vide their F No.12/2009-10/Tech-3036 dated 17th Feb 2011 (Annexure 4.2.2, Volume-II) submitted the brief report on the archaeological survey and informed that no monuments or any remains of archaeological importance were noticed at dam site and in the submergence area of Jheri reservoir proposed under Par-Tapi-Narmada link project

11.4.3.4 Geology

The geology of the Par-Tapi-Narmada link project area, which forms a part of the peninsular shield of India, is mostly covered by basaltic rock formed by eruption and solidification of lava flows (Misra, 2005). The Indian sub-continent has experienced at least 5 continental flood basalt eruptions ranging in age from Middle Proterozoic to Late Cretaceous and Early Tertiary. The youngest of these is the Deccan Flood Basalt of Cretaceous to Eocene age. The series of eruptions proceeded from fissures and cracks in the surface of the earth, from where lava welled out intermittently till a thick sheet of basalt was formed. This obliterated the previously existing topography of the country and converted it into an immense volcanic plateau. This epochal volcanic formation is known in Indian geology as the Deccan Trap formation. Most of the land around the project site is covered by Deccan Traps, which almost entirely constitute the exposed rock unit of this terrain.

The most prominent rock formations at all the 6 dam sites of Par-Tapi-Narmada link project are of Deccan trap represented by Amygdaloidal basalt. The Par and Auranga basins, where Jheri, Paikhed and Chasmandva dam sites are located, belong to the Precambrian, melipozoice, tertiary and quaterniary ages. Deccan traps in this region are of two types; one being dark grey to bluish black, which are hard, compact and massive; and the other being light brown to pink, which are soft. The Ambica basin wherein Chikkar and Dabdar dams are proposed belong to the Quaternary and Tertiary ages. Deccan traps with dykes alluvial plains. Rocks found in Purna basin, where Kelwan dam is proposed are Neogene, Paleogene and early Paleogene. In the east of Purna basin, there are high ridges and deep valleys; which towards west merge into the lower reach composed of recent and sub-recent alluvium.

11.4.3.5 Soils

The Par-Tapi-Narmada link in the western part of India is planned to transfer water from the surplus regions of Western Ghats to the water deficit regions of Saurashtra and Kutch regions. Soil is the product of geological, chemical and biological interactions. The soils of district Vadodara are shallow to deep and are dominantly fine textured (clayey) followed by medium textured (loamy). The soils in southern region are very deep, well drained, fine to medium textured. The soils in district Bharuch, Narmada, Surat and Valsad are mainly very deep followed by shallow depths. Soil depths in Tapi district are mainly shallow followed by very deep and in Dangs district are dominantly distributed in shallow depths. The soil quality was monitored at various locations in the project area. The monitoring has been conducted for 3 seasons viz summer (June 2010), winter (Dec 2010) and monsoon (Aug-2011). As per EIA manual, the soil sample has been collected once in a season. The list of parameters monitored along with Protocols used for analysis is given in Table- 11.6. The list of Sampling Locations for command area is given at Table- 11.7(A) for Summer and Winter seasons; 11.7 (B) for Monsoon season; 11.7 (C) for dams in Monsoon season; 11.7 (D) for canal / catchment area in Monsoon season.

Table- 11.6
Soil Quality Parameters Monitored alongwith List of Protocols

Sl. No.	Parameter	Protocol
1	pH @ 25 ºC	Electrometric method
2	Electrical Conductivity (EC)	Electrometric method
3	Texture	Field method
4	Porosity	Calculation method
5	Available Moisture Content	Evaporation method
6	Calcium (Ca+)	EDTA method
7	Magnesium (Mg+)	Calculation method
8	Sodium (Na)	Flame photometric method
9	Potassium (K)	Flame photometric method
10	Sodium Absorption Ratio (SAR)	Calculation method
11	Total Phosphorus	Colorimetric method
12	Total Nitrogen	Modified Kjeldahl method

Table- 11.7 (A)
Samples in Par-Tapi-Narmada Command Area for Summer and Winter Seasons

Sl. No.	Location	Dam	Sample ID
1	Dharampur	Chasmandva	S1
2	Ulaspedhi	Paikhed	S3
3	Sadarvera	Paikhed	S5
4	Bopi	Chasmandva	S6
5	Mankuniya	Chasmandva	S7
6	Khambhla	Dabdar	S8
7	Ahwa	Chikkar	S9
8	Davdahad	Dabdar	S10
9	Sarwar	Dabdar	S11
10	Mheskatri	Kelwan	S12
11	Dabdar	Dabdar	S13
12	Dungarda	Dabdar	S14
13	Jamalpada	Chikkar	S15
14	Dhangdi	Chikkar	S16
15	Saputara	Chikkar	S17
16	Surgana	Jheri	S18
17	Manigam	Jheri	S19
18	Bedse	Jheri	S20

Table- 11.7 (B)
Samples in Par-Tapi-Narmada Command Area for Monsoon Season

Sl. No.	Village	Taluka	District	Sample ID
1	Moti Vahial	Kaparada	Valsad	S1
2	Bhensadara	Dharampur	Valsad	S2
3	Tumbi	Dharampur	Valsad	S3
4	Pendha	Dharampur	Valsad	S4
5	Mindbhari	Vasada	Navsari	S5
6	Kelia	Vasada	Navsari	S6
7	Motivelzar	Vasada	Navsari	S7
8	Moti Dabhas	Dang	Dang	S8
9	Vgulwchali	Dang	Dang	S9
10	Amhia	Vyara	Tapi	S11
11	Dhamodi	Vyara	Tapi	S12
12	Bhurivel	Songadh	Tapi	S13
13	Parvat	Mandvi	Tapi	S15
14	Mangrol	Mangrol	Surat	S16
15	Nani Narol	Mangrol	Surat	S17
16	Supdahad	Ahwa	Dang	S19

Table- 11.7 (C)

Samples in Par-Tapi-Narmada Dams for Monsoon Season

Sl. No.	Dam Site	River	Sample location	Sample ID
1	Jheri	Par	Bedse	S20
			Kankavani	S 21
2	Paikhed	Par	Moti Korval	S 22
3	Chasmandva	Auranga	Bopi	S 25
			Nirpa or Chorvan	S 26
4	Chikkar	Ambica	Jamalpad	S 27
			Dhangdi	S 28
5	Dabdar	Ambica	Davdhad	S 29
			Chikkar	S 30
6	Kelwan	Purna	Mheskatri	S 31

Table- 11.7 (D)

Samples in Par-Tapi-Narmada Canal for Monsoon Season

Sl. No.	Village	Taluka	District	Sample ID
1	Ukai	Songadh	Tapi	S 33
2	Kantol	Jaghadia	Bharuch	S 34
3	Dharoli	Jaghadia	Bharuch	S 35

4	Garudeshwar	Near Kevadia	Narmada	S 36
5	Amreshwar	Dabhoi	Vadodara	S 37
6	Mangrol	Mangrol	Surat	S16
7	Nani Narol	Mangrol	Surat	S17
8	Amhia	Vyara	Tapi	S11
9	Bhurivel	Songadh	Tapi	S13
10	Chelwas	Mandvi	Tapi	S14

The season wise findings of soil monitoring are briefly described below:

i) Summer Season: The pH @ 25 ^{o}C ranged from 5.99 to 7.64 located at Dharampur and Saputara. The Electrical Conductivity ranged between 72.60 µS/cm and 1670.00 µS/cm located at Manigam and Khambla. The Porosity ranged between 32.66% and 58.18% located at Dhangdi and Moti-Korwad. The Available Moisture Content ranged from 0.46% to 6.72% located at Manigam and Ahwa. The concentration of Calcium is in range between 240.48 mg/kg and 11382.72 mg/kg located at Moti-Korwad and Khambhla. The concentration of Magnesium is in range between 45.78 mg/kg and 825.03 mg/kg located at Sadarvera and Surgana. The concentration of Sodium is in range between 33.00 mg/kg and 2126.40 mg/kg located at Manigam and Chikkar. The concentration of Potassium is in range between 2 mg/kg and 227 mg/kg located at Bheskatri and Sadervera. The concentration of SAR is in range between 0.28 and 15.42 located at Manigam and Chikkar. The concentration of Total Phosphorus is in range between 0.12% and 0.37% located at Jamalpada, Dhangdi and Surgana. The concentration of Total Nitrogen is in range between 0.04% and 0.43% located at Dungarda, Saputara and Bheskatri.

ii) Winter Season: The range of pH @ 25 ^{o}C is in between 6.4 and 7.3 located at Dungarda, Dhankwad and Chikkar. The Electrical Conductivity is in range between 101 µS/cm and 1670 µS/cm located at Surgana and Khambhla. The Porosity is in range between 35.1% and 54.0% located at Surgana and Moti-Korwada. The Available Moisture Content is in range between 1.1% and 5.8% located at Manigam and Sarvar. The concentration of Calcium is in range between 287 mg/kg and 2584 mg/kg located at Moti-Korwad and Sadarvera. The concentration of Magnesium is in range between 54 mg/kg and 680 mg/kg located at Sadarvera and Surgana. The concentration of Sodium is in range between 80 mg/kg and 2150 mg/kg

located at Mankuniya and Khambhla. The concentration of Potassium is in range between 2 mg/kg and 246 mg/kg located at Bheskatri, Dungarda and Sadarvera. The concentration of SAR is in range between 0.089 and 2.256 located at Dhangdi and Chikkar. The concentration of Total Phosphorus is in range between 0.12% and 0.35% located at Jamalpada, Khambhala and Davdahad. The concentration of Total Nitrogen is in range between 0.05% and 0.30% located at Manigam and Bedse.

iii) Monsoon Season (Command Area): The range of pH @ 25 ^{o}C is in between 7.1 and 6.6 located at Mheskatri, Chikkar and Dungarda. The Electrical Conductivity is in range between 180 µS/cm and 1470 µS/cm located at Dhangdi and Sadarvera. The Porosity is in range between 39.1% and 46.2% located at Dhangdi and Jamalpada. The Available Moisture Content is in range between 2.5% and 4.5% located at Dhangdi and Jamalpada. The concentration of Calcium is in range between 0.82 gm/kg and 2.45 gm/kg located at Dhankwal and Sarwar. The concentration of Magnesium is in range between 0.055 gm/kg and 0.50 gm/kg located at Dhankwal and Jamalpada. The concentration of Sodium is in range between 0.061 gm/kg and 0.992 gm/kg located at Dhankwal and Bopi. The concentration of Potassium is in range between 0.002% and 0.273% located at Jamalpada and Dharampur. The concentration of Total Phosphorus is in range between 0.17% and 0.28% located at Jamalpada and Mheskatri. The concentration of Total Nitrogen is in range between 0.07% and 0.25% located at Mheskatri and Jamalpada.

iv) Monsoon Season (at Dam Site): The range of pH @ 25 ^{o}C is in between 6.7 and 7.2 located at Nirpan and Chikkar. The Electrical Conductivity is in range between 165 µS/cm and 1370 µS/cm located at Jamalpad and Bopi. The Porosity is in range between 36.8% and 50.6% located at Dhangdi and Mheskatri. The Available Moisture Content is in range between 1.9% and 4.8% located at Dhangdi and Chikkar. The concentration of Calcium is in range between 0.36 gm/kg and 2.56 gm/kg located at Bedse and Mheskatri. The concentration of Magnesium is in range between 0.065 gm/kg and 0.525 gm/kg located at Nirpa and Mheskatri. The concentration of Sodium is in range between 0.088 gm/kg and 1.75 gm/kg located at Nirpa and Chikkar. The concentration of Potassium is in range between 0.002% and 0.26% located at Chikkar and Girnaru. The concentration of Total Phosphorus is in range between 0.16%

and 0.37% located at Jamalpada and Davdhad. The concentration of Total Nitrogen is in range between 0.06% and 0.32% located at Bopi and Bedse.

v) Monsoon season (in Canal /Catchment area): The range of pH @ 25 ^{o}C is in between 6.8 and 7.0 located at Kantol and Dharoli. The Electrical Conductivity is in range between 1130 µS/cm and 1260 µS/cm located at Garudeshwar and Ukai. The Porosity is in range between 39.9% and 44.9% located at Kantol and Dharoli. The Available Moisture Content is in range between 3.9% and 4.6% located at Garudeshwar and Ukai. The concentration of Calcium is in range between 2.2 gm/kg and 2.62 gm/kg located at Dharoli and Amreshwar. The concentration of Magnesium is in range between 0.48 gm/kg and 0.52 gm/kg located at Dharoli and Amreshwar. The concentration of Sodium is in range between 0.50 gm/kg and 1.75 gm/kg located at Amreshwar and Kantal. The concentration of Potassium is in range between 0.48% and 0.52% located at Dharoli and Amreshwar. The concentration of Total Phosphorus is in range between 0.24% and 0.27% located at Garudeshwar and Dharoli. The concentration of Total Nitrogen is in range between 0.25% and 0.28% located at ukai and Garudeshwar.

11.4.4 Terrestrial Ecology

11.4.4.1 Delineation of Flora in Study Area

According to Champion and Seth's revised (1986) classification of forest types, the study area falls in the South Indian Tropical Moist Deciduous forests (Group 3A/C1). The main two categories of the forest types existing in the study area are:

- Southern Indian Moist Deciduous Forests and
- Southern Dry Deciduous Forests

These two broad categories are further divided into eight sub types viz:

- 3B/C1a Very moist teak forests
- 3B/C1b Moist teak forests
- 3B/C1c Slightly moist teak forests
- 3B/C2 Southern moist mixed deciduous forests
- 5A/C1b Dry teak forests

- 5A/C3 Dry mixed deciduous forests
- 5E9 Dry Bamboo brakes
- 5/1S1 Dry tropical riverine forests

A rapid reconnaissance survey was conducted to understand the existing ecosystem types and to identify the presence of ecologically sensitive areas in the study area. In intensive survey, status of flora was assessed using circular plot of various sizes for trees, shrubs, herbs and grass species. Ten and one m radius plots were used to quantify trees, shrubs and herbaceous (herb and grass) species respectively. Trees with > 25 cm GBH were considered as matured trees and rest were classified in the recruitment and regeneration classes. Within the plots all the trees and shrubs were identified and enumerated. For grass and herbs species list and cover availability were estimated visually.

During rapid survey, identified the plants from the fresh material; those that could not be satisfactorily identified in the field were brought to the laboratory and identified by checking it with monographs, herbarium specimens and other available literature on regional and State floras. The forests of the study sites belong to the subgroup Southern moist deciduous forest, and within this are more specifically classified as moist teak forests (Champion and Seth, 1968). According to the classification followed by Puri *et. al.*, (1983) these forests are classified as deciduous teak forest types which are intermediate between dry and moist categories. They are named as the Tectona-Terminalia-Adina-Anogeissus series. The forests are known to be the richest in Gujarat and contain many invaluable timber species as well as medicinally important species (presently Dangs occupy about 30% of the forest area of Gujarat and generate 50% of its forest revenue and flora of Dangs is richest in Gujarat) (WWF, 2005). Teak (Tectona grandis) is the most dominant species in study sites and occurs throughout the area. Other dominating tree species are bamboo, shisam (Dalbergia sisoo), khair (Acacia catectu), dhavdo (Anogeissus latifolia) and kadam (Anthocaphalus sp.). The other indigenous tree species available in the forest are Anogeissus sps. (dhav, dhavdo), Bauhinia racemosa (asitro), Butea monosperma (khakharo, kesudo), Terminalia crenulata (sadad), Lannea coromandelica (modad, golado), Boswellia serrata (salai, halar, gugur), Diospyros melanoxylon (timaru, bidi patta), Cassia fistula (garmaro), Syzygium

cumini (jamu), Prosopis juliflora (gando bavar), Eucalyptus sp (nilgiri)., Gmelina arborea (shevan), Termenelia arjuna (arjun sadad), Cassia auriculata (avar), Emblica officinalis (amara) etc. (Shah, 1978).

During rapid assessment of ecosystems, the overall study area is categorized into different land uses under the land ownership and different levels of productive potential. However, for the study purpose they have been delineated into five major habitat types according to the nature of vegetation existing in it.

1) **Stream Beds;** this includes the area on the banks of seasonal rivers, stream and small nallah.

2) **Wetland:** Since these water bodies (manmade village ponds) are located within the buffer zone of the proposed dams/reservoirs in area, aquatic plants were counted and discussed under wetland habitats (at preliminary level).

3) **Agro-ecosystem;** it means areas under the agriculture use (irrigated lands, un-irrigated lands, cultivable waste/fallow land) and its surrounding hedge vegetation (locally known as – *khetars* or *wadis*) owned by the private people.

4) **Open scrub or degraded Forest;** mainly small patches of waste lands and Gauchar lands with scrub vegetation and scattered tree species which belongs to revenue or government.

5) **Moist deciduous Forest;** all the categories of forest lands including species specific as well as composition of dominant tree species belongs to forest department.

Visible observation of study area, tree and shrub covers suggest that:

- The visibility observation during the visit to all project sites, tree and shrub covers suggest that the maximum diversity in buffer zone beyond 2-5 km radius from the proposed dam sites. The density and diversity of tree and shrub covers decrease away from the proposed sites. The forest

lands found to be most suitable habitat for all floral components which was followed by degraded-open lands.

- Different types of forests that constitute varied habitats are moist mixed deciduous forest, moist teak forest and very rarely seen bamboo brakes. Bamboo forms thick middle storey in large area with tree cover having moderately dense canopy.

- The natural vegetation of the proposed project sites is a three-tiered forest adapted to the monsoon and dry season climate. The forests typically have an upper canopy at 10–15 meters, 5-10 meter understory of smaller trees and large shrubs, and 3-4 meter undergrowth.

- Based on rapid survey in and around the agricultural area and dialogue with the local farmers a total of more than 20 species have been listed as crop species. The crops list includes 7 grains, 5 fruits and 5 vegetable species. Fruit and vegetable crops were found cultivated along the agricultural hedges in a small extent of area (as visible). In addition 2 cash, 2 timber crop also observed to grow in the area.

11.4.4.2 Status of Fauna

As per the survey conducted on major bird species observed in the study area are Pea fowl, Indian cuckoo, Blue rock pigeon, King fisher, Griffon vulture. As per the secondary data available, the common mammals found in the project area are Leopard, Jungle Cat, Indian Fox, Jackal, Four horned Antelope, Woodpeckers, Barking Deer, Chital, Pangolin, Lizard etc.

11.4.4.3 Status of Fish Fauna

Major fish species reported in the study area are Catlacatla, Labeo frimbriatus, Labeo calabasu, Cirrhinus reba, Puntius sarana, Mystus senghala, M. aor, M. cavasius, Wallago attu, Channa spp, Mastacembalus armatus. Among these only two species of fishes ie Channa spp and Mastacembalus armatus are observed during the survey. None of the fish species appear to have long migration pattern.

11.4.5 Public Health Facilities

The information regarding health facilities including availability of hospital, maternity and child welfare centre and Primary Health Centre (PHC) etc. are collected and found that Hospital facility is available for all the villages but its average distance is more than 10 km. Similarly, Maternity and Child Welfare Centre are also available at the average distance of more than 10 km. Village wise availability of medical facilities in the affected villages are given at Table - 11. 8 to 11. 13.

Table – 11.8
Village-wise Medical Facilities in Jheri Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child welfare Centre	Primary Health Centre
1	Kirdi	>10	>10	>10
2	Khokarvihir	>10	>10	>10
3	Kayare	>10	>10	>10
4	Gandole	>10	>10	>10
5	ModhalPada	>10	>10	5 to 10
6	Ambe	>10	>10	x

Table – 11.9
Village-wise Medical Facilities in Paikhed Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child welfare Centre	Primary Health Centre
1	Paikhed	>10	>10	>10
2	Gundiya	>10	>10	>10
3	Khudki	>10	>10	>10
4	Madhuri	>10	>10	>10
5	Chavra	>10	>10	>10
6	Khapatiya	>10	>10	>10
7	Satvankal	>10	>10	>10

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child welfare Centre	Primary Health Centre
8	Tutrkhed	>10	>10	>10
9	Karanjul	>10	>10	>10
10	Rkshabhuwan	>10	>10	>10
11	Bhendval	>10	>10	>10

Table – 11.10

Village-wise Medical Facilities in Chasmandva Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child welfare Centre	Primary Health Centre
1	Chasmandva	>10	>10	>10
2	Jugiri	>10	>10	>10
3	Chorvani	>10	>10	>10
4	Nirpan	>10	>10	>10
5	Nadagheri	>10	>10	>10
6	Mandhu	>10	5 to 10	>10
7	Ragatvihir	>10	>10	5 to 10

Table – 11.11

Village-wise Medical Facilities in Chikkar Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child welfare Centre	Primary Health Centre
1	Baj	>10	>10	within 5
2	Barkhdya (Barkhandhia)	>10	>10	>10
3	Eanbhas (Ranbhas)	>10	>10	>10
4	Khirnani	>10	>10	>10
5	Khirdi (Chikkar)	>10	>10	>10
6	Kundu	>10	within 5	within 5
7	Laha Dabdar	>10	within 5	within 5
8	Sakarpatal	>10	Available	Available

9	Susarda	>10	x	x

Table – 11.12

Village-wise Medical Facilities in Dabdar Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child Welfare Centre	Primary Health Centre
1	Bhavadi	>10	>10	>10
2	Chinchingarvtha	>10	>10	5 to 10
3	Dabdar	>10	>10	5 to 10
4	Dhadhra	5 to 10	5 to 10	5 to 10
5	Ghodi	>10	>10	5 to 10
6	Ghoghalpada	>10	>10	>10
7	Gira	>10	>10	within 5
8	Malin	>10	>10	>10
9	Kudkas	5 to 10	>10	>10
10	Kukadnakhi	5 to 10	>10	>10
11	Pimpri	>10	>10	>10

Table – 11.13

Village-wise Medical Facilities in Kelwan Reservoir Area

Sl. No.	Village	Medical Facilities (Within Range (in km)		
		Allopathic Hospital	Maternity and Child Welfare Centre	Primary Health Centre
1	Balkhet	>10	>10	within 5
2	Bhogadiya (Bhongdya)	>10	>10	5 to 10
3	Bhujad	>10	>10	within 5
4	Chikhala	>10	>10	>10
5	Chikar	>10	>10	>10
6	Divdayavan	>10	>10	5 to 10
7	Engin Pada	>10	>10	>10
8	Godadiya	>10	>10	>10
9	Kakarda	>10	>10	within 5
10	Kalibel	>10	>10	Available
11	Masli	>10	>10	x

12	Khatal	>10	>10	Available
13	Khopriamba	>10	>10	Available
14	Pandharmal	>10	>10	x
15	Patli	>10	>10	x
16	Tekpada	>10	>10	Available
17	Wankan	>10	>10	x

11.4.6 Drinking Water Supply

Data on sources of water for drinking purpose indicates that the villages fetch water from different sources including hand pumps followed by wells, tanks and rivers. It was further observed that in most of the villages of the study area during summer season, the hand pumps are getting dry for almost 2 to 4 months annually and then the study area population is mainly depending on wells, tanks and rivers as drinking water sources.

11.5 Environmental Impact Assessment

Environmental Impact Assessment is a process of assessment of both positive and negative impacts on the environment due to implementation of the developmental projects. The primary objective of Environmental Impact Assessment is to encourage the inclusion of environmental considerations in planning and decision making and to ultimately arrive at actions that are environmentally more compatible. Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Par-Tapi-Narmada link project have been identified. The Impact Assessment for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, impacts have been quantified and otherwise, qualitative assessment has been undertaken. The impacts on various aspects of Environment have been assessed for construction as well as operation phases of project.

11.5.1 Impacts on Air Environment

11.5.1.1 Impact on Air Quality

i) Construction Phase: The air pollution Impact on surroundings shall be mainly during construction phase-

a) Pollution Due to Fuel Combustion in Various Equipments: The operation of various construction equipments requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of diesel combustion is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment is operating at a common point is quite low ie of the order of less than 1 $\mu g/m^3$. Hence, no major impact is anticipated on this account.

b) Fugitive Emissions from Various Sources: During construction phase, there will be increased vehicular movement and a lot of construction material like sand, fine aggregate is stored at various sites. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

c) Impacts Due to Vehicular Movement: During construction phase, increase in number of vehicles is anticipated for transportation of construction material. The increase in number of vehicles is expected to be a maximum of 35 / hour. As such; no major impact on ambient air quality is anticipated due to increase in vehicular movement during construction phase.

ii) Operation Phase: During operation phase, no major impacts are envisaged.

11.5.1.2 Impacts on Noise Environment

i) Construction Phase: The impacts on ambient noise levels are expected during the project construction phase only due to earth moving machinery, increased vehicular movement etc. The present noise level was monitored at 9 locations in the project area. No increase in noise level is anticipated as a result of various activities during the project construction phase. There could be marginal impact on the population residing in proximity to the canal alignment during construction phase as a result of

various activities. However, based on past experience, in similar project, the impact however, is not expected to be significant.

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. The vehicular movement is expected to increase upto a maximum of 45 to 50 trucks / hour. The impact on noise level due to increased vehicular movement was studied Federal Highway Administration model. No significant impact other than the above on this account is anticipated.

ii) Operation Phase: Noise pollution occurs mainly during project construction phase. During project operation phase, no major impacts are envisaged.

11.5.2 Impacts on Water Resources and Quality

i) Construction Phase

a) **Impacts Due to Sewage Generation from Labour Camps:** The major sources of water pollution during project construction phase are the sewage generated from the labour camps / colonies. The project construction is likely to last for a period of **7** years. About 5000 workers and 800 technical staff are likely to migrate during project construction phase. The employment opportunities in the area are limited. Thus, during the project construction phase, many of the locals may get employment. It has been observed during construction phase of many of the projects, the major works are contracted out, and who bring their own skilled labour. However, it is only in the unskilled category, that locals get employment. The construction phase also leads to mushrooming of various allied activities to meet the demands of the immigrant labour population in the project area. The increase in the population is expected to be of the order of 14000. The total domestic water requirement of the labour population (including families) is expected to be of the order of 0.98 mld @ 70 lpcd. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 0.8 mld. The total BOD load contributed by various labour camps/colonies will be about 630 kg/day. The above pollution loading is

likely to be spread over 3 to 4 labour camps. The disposal of sewage without treatment could lead to adverse impacts on land environment or water environment in which the effluent from the labour camps / colonies are disposed.

Disposal of Sewage Water is an essential part of the EMP. One community toilet needs to be provided for 20 persons. The wastewater generated from the colonies will be collected and disposed in specifically designed Soak pits and Septic tanks. The wastewater and sewage generated will not be allowed to flow into the rivers and streams of the area. The sanitary facilities at the colonies should be of standard municipal design for hill areas. However, efforts shall be made to ensure, that treated effluent is disposed only in these water bodies, which are not used for meeting domestic water requirements.

b) Impacts Due to Runoff from Construction Sites: Substantial quantities of water would be used in the construction activities. With regards to water quality, waste water from construction activities would mostly contain suspended impurities. Adequate care should be taken so that excess suspended solids in the waste water are removed before these are disposed into water body or over land. Similarly, effluents due to washing from truck parking area, workshop, etc. would have high concentration of oil and grease. The effluent quality is too small to cause any adverse impact. However, it is still recommended to treat the effluent from these units / areas by oil and separator unit, to ameliorate even the marginal adverse impacts likely to accrue on this account.

ii) Operation Phase

a) Impacts on Downstream Users: A total quantity of 1330 MCM is proposed for diversion from 6 reservoirs in Par, Auranga, Ambica and Purna river basins against the net yield in an average year for 6 reservoirs 1425 MCM. It is planned to utilise the water proposed to be transferred, for various command areas in the vicinity of the project, viz., in the en-route command, command area of five projects proposed by Government of Gujarat, command area in the vicinity of of reservoirs, en-route command

right side of canal by lift, Command area in Chhota Udepur and Panchmahal districts, drinking water supply and filling of tanks, and Target command to the tune of about 382 MCM, 285MCM, 48 MCM, 138 MCM , 130 MCM, 76 MCM, 50 MCMand 161 MCM respectively. Thus, the quantity of water saved in Sardar Sarovar project to the tune of 291 MCM will be available for irrigation in target command i.e. in drought prone area of Saurashtra and Kutch regions.

The diversion of water for meeting irrigation and other requirements could lead to following impacts:

- Modification of hydrologic regime
- Impacts on downstream water quality due to diversion of water from various dams
- Impacts due to change in waste assimilation capacity of the river system including downstream of dam
- Impacts on downstream water users for various dams
- Impacts on drainage system due to canal network
- Impacts due to siltation
- Impacts on performance of existing projects due to diversion of water for irrigation

The reservoir formation on account of construction of 6 dams could lead to impacts on present and future ground water and surface water use in the upstream and the impacts on water availability of the project. The impacts envisaged are:

- Impacts on existing water bodies upstream of dams in the project area: No water body / tank / pond / lake are likely to submerge due to the submergence of the proposed six reservoirs. Hence, no impacts on existing water bodies upstream of dam are envisaged.

b) Impacts on Water Logging and Soil Salinity: The main cause of water logging in a command area due to irrigation could be as follows:

- Developmental activities such as construction of roads, bridges, railway lines, buildings etc. resulting in choking of natural drainage.

- Poor natural drainage as consequences of topography or unfavourable sub-soil geology like existence of hard pan at shallow depths.
- Heavy storm and rainfall coupled with poor natural drainage.
- Heavy losses of water due to seepage from canals, distributaries and water courses.
- Excess application of water particularly in the initial years when the command is not fully developed.
- Poor on-farm water management resulting in poor application efficiencies.
- Inadequate drainage and poor maintenance of existing drainage system and outlets.
- Lack of conjunctive use of surface and ground waters.

The imbalance of air and water in root zone leads to adverse impacts on crop growth and are listed as under:

- Depletion of oxygen in the root zone and increase/saturation of carbon dioxide due to water logging. This anaerobic condition has an adverse effect on the growth of useful micro-organisms and harmful organisms proliferate and create several problems in the plant growth.
- Physio-chemical and biological activities in the soil and disturbed on account of low temperature which is the result of water logging conditions. This also creates the problem of increase in pests and diseases.
- Field operations also become either impossible or difficult in such soils.

c) Changes in Water Quality due to Increased Use of Fertilizers: The fertilizer dose is likely to increase once irrigation is introduced in the command area. Under the best farming practices, only 40 - 50% of the applied fertilizers is used by the crop and the balance finds its way into the aquatic environment through drainage runoff. An unexpected intense shower immediately after the spread of fertilizers may bring even greater amount of nutrients as a part of the runoff into the receiving water body.

To compensate the nutrient removal by crops, additional dose of nutrients, ie fertilizers dosing needs to be given. Wash down of fertilizers and organic matter rich in nutrients from the surrounding agricultural fields cause eutrophication of water bodies. Overgrowth of aquatic weeds affects the survival of aquatic organisms through depletion of oxygen, change in odour and taste of water. With the introduction of irrigation, use of fertilizers is likely to increase, to maintain the increased levels of production. The drainage system (natural or man-made) is likely to contain much higher level of nutrients. The climatic conditions in the project area too are suitable for the proliferation of eutrophication in the project area. Thus, in the project operation phase, there will be increased probability of eutrophication in the water bodies receiving agricultural runoff.

d) Impacts due to Effluent from Project Colony: During project operation phase, due to absence of any large scale construction activities, the cause and source of water pollution will be much different. Since, only a small number of OandM staff will reside in the area in a well designed colony which will have a Sewage Treatment Plant and other infrastructure facilities, the problems of water pollution due to disposal of sewage are not anticipated.

e) Recharge of Ground Water: Par-Tapi-Narmada link project envisages creation of Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs and link canal. Due to these reservoirs and link canal, recharge of ground water in the area of downstream of dams and en-route link canal will take place. This will be a positive impact of the project.

11.5.3 Impacts on Land Environment

i) Construction Phase: The construction of the proposed Par-Tapi-Narmada link project is expected to be completed in about 7 years. Majority of the environmental impact during construction phase are temporarily in nature, lasting mainly during the construction phase and for small duration beyond the construction period. The major impacts anticipated on land environment during construction phase are as follows:

- Environmental degradation due to immigration of labour population
- Operation of construction equipment
- Soil erosion
- Impacts due to construction of roads

a) Environmental Degradation due to Immigration of Labour Population: The peak labour and technical staff congregation would be of the order of 5000 and 800 respectively. The population of construction labour, technical and other work force for construction and related activities and service providers including their families is expected to be 14000. Separate accommodation and related facilities for workers, service providers and technical staff are to be provided as a part of the project. Congregation of labour force is likely to create problems of sewage disposal, solid waste management and falling of trees for meeting fuel requirements etc.

b) Operation of Construction Equipment: During construction phase, various types of equipment will be brought to the site. These include batching plant, earth movers, etc. The sitting and storage of these construction equipments would require significant amount of space. The site for storage of construction material and equipment will be selected such that it causes minimum adverse impacts on various aspects of environment. Efforts shall be made that such facilities are located on government or panchayat land only, so that hardships caused as a result of land acquisition, though temporarily on this account are minimized to the extent possible.

c) Soil Erosion: Due to various construction activities such as construction of colonies / houses / toilet blocks etc. Soil erosion in the project area is bound to increase. During construction activities, the share of the forest cover will be adversely affected which in turn will cause loosening of the soil particles, thus increasing the rate of soil erosion and hence degradation of land environment. Substitute Plantation will mitigate the adverse affect of soil erosion.

Impacts due to Construction of Roads: Roads are the only main mode of communication in the area. Waghai- Saputara National Highway (NH-360) passes in the submergence area of Chikkar dam. In addition, there is a wide network of Major roads, village roads and cart tracks. The status of village roads and cart tracks will have to be improved and new approach roads to

quarries, labour colony, stores and construction sites will have to be constructed. Frequent movement of heavy vehicle loaded with construction material will cause air pollution in terms of SPM, noise and gases. To mitigate the pollution effects, preventive measures such as sprinkling of water, plantation of trees etc. have to be taken in right earnest.

ii) Operation Phase:

a) **Acquisition of Land:** The proposed project envisages construction of 6 reservoirs, 2 barrages, link channels and canal network. About 6065 ha of land will be acquired for proposed Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs. Details are given at Table- 11.14:

Table- 11.14
Land to be Acquired under Reservoir Submergence of Various Dams

Dam site	Submergence Area (ha)			
	Forest Land	Culturable and Other Land	River Portion	Total
Jheri	408	256	172	836
Paikhed	317	589	88	994
Chasmandva	300	255	60	615
Chikkar	300	332	110	742
Dabdar	614	482	153	1249
Kelwan	890	450	289	1629
Total	**2829**	**2364**	**872**	**6065**

About 2509 families will be affected due to the submergence of these reservoirs, of which 98, 331, 379, 345, 563 and 793 families will be affected due to Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs respectively.

The land to be acquired for link canal including feeder pipe lines for Par-Tapi-Narmada link canal is 4554 ha. Details are given in Table-11.15:

Table-11.15
Details of Land to be Acquire for Link Canal and Feeder Pipe lines

Link	Details of Land (ha)				
	Forest Land	Culturable Land	Uncultivable Land	River Portion	Total
Par- Tapi	964.30	855.00	133.80	26.60	1979.70
Tapi-Narmada	402.00	1457.70	188.50	60.10	2108.30
Feeder Pipe lines	244.10	152.60	0.90	9.10	406.70
Total	**1610.40**	**2465.30**	**323.20**	**95.80**	**4494.70**

11.5.4 Impact on Biological Environment

11.5.4.1 Terrestrial Environment

11.5.4.1.1 Impacts on Forest Cover

i) Construction Phase: During project construction phase, labour population is likely to congregate near various construction sites. The workers and other population groups residing in the area may use fuel wood (if no alternate fuel is provided). To minimize impacts, community kitchens will be provided. These community kitchens shall use Liquefied Petroleum Gas or kerosene as fuel.

ii) Operation Phase: Total forest land to be acquired in the reservoir submergence of 6 dams viz Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan is 2829 ha. Details are given at Table- 11.16(A).

Table- 11.16(A)
Details of forest land to be acquired for the reservoirs

Sl. No.	Dam site	Forest land (ha)		
		Maharashtra	Gujarat	Total
1	Jheri	408	0	408
2	Paikhed	0	317	317
3	Chasmandva	0	300	300
4	Chikkar	0	300	300
5	Dabdar	0	614	614
6	Kelwan	0	890	890
Total		**408**	**2421**	**2829**

Total forest land to be acquired in the canal alignment is 1610 ha. Details are given at Table- 11.16(B).

Table-11.16(B)
Details of forest land to be acquired for link canal and feeder pipe line.

Sl No.	**Canal Reach**	**Forest land (ha)**
1	Par- Tapi	964.30
2	Tapi-Narmada	402.00
3	Feeder Pipe lines	244.10
	Total	**1610.40**
	Say	**1610.00**

As per the findings of the study, rare, endangered and threatened species are not reported in the study area. The impacts due to acquisition of forest land shall be mitigated through compensatory afforestation measures and implementation of a detailed set of bio-diversity conservation measures outlined in the Environmental Management Plan.

11.5.4.2 Impacts on Wildlife

i) Construction Phase: The area to be brought under irrigation within the command area is devoid of forests. The project area is interspersed with settlements and agricultural land. In such settings large scale faunal population is not observed. Thus, no significant impact on wildlife is anticipated due to the project.

Purna and Vansda Wildlife Sanctuaries are falling within the study area. The project shall not be acquired any land from these sanctuaries. However, adverse impacts on account of increased human interferences will take place during project construction phase. A detailed anti-poaching plan including surveillance measures outlined in Environmental Management Plan.

ii) Operation Phase: The following impacts on account of forest land acquisition and canal alignment shall be studied:

a) Impact due to habitat change having effect like corridor loss and loss of migratory path for wildlife including birds.

b) Impact on breeding grounds of species.
c) Impacts on access of animals to food and shelter.
d) Impacts on rare, endangered, threatened and endemic species.

11.5.4.3 Impacts on Aquatic Ecology

i) Construction Phase

a) Impact Due to Excavation of Construction Material from River Bed: During the construction phase a large quantity of construction material like stones, pebbles, gravel and sand would be extracted from the Borrow areas in the river bed. The extraction of construction material may affect the river water quality due to increase in the turbidity levels. This is mainly because the dredged material gets released during one or all the operations mentioned below:

- Excavation of material from the river bed.
- Loss of material during transport to the surface.
- Overflow from the dredger while loading.
- Loss of material from the dredger during transportation.

The dredging and deposition of dredged material may affect the survival and propagation of benthic organisms. The macro-benthic life which remains attached to the stones, boulders etc. gets dislodged and is carried away downstream by turbulent flow. The areas from where construction material is excavated, benthic fauna get destroyed. In due course of time, however, the area gets re-colonized, with fresh benthic fauna. The density and diversity of benthic fauna, will however, be less as compared with the pre-dredging levels.

The second important impact is on the spawning areas of fishes. The spawning areas of various fish species are found amongst pebbles, gravel, sand etc. The eggs are sticky in nature and remain embedded in the gravel and subsequently hatch. Any disturbance of stream bottom will result in adverse impacts on fish eggs.

Thus, if adequate precautions during dredging operations are not undertaken, then significant adverse impacts on aquatic ecology are anticipated.

ii) Operation Phase

a) Impacts Due to Damming of River: The damming of river due to construction of various dams will result in creation of reservoir of varied areas. The dam will change the fast flowing river to a quiescent lacustrine environment. The creation of a pond will bring about a number of alterations in physical, abiotic and biotic parameters both in upstream and downstream directions of the proposed dam site. The micro and macro benthic biota is likely to be most severely affected as a result of the proposed project.

b) Impacts on Migratory Fish Species: The obstruction created by the dam would hinder migration of various migratory species. These fishes undertake annual migration for feeding and breeding. Therefore, fish migration path may be obstructed due to the dams and fishes are expected to congregate below the dam wall. Under this situation poaching activities may increase in the area. Most of the species will shift to the section of the river where they find favourable environment for breeding. However, it is proposed that the artificial seed production in hatchery may be adopted which can be stocked in the river stretches downstream and upstream of the proposed dams.

11.5.4.4 Impacts on Socio-Economic Environment

i) Construction Phase

a) Impact of Influx or Migration of Labour: The construction phase will last for about 7 years. The peak labour force and technical staff required is estimated at about 5800. The total number of persons inhabiting the area including the service population will be about 14000. The project will open a large number of jobs to the local population. Job opportunities drastically improve in this area. The availability of infrastructure is generally a problem during the initial construction phase. Though the

construction workers can be subsidized for certain facilities like health, education etc. The facilities of desired quality are often not made available in the initial stages. The adequacy of water supply, sewage treatment, housing, etc should therefore, be ensured before and adequate measures would be taken at the very start of the project.

e) Impacts on Public Health due to Water Borne Diseases:

Construction Phase- The construction phase of the project could lead to increase incident of various water borne and vector borne diseases if adequate precautions / control measures are not under taken. The health risk specific to water resources projects emanate from congregation of labour at various construction sites. During construction phase, new groups come and go constantly keeping the human population in a flux. These groups are usually housed temporary dwelling without proper sanitary conditions and water supply. In the final stages, colonies for project maintenance, town ships are built. Population migration indicated by actual or possible opportunity for work can aggregate problems as a result of housing difficulties, overcrowding, raise in cost of living and some un-predicted social problems as well introduction of new sources of diseases or immigrants immunologically susceptible to the endemic diseases prevalent in the areas of development.

Many of the immigrant population could be reservoir of infection for various communicable diseases. Once they settle in labour camps / colonies, there could be increased incidence of various diseases. This aspect needs to be looked into with caution, and efforts must be made to ensure that a thorough check up of the labour population congregating in the area is conducted. Those affected by any ailments need to be properly quarantined depending on the ailment with which they are suffering.

Operation Phase- Improvement in availability of water for various uses, increased agricultural production, availability of diversified food, strengthening of educational and health facilities significantly improves public health in project area. On the other hand, water resources development also has negative impacts, since it could increase the habitat of certain vectors like mosquitoes. Malaria is a common vector borne disease in the project area. The project may create favourable conditions

for breeding of new pathogens or vectors such as mosquitoes, etc. Most of the water borne diseases can largely be prevented by adequate hygiene. With the increased water availability, quality of water being supplied is expected to improve and the incidence of water borne diseases will reduce. However, adequate measures in the form of strict public health measures are proposed.

11.5.5 Impacts on Micro Climate

The increase in surface area of water, irrigation and vegetation cover in the project area may on a local level moderate the temperature, ie lead to reduction in the number of days of high temperature, if not in the maximum temperature itself. The higher humidity as a result of higher evapotranspiration is likely to raise the minimum temperature and increased occurrence of fogs during the cooler months. The increased humidity level may also increase the instances of fog due to increased moisture content in the atmosphere. At the current level of knowledge a qualitative assessment on the above item is not possible.

11.5.6 Greenhouse Gas Emissions

The major Green House Gases (GHGs) are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These gases are emitted from both natural aquatic (lakes, rivers, estuaries, wetlands) and terrestrial ecosystems (forest, soils) as well as from anthropogenic sources. CO_2 emissions account for the largest share of GHGs equivalent of ±80-85% of the emissions. Fossil fuel combustion for transportation and electricity generation are main source of CO_2 contributing to more than 50% of the emissions. Thermal power plants represent 66% of the world's electric generation capacity. Hydropower represents about 20% of the world's electricity generation capacity and emits 35 to 70 times less GHGs per TWh than thermal power plants.

In last few years GHG emissions from freshwater reservoirs and their contribution to the increase of GHGs in the atmosphere are also being

considered as a source of greenhouse gas emissions. In the case of reservoirs, it is known that the amount of GHGs emitted at the air water interface varies over time. In fact, there is an initial peak which occurs immediately after impoundment. The increase of GHG emissions in reservoirs shortly after flooding is related to the release of nutrients, enhanced bacterial activity and decomposition of liable carbon. Magnitude of emissions for both reservoirs and natural aquatic systems depend on physico-chemical characteristics of the water body and on the incoming carbon from the watershed.

The issue of reservoir emissions has been recognized at the international level by the Clean Development Mechanism Executive Board (UNFCCC, 2006b) as well as the Intergovernmental Panel for Climate Change-2006. Beyond such preliminary developments, progress in the policy remains at a very early stage and is generally held back by a number of scientific uncertainties.

Based on available literature, greenhouse details of gas emissions from reservoirs in India are given at Table- 11.17:

Table- 11.17
Gas emissions from Reservoirs in Tropical Countries

Sl. No.	Project	Predicted Gross* Annual CO_2 Diffusive Flux (mg C-CO_2 $m^{-2}d^{-1}$)			Predicted Gross* Annual CH_4 Diffusive Flux (mg C-CH_4 $m^{-2}d^{-1}$)		
		Predicted Value	67% Confidence Interval		Predicted Value	67% Confidence Interval	
			Lower Limit	Upper Limit		Lower Limit	Upper Limit
1	Sardar Sarovar	1156	503	2659	238	67	846
2	Pong	361	157	829	55	15	195
3	Bhadra	354	154	815	62	17	220
4	Sabarigiri	361	157	830	56	16	200
5	Madhikhera	1115	485	2565	231	65	820
6	Doyang	744	324	1712	19	5	67
7	Hirakud	679	295	1561	75	21	266

11.6 Environmental Management Plan

11.6.1 Pollution Control at Construction Sites

11.6.1.1 Air Pollution Control

Control of Emissions: Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of construction equipment and material.

The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

Air Pollution Control due to DG Sets: The Central Pollution Control Board (CPCB) has issued emission limits for generators upto 800 KW. Details are given at Table- 11.18:

Table- 11.18
Emission Limits for DG Sets Prescribed by CPCB

Parameter	Emission Limits (gm/kwhr)
NO_x	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

***Note:** *Light absorption co-efficient at full load (M^{-1})*

The above standards needed to follow by the contractor while operating the DG sets. The other measures are recommended as below:

- Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:

$H = h+0.2 \times \sqrt{KVA}$
H = Total height of stack in meter
h = Height of the building in meters where the generator set is installed
KVA = Total generator capacity of the set in KVA

Dust Control: The authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (eg through direct meeting, utilization of construction management and inspection program, and / or through the complaint response program).

- Identification of constructions limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and / or swept and unpaved areas will be sprayed and / or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand and other loose materials (or required truck to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks / vehicles to move at various construction sites to be fixed.

- Dust sweeping – The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust.

Budget: An amount of Rs. 159.38 lakh is earmarked for air pollution control. Details are given at Table- 11.19:

Table- 11.19
Cost Estimate for Implementation of Air Pollution Control Measures

S.No.	Activity	Cost(Rs.) Lakh
1	5 Traffic managers @ Rs. 20000 per month per person for 7 years including 10% escalation per year	113.84
2	5 sweepers @ Rs. 8000 per month per person for 7 years including 10% escalation per year	45.54
	Total	**159.38**

11.6.1.2 Noise Control Measures

i) Noise Generation from Construction Equipments: The construction equipments, vehicles, DG sets etc shall be properly maintained and occupational safety and health standards shall be complied. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Notification will be given to residents within 100 m of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.

- Monitoring of noise levels will be conducted during the construction phase of the project.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the manufacturer which would help prevent noise levels from deteriorating with use.

ii) Noise Generation from Controlled Blasting Operations

- Controlled blasting will be done as per the provisions of Indian Explosives Act.
- Blasting will not be undertaken in night hours.
- Workers at blasting sites will be provided with proper earplugs and helmets.
- Explosives used for controlled blasting will be kept in safest custody under lock and key as per the provisions of Indian Explosives Act

iii) Noise Due to Crusher: The exposure of labour operating with crushers shall be restricted upto 30 minutes on a daily basis. Alternatively, the workers need to be provided with ear muffs or plugs, so as to attenuate the noise level near the crusher by at least 15 dB(A). The exposure to noise level in such a scenario to be limited upto 4 hours per day.

11.6.2 Water Pollution

Sewage generated from various labour camps during project construction phase shall be treated in a sewage treatment plant prior to disposal. Efforts shall be made to discharge the treated effluent only in these water bodies, which are not used for meeting domestic water requirements.

The effluent generated from the crushers will have high-suspended solids and needs to be treated before disposal. Settling tanks of appropriate size for treatment of effluent from various crushers should be provided. The sludge from the various settling tanks can be collected once in 15 days and disposed at the site designed for disposal of municipal solid wastes from the labour camps. The sludge after drying could also be used as cover material

for landfill disposal site. An amount of Rs. 60 lakh needs to be earmarked for construction of various settling tanks.

11.6.3 Land Management Plan

11.6.3.1 Disposal of Muck and Reclamation of Muck Disposal Sites

The Par-Tapi-Narmada link project envisages construction of 6 dams, 2 barrages, 6 power houses, 1 tunnel of 12.70 km long and 406.118 km long link canal system including 5 Nos. of tunnels along the canal alignment of total length of 1.15 km and large number of CD/CM structures. A large quantity of muck is expected to be generated as a result of tunnelling operations and excavations for foundation of these dams barrages and canal. Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck can be used as construction material and balance muck requires being suitably disposed in muck disposal sites in the project area. The muck disposal sites are planned along the river course and in low level areas or depressions. The dumping of muck will be done in the scientific manner by providing appropriate protection walls with deep foundations so that muck will not flow and washed away in the river. Protection structures in the form of masonry work, crate work and check dam will also be provided wherever necessary in order to avoid the chances of soil erosion and to ensure flow of silt free water. Besides these engineering measures, proper plantation will be done at the dumping sites for reclamation of the dumping areas.

Muck generally lacks nutrients and therefore, is difficult to re-vegetate. However, if no attempts to vegetate the slopes are made, the muck could slide lower down during rain and may eventually wash off the check dams also. Bio-fertilizer technique developed by National Environmental Engineering Research Institute can be adopted in the proposed project. Unused excavated material will be piled and stacked with proper slopes at the designated muck disposal sites. The slopes are broken up by creating benches across them. This is done to provide stability to the slopes and also to provide ample space for planting of trees that would further help in holding and consolidating biotechnological approach. The afforestation with suitable plant species shall be done in consultation with the forest Departments of Gujarat and Maharashtra. A provision of Rs. 870 lakh has

been kept towards restoration of muck disposal sites near dam sites and a provision of Rs.2391.67 lakh along the link canal.

11.6.3.2 Restoration Plan for Quarry Sites

The proposed Par-Tapi-Narmada link project would involve construction of dams, barrages, canal, tunnels / adits, power houses, colonies for staff and labourers, and other various components. During construction, these activities could also result in accumulation of large amount of unused material at various sites which require proper restoration measures. This land also includes areas likely to be disturbed due to quarries and dumping of unused muck, dam area. The existing landscape will be totally modified or changed due to proposed project. Therefore, all areas disturbed by construction activity will be landscaped to reflect natural contours and encourage the re-establishment of vegetation.

Disturbed Sites and their Restoration: Construction activities like roads, quarry sites, project colonies, workshops, offices etc. will change the existing land use / land cover in the region. After completion of the construction work, it is required to restore the disturbed areas to its original condition wherever it is possible. Various engineering and biological measures have been suggested for the restoration of these areas. Proposed mitigation measures will also help to arrest soil erosion in the region.

Quarrying Operation: A project of this magnitude would require significant amount of construction material. The aggregate requirement for concrete is proposed to be met from nearby quarries. The proposed project would require significant amount of fine material, which shall be met by crushing the aggregates.

The quarrying operations are semi-mechanised in nature. Quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential sources of landslide. Thus it is necessary to implement appropriate

slope stabilisation measures to prevent the possibility of soil erosion and landslides in the quarry sites.

After excavation of the required material, these quarry sites will require restoration. Appropriate engineering, bio-engineering and biological methods are proposed for effective restoration of the quarry sites.

Engineering and Bio-Engineering Measures: Opening of the quarries will cause visual impacts because they remove a significant part of the hills. Other impacts will be the noise generated during aggregate acquisition through explosive and crushing, which could affect wildlife in the area, dust produced during the crushing operation to get the aggregates to the appropriate size and transport of the aggregates and transport of material to the nearby project sites. The quarrying for rock material in the proposed project would lead to removal of vegetation cover, top soil and leave the area barren. After the completion of mining activity, these areas will be restored to their normal habitat conditions.

Standard mitigation measures against erosion and sedimentation, noise and air pollution will be taken in particular for the use of explosive. At the end of the exploitation, quarries will be rehabilitated. This will include re-establishment of vegetation, restoration of natural watercourses, avoidance of flooding of the excavated areas, achievement of stable slopes, and avoidance of features, which would otherwise constitute a risk to health and safety or a source of environmental pollution.

The measures adopted for landscaping of these quarry sites and borrow area have been described in the following paragraphs.

Measures to be Adopted before Quarrying: The top soil (top 6 – 12 inch soil) should be removed before excavating the sand or rocks from the quarry sites. This soil contains all microbes (including earthworms) and important nutrients and organic matters which will be required at the time of restoration of these quarry sites.

Measures to be adopted after Quarrying:

- **Diversion of Run-off-** Effective drainage system will be provided to avoid the infiltration of run-off and surface waters into the ground of quarry sites.

- **Filling of Depressions-** The craters formed at the quarry sites will be filled with dumping materials consisting of boulders, rocks, gravels and soil from the nearby sites. After filling these craters, the top soil collected prior to quarrying will be spread as top layer. The top soil then should be covered with geo-textiles like coir, jute or by other locally available bio-degradable material. This will protect the top soil from erosion.

- **Construction of Retaining Walls-** Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particular where there are moderately slopes.

- **Rocks for Landscaping-** After the quarrying activities are over, these sites will be splattered with the leftovers of rocks and boulders. These boulders and rocks can support the growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization. The boulders of moderate size will be used to line the boundary of a path.

- **Laying of the Top Soil-** The depressions / craters filled up with rock aggregates will be covered with top soils. Fungal spores naturally present in top soil will aid plant growth and natural plant succession. The top soil will be further enriched by organic manure and Vesicular-Arbuscular Mycorrhizal (VAM) fungi. This will help in the process of soil reclamation and the early establishment of juvenile seedlings.

- **Re-vegetation-** The work plan for re-vegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach' would be based upon the following parameters:

    i) Evaluation of rock material for their physical and chemical properties to assess the nutrient status to support vegetation.

ii) Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.

iii) Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculums) suitable for the mined out sites.

iv) Mass culture flant specific biofertilizer and mycorrihizal fungi to be procured from different institutions / organizations which are engaged in the phyto-remediation activity of degraded areas.

v) Plantation at quarry sites / areas using identified blend and biofertilizer inoculums.

A provision of Rs. 736 lakh has been earmarked for quarry slope stabilization. Details are given at Table- 11.20:

Table- 11.20
Cost Estimate for Restoration of Quarry Site and Borrow Area

Sl. No.	Activities / Purpose	Cost (Rs. in lakh)
1	Filling up the land with soil	129
2	Cost of green manure	43
3	Cost of sapling (10000 saplings / ha)	26
4	Cost of fertilizers and pesticides	86
5	Fencing with RCC pillars and barbed wire	214
6	Maintenance activities including cleaning of weeds @ Rs. 2 lakh / year for 5 years	21
7	Digging of pits	3
8	Construction of garland drains	214
	Total	**736**

11.6.3.3 Restoration of Colony and Office Complex

The working area of dam site, Labour colony, Project colony areas have been selected for beautification of the project area after construction is over. The reservoir created due to the construction of dam may be a local point of tourist attraction. This could be used for sport fishing, so there is a need to construct benches for sitting, development of resting sheds and footpath. The beautification would be carried out by developing flowering beds for plantation of ornamental plant and flower garden.

There would be sufficient open space in power house complex and colony area. Forested area in the power house complex would provide aesthetic view and add to natural seismic beauty. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

A provision of Rs. 102 lakh has been earmarked for landscaping and beautification of the area.

- Implementing Agency: It should be mandatory in the scope of work of the contractor to restore the construction sites and implement various reclamation measures.
- Budget: A total provision of (736 + 102) Rs. 838 lakh has been earmarked for Restoration of quarry and borrow area, reclamation of construction sites landscaping and beautification.
- A provision of Rs.42 lakh has been earmarked towards landscaping along the link canal.

11.6.4 Biodiversity Conservation and Management Plan

11.6.4.1 Compensatory Afforestation

As already described in preceding paras total 4439.40 ha (2829 ha due to submergence of 6 reservoirs and 1610.40 ha due to canal alignment) forest area will be affected. No rare, endangered and threatened species are reported in the project area. To compensate the forest land the afforestation will be done in 8878.80 ha (double the area of forest land likely to be affected ie due to reservoirs 5658 ha and for canal alignment 3220.80 ha) in degraded forest land as per the provisions of Forest (Conservation) Act, 1980. The afforestation work is to be done by the Forest Department of concerned State Governments. A provision of Rs. 11459.76 lakh (Rs. 6789.60 lakh towards reservoirs plus Rs.4670.16 towards canal alignment) has been kept for compensatory afforestation. In addition the NPV and cost of trees will be paid to the Forest Department, which shall be estimated by the Forest Department, as a part of Forestry clearance.

11.6.4.2 Biodiversity Management Plan

i) Forest Protection Plan: About 4439.40 ha (2829 ha due to submergence of 6 reservoirs and 1610.40 ha due to canal alignment) of forest area is proposed to be acquired for Par-Tapi-Narmada link project. The following measures are proposed as a part of Forest Protection Plan:

- Under the reward for informers programme, it is proposed to engage the workers who are well acquainted with the area and will be resourceful in gathering information for anti-poaching and better vigilance. These youth could be hired on a contractual basis.
- Arrangement of an office for this purpose would be essential to monitor all these activities.
- Organizing public awareness programmes, conducting training camps, preparation of pamphlets, brochures, hoardings etc.
- Provision of fire lines within critical areas to protect the forest from accidental fires.
- For improvement of vigilance and measures to check poaching, check posts and watch towers will be needed. In order to strengthen the working capacity of the officers the equipments such as a camera, wireless, binoculars and other minor equipments (spot scope, search lights, sleeping bags, health kits etc) shall be provided.
- Construction of bridges, roads, inspection paths for more effective and meaningful patrolling of the staff shall be undertaken.
- Improvement of vigilance by procurement of field vehicles and motorbikes.
- Creation of veterinary facilities and rescue camps for healthcare of wild animals and for controlling diseases. For this purpose it is essential to maintain a stock of medicines in addition to setting up of a mobile-rescue-cum-publicity-van.
- An amount of Rs.1200 lakh has been earmarked for implementation of Forest Protection Plan. Details are given at Table- 11.21:

Table- 11. 21

Cost Estimates for the Forest Protection Plan

Sl. No.	**Measure**	**Budget (**Rs.**in lakh)**
1	Provision of fire lines within critical areas	429
2	Construction of bridges and patrolling paths	257

3	Mobile rescue van	206
4	Creation of veterinary facilities and rescue camps	308
	Total	**1200**

ii) Safeguards during Construction Phase: During the construction phase, various adverse impacts on the forests and wildlife are anticipated in the surrounding areas of the proposed project in terms of increased noise levels, land vibrations during controlled blasting, air pollution etc. To avoid and minimize the negative impacts from these activities project authorities are advised to prepare strict guidelines as follows:

- Strict restrictions shall be imposed on the workers at project sites to ensure that they do not harvest any species / produce from the forests and cause any danger or harm to animals and birds in wilderness area.
- The fuel wood to the labourers shall be provided by the project proponents so that there is no pressure for cutting of trees to meet fuel wood requirements.
- The interference of human population would be kept to a minimum in the adjacent forest areas and it would be ensured that the contractors do not set up labour colonies / camps in the vicinity of forests and wilderness areas.
- Only well maintained / new equipment that produces lesser noise would be installed at the work sites.
- The best way to control the noise is at source. Certain equipment that needs to be placed permanently at one place like generators etc would be housed in enclosed structures to cut off the noise.
- The heavy equipment like rotating or impacting machines will be mounted on anti-vibration mountings.
- Wherever combustion engines are required they will be fitted with silencers.
- The traffic (trucks etc) used by the project works will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training / orientation will be provided to the traffic operators / drivers. Sounding of loud horns etc in the forested areas should be banned. Project authorities will use water sprinklers on the road to avoid the dust from constructions activities.
- While clearing the land of vegetation for any project work, the project

authorities will ensure that the work area has sufficient layer of tree cover around it. It will act as an effective noise absorber and dust barrier. The tree layer will act as buffer zone and these are known to cut off noise by about 5 – 20 dB at a site depending upon the density of vegetation. These measures will be planned in advance and well before starting operation at any site.

iii) Measures to Improve Habitat of Avi-fauna: Forests are vital for survival, foraging, breeding and nesting of avifauna. Natural forests provide a variety of food material to birds not only in the form of nectar of flowers, fruits, seeds etc. in the trees, shrubs, herbs and grasses but they also contain a large number of insects eaten by birds. In the forests, food is always available for the faunal component. Although most floral species flower during spring through summer but fruit maturation and seed ripening takes place in them throughout the year. Therefore, first strategy of improvement of habitat for birds is avoiding nest predation or brood parasitism through maintenance of large contiguous forest tract. These areas have ability to support the largest number of forest interior birds and will also be more likely to provide habitat for area sensitive species. It is more practicable to protect existing forest area rather than creating new forest area.

Another measure for habitat improvement for avifauna is to be installation of artificial nest boxes in the influence zone and catchment area of the project after consultation with the forest department as well as local Non-Governmental Organisations. These nest boxes have been found to be quite beneficial for attracting hole nester birds. The size and capacity of boxes vary from one species to another.

It is proposed to provide wooden boxes around water bodies in the study area. About 200 nest boxes are proposed to be kept along the periphery of six reservoirs. It is proposed that five qualified person be hired for a period of 7 years. An amount of Rs. 171.84 lakh can be earmarked for habitat improvement of avi-fauna in the study area. Details are given at Table-11.22:

Table- 11.22

Cost of Habitat Improvement for Avi-fauna in the Study Area

Sl. No.	Particulars	Amount (Rs. in lakh)
A	**Non-recurring cost**	
1	Cost of nests of different sizes (10'x10'x to 20'x20') average cost Rs. 1000 per wooden box and installation of 1200 wooden boxes	12.00
2	Repair and maintenance of the nests	6.00
B	**Recurring cost (for 7 years)**	
1	Salary for 5 skilled persons @ Rs. 20000 per month for implementation and data collection including 10% escalation for 7 years	113.84
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	40.00
	Total (A+B)	**171.84**

iv) Wildlife Management Plan: An amount of Rs.500 lakh has been earmarked for implementation of Wildlife Management Plan. Details are given at Table- 11.23:

Table- 11.23

Cost estimates for Wildlife Management Plan

Sl. No.	Measure	Budget (Rs. in lakh)
1	Wildlife survey	100
2	Immunization of wildlife	100
3	Rehabilitation of a small wildlife health cum ex-situ conservations centre	200
4	Awareness, education and training	100
	Total	**500**

v) Anti-poaching Measures: There are no ecologically sensitive areas around the project sites. However, the forests at the site and in the vicinity serve as a habitat for wildlife. Due to construction activities and increased human interferences, as a result of immigration of large labour population and their family members, some adverse impacts may take place on wildlife during construction phase; the increased human interferences can have adverse impact on wildlife in and around the project area

It is recommended that check posts should be installed near major construction sites and labour camps which shall be operational during construction phase. It is proposed to develop 10 (ten) check posts to implement anti-poaching measures during project construction phase. Each check post shall have 3 guards to ensure that poaching does not take place in the area. The guards will be supervised by a range officer. It is also recommended that the staff manning these check posts have adequate communication equipment and other facilities. Apart from inter-linking of check posts, communication link needs to be extended to Divisional Forest Office and the local police station also.

vi) Purchase of Anti-poaching Kits: To capture and translocate wild animals out of human habitations or agricultural lands, various trapping equipments pertaining to anti-poaching activities are needed. In the absence of these the staff faces difficulties and all efforts made on this behalf are futile. For this an amount of Rs.60 lakh has been earmarked. The anti-poaching kits will include equipments for self defence of the staff as well.

vii) Infrastructure Development: This includes anti-poaching huts, rock shelters development and residential quarters for forest guards. For effective monitoring, one watch tower is also proposed to be established at an identified place having high pressure of biotic interference. These are the basic amenities for the field staff to enable them to do effective patrolling in the areas. For watch tower and accommodation an amount of Rs.100 lakh has been earmarked.

viii) Purchase of Survey Equipment and Vehicle: In order to improve network and vigilance it is required to procure equipment like V-SAT and to document and develop a database IT infrastructure like laptops, LCD projectors, altimeters, GPS, spot scope, binoculars, video as well as digital still cameras are essential. Purchase of field vehicle will help in increased vigilance. For better communication and purchase of survey equipment an amount of Rs.200 lakh has been earmarked.

ix) Construction of Check Posts: To improve vigilance for anti-poaching, better protection, enforcement for control grazing practices is necessary. For

the construction of control-grazing-cum-anti poaching checks posts, amount of Rs.50 lakh has been earmarked.

Total Rs. 706 lakh has been earmarked for this purpose. Details are given below:

a)	Salary	
	i) 30 Guards @ Rs. 8000 per month for 1 year	28.80
	ii) 1 Range officer @ Rs. 20000 per month for 1 year	2.40
	Total cost for one year	31.20
	Cost for 7 years (assuming 10% increase per year)	296.09
b)	Purchase of anti-poaching kits	60.00
c)	Infrastructure development	100.00
d)	Purchase of Survey equipment and Vehicles	200.00
e)	Construction of check posts	50.00
	Total	Rs.**706.09 lakh**
	Say	**Rs. 706 lakh**

x) Eco-Tourism: The reservoirs will have great tourism potential and it can create many income generating resources to the local people in many ways viz; boating, angling competition, guide, creation of the paying guest houses, travellers' tour packages to the nearby sightseeing places, development of camping sites, birds watching etc. This shall be linked with the ecology environment of the reservoir. For tourism development, brochures, pamphlets, signage, models, opening of the tourism information centres, Telescopes, Binoculars, computerized data, trekking routes and their stay arrangements etc shall be required.

The following activities are proposed for the development of the eco-tourism zone:

- Create interest for birds by Bird watching
- Develop infrastructure for perform various water sports activities such as Boating etc.
- Infrastructure for stay of tourists
- Provision of house boats, paddle boats
- Distribution of plants for plantation on community and private lands
- Distribution of fruit tray for planting on private lands

- Training to locals viz Bird watching, Boating, Catering, Tourist guides etc.

As such, proposed reservoirs will be developed as Eco-tourist spot. A provision of Rs.418 lakh has been earmarked for development of eco-tourism. Details are given at Table- 11.24:

Table- 11.24
Budgetary Estimate for Development of Eco-tourism

Sl. No.	**Items of Expenditure**	**Amount (**Rs. **in lakh)**
1	Purchase of House boat, Battery operated boat and Motor boat, computers, GPS etc.	300
2	POL for vehicles, boats, generators etc including hiring of vehicle in apprehending of poaching cases	60
3	Training to locals viz Bird watching, Boating, Catering, Tourist guides etc	58
	Total	**418**

xi) Budget for Biodiversity Conservation and Management Plan: A total provision of Rs.2995.93 lakh has been earmarked for biodiversity conservation. Details are given at Table- 11.25:

Table- 11.25
Budgetary Estimate for Biodiversity Conservation and Management Plan

Sl. No.	**Particulars**	**Amount (**Rs. **in lakh)**
1	Forest Protection Plan	1200.00
1	Measures to improve habitat of avi-founa	171.84
3	Wildlife Management Plan	500.00
4	Anti-poaching measures	706.09
4	Tourism Development	418.00
	Total	**2995.93**

11.6.5 Green Belt Development Plan

Forest loss due to reservoir submergence and other project appurtenances have been compensated as a part of compensatory afforestation. However in addition to above, it is proposed to develop greenbelt around the periphery of various project appurtenances, selected stretches along reservoir periphery, etc. The greenbelt development plan aims to overall improvement in the environmental conditions of the region. The plan with a five-fold objective addresses issues such as prevention of land degradation due to activities during construction phase; enhancing the forest cover for increasing the biodiversity of the region; providing aesthetic value to the project area and consequently inviting a proportionate tourist flux; enhancing the ecological equilibrium of the area; and to a large proportion in combating soil erosion. A provision of Rs.216 lakh has been kept for Green belt Development on the periphery of reservoirs and Rs.480 lakh has been kept for green belt plantation along link canal. The plantation for this purpose will be carried out by Forest Departments of Gujarat and Maharashtra.

11.6.6 Environmental Management in Labour Camps

The aggregation of large number of workers in the project area during the construction phase is likely to put considerable stress on the prevailing biotic and abiotic environment of the area. The stress could be on account of increased water demand, sewage and solid waste generation, fuel wood requirements etc. The aim of the Environmental Management Plan is to minimize these stresses. The construction activities are likely to be concentrated at various locations at dam sites and along the canal alignment. The estimated peak labour force including technical staff for the proposed project is around 5800. The total increase in population considering the fact that some of the labour will be staying along with their families shall be about 14000. Community kitchens will be provided to worker families and the kerosene / Liquefied Petroleum Gas will be provided at subsidised rates.

It is proposed that each of the labour family involved in the construction activities shall be provided living units of 30-40 m^2 with proper ventilation. Adequate facilities for water supply and sanitation shall also be provided. One community toilet needs to be provided for 20 persons. The wastewater generated from the colonies will be collected and disposed in specifically designed soak pits and Septic tank. The wastewater and sewage

generated will not be allowed to flow into the rivers and streams of the area. The sanitary facilities at the colonies should be of standard municipal design for hill areas. However, efforts shall be made to ensure, that treated effluent is disposed only in these water bodies, which are not used for meeting domestic water requirements. Adequate facilities for collection and conveyance of municipal wastes generated to the disposal site shall be developed. At each labour camp, covered trailers to collect the solid waste from the common collection point and transfer it to the disposal site needs to be put to service.

All necessary safety appliances such as helmets, masks, ear plugs, etc. shall be provided to the workers and staff. The regulations regarding working platforms, excavations, trenches and safe means of entry and egress shall be strictly complied. Efficient lighting and safety signs shall be installed on temporary roads during construction and adequate traffic regulations shall be adopted and implemented for temporary roads. All facilities to be constructed shall be fully equipped with the fire protection equipments as per IS standards. A provision of Rs. 6217.61 lakh is kept for implementation of various environmental measures in labour camps.

11.6.7 Public Health

i) Control of Malaria: Increase in water fringe area provides suitable habitats for the growth of vectors of various diseases, which is likely to increase the incidence of water-related diseases. Malaria could be the major in the months of Sept and March. The preferred habitat is stagnant or slow moving fresh water open to vector-borne disease in the area. The main breeding seasons of the anopheline mosquito (malaria vector) is sunshine or moderate shade. Mosquito control and mosquito proofing measures have been recommended to control malaria. The anti-malarial operations can be coordinated by various Primary Health Centres located in villages close to the submergence area of the dams.

ii) Development of Medical Facilities: It is proposed to develop 3 first-aid posts manned by a doctor each and supporting staff during construction phase. The first-aid posts should be located such that they are close to major construction sites. The doctor posted at the first-aid posts shall also coordinate the anti-malarial campaign be carried out under his immediate

personal supervision. A systematic campaign shall be conducted in the months of March and Sept which are the breeding months of mosquito.

There shall be regular fumigation and sprays of insecticides in the areas where water is likely to be stagnant, to prevent the growth of malarial larvae. The project proponents shall seek an expert opinion before selecting the appropriate insecticide for malaria control. The National Centre for Communicable Diseases, Delhi can provide assistance to the State government in the matter.

iii) Health Extension Activities: The health extension activities will have to be carried out in the villages situated close to the dams being developed as a part of the project. There would be possibility of the transmission of communicable diseases due to migration of labour population from other areas at the construction site. The doctors from the dispensary constructed as a part of the project and other dispensaries in various villages in the project area will make regular visits to the villages and organize health promotional activities with the active participation of the local village leaders, Non-Governmental Organisations and available local health functionaries.

iv) Water-borne Diseases: Following measures are recommended for control of water-borne diseases:

- Details of incidence of various water-borne diseases in the project areas be collected and analysed to defect any particular trend.
- A detailed water quality monitoring programme be designed and implemented. In areas showing incidence of water-borne diseases, intensive water quality monitoring shall be done.

v) Disposal of Bio-Medical Waste: Dispensaries use a variety of drugs including antibiotics, cytotoxics, corrosive chemicals etc. a part of which is generated as a solid waste. With greater emphasis on disposables, the quantum of solid waste generated in a hospital is quite high. The bio-medical waste must be segregated in accordance to the guidelines laid under Schedule-I of Bio-medical Waste (Management and Handling) rules notified

by Ministry of Environment and Forests. The bio-medical waste shall be treated prior to its disposal.

vi) Cost Estimates: The total budget earmarked for Public Health delivery system shall be Rs. 2062.98 lakh towards labour camps at head works and Rs.7665 lakh towards camps along the link canal. Provision of free fuel or at subsidized rate to labour engaged departmentally at camps along link to avert biological loss shall be Rs.50.00 lakh.

11.6.8Catchment Area Treatment Plan

11.6.8.1 Approach for the Study

Various thematic maps have been used in preparation of the Catchment Area Treatment Plan. Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, not all areas contribute equally to the erosion problems. In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted. The various steps covered in the study are as follows:

- **Data Acquisition**

The requirement of the study was first defined and the outputs expected were noted. The various data layers of the catchment area used for the study are as follows.

- Slope map
- Soil map
- Land use classification map
- Current management practices
- Catchment area map

- **Data preparation**

The ground maps, contour information etc were scanned, digitized and registered as per the requirement. In the present study, IRS 1C-LISS III digital satellite data was used for interpretation and classification. The classified land use map of the catchment area considered for Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs.

- **Output presentation**

The result of the modelling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

11.6.8.2 Estimation of Soil Loss using Silt Yield Index (SYI) Method

The Silt Yield Index is defined as the yield per unit area and Silt Yield Index value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation. Details are given at Table- 11.26:

Table- 11.26
List Showing Priority Categories and SYI Values

Priority categories	SYI Values
Very high	>1300
High	1200 – 1299
Medium	1100 – 1199
Low	1000 – 1099
Very low	<1000

11.6.8.3 Catchment Area Treatment Measures

The erosion category of various watersheds in the catchment area as per a SYI index for Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs is given at Table- 11.27:

Table- 11.27
Erosion Intensity Categorization as per SYI Classification in Catchment Area

Watershed Number	Area (ha)	SYI Value	Category
Jheri Dam			
W1	1787	1160	Medium
W2	1602	1220	High
W3	3545	1230	High
W4	885	1110	Medium

Watershed Number	Area (ha)	SYI Value	Category
W5	1444	1170	Medium
W6	2434	1220	High
W7	1305	1150	Medium
W8	1113	1160	Medium
W9	1955	1230	High
W10	1827	1180	Medium
W11	1205	1170	Medium
W12	937	1180	Medium
W13	1667	1150	Medium
W14	943	1210	High
W15	1971	1170	Medium
W16	3686	1240	High
W17	1169	1150	Medium
W18	1796	1210	High
W19	1222	1220	High
W20	2134	1230	High
W21	1918	1240	High
W22	1689	1220	High
W23	1402	1150	Medium
W24	1265	1210	High
W25	1600	1160	Medium
Total	**42500**		
Paikhed Dam			
W1	1889	1170	Medium
W2	823	1180	Medium
W3	1387	1150	Medium
W4	1765	1160	Medium
W5	1759	1210	High
W6	2182	1220	High
W7	1194	1240	High
W8	3433	1180	Medium
W9	3456	1210	High
W10	2595	1170	Medium
W11	1421	1220	High
W12	2314	1220	High
W13	3071	1210	High
W14	1347	1170	Medium
W15	932	1180	Medium
W16	812	1150	Medium
W17	1122	1150	Medium

Watershed Number	Area (ha)	SYI Value	Category
Total	**31500**		
Chasmandva Dam			
W1	597	1240	High
W2	1078	1180	Medium
W3	1171	1170	Medium
W4	957	1150	Medium
W5	486	1090	Low
W6	1108	1210	High
W7	895	1210	High
W8	1300	1180	Medium
W9	889	1240	High
W10	419	1250	High
Total	**8900**		
Chikkar Dam			
W1	668	1070	Medium
W2	1869	1120	High
W3	2006	1220	High
W4	644	1210	Medium
W5	949	1220	Medium
W6	832	1150	High
W7	705	1180	Medium
W8	725	1220	Medium
W9	1328	1180	High
W10	1772	1170	Medium
W11	1454	1210	Medium
W12	1358	1230	Medium
W13	834	1260	Medium
W14	1220	1180	High
W15	596	1220	Medium
W16	1449	1210	High
W17	1422	1210	Medium
W18	1778	1180	High
W19	1772	1090	High
W20	1216	1120	High
W21	1351	1180	High
W22	1206	1150	High
W23	1407	1150	Medium
W24	801	1220	High
W25	888	1140	Medium
W26	1420	1180	Medium

Watershed Number	Area (ha)	SYI Value	Category
W27	630	1130	Medium
Total	**32300**		
Dabdar Dam			
W1	2219	1250	High
W2	2295	1210	High
W3	4093	1210	High
W4	823	1170	Medium
W5	938	1220	High
W6	1566	1180	Medium
W7	2052	1230	High
W8	3085	1150	Medium
W9	2096	1180	Medium
W10	2052	1160	Medium
W11	3069	1220	High
W12	1856	1170	Medium
W13	3981	1260	High
W14	2330	1150	Medium
W15	2753	1210	High
W16	2094	1220	High
W17	1640	1160	Medium
W18	2681	1130	Medium
W19	2236	1140	Medium
W20	1407	1230	High
W21	1474	1160	Medium
W22	1459	1150	Medium
Total	**48200**		
Kelwan Dam			
W1	3034	1120	Medium
W2	1974	1050	Low
W3	2978	1080	Low
W4	2447	1210	High
W5	1945	1040	Low
W6	1087	1170	Medium
W7	3840	1220	High
W8	3372	1180	Medium
W9	3332	1150	Medium
W10	2200	1230	High
W11	2767	1230	High
W12	2606	1050	Low
W13	1991	1050	Low

Watershed Number	Area (ha)	SYI Value	Category
W14	3711	1090	Low
W15	3315	1150	Medium
W16	2952	1210	High
W17	6180	1250	High
W18	2309	1210	High
W19	3399	1220	High
W20	3085	1180	Medium
W21	3863	1120	Medium
W22	2071	1170	Medium
W23	3100	1180	Medium
W24	2448	1210	High
W25	3294	1150	Medium
Total	**73300**		

Area under different Erosion Categories upto Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dam catchments is summarised at Table- 11.27:

Table- 11.27
Area under Different Erosion Categories

Unit: ha

Dam	Category	Very Low	Low	Medium	High	Very High	Total
Jheri	Area(ha)	-	-	18311	24189	-	**42500**
	%age	-	-	43.09	56.91	-	**100.00**
Paikhed	Area(ha)	-	-	16105	15395	-	**31500**
	%age	-	-	51.13	48.87	-	**100.00**
Chasmandva	Area(ha)	-	486	4506	3908	-	**8900**
	%age	-	5.46	50.63	43.91	-	**100.00**
Chikkar	Area(ha)	-	-	15472	16828	-	**32300**
	%age	-	-	47.90	52.10	-	**100.00**
Dabdar	Area(ha)	-	-	23298	24902	-	**48200**
	%age	-	-	48.34	51.66	-	**100.00**
Kelwan	Area(ha)	-	15205	29553	28542	-	**73300**
	%age	-	20.74	40.32	38.94	-	**100.00**

The Objective of the SYI method is to prioritize sub-water shed in a catchment area for treatment. Area under high erosion category in Jheri

dam 24189 ha, in Paikhed dam 15395 ha, in Chasmandva dam 3908 ha, in Chikkar dam 12238 ha, in Dabdar dam 24902 ha and in Kelwan dam 28542 ha. Various engineering and biological measures have been suggested for catchment area treatment categorised in the high erosion category of watersheds upto Jheri 12, Paikhed 7, Chasmandva 5, Chikkar 12, Dabdar 10 and Kelwan 9. Total cost of the catchment area treatment plan worked out as Rs. 4814 lakh.

11.6.8.4 Silt Transfer

The yield received from rains in the catchment area would be stored in reservoir and then let out into the link canal through the upper level tunnel. Normally, the silt transported from the catchment area would settle down into the lower layers and finally to the bottom and the top silt free water would be admitted into the link canal. However, during monsoon season the flood waters due to heavy rain fall would be laden with more suspended silt which would require mitigative measures. Silt excluders need to be built at the head regulator of main canal and branch canals. The silt excluders shall extract silt from the water and lead it to the river or other natural drainage through a tail race.

Silt escape or bed escapes, provided with vents and gates, need to be provided on the link canal nearer to the streams or rivers at suitable location. Even after providing silt excluders and silt escapes, some quantity of suspended silt still shall get deposited on the bed of link canal. Every year during the closure period of the canal, the deposited silt would have to be removed from the bed of the canal in order to avoid growth of weeds. Since the bed of the canal shall be entirely lined, desilting can be done with ease. A provision of Rs.2436.67 lakh has been kept for measures to arrest transportation of silt across basins.

11.6.9 Disaster Management Plan

Dam Break may be summarized as partial or catastrophic failure of a dam leading to uncontrolled release of water. Such an event can have a major impact on the land and communities downstream of the failed structure. A dam break may result in a flood wave up to several meters high

travelling along the valley at very high speed. The impact of such a flood wave on the inhabitation downstream areas can be disastrous and may sweep away infrastructure such as roads, railways, bridges and buildings, in addition to endangering several human lives and livestock. Such destructive force results in heavy loss of life and property, if advance warning and evacuation is not made. Keeping all these in view, the disaster preparedness for such likely events is necessary.

The disaster Management Planning for dam break scenario consist of: Identification / construction of Evacuation path; setting up of alarms and warning systems at appropriate locations; establishing communication system; Dam safety and maintenance manual; Emergency Action Plan (EAP); Administration and procedural aspects; Preventive action; Evacuations plans; Evacuations team; Public awareness for disaster mitigation; Notifications; Notification procedures and Management after receding of flood water.

In the event that the failure is imminent or the failure has occurred or a potential emergency conditions is developing, the observer at the site is required to report it to the Junior Engineer / Assistant Engineer who will report to the Executive Engineer / Superintending Engineer for their reporting to the Chief Engineer through a wireless system or by any available fastest communication system. The Engineer-in-Charge is usually responsible for making cognizant with the developing situation to the Civil Administration viz., District Magistrate and concerned sub-divisional magistrates and tehsildars.

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared the whole State machinery will come into swing and will start evacuating people in the inundation areas delineated in the inundation maps. For successful execution, annually demo exercise will be done. The District Magistrate is to monitor the entire operation. A provision of Rs. 654 lakh has been kept for implementation of dam break management plan for mitigation and prevention of hazard from the dams.

11.6.10 Energy Conservation Measures

Various construction and other activities of the proposed Par-Tapi-Narmada link project would lead to increased demand for fuel wood in the project area and its vicinity and would therefore exert pressure on forest areas located around the project. The major source of energy in the villages of the project area is fuel wood, acquirement of which is one of the main causes of ecological degradation and human drudgery. It is estimated that during the construction of the project, which would last for about 7 years, around 5000 labourers will be working. Majority of the labour force will be outsiders and it will be very important to meet their energy requirement in an ecologically sustainable manner.

To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests. Further, community kitchen facilities would also be provided to the labourers by the contractors. In addition to above, efforts would be made towards energy conservation by installing non-conventional energy sources. Energy conservation measures would be implemented to ensure that the use of non-renewable resources is minimized. A key component of achieving energy conservation would be the development of an Energy Management Action Plan. This plan would be included as part of the Construction and Operational EMPs. The Energy Management Action Plan would be consistent with the energy conservation measures during both construction and operation phase.

11.6.10.1 Energy Conservation during Construction Phase

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize equipment idle time and double handling of material
- Throttling down and switching off construction equipment when not in use

- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes.
- Careful design of temporary roads to reduce transportation distance
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency.
- The specification of energy efficient construction equipment.

11.6.10.2 Energy Conservation during Operation Phase

The following energy conservation measures would be implemented during operation phase:

- Use of CFL lights up to maximum possible extent.
- Awareness about the use of CFL lights by locals.
- Development of heating, cooling and lighting use in buildings through climate-responsive design and conservation practices.
- Employing renewable energy sources such as day lighting and passive solar heating.
- Optimizing building performance and system control strategies, such as controlling lights with occupancy sensors and controlling comfort.
- Maximizing the use of solar power for signage and pedestrian lighting.
- Designing roads on site to reduce transportation distances.

11.6.10.3 Budget

An amount of Rs. 440 lakh has been earmarked for implementation of Energy Conservation Measures.

11.6.11 Environmental Monitoring Programme

Environmental Monitoring is an essential tool in relation to environmental management as it provides the basis for rational management decisions regarding impact control. Environmental monitoring shall be performed during construction, commissioning and operation phases to

ensure that the adverse impacts have been mitigated efficiently and to verify the impact predictions. The monitoring program will indicate where changes to procedures or operations are required, in order to reduce impacts on the environment or local population. The monitoring program will be undertaken to meet the following objectives:

- To monitor the environmental conditions of reservoirs areas and areas benefited and impacted by the project
- To check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice
- To provide information on the actual nature and extent of key impacts
- Effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of future, similar projects.

From the monitoring point of view, the important parameters are water quality, air quality, noise, erosion and siltation, afforestation, fishery, etc. An attempt will be made to establish early warning of indicators of stress on the environment. Suggested environmental monitoring plans are described in the following sections. The environmental monitoring programme during construction phase is at Table- 11.29:

Table- 11.29

Environmental Monitoring Programme during Construction Phase

Sl. No.	Particulars	Parameters	Frequency	Location
1	Treated waste water from STPs	pH, BOD, COD, TSS and Oil and Grease	Once in a month	Before and after treatment from STPs at various labour camps
2	Ambient Air quality	SPM, RPM, SO_2, NOx and CO	Once in a season	Major Construction sites
3	Noise	Equivalent noise level (Leq)	Every month	Major Construction sites

Sl. No.	Particulars	Parameters	Frequency	Location
4	Water-related diseases	Identification of water related diseases, adequacy of local control and curative measure, etc.	Once in a season	Labour camps and nearby settlements

The Environmental monitoring programme during project operation phase is at Table- 11.30:

Table- 11.30
Environmental Monitoring Programme during Project Operation Phase

Sl. No.	Particulars	Parameters	Frequency	Location
1	Water	pH, turbidity, total dissolved solids, calcium, magnesium, chlorides, sulphate, nitrates, iron, DO, BOD, COD etc.	Pre and Post monsoon seasons	Reservoirs
2	Treated waste water from STP	pH, BOD, COD, TSS and Oil and Grease.	Once in a month	Before and after treatment from STP
3	Ecology	Status of afforestation programmes	Once in 5 years	-
4	Fisheries	Phytoplanktons, zooplanktons, benthic life, fish composition	Twice in a year	Reservoirs.
5	Incidence of water-related diseases	Cause and control measures for various diseases.	Once in a year	Settlements around reservoirs and in command area
6	Meteorological parameters	Temperature, rainfall, humidity, cloud cover, wind speed and direction, solar insulation, evaporation rate	Continuous	At a location close to each of the two dam sites

The cost of Environmental Monitoring Programme will be Rs. 519.91 lakh for construction phase at head works and Rs.25 lakh at canal system. A provision of Rs. 43.25 lakh per year during project operation phase at head works.

11.6.12 Cost of Environmental Management Plan

The total estimated cost for implementation of Environmental Management Plan is Rs. 445 crore (excluding the cost of RandR Plan). Details are given at Table- 11.31:

Table- 11.31
Details of Cost for Implementation of Environmental Management Plan

Sl. No.	Item	Head works (Rs. in lakh)	Canal (Rs.in lakh)	Total (Rs. in lakh)
1	Compensatory afforestation	6789.60	4670.16	11459.76
2	Green belt Development on reservoir periphery and along link canal	216.00	480.00	696.00
3	Environmental Management in Labour camps including dams and canal	6217.61	-	6217.61
4	Public health and health delivery system and disposal of Bio medical waste	2062.98	7665.00	9727.98
5	Restoration of Quarry sites and land scaping	838.00	42.00	880.00
6	Stabilisation of Muck Disposal management / Land management	870.00	2391.67	3261.67
7	Implementation of water pollution Control measures	60.00	0.00	60.00
8	Implementation of Air pollution Control measures	159.38	0.00	159.38
9	Implementation of energy conservation measure	440.00	0.00	440.00
10	Catchment Area Treatment plan	4814.00	0.00	4814.00
11	Implementing Disaster management	654.00	0.00	654.00

Sl. No.	Item	Head works (Rs. in lakh)	Canal (Rs.in lakh)	Total (Rs. in lakh)
	plan			
12	Implementing Environmental Monitoring Programme	563.16	25.00	544.91
13	Biodiversity Management Plan	2995.93	0.00	2995.93
14	Measures to arrest transportation of silt across basins	0.00	2436.67	2436.67
15	Provision of free fuel or at subsidized rate to labour engaged departmentally at camps along link to avert biological loss	0.00	50.00	50.00
16	Purchase of noise meter	1.00	0.00	1.00
17	Purchase of meteorogical instruments	18.00	0.00	18.00
	Grand Total	26699.66	17760.50	44460.66
			Say	**445 crore**