Chapter – 11
Environmental Impact Assessment and Environmental Management Plan

General

Water is an essential element in all the sustenance and 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 monsoon season i.e. June to October in the Indian Continent. As such, storage reservoirs 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, some adverse impacts on account of them on the environment are also likely. 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 while enhancing the beneficial impacts.

In order to identify both positive and adverse environmental impacts with their economic evaluation due to the proposed Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project and to suggest measures to mitigate or ameliorate the anticipated adverse impacts on the environment, the Environmental Impact Assessment (EIA) study of the link project is required to be carried out. EIA is to be undertaken to ensure that the project is in compliance with the national environmental and social requirements. The Terms of Reference (ToR) for the proposed EIA study have been submitted by the Govt. of Maharashtra to the Ministry of Environment, Forests and Climate Change (MoEF&CC) in April, 2016 for approval. On obtaining the approved ToR, the State as the project proponent will get the EIA study of the link project carried out in due course. Therefore, for the present, based on the available information for similar projects, general description and the proposed approach for Environmental Impact Assessment of the project, Environmental Management Plan and Environmental Monitoring Plan along with the tentative costs to implement the Environmental Management Plan are presented in the following paragraphs:

The Proposed Project

Project Background

Wainganga (Gosikhurd) - Nalganga (Purna Tapi) Link Project is planned to divert waters from the available surplus in Wainganga river at Gosikhurd project and feed about 40 enroute storages/tanks and through these tanks to provide irrigation, domestic and industrial water supply benefits in six districts viz. Nagpur, Wardha, Amravati, Yeotmal, Akola and Buldhana of drought prone Vidarbha region in Maharashtra.

Govt. of Maharashtra submitted about 20 intra-State link proposals to NWDA for detailed studies to assess their feasibility in June, 2009. River linking in Vidarbha region comprising of three links viz. (i) Kanhan–Wardha, (ii) Wainganga-Nalganga-Purna Tapi and (iii) Indravati-Wardha-Penganga is one such proposal. This proposal meant for benefiting water short Vidarbha region has been reviewed by NWDA keeping in view the deficit areas, length of conveyance system and the total lift involved and then came up with a comprehensive proposal viz., "Wainganga (Gosikhurd) – Nalganga (Purna Tapi)" to divert water from Gosikhurd on Wainganga river to serve the areas in Wainganga and Wardha sub-basins of Godavari basin and Purna Tapi sub-basin of Tapi basin of Vidarbha region. The proposal initially involved diversion of 2721 Mm^3 of water from the existing Gosikhurd project across river Wainganga to the western Vidarbha to irrigate a command of 413750 ha. A pre-feasibility report of the link project had been prepared by NWDA in 2009 and circulated to the State of Maharashtra.

In the bilateral discussions between the officials of WRD, Govt. of Maharashtra and NWDA on the PFR study, it was mutually decided to transfer 1912 Mm^3 of water through the link project in view of the reported increase in water utilisations in the upstream catchment by the State. Accordingly, the Govt. of Maharashtra has formally requested NWDA to prepare the DPR of the link project for a diversion of 1912 Mm^3. Also, in view of the limitation of Gosikhurd reservoir in meeting the rabi demands of the link project and lack of scope for creation of supplementary storage upstream of Gosikhurd, the diversion through the link project is planned only during the monsoon period. Therefore, in order to store the link water during monsoon and subsequent utilisation in rabi season, about 40 tanks/storages have been identified along the link canal. Further, out of

these, in order to ensure effective functioning of the whole link system, two existing major projects viz., Lower Wardha and Katepurna are proposed to be integrated as balancing reservoirs. Detailed studies are made on 1: 50000 toposheets and the link alignment has been so planned as to feed most of the proposed enroute storages/tanks to cater the upland needy areas by gravity while limiting the lift in the main canal to about 155 m in 6 stages (static).

As part of DPR of Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project, the proposed terms of reference (ToR) for carrying out the Comprehensive Environmental Impact Assessment (CEIA) study of the link project were submitted for approval to MOEF & CC in April, 2016 by the project proponent i.e. WRD, Govt. of Maharashtra. The Expert Appraisal Committee (EAC) of MOEF & CC after detailed deliberations on the proposal in its meetings held on 02/03-06-2016 & 11/12-07-2016 recommended the standard TOR subject to the confirmation of the water flow series availability at Gosikhurd by CWC. Accordingly, the yield study prepared by WRD, Nagpur considering the data upto 2014-15 has been submitted by the State to CWC in July, 2016 for finalization of hydrology at Gosikhurd. CWC, in the process of scrutiny, has made an assessment of the yield at Gosikhurd based on the data available in the yield study submitted by the State by modifying the rainfall-runoff models of different sub-catchments as necessary and generating the sub-catchment/sub-valley wise yield series for the period from 1970-71 to 2014-15. The gross yield series as per CWC have been considered for computing the net inflows at Gosikhurd dam site and for arriving at the quantum of diversion through the Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project. From the net yield series, the water balance at Gosikhurd at 75% dependability has been worked out to be 1921 Mm^3. Out of this, it has been found that about 1772 Mm^3 of water annually can be diverted through the link project at 75% success rate based on the simulation studies of Gosikhurd reservoir. Accordingly, the DPR of the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project is prepared for diversion of 1772 Mm^3 of water.

Project Justification

Vidarbha is the eastern region of Maharashtra State consisting of Nagpur and Amravati divisions. It comprises eleven districts: Amravati, Akola, Buldhana, Washim and Yeotmal in Amravati division while Nagpur, Wardha,

Bhandara, Gondia, Chandrapur and Garchiroli in Nagpur division. Vidarbha region is not so developed in irrigation in comparison to the rest of Maharashtra. Though, the region occupies 31.62% of the State's geographical area, the cultivable area is only 25.29% while the surface water resources constitute to only about 17.38% of the State. The irrigation backlog in Vidarbha region in relation to the State average of 60.27% (2012) is about 11.85 lakh ha, out of which 9.97 lakh ha is in Amravati division itself. While the Eastern Vidarbha region in Wainganga valley receives good amount of rainfall under the influence of Bay of Bengal, Western Vidarbha comprising of Amravati, Akola and Buldhana districts receives less rainfall. The normal rainfall in the project area varies from 1100 mm in Wainganga/Eastern Vidarbha (Nagpur) to 782 mm in Western Vidarbha (Amravati). Large portions of Western region come under drought prone areas and the project area of the Wainganga –Nalganga link falls in this region. Due to non-availability of canal irrigation facilities in the upland areas in the vicinity of the proposed project, the farmers depend mainly on rainfall and ground water for irrigation.

The link canal will bring additional areas in the Vidarbha region to an extent of 371277 ha under irrigation besides providing drinking and industrial water supply. The link canal envisages to serve the command areas lying in upper reaches through pumping and feeding storages/tanks, which could not possibly be served through conventional projects. Thus, the link project will help in removing the backlog in irrigation development in Vidarbha region by meeting the demands of one of the most water short areas in the country lying in Akola, Buldhana and Amravati districts apart from other three districts of Nagpur, Wardha and Yeotmal. This link project will thus bring economic prosperity to the acute water short, drought-prone command area lying in the vicinity of the link project in the Vidarbha region.

While working out the quantity of water that can be diverted through Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link, the in-basin requirements of water in Wainganga upto Gosikhurd dam at ultimate stage of development have been duly considered and the diversion of water through the link project is planned only during monsoon so as not to affect the performance of the reservoir in meeting the project's own rabi requirements. Thus, the link project is a viable

option to effectively utilise the surplus waters of Wainganga available at Gosikhurd for the benefit of water short areas in the western Vidarbha.

Project Description

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project envisages construction of the following components at the DPR preparation stage:

i) Head works at existing Gosikhurd reservoir (FRL 245.5 m) across Wainganga river for a peak discharge of 347.2 cumec.

ii) Link canal of length 426.54 km from Gosikhurd reservoir to Nalganga reservoir, comprising of open canal, pipe lines & tunnels

iii) Lifting arrangements through 6 stages of lifting 23.25 m (RD 2.4 to 2.9 km), 23.5 m (RD 20 to 20.9 km), 29.25 m (RD 39.9 to 42.7 km), 28 m (RD 169.6 to 170.4 km), 30 m (RD 176.9 to 178.1 km) and 21.25 m (RD 292.85 to 293.7 km) totaling to 155 m of static lift

iv) Canal falls at two locations at RDs 302.925 km (7 m) and 426.425 km (6 m) to dissipate the available excess head and reduce quantum of filling

v) Pipelines for 25.978 km length in 11reaches viz., RD 27.40 km (1210 m), RD 44 km (553 m), RD 49.65 km (1937 m), RD 60.05 km (9783 m), RD 83.6 km (3485 m), RD 87.7 km (1819 m), RD 93.4 km (3551 m), RD 112.45 (1111 m), RD 257.1 km (500 m), RD 363.88 km (1698 m) and RD 370.48 km (331 m)

vi) Seven tunnels for a cumulative length of 13.826 km located at RD 73.50 km (3317 m), RD 141.45 km (776 m), RD 150.25 km (6489 m), RD 298.975 km (667 m), RD 371.525 km (781 m), RD 406.075 km (948 m) and RD 411.775 km (848 m)

vii) Out fall structures and Head regulators for integration of existing reservoirs of Lower Wardha and Katepurna

viii) Raising of six existing storages to accommodate link waters

ix) Construction of 31 new storages along the link alignment to receive diverted waters

x) 22 nos. of Feeder canals/Direct sluices for integration of the existing/ proposed intermittent storages along the alignment

xi) Subsidiary lift arrangements from main link canal to feeder canals at RD 115.45 km (7 m), RD 147.55 km (5 m), RD 150.00 km (10 m), RD 246.30 km (10 m) and RD 377.13 km (8 m)
xii) Cross drainage/cross masonry and regulating works across the link canal (582 nos.)
xiii) Command area development of about 371277 ha in Nagpur, Wardha, Yeotmal, Amravati, Akola and Buldhana districts
xiv) Canal top solar power generation arrangement at appropriate reaches along the link canal alignment.
xv) Outfall structure at existing Nalganga reservoir on Nalganga river, a tributary of Purna Tapi with FRL 294.44 m

Study Area

The study area to be considered for the Environmental Impact Assessment study and preparation of Environmental Management Plan for the proposed Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project is given as under:

i) Catchment area intercepted at enroute storage sites.
ii) Area to be acquired for various project appurtenances including submergence under proposed storages.
iii) 10 km on either side of the link canal.
iv) Command area of the project.
v) 10 km radius around the project area from the periphery of the project site.

Legal Status of the Project

The Water Resources Project, when implemented provides 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 will have impacts, both positive and negative on the environment of the project area and in the vicinity and also affect the socio-economic conditions of the population in the region. The project before implementation requires statutory clearance from the Ministry of Environment and Forests and Climate Change (MoEF&CC), Govt. of India. As stipulated in the Environmental Impact Assessment Notification of 14th Sept 2006, the Terms of Reference (ToR) for carrying out the Comprehensive

Environmental Impact Assessment (CEIA) study of Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project were submitted to the MoEF&CC for approval on 28th April, 2016. The proposal was discussed in the 94th meeting of the Expert Appraisal Committee (EAC) for River Valley and Hydroelectric Projects (RV&HEPs) held on 2nd and 3rd June, 2016 at New Delhi. After detailed deliberations, the EAC informed the project proponent to submit the DPR of Gosikhurd project for ascertaining surplus water. In the 95th meeting of the EAC for River Valley and Hydroelectric Projects (RV & HEP) held on 11th and 12th July, 2016, the DPR of Gosikhurd project was produced before the EAC. After detailed deliberations, EAC recommended the standard TOR for the CEIA studies of the link project subject to the confirmation of the water flow series availability by CWC. The project proponent has to submit the same to the MoEF & CC for issuance of ToR. The relevant extracts of the minutes of 94th & 95th meetings of the EAC are at **Annexure 11.1**. The model ToR of MoEF & CC for River valley and Hydroelectric Projects is at **Annexure 11.2.**

No new dams/reservoirs are contemplated along the main link canal under the project proposal. Existing Lower Wardha & Katepurna reservoirs are planned to be utilised as balancing reservoirs, besides the existing Gosikhurd & Nalganga reservoirs as terminating structures of the link project. However, in addition, the Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project comprises 31 new storages/tanks enroute the link canal and raising the height of six existing storages besides utilisation of existing Bembla storage for extending the envisaged benefits in the command area. This will involve submergence of villages and displacement of people under some of the storages. The total submergence area under the enroute storages shall be 19818 ha. The details of tank wise submergence area, villages affected (fully and partly) and population to be displaced are at **Annexure 11.3**. These project affected families are required to be resettled at the new locations. Therefore, with a view to compensate the Project Affected Families (PAFs) and ensure proper amenities in the resettlement colonies, an appropriate Rehabilitation and Resettlement (R&R) Plan is required to be evolved. A detailed R&R package shall be prepared in accordance with the 'National Rehabilitation & Resettlement Policy-2007(NRRP-2007)' and the 'Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Bill, 2013' formulated by Department of Land Resources, Ministry of Rural Development (MoRD), Govt. of India. Due weightage shall also be given to the R&R Policy / Act of Maharashtra State and

best of the provisions from the National/State acts shall be adopted in the R&R package.

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project requires about 395 ha of forest land (241 ha under proposed storages and 154 ha for link canal) and as such forest clearance under Forest (Conservation) Act, 1980 is required. A provision for afforestation in double the area in degraded forests region shall be kept as per the Forest (Conservation) Act, 1980. The project will also require Techno-economic clearance from Central Water Commission; investment clearance from Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR); and consent to establish from Maharashtra Pollution Control Board 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), Central region, Nagpur has carried out the mineral surveys for the project area. GSI, Nagpur vide Letter No. 232/8/PSS/GSI/CR/2014 dated 12th March, 2014 (**Annexure 4.4**) informed that Rengatur Gold prospect in Bhiwapur tehsil, Kolari Gold prospect located about 2 km NW of Pular village on Pular-Dhamna forest road and Ranbori tungsten prospect all in Nagpur district are found to lie in the vicinity of the link alignment in its initial reach of about 32 km, but do not fall in the proposed route of the alignment. In the further reaches of the link canal upto Lower Wardha river crossing, only basalt is exposed and no significant mineral deposit/prospect is reported. For the reach of the link alignment beyond Lower Wardha upto Nalganga, GSI vide letter No. NWDA/JKN/SUM (NGP)/GSI/CR dated 19th July, 2016 (**Annexure 4.5**) had indicated that the link alignment is mostly on the Deccan Trap terrain and small stretch is proposed over the alluviums. No significant economic mineral deposit/prospect is reported in these areas.

The archaeological survey of the project area has been carried out by Archaeological Survey of India (ASI), Nagpur. An area of 5 km on either side of the proposed canal route was surveyed in order to explore the archaeological remains/sites, ancient temples or their remains and Central/State protected monuments falling in the area. The Superintending Archaeologist, Pre-history branch, Nagpur vide letter No.1/1/Gosikhurd Pr/2013-14/642 dated 16-2-2015 submitted a report informing that there is no adverse impact on Centrally protected monuments located in the reach upto Wardha river crossing, since all

are more than 3 km away from the proposed link canal alignment. State protected monuments are also unaffected in this reach. All other sites bearing ancient remains are safe from the construction of canal in this reach since all are far from the proposed alignment. A copy of the report on archaeological survey by ASI is given at **Appendix 4.1.1**. Also, ASI vide letter N. 1/2/2016/WNCP/Tech-71 dated 7.6.2017 submitted a brief report on archaeological exploration in the reach of the link alignment beyond Lower Wardha upto Nalganga and informed that the area marked for the proposed link canal is devoid of archaeological sites and monuments. A copy of the report on archaeological survey by ASI for this reach is given at **Appendix 4.1.2**. As such, No Objection Certificates (NoC) from Ministry of Coal and Mines and Archaeological Survey of India are not required to be obtained in respect of the link alignment. Similar reports from GSI and ASI in respect of the proposed enroute storages/tanks shall be obtained by the project proponent, Govt. of Maharashtra, after completion of necessary topographical surveys for the same.

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 so that the project induced effects on these parameters can be properly estimated. The baseline status shall involve both field work and review of data collected from secondary sources. The baseline studies will consist of 3 seasonal studies (Pre monsoon, monsoon and winter) to cover the entire annual cycle accommodating seasonal variations on various parameters.

The baseline survey planning shall focus on short listing of impacts and identification of parameters for which the data needs to be collected. Baseline status will be ascertained for air environment, water environment, land environment, public health and biological (terrestrial and aquatic) environment.

Air Environment

Ambient Air Quality

The likely sources of air pollution in the study area are emissions from vehicles, burning of fossil fuels, dust arising from unpaved village roads,

construction activities and domestic fuel burning. The pollutants are either absorbed by the atmosphere or dispersed effectively. The prime objective of the baseline air quality study is to establish the existing ambient air quality of the area. The Central Pollution Control Board is executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP) with the objective of assessing the status and trend in the ambient air quality, evaluate air pollution levels, understand natural cleansing process and to develop ways and means for taking preventive and corrective measures. Under NAMP, four air pollutants viz ., Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO_2, Respirable Suspended Particulate Matter (RSPM / PM_{10}) and Fine Particulate Matter ($PM_{2.5}$/SPM) have been identified for regular monitoring. The major sources of SPM include soil borne dust, dust from construction activities, resuspension of dust etc. NO_2 is formed in the atmosphere due to reaction of nitric oxide with ozone and hydrocarbons. Areas with high population and vehicular traffic give rise to high levels of NO_2. Sulphur dioxide (SO_2) is found in emissions of industries, diesel vehicles and domestic emissions from fossil fuel burning. The major sources of Respirable Suspended Particulate Matter (PM_{10}) are emissions from diesel vehicles and industries where combustion processes take place.

The testing methods that shall be followed for monitoring various ambient air quality parameters and their permissible levels at 24 hourly or 8 hourly monitored values as specified in 'National Ambient Air Quality Standards, 2009' for industrial, residential, rural and other areas are at **Table- 11.1**.

Table- 11.1

National Ambient Air Quality Parameters and their Standards

Parameter	Description	Methods of Measurement	Permissible Limit ($\mu g/m^3$)
PM_{10}	Respirable Suspended Particulate Matter	Gravimetric/TOEM/ Beta Attenuation methods	100
$PM_{2.5}$	Suspended Particulate Matter	Gravimetric/TOEM/ Beta Attenuation methods	60
SO_2	Sulphur	Improved West &	80

	dioxide	Gaeke / Ultraviolet Fluorescence methods	
NO_2	Oxides of Nitrogen	Modified Jacob & Hochheiser /Chemiluminescence methods	80

Source: 'National Ambient Air Quality Standards, 2009', CPCB

Maharashtra Pollution Control Board (MPCB) under NAMP regularly monitors the ambient air quality at certain locations in the State. The latest available information on the parameters measured at Nagpur, Amravati & Akola in the project area are given below at **Table 11.2**.

Table 11.2
Ambient Air Quality Parameters observed in Project Area by MPCB

Location	Date	Type	AQI	RSPM µg/m³	SPM µg/m³	SO_2 µg/m³	NO_x µg/m³
Standards			**51-100**	**100**	---	**80**	**80**
Nagpur City							
RO Office, Civil lines	28-05-18 to 24-06-18	Residential	55-96	55-96		6-12	18-37
Divisional Commissioner office, Civil Lines	20-11-17	Residential	51	51	-	11	38
Institute of Engg., North Ambazari road	28-05-18	Residential	133	149	198	13	41
MIDC Office Hingna road	27-05-18 to 31-05-18	Industrial	125-139	137-159	192-199	9-10	29-34
Polytechnic college, Sadar	27-05-18 to 31-05-18	Rural & other areas	131-142	147-163	176-213	9-11	24-34
Amravati City							
Govt. Engg. College	29-05-18	Residential	74	74	---	11	13
Apurva Oil Industries	30-05-18	Industrial	114	121	---	18	19
Vanita	28-05-18	Rural &	110-	115-	---	14-21	15-22

Samaj building	to 31-05-18	other areas	121	131			
Akola Town							
College of Engg. & Technology	28-05-18 to 31-05-18	Commercial	65-66	65-66	64-66	4	11-12
Ranpise Nagar Professor Colony	30-05-18 to 31-05-18	Residential	63-64	63-64	66-68	11	11
Phase-II, MIDC	27-04-18 to 26-05-18	Industrial	79-82	79-82	79-82	13-14	13-15

Source: Website of Maharashtra Pollution Control Board www.mpcb.gov.in

Noise Environment

The noise levels shall be monitored continuously for 24 hours at each location set up for the purpose by measuring hourly equivalent noise level. These values will then be used to estimate the day time and night time equivalent noise levels. The permissible noise levels specified are (i) for residential areas - 55 dB(A), (ii) for commercial area - 65 dB(A), (iii) for industrial area - 70 dB(A) and (iv) for silence zone - 50 dB(A).

Maharashtra Pollution Control Board has conducted noise monitoring study at 25 locations covering six major cities viz. Mumbai, Pune, Nashik, Aurangabad, Nagpur and Kolhapur in Maharashtra as per CPCB protocol. It is also aimed at generating long term ambient noise level data and trend at the identified locations, by repeating the monitoring survey every year. As per the 'Report on Ambient Noise Monitoring of Metropolitan Cities in Maharashtra-2014' of MPCB, noise monitoring was carried at these locations for 24 hours continuously (16 hrs. day time and 8 hrs. night time), for two days on 14th (Non-working day) and 15th (Working day) December, 2014. Results are reported as L_{eq} day time, L_{eq} night time, L_{10}, L_{50}, L_{90}, L_{max} and L_{min} in dB(A). The ambient noise levels monitored at three locations in Nagpur city in the vicinity of the project area by MPCB on 14th & 15th December, 2014 are presented in **Table 11.3**.

Table 11.3: Ambient Noise Levels on 14th & 15th December, 2014 in Nagpur

Sl. No.	Monitoring Site	Date	Day time (6AM-10 PM) values in dB(A)					
			L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}
1.	Govt. Medical College	14.12.2014	49.5	54.1	42.7	53.3	52.2	48.0
2.	Sitabardi Police Station	14.12.2014	70.6	79.4	62.4	78.0	74.9	70.4
3.	Shivaji Nagar	14.12.2014	62.9	74.8	56.9	71.8	67.8	61.6
Sl. No.	**Monitoring Site**	**Date**	**Night Time (10PM-6AM)values in dB(A)**					
			L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}
1.	Govt Medical College	14.12.2014	46.8	49.7	43.9	48.4	46.9	45.0
2.	Sitabardi Police Station	14.12.2014	62.3	70.7	56.7	68.8	62.3	57.1
3.	Shivaji Nagar	14.12.2014	54.4	61.2	46.2	59.2	55.8	47.2
Sl. No.	**Monitoring Site**	**Date**	**Day Time (6AM-10PM)values in dB(A)**					
			L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}
1.	Govt Medical College	15.12.2014	56.0	67.8	51.8	64.6	59.2	57.1
2.	Sitabardi Police Station	15.12.2014	71.3	80.8	70.3	79.7	73.9	71.6
3.	Shivaji Nagar	15.12.2014	64.1	71.9	61.5	71.7	70.1	63.3
Sl. No.	**Monitoring Site**	**Date**	**Night Time (10PM-6AM)values in dB(A)**					
			L_{eq}	L_{max}	L_{min}	L_{10}	L_{50}	L_{90}
1.	Govt Medical College	15.12.2014	47.7	50.3	44.2	49.7	47.9	45.4
2.	Sitabardi Police Station	15.12.2014	61.8	72.6	56.6	66.4	62.8	57.0
3.	Shivaji Nagar	15.12.2014	55.2	62.0	46.2	61.3	55.9	48.3

Source: 'Report on Ambient Noise Monitoring of Metropolitan Cities in Maharashtra-2014' of MPCB

Note: Govt. Medical College: Silence Zone; Sitabardi Police Station: Commercial Zone; Shivaji Nagar: Residential Zone;

Meteorology

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

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

There are six IMD observatories in the project area viz. Nagpur, Wardha, Amravati, Yeotmal, Akola and Buldhana. Based on the data for the period from 1981- 2010 at these stations, the meteorology in the project area is described as under.

Temperature: Mean maximum temperature of 42.7^0C is observed at Nagpur and Wardha stations. The mean minimum temperature observed at Nagpur station is 12.9^0C.

Rainfall: The monsoon rainfall occurs mainly during mid June to Sept. Maximum rainfall is received in the months of July and August. The annual average rainfall observed in the project area varies from 782 mm at Amravati to 1100 mm at Nagpur. Most of the rainfall is received under the influence of south –west monsoon.

Humidity: Monthly mean maximum relative humidity in the project area is recorded as 87% (August) at Buldhana station while monthly mean minimum relative humidity is recorded as 18% (April) at Akola.

Wind Velocity: Monthly mean maximum wind speed in the project area is observed as 13.9 km/hr (June) at Yeotmal station while monthly mean minimum wind speed is recorded as 2.4 km/hr (Dec) at Akola.

Evaporation: The annual potential evapo-transpiration varies between 1562 mm and 2009 mm in the region.

Cloud Cover: Monthly mean maximum cloud cover in the project area is observed as 6.8 octas (July) at Nagpur station while Monthly mean minimum cloud cover is recorded as 0.3 octas (November) at Amravati.

Water Quality

Surface Water Quality Monitoring

Water Resources Department (WRD), Govt. of Maharashtra collects the water samples from Gosikhurd reservoir periodically for analysis at Water Quality Lab, Hydrology Project Division-II, Nagpur for both chemical and physio-chemical analysis for ascertaining the water quality status. The latest data pertaining to the years 2015 to 2018 on laboratory test results of the water samples of Gosikhurd reservoir have been collected and are presented in **Table 11.4.**

Table 11.4

Test results of water samples from Gosikhurd reservoir

S.No	Characteristic (Parameter)	unit	Analysis Result				Drinking Water Specifications (IS 10500 : 2012)
			22/7/15	15/1/16	20/6/17	30/1/18	Requirement (Acceptable Limit)
1	Colour	Hazen	1	1	1	1	5 Max
2	Odour		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	pH		8.3	8.1	8.3	8.4	6.5 to 8.5
4	Dissolved Oxygen	mg/l	6.1	6.3	6.8	7	6 mg/l Min as per CPCB class A Tolerance limit
5	Total Dissolved Solids	mg/l	178	196	220	240	500 Max
6	Turbidity	NTU	7.4	4.4	4.6	7.6	1 Max
7	Total Alkalinity (as $CaCO_3$)	mg/l	112	152	156	180	200 Max
8	Chloride (as Cl)	mg/l	16	14	18	13	250 Max
9	Sulphate (as SO_4)	mg/l	14.2	10.7	10.6	9.8	200 Max
10	Fluoride (as F)	mg/l	0.58	0.5	0.5	0.52	1.0 Max
11	Total Hardness (as $CaCO_3$)	mg/l	104	136	132	132	200 Max

12	Calcium (as Ca)	mg/l	30.5	31.3	29.7	31.3	75 Max
13	Magnesium (as Mg)	mg/l	6.8	14.1	14.1	13.1	30 Max
14	Boron (as B)	mg/l	0.08	0.12	0.14	0.16	0.5 Max
15	Ammonia	mg/l	0.05	0.05	0.06	0.05	0.5 Max
16	Nitrate (as NO_3)	mg/l	1.6	1.94	2	2.3	45 Max
17	BOD	mg/l	2.8	2.8	2.9	2.8	2 mg/l Max as per CPCB class A Tolerance limit
18	Manganese (as Mn)	mg/l	N.D	N.D	N.D	N.D	0.1 Max
19	Aluminium (as AI)	mg/l	0.02	0.02	0.01	0.01	0.03 Max
20	Silica	mg/l	3.4	2.8	1.68	1.76	----
21	Iron (as Fe)	mg/l	0.18	0.14	0.1	0.12	0.3 Max
22	Total Coliforms	MPN/ 100ml	790	17	24	11	Shall not be detectable in any 100 ml sample
23	Faecal Coliforms	MPN/ 100ml	170	4.5	6.8	4	Shall not be detectable in any 100 ml sample

Source: EE, I&HEP Division, WRD, Nagpur; Note: ND - Not Detectable

It is observed that the pH level of water in Wainganga river ranges between 8.1 to 8.4 during the period. The pH level indicates slightly alkaline nature of the water and the values are within acceptable limits of 6.5 to 8.5 as per IS 10500-2012 specified for drinking and domestic uses. The levels of dissolved oxygen in various collected samples are in the range of 6.1 to 7.0 mg/l and fulfil the CPCB class A tolerance limit of 6mg/l Min. The levels of total dissolved solids are well within the acceptable limit of 500 mg/l i.e. ranging from 178 to 240 mg/l. The range of total Alkalinity (as Ca Co_3) is between 112 to 180 mg/l and satisfies the acceptable limit of 200 mg/l Max. It indicates that the water is suitable for drinking and domestic uses. The range of total hardness (as Ca Co_3) of the above water samples is from 104 to 136 mg/l which is well within the acceptable limit of 200 mg/l specified for drinking water. The concentration of Sulphate is in the range of 9.8 to 14.2 mg/l which is within the acceptable limit of 200 mg/l. The concentration of Chlorides (as Cl) is in the range of 13 to 18 mg/l which is within the acceptable limit of 250 mg/l as per IS 10500-2012 for drinking water quality standards. The concentration of Calcium also is within the acceptable limit of 75 mg/l, ranging from 29.7 to 31.3 mg/l. Other parameters such as Fluoride, Magnesium, Boron, Ammonia, Nitrate, Manganese, Aluminum, Silica and Iron are also within the respective acceptable limits as per IS 10500-2012. Though the water is suitable for drinking and domestic uses, it cannot be supplied directly

without proper filtration and chlorination. As the turbidity is high and varies from 4.4 to 7.6 against the permissible limit of only 1.0, water filtration plants with chlorination are required to be set up for water purification to make it potable.

As per the test results of water samples from Gosikhurd reservoir, the pH is within the limits of 6.5 to 8.5 indicating slightly alkaline nature of water and is fit for irrigation use. As the levels of total dissolved solids in various samples collected are well below the acceptable limits of less than 500 mg/l, the same is 'Excellent to Good-Class-1' for irrigation. The range of Chlorides in the water is less than 250 mg/l which indicates it as 'Excellent to Good-Class-1' for irrigation. Also, the other parameters such as Alkalinity, Total hardness, Calcium/Magnesium/Sulphates etc. are within the limits for irrigation water. Hence, the water proposed for diversion from Gosikhurd reservoir through the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link canal is found to be suitable for irrigation purpose and with proper treatment for drinking and domestic use as well.

Ground Water Quality Monitoring

Central Ground Water Board has been monitoring the quality of ground water in all the six districts viz. Nagpur, Wardha, Amravati, Yeotmal, Akola and Buldhana pertaining to the project command area. As per the latest district ground water brochures of CGWB (2017/2018), the information on no. of monitoring wells, quality, water table, discharge, storativity, transmissivity, pre and post monsoon levels are presented in **Table 11.5**.

Table 11.5

District wise Ground Water Information in the Project Command Area

Sl. No	Parameter	Nagpur	Wardha	Amravati	Yeotmal	Akola	Buldhana
1	**Monitoring wells**						
a.	Dug wells	76	51	86	72	30	55
b.	Piezometers	18	13	15	23	9	13
2	**Depth to water level (m bgl)**						
a.	Pre-monsoon	2.1 to 24.1	2.4 to 19.4	1.5 to 35	2.1 to 22.75	1.3 to 30.3	2.79 to 30.1
b.	Post-monsoon	0.6 to 22.6	1.35 to 17.12	0.2 to 35	1.1 to 11.5	0.5 to 29	0.8 to 23.4

3.	**Groundwater Exploration**						
a.	Wells drilled EW- OW- PZ-	 91 48 24	 39 13 3	 102 36 33	 95 29 26	 112 35 15	 53 17 21
b.	Depth range (m bgl)	6.5 to 307	30 to 201	15.15 to 300.1	19.45 to 470	11.3 to 434	19.55 to 311.2
c.	Discharge lps	0.14-38.05	Traces-14.88	0.24-23.5	0.14-49.4	0.025-33	Traces-14.89
d.	Storativity	$5.5x10^{-5}$ to $2.95x10^{-3}$	$4.38x10^{-4}$ to $1.3x10^{-2}$	$3.57x10^{-3}$ to $6.15x10^{-3}$ (Basalt)	NA	$3x10^{-6}$ to $1.7x10^{-3}$	$1.09x10^{-3}$ to $3x10^{-6}$ (Alluvium) $8x10^{-8}$ to $4.2x10^{-2}$ (Basalt)
e.	Transmissivity (m^2/day)	7.11to 279.13 (Basalt)	5.27 to 293.36	12.7 to 835.14 (Alluvium) 0.4 to 95.82 (Basalt)	2.26 to 202	1.71 to 247 (Basalt) 18.55 to 6725 (Alluvium)	0.89 to 1575 (Alluvium) 8.35 to 396 (Basalt)

Source: Ground Water Brochures of the Districts, 2017/2018, CGWB

Ground water assessment has been made for the proposed command area based on 'Dynamic Groundwater Resources of India, June, 2017' publication of Central Ground Water Board (CGWB) on pro rata basis and is presented at **Table 11.6**.

Table 11.6

Ground Water Potential and Draft in the Project Command Area

District	Whole district		Within the project region		
	Potential	Draft	Potential	Draft	Balance
Nagpur	1100	617	128	72	56
Amravati	965	704	83	60	23
Yeotmal	1337	273	20	4	16
Wardha	828	411	93	46	47
Akola	404	176	75	33	42
Buldhana	944	678	47	34	13

Source: Dynamic Ground Water Resources of India, June, 2017, CGWB (data as on 31st March, 2013)

Further, it is seen that ground water exploration was taken up in different phases by CGWB in Maharashtra State. The salient features of ground water exploration in respect of all the 15 talukas in the project area are given at **Table 11.7**.

Table 11.7

Salient features of Taluk wise ground water exploration by CGWB

Sl No	Taluka	Wells			Depth (mbgl)	SWL (mbgl)	Discharge (lps)	Draw down (m)	Zones (mbgl)
		EW	OW	PZ					
Nagpur district									
1.	Nagpur	3	2	3	27.6 - 300	7.7- 24.15	2.16- 14	-	16- 57.9
2.	Hingna	2	3	2	40.0 - 234.8	3 - 27.65	0.78 - 21.33	-	
3.	Kuhi	4	3	-	36.5 - 200	1.3- 3.42	5.84- 25.04	-	5.0 - 99.75
4.	Umred	2	-	3	40 - 200	3.64 - 5.7	0.78 - 2.16	-	24.0 - 122
Wardha district									
5	Arvi	3	1	-	99 - 201	9.00 - 30.20	1.37 - 14.88	10.37- 10.55	25 - 93
6	Seloo	3	1	-	140 - 201	1.87 - 16.00	0.38 - 4.43	0.26 - 11.25	15 - 138

7	Wardha	9	5	1	30 - 86	2.60 - 6.51	0.19 - 8.6	4.31 - 22.78	GL - 80.50
Amravati district									
8	Dhamangaon	-	-	1	40	37.35	Traces	-	37.35
9	Nandgaon Khandeswar	4	1	1	40 - 202	6.95-23.5	0.43 - 12.2	-	30-146
Yeotmal district									
10	Babulgaon (i) Basalt (ii)Sandstone	 3 1	 1 -	 1 -	 30 - 128.1 85.4	 5.45 - 7.65 -	 0.14 - 3.17 -	 - -	 - -
11	Ner	5	2	1	19.45 - 201.30	2.2 - 3.38	0.14 - 17.90	-	-
Akola district									
12	Akola Alluvium Basalt	 9 11	 1 5	 - 1	 26.5-302.6 20.00 - 200	 6.2-25.4 1.4-5.24	 0.14 -33 0.025 - 15	 5.69 - 44.9 2.78 - 23.05	 13.45-116 -
13	Barshi Takli	5	1	1	40-203	3.65 - 30.3	0.025 - 2.16	11.85 - 17.68	10-117.41
Buldhana district									
14	Shegaon	2	3	-	56.15 - 200	6.42 - 7.85	0.38 - 12.18	13.9 - 15.84	15 - 158
15	Motala	5	1	1	40 - 200	1.14 - 29.07	0.14 - 14. 89	4.26	12 - 125

Source: Ground Water Brochures of the Districts, 2017/2018, CGWB

In the project region Deccan Trap basalt is the main water bearing formation where ground water occurs under phreatic condition in the exposed lava flows and in semi-confined to confined state in the sub-surface flows. Archaeans and the Deccan trap basalts are the two consolidated formations, which form the hard rock aquifers occurring in Nagpur district. Deccan Trap Basalt is the predominant water bearing formation in the district, followed by Gondwana formation having Sandstone and Shale sequence. In Amravati district, basaltic lava flows are the major rock formations along with alluvium, Lameta beds, Gondwana sediments and unclassified metamorphic rocks. About 70% of the area

is underlain by Deccan Traps and remaining by other soft rock formations, particularly the alluvium, which occupies nearly a third of the district on the northern side along Purna River system. Deccan Trap lava flows and Purna Alluvium are the major water bearing formations of Buldhana district. Alluvium and Basalt forms the principal aquifers in the district.

CGWB is monitoring the ground water quality of all the six districts pertaining to the project area for four decades through its established monitoring wells. During the year 2016, the Board has carried out the ground water quality monitoring in the month of May 2016 (pre-monsoon period). The water samples were subjected to analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analyzed include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F).

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91 Revised in 2012) were used to decide the suitability of ground water. It is observed that the concentrations of all the parameters in most of the samples are within the maximum permissible limit of the BIS standards. The ground water in some parts of the project region (Yeotmal, Akola and Buldhana districts) is affected by excessive Nitrate (NO_3) concentration. Overall, it can be concluded that the ground water quality in the wells monitored is suitable for drinking purpose with proper treatment.

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation. It was observed that the overall quality of ground water in the monitoring wells is good for irrigation purpose. However, the ground water in the pre-monsoon season from shallow aquifer should be used for irrigation with proper soil and crop management practices. The chemical analysis of water samples collected from various sites in the 15 talukas pertaining to the project command area by CGWB is presented in **Annexure 11.4**.

Land Environment

Land Use

The land use particulars in respect of the six districts pertaining to the Project area as available for the year 2015-16 (Estimated) are presented in **Table 11.8**.

Table 11.8: Land Use Particulars of the Districts in the Project Area Unit:'00' ha

Sl. No	Category	Nagpur	Wardha	Amravati	Yeotmal	Akola	Buldhana	Total	% of GA
1	Forest land	1594	619	3099	2374	301	893	8880	15.6
2	Barren& Uncultivable land	338	106	196	397	110	476	1623	2.8
3	Land under Non Agri. use	991	482	449	617	340	559	3438	6.0
4	Permanent Pastures	553	353	332	605	166	380	2389	4.2
	Sub-total	**3475**	**1560**	**4075**	**3992**	**917**	**2308**	**16327**	**28.6**
5	Land under Mise.Trees & Grooves	76	94	62	116	12	12	372	0.7
6	Culturable Waste	369	163	92	228	30	262	1144	2.0
7	Current Fallows	198	634	334	378	106	242	1892	3.3
8	Other Fallows	214	205	144	258	54	256	1131	2.0
9	Net Area Sown	5532	3634	7510	8547	4310	6592	36125	63.4
	Sub-Total (Culturable area)	**6389**	**4729**	**8142**	**9527**	**4512**	**7363**	**40662**	**71.4**

10	Area Sown more than once	966	992	2328	1379	2452	2623	10740	18.8
11	Gross Cropped Area	6498	4625	9838	9926	6761	9215	46863	82.2
12	**Geographical area**	**9864**	**6289**	**12217**	**13519**	**5429**	**9671**	**56989**	**100**

Source: Website of Commissioner of Agriculture, Maharashtra, Pune Seasonal crop report, Government of Maharashtra

However, the land use and land cover information of the catchment area of the 31 new storages and six existing storages which are proposed to be raised to accommodate link waters will be mapped using the digital satellite data during the proposed CEIA study of the link project. The land use/land cover pattern of the area indicating forests/settlements/water bodies/cropped lands/open shrub shall be determined through remote sensing studies, interpretation of satellite imagery, topographic sheets coupled with ground truthing.

Mineral Deposits

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link alignment passes through Nagpur, Wardha, Amravati, Washim, Akola and Buldhana districts of Maharashtra State. As per Geological Survey of India (GSI), Nagpur vide Letter No. 232/8/PSS/GSI/CR/2014 dated 12th March, 2014, Rengatur Gold prospect in Bhiwapur tehsil, Kolari Gold prospect located about 2 km NW of Pular village on Pular-Dhamna forest road and Ranbori tungsten prospect all in Nagpur district are found to lie in the vicinity of the link alignment in its initial reach of about 32 km. In the further reaches of the link canal upto Wardha river, only basalt is exposed and no significant mineral deposit/prospect is noticed. Further, as per GSI vide letter No. NWDA/JKN/SUM (NGP)/GSI/CR dated 19th July, 2016, the link alignment beyond Lower Wardha and upto its outfall point (Nalganga project) is mostly on the Deccan Trap terrain and small stretch is proposed over the alluvium. No significant economic mineral deposit/prospect is reported in these areas.

Historic / Archaeological Monuments

As per the Archaeological Survey of India (ASI), Nagpur vide letter No.1/1/Gosikhurd Pr/2013-14/642 dated 16-2-2015, there is no adverse impact on Centrally protected monuments located in the districts of Nagpur, Wardha, Amravati, Akola and Buldhana. State protected monuments are also unaffected. All other sites bearing ancient remains are safe from the construction of canal. Especially, the project area from Wardha river to outfall point (Nalganga project) is devoid of archaeological sites and monuments.

Geology

The study area of Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project forms a part of the "Peninsular Shield", which is composed of rocks commencing from the most ancient rocks of diverse origin, which have undergone considerable metamorphism. Over these ancient rocks of Precambrian era lie a few basins of Proterozoic era and of permo carboniferous periods which are covered by extensive sheets of horizontally bedded lava flows comprising the Deccan trap. Hence, the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link Project is mostly covered by Deccan trap.

Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link canal traverses for its entire length of 426 km through Nagpur, Wardha, Amravati, Washim, Akola and Buldhana districts of Maharashtra. The lithotypes broadly belong to Amgaon gneissic complex/Tirodi gneissic complex/ Bengpal gneiss and partly by Sakoli Group (Bhiwapur Formation), Deccan trap Super group (Basalt flows) and granite/pegmatite intrusive and considerable variations are observed in regard to their mineral assemblage, structural set-up and field relationship along the proposed link canal alignment. It is broadly summarised that the thickness of overburden soils in granite gneissic terrain is up to a maximum of 5m, whereas it extends 5 to 7m in Sakoli meta-sediments and Nil to 1.5m in basaltic terrain.

The area around the link canal alignment from Gosikhurd to Lower Wardha is predominantly occupied with the rock formations ranging in age from Archaean to Upper Cretaceous-Palaeocene age. Granite gneiss and migmatites belonging to the Tirodi Gneissic Complex, Amgaon Gneissic Complex and Bengpal Group occupy the major eastern and northern part of the area. They form

the basement for the overlying rocks of Sakoli Group, Sausar Group, Gondwana Super group, Lameta Group and Deccan Trap Super group.

In the 50 km reach beyond Lower Wardha, major portion of proposed canal alignment passes through cultivation area with shallow soil (overburden) cover (~ up to 3m). Scanty rock exposures comprising massive and at places vesicular basalt constitutes the geology along proposed canal alignment. Based on surface geological mapping, it has been interpreted by GSI that basalt lava flows of Deccan Trap Supergroup shall be encountered as rock type at different reaches of the canal alignment and as such no geological uncertainty had been observed within the stretch.

Soils

Soil is the product of geological, chemical and biological interactions. The National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur has published a map of the 'Soils of Maharashtra', dividing the State into 356 soil-mapping units, which are broadly categorized as follows: Soils of Konkan coast, Soils of Western Ghats and Deccan Plateau. The Deccan Plateau region is further sub-divided into 'Soils of Upper Maharashtra', 'Soils of Lower Maharashtra' and 'Soils of Lower Maharashtra (Metamorphic)'.

The command area of the link project mostly falls in the Lower Maharashtra region of Deccan Plateau in Buldhana, Akola, Amravati, Wardha, Yeotmal and Nagpur districts. Western and southern talukas of Nagpur district have coarse shallow soils. Amravati district has medium black soils. In Buldhana district, medium black soils are found on plains. The main rock formation of the command area is basalt. Most of the insitu soils of the command area are derived from basaltic rock. The soils along the banks of the Wainganga, Wardha and Purna rivers and/or their tributaries are derived from alluvium of the same origin. Majority of the area has deep, clayey, cracking soils which have high water retentive capacity and length of growing period. The area has high productivity potential due to inherent fertility of soils. The soils of the area are fine to moderately fine in texture and mostly free from salinity.

The quality of various types of soils in the project area shall be monitored during the CEIA study of the link project. Soil map of the command area prepared

based on the 'Soil map of Maharashtra' of NBSS & LUP, Nagpur is given at **Plate-8.2** of Chapter-8 'Irrigation Planning & Command Area Development'.

Terrestrial Ecology

Delineation of Flora in Study Area

The project region has great biodiversity of flora with many economically and medicinally important plants. A great variety of plant species that include Jamun (Syzigium cumini), Palas (Butea monosperma), Shisam (Dalbergia latifolia), Kate sawar (Bombax ceiba), Neem (Azardiracta indica), Teak (Tectona grandis), Dhawada (Anogeissus latifolia), Kalam (Mitragyna parviflora), Saja/Ain (Terminalia tomentosa), Bija (Pterocarpus marsupium), Shirish (Albizia lebbeck), Mango (Mangifera indica), Awala (Emblica officinalis), Kadamba (Anthocephalus cadamba), Moha, etc are found in this region. A rapid reconnaissance survey will initially be conducted to understand the existing ecosystem types and to identify the presence of ecologically sensitive areas in the study area during the CEIA study of the link project. In intensive survey, status of flora will be assessed using circular plot of various sizes for trees, shrubs, herbs and grass species.

Status of Fauna

Vidarbha has lush green deciduous forests which are home to a variety of flora and fauna. A no. of Maharashtra's tiger reserves are located in the Project area such as Melghat Tiger Reserve in Amravati district, Bor Tiger reserve in Wardha district and Pench Tiger Reserve in Nagpur district. Two wild life sanctuaries viz., Umred-Karhandla and New Bor are located in the vicinity of the project area. Wildlife species such as giant Indian squirrel, spotted deer, nilgai, tiger, wild dog, jungle cats, butterflies, python, crocodile, wolves, fishes and migratory species are found in this region.

Status of Fish Fauna

As far as economic importance is concerned, the scope of fish and fisheries in Maharashtra is of prime interest. There is a rich diversity of fish in Maharashtra. The Fresh water fish resource of Maharashtra constitutes 6 orders, 25 families and 160 species. There are many species like Oriochromis, Grass carp, common carp, silver carp, etc. that have been introduced in the inland water

of Maharashtra. During CEIA study, the fish fauna specific to the project area will be detailed.

Public Health

Medical and Health Facilities in the Project Command Area

The Govt. of Maharashtra has created three-tier health infrastructure to provide comprehensive health services. The primary tier comprises of Sub-centres, Primary Health Centres (PHC) and Community Health Centres (CHC). The sub-district hospitals and district hospitals constitute secondary tier whereas, well equipped medical colleges and super-speciality hospitals located in major cities are at the tertiary level.

The medical and health facilities available in the project area (2014-15) are given below at **Table 11.9.**

Table 11.9

Govt. run Medical and Health facilities available in Project Area

Name of Taluka	Hospital Incl. Speciality	Dispensary	Maternity hospital	PHC	Sub-Centre
Nagpur District					
Nagpur	-	3	-	2	17
Umrer	3	5	1	8	47
Hingna	3	5	2	8	42
Kuhi	3	10	1	8	59
Wardha district					
Arvi	1	3	1	3	23
Seloo	1	4	1	5	27
Wardha	2	1	1	4	27
Amravati district					
Dhamangaon	1	3		4	18
Nandgaon Khandeswar	1	10		5	20
Yeotmal district					
Babhulgaon	1	1	4	3	21
Ner	1	2	4	3	17
Akola district					
Akola	12	7	2	6	13
Barshi Takli	1	1	1	4	23

Buldhana district					
Shegaon	1	6	1	4	16
Motala	1	4	1	2	22

Source: District Social and Economic Abstracts, 2014; Bureau of Economics & Statistics, Maharashtra

Drinking Water Supply

As per 'Economic Survey of Maharashtra 2017-18', the National Rural Drinking Water Programme (NRDWP), a flagship programme of Govt. of India, is being implemented in the State since April, 2009. This programme aims at providing safe and adequate drinking water in rural areas. Drinking water sustainability a component of NRDWP, is being implemented with an objective of conservation of water by conventional and non-conventional measures. Under this programme, measures of strengthening sources of drinking water such as rooftop rainwater harvesting, construction of tanks in hilly areas for storage of rainwater, recharge shaft, recharge trench, cement nala bund, well deepening, etc. for availability of drinking water on sustainable basis are undertaken. Water scarcity programme is implemented every year from October to June in villages and wadis facing water scarcity. The State has taken various measures in order to tackle scarcity situation such as temporary piped water supply, rejuvenation of bore wells and other water sources, water supply by tankers, etc. for scarcity affected villages and wadis. Further, the State under 'Mukhyamantri Rural Drinking Water Programme' (MRDWP) aims to improve water supply to provide clean & sufficient drinking water in the rural areas. The components of the programme are implementation of new water supply schemes, rejuvenation of non-functional regional water supply schemes and maintenance & repairs of regional rural water supply schemes.

The villagers in the project area fetch drinking water from different sources viz. taps, wells, hand pumps, tanks and rivers. The ground water in certain parts of the region contains higher concentration of nitrates. The different sources of drinking water for the people in the region are presented in **Table 11.10**. A predominant portion of the region gets protected water supply as is evident from the table.

Table 11.10
Different Sources of drinking water

Unit : %

Name of district	Tap	Wells	Bore wells	Other sources
Nagpur	76	12	11	1
Wardha	63	18	18	1
Amravati	78	9	12	1
Yavatmal	44	29	25	2
Akola	59	9	31	1
Buldhana	54	24	20	2

Source: District Census Hand books, 2011

Sanitation

Adequate sanitation is essential for the protection & promotion of individual's and community health. Various schemes are being implemented by the State to improve sanitation conditions. The Government of India runs Total Sanitation Campaign (TSC) to provide sanitation facility. According to TSC reports (June, 2011), 78.7% households in Maharashtra have their own toilet facilities. Rural sanitation has always been on priority for Government of Maharashtra. State Govt. is steadily progressing on its path to make Maharashtra free of open defecation by 2nd October, 2019 as part of 'Nirmal Bharat Abhiyan' (renamed as Swachh Bharat Mission). The objectives of this mission are to ensure cleanliness in rural areas, to stop the practice of open defecation, construction and utilisation of latrine at household level.

Water Borne and Communicable Diseases

The outbreak of water borne diseases like Cholera, Gastro, Acute Diarrhoea/dysentery, Infective hepatitis, Typhoid, etc occurs sporadically in the project region. As reported in the 'Economic Survey of Maharashtra 2017-18', under 'Epidemic Control Programme', outbreaks as well as sporadic cases of these water borne diseases are monitored by the State and to control occurrences and deaths due to these diseases, containment measures are taken. As a result, there has been a steady decline in the no. of casualties from these diseases.

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 include all the plausible environmental considerations in planning and decision making so as to ultimately arrive at appropriate 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 Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project will be identified. Wherever possible, impacts will be quantified or otherwise, qualitative assessment shall be undertaken using predictive modelling techniques. The impacts on various aspects of Environment will be assessed for construction as well as operation phases of project.

Impacts on Air Environment

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 i.e 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. Some emissions will occur from crushing plants and the DG sets. However, such impacts are normally visible only in and around the construction 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. However, 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.

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, crushing equipment, DG sets, increased vehicular movement etc. There could be impact on the population residing in the proximity to the canal alignment/storage sites during construction phase as a result of various activities. However, based on past experience in similar projects, 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.

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

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 5 years. A large number of workers and technical staff are likely to migrate during project construction phase. Presently, the employment opportunities in the area are limited. Therefore, during the project construction phase, many of the locals may get employment. It has been observed during construction phase of many such projects, the major works are contracted out

and they bring their own skilled labour. Mostly, it is only in the unskilled category, that locals get employment. 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. Sufficient no. of community toilets need to be provided in the labour camps/colonies. The wastewater generated from the colonies will have to be collected and disposed in specifically designed soak pits and septic tanks. The wastewater and sewage generated should not be allowed to flow into the rivers and streams of the area. Efforts shall be made to ensure that treated effluent is disposed only in such water bodies, which are not used for meeting domestic water requirements.

(b) Impacts due to Runoff from Construction Sites: Substantial quantities of water would normally be used in the construction activities. With regard 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 on account of this may be too small to cause any adverse impact. It can, however, be treated by oil and separator unit, so as 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 1772 Mm^3 is proposed for diversion through the Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project from Gosikhurd dam site. It is planned to utilise the water in the commands under the proposed enroute storages along the link alignment in Nagpur, Wardha, Amravati, Yeotmal, Akola and Buldhana districts in Vidarbha region of Maharashtra for domestic, irrigation and industrial water supply to the tune of about 32 Mm^3, 1286 Mm^3 and 397 Mm^3 respectively.

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

- Modification of hydrologic regime
- Impacts on drainage system due to canal network

- Impacts due to siltation

The reservoir formation on account of construction of 31 new storages and raising of six existing storages 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 is likely to submerge due to the submergence of the proposed enroute reservoirs. Hence, no impacts on existing water bodies upstream of storages are envisaged.

b) Impacts on Water Logging and Soil Salinity: The main causes 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 a consequence 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 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 water.

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 will have an adverse effect on the growth of useful micro-organisms. Besides, harmful organisms may proliferate and create several problems in the plant growth.
- Physico-chemical and biological activities in the soil on account of low temperature. This may create the problem of increase in pests and diseases.

- Field operations may 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, i.e fertilizers dosing may need 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, t he drainage system (natural or man-made) is likely to contain much higher level of nutrients. The climatic conditions in the project area may also supplement 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 O&M staff will reside in the area in a well designed colony which will have a sewage t reatment plant and other infrastructure facilities, the problems of water pollution due to disposal of sewage may not be anticipated.

e) Recharge of Ground Water: Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project envisages creation of 31 new storages and raising of six existing storages besides construction of 426.54 km long canal. Due to these reservoirs and link canal, recharge of ground water in the area downstream of the storages as well as en-route the link canal will take place. This will be a positive impact of the project.

Impacts on Land Environment

i) Construction Phase: The construction of the proposed Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project is expected to be completed in about 5 years. Majority of the environmental impacts during construction phase are temporary 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 will be as follows:

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

a) Environmental Degradation due to Immigration of Labour Population: There is likely a huge influx of construction labour, technical and other work force for construction and related activities and service providers including their families in the project area. Congregation of labour force is likely to create problems of sewage disposal, solid waste management and cutting of trees for meeting their 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 siting and storage of these construction equipments would require significant amount of space. The site for storage of construction material and equipment will have to be selected in such a way that it causes minimum adverse impact 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 have to be planned to mitigate the adverse effect of soil erosion.

Impacts due to Construction of Roads: The transport routes are the main arteries of the economy. The status of village roads and cart tracks in the vicinity of the project area 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 vehicles loaded with construction material is likely to 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. may have to be taken.

ii) Operation Phase:

Acquisition of Land: The proposed project envisages construction of 31 new storages besides raising of six existing storages and canal network. About 19818 ha of land will be acquired for the enroute storages reservoirs. Reach wise details are given at **Table -11.11**

Table-11.11

Details of Land to be Acquired under the Enroute Storages

Link	Details of land under submergence (ha)			
	Forest Land	**Private Land**	**Revenue Land**	**Total**
Gosikhurd - Lower Wardha (Reach I)	191	10145	609	10945
Lower Wardha – Katepurna(Reach II)	10			6061
Katepurna – Nalganga (Reach III)	40			2812
Total	**241**			**19818**

Source: EE, WRD, Napur/Akola

About 15640 persons will be affected due to the submergence of these reservoirs. 26 villages will be fully submerged and another 3 villages will get partly submerged. Further, only land pertaining to 80 villages will come under submergence. Thus, a total of 109 villages are likely to get affected due to the submergence under the enroute storages.

The land to be acquired for Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link canal is 7342 ha. Details are given in **Table-11.12**:

Table-11.12

Details of Land to be Acquired for the Link Canal

Reach of the Link	Details of Land (ha)					
	Culturable land	Waste Land	Water body	Habitat	Forest Land	Total
Gosikhurd - Lower Wardha (Reach I)	2922	236	32	194	135	3519
Lower Wardha – Katepurna (Reach II)	2036	96	7	0	8	2147
Katepurna – Nalganga (Reach III)	1441	216	0	8	11	1676
Total	**6399**	**548**	**39**	**202**	**154**	**7342**

Impact on Biological Environment

Terrestrial Environment

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 have to 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 submergence under 31 enroute storages and raising of 6 existing storages is 241 ha. Details are given at **Table- 11.13**.

Table- 11.13
Details of forest land to be acquired for the enroute storages

Sl. No.	Dam site	Forest (ha)
1	Makardhokda	141
2	Borkhedi kalan	50
3	Lower Katepurna	10
4	Yelwan	40
Total		**241**

Total forest land to be acquired in the canal alignment is 154 ha. Details are given at **Table- 11.14**

Table-11.14
Details of forest land to be acquired for link canal

Sl No.	Canal Reach	Forest land (ha)
1	Gosikhurd - Lower Wardha (Reach I)	135
2	Lower Wardha – Katepurna (Reach II)	8
3	Katepurna – Nalganga (Reach III)	11
	Total	**154**

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 that will be outlined in the Environmental Management Plan of the proposed CEIA study.

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 usually not observed. Thus, no significant impact on wildlife is anticipated due to the project.

Umred-Karhandla and New Bor Wildlife Sanctuaries fall within the study area. The link project shall not propose to acquire any land from these sanctuaries. However, adverse impacts on account of increased human

interferences may take place during project construction phase, for which appropriate measures shall be outlined in the Environmental Management Plan of the proposed CEIA study.

ii) Operation Phase: The following impacts on account of forest land acquisition for the storages 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.

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 may be 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. may get dislodged and is carried away downstream by turbulent flow. In the areas from where construction material is excavated, benthic fauna may get destroyed. In due course of time, however, the area is likely to get 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 g e t hatched. Any disturbance of stream bottom may result in adverse impact on fish eggs.

Thus, significant adverse impacts on aquatic ecology can be anticipated for which adequate precautions during dredging operations are required to be undertaken.

ii) Operation Phase

a) Impacts due to bunding of Streams: The bunding of various streams for construction of enroute storages will result in creation of reservoirs of varied areas. The bunds will change the fast flowing stream 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 bund site. The micro and macro benthic biota is likely to be affected as a result of the proposed project, which will be duly assessed in the CEIA study.

b) Impacts on Migratory Fish Species: The obstructions created by the bunds would hinder migration of various migratory species. These fishes normally undertake annual migration for feeding and breeding. Therefore, fish migration paths may be obstructed due to the bunds and fishes are expected to congregate below the bund 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. Appropriate measures may have to be devised for conservation of fish species in the CEIA study.

Impacts on Socio-Economic Environment

i) Construction Phase

a) Impact of Influx or Migration of Labour: The construction phase will last for about 5 years. There is likely to be a huge influx of labour force and technical staff (along with their families) to the project area. The project will open a large number of jobs to the local population. Job opportunities drastically improve in

this area. The adequacy of infrastructure will generally be 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 cannot often be made available in the initial stages. The adequacy of water supply, sewage treatment, housing, etc should therefore, be ensured before and adequate measures will have to be taken at the very start of the project.

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

Construction Phase- The construction phase of the project can lead to increase in incidence of various water borne and vector borne diseases. Therefore, adequate precautions / control measures are to be undertaken. The health risk specific to water resources projects usually 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 in temporary dwellings without proper sanitary conditions and water supply. Only, in the final stages, colonies for project maintenance, town ships etc are built. Population migration indicated by actual or possible opportunity for work can aggregate problems as a result of housing difficulties, overcrowding, rise in cost of living and some un-predicted social problems as well as introduction of new sources of diseases. Immigrants immunologically may become susceptible to the endemic diseases prevalent in the areas of development.

Many of the immigrant population could be reservoirs 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 may have to 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, particularly if they are suffering from communicable diseases.

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. 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 is likely to reduce. However, adequate measures in the form of strict public health measures shall be proposed in the EMP.

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, i.e. 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 evapo-transpiration is likely to raise the minimum temperature and increased occurrence of fogs during the cooler months.

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 which normally contribute to more than 50% of the emissions.

Of late, 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 CHG emissions from reservoirs 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 nascent stage and is generally held back by a number of scientific uncertainties.

Based on available literature, predicted greenhouse details of gas emissions from reservoirs in India are given at **Table- 11.15**:

Table- 11.15
Predicted Gas Emissions from some Major Reservoirs in India

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

Environmental Management Plan(EMP)

Based on environmental impact assessment, mitigation of adverse impacts and enhancement of beneficial impacts are specified in the EMP.

Pollution Control at Construction Sites

Air Pollution Control

Control of Emissions: Minor air quality impacts are likely to 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 can be recommended to control air pollution:

- The contractor can be made responsible for maintaining and proper functioning of construction equipment to minimize exhaust.
- Construction equipment and vehicles can be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles can be prohibited.
- Effective traffic management can be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities can 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- 11.16**:

Table- 11.16
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 can be followed by the contractor while operating the DG sets. The other measures are recommended as below:

- Location of DG sets and other emission generating equipment can be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.

- Stack height of DG sets can 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 metre
h = Height of the building in metres where the generator set is installed
KVA = Total generator capacity of the set in KVA

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

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils can be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material can be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas can be sprayed (wet) and / or swept and unpaved areas can be sprayed and / or mulched. The use of petroleum products or similar products for such activities may be strictly prohibited.
- Contractors may be required to cover stockpiled soils and trucks hauling soil, sand and other loose materials (or required to maintain load in the truck with at least two feet of freeboard).
- Contractor may ensure that there is effective traffic management at site. The number of trucks / vehicles to move at various construction sites can be fixed.
- Dust sweeping – The construction area and vicinity (access roads, and working areas) can be swept with water sweepers on a daily basis or as necessary to ensure that there is no visible dust.

A lump sum provision of Rs. 65 lakh is made towards air pollution control.

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 are to be equipped with mufflers as recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Notification can be given to residents within 100 m of major noise generating activities. The notification can also describe the noise abatement measures that will be implemented.
- Noise levels can be regularly monitored during the construction phase of the project.
- A proper routine and preventive maintenance procedure for the DG set can be in place which can be followed in consultation with the manufacturer which would help prevent noise levels from its deterioration with use.

ii) Noise Generation from Controlled Blasting Operations

- Controlled blasting may be done as per the provisions of Indian Explosives Act.
- Blasting may not be undertaken in night hours.
- Workers at blasting sites may be provided with proper earplugs and helmets.
- Explosives used for controlled blasting can be kept in safe 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 may be restricted upto 30 minutes on a daily basis. Alternatively, the workers can 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 may have to be limited upto 4 hours per day.

Water Pollution

Sewage generated from various labour camps during project construction phase can be treated in a sewage treatment plant prior to disposal. Efforts may be made to discharge the treated effluent only in those 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 can be provided. The sludge from 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 can be used as cover material for landfill disposal site. A lump sum amount of Rs. 25 lakh is provided for construction of settling tanks.

Land Management Plan

Disposal of Muck and Reclamation of Muck Disposal Sites

The Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project envisages construction of 31 new storages, raising of six existing storages, 426.54 km long link canal (comprising of mostly open canal and in small stretches pipelines/tunnels) 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 storages 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 to be suitably disposed to the muck disposal sites in the project area. The muck disposal sites can be planned along the river course and in low level areas or depressions. The dumping of muck will be done in a 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 have to 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 bunds also. Bio-fertilizer technique developed by National Environmental Engineering Research Institute, Nagpur can be adopted in the proposed project. Unused excavated material can 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 will have to be done in consultation with the forest department of Maharashtra. A lump sum provision of Rs. 1350 lakh has been kept towards restoration of muck disposal sites.

Restoration Plan for Quarry Sites

The proposed Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project would involve construction of storages, canal, tunnels / adits, colonies for staff and labourers and other various components. During construction, these activities could result in accumulation of large amount of unused material at various sites which require proper restoration measures. This also includes areas likely to be disturbed due to quarries and dumping of unused muck in the project area. The existing landscape is likely to 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 their original condition wherever possible. Various engineering and biological measures will be undertaken for the restoration of these areas which inter alia may help 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 the quarries in the vicinity along the link alignment. The proposed project would require significant amount of fine material, which shall be met from the nearby sand quarries. The CSMRS, New Delhi has carried out the construction materials survey of coarse and fine aggregates for the link project. Based on physical & chemical tests and ASR test conducted by CSMRS, it is found that the coarse aggregate and fine aggregate samples in general are conforming to the codal requirements for use in concrete for both wearing as well as non wearing surfaces.

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 may get slowly weathered and after some time, it may become a potential source of landslide. Thus, it may be 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 will be 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, dust produced during the crushing operation to get the aggregates to the appropriate size and transport of the aggregates and material to the nearby project sites, which may disturb to some extent wildlife in the nearby two wild life sanctuaries viz., Umred-Karhandla & New Bor in the initial reaches. The quarrying for rock material in the proposed project may lead to removal of vegetation cover and top soil and leave the area barren. After the completion of mining activity, these areas will have to 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 explosives. At the end of the exploitation, quarries will be rehabilitated adopting such measures as re-establishment of vegetation, restoration of natural water courses, avoidance of

flooding of the excavated areas, achievement of stable slopes and avoidance of features. Otherwise these may constitute a risk to health and safety or a source of environmental pollution.

The measures that will be adopted for landscaping of the quarry sites and borrow areas have been described in the following paragraphs.

Measures to be adopted before Quarrying: The top soil (top 6 – 12 inch soil) shall 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 shall 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 shall 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 shall be spread as top layer. The top soil then can be covered with geo-textiles like coir, jute or by other locally available bio-degradable material so as to protect it from erosion.

- **Construction of Retaining Walls-** Retaining walls shall be constructed at the filled up depressions of quarry sites to provide necessary support.

- **Rocks for Landscaping-** After the quarrying activities are over, these sites will get 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 therefore be used to line the boundary of a path.

- **Laying of the Top Soil-** The depressions / craters filled up with rock aggregates shall 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, which will help in the process of soil reclamation and the early establishment of seedlings.

- **Re-vegetation-** Re-vegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach' shall be practised.

A lump sum provision of Rs. 365 lakh has been earmarked for restoration of quarry sites and borrow area.

Restoration of Colony and Office Complex

The working area of Storage sites, Labour colony and Project colony areas will be developed for beautification of the project area after construction is over. The reservoirs/storages may certainly be local points of tourist attraction. These could be used for sport fishing; recreation etc. So, there is a need for proper seating arrangement, development of resting sheds and footpath. The beautification shall be carried out by developing flowering beds for plantation of ornamental plants and flower gardens.

There would be sufficient open space in the colony area. The beautification in the colony area will be carried out by development of flowering beds for plantation of ornamental plants, creepers, flower garden, small park, construction of benches for sitting, resting sheds, walk way and fountains. A lump sum provision of Rs. 50 lakh is made for beautification & landscaping of the colonies & office complex and all along the link canal.

Implementing Agency: The restoration of the construction sites and implementation of various reclamation measures shall be part of the scope of work of the contractor.

Biodiversity Conservation and Management Plan

Compensatory Afforestation

As already described in preceding paras total 395 ha (241 ha under four enroute storages and 154 ha due to canal alignment) of forest area will have to be acquired. No rare, endangered and threatened species are reported in the project area. The cost of enroute storages have been worked out on volumetric basis (Cost/Mm^3 of storage) which includes structural as well as other components like R&R, afforestation etc. Therefore, separate provision towards compensatory afforestation in respect of enroute storages is made. As regards to compensation of the forest land to be acquired for the link canal, the afforestation will be done in 309 ha (double the area of forest land of 154.3 ha likely to be affected) 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 Maharashtra. A provision of Rs. 2030 lakh shall be kept for compensatory afforestation @ Rs. 6.57 lakh/ha as prescribed by the Govt. of India in June, 2009. 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 Forest clearance.

Biodiversity Management Plan

i) Forest Protection Plan: As Stated above, about 395 ha (241 ha under four enroute storages and 154 ha due to canal alignment) of forest area is proposed to be acquired for Wainganga (Gosikhurd) - Nalganga (Purna Tapi) link project. The following measures can be proposed as a part of Forest Protection Plan on the lines of similar link projects for which CEIA studies have been carried out:

- Under the reward for informers programme, workers who are well acquainted with the area and will be resourceful in gathering information for anti-poaching and better vigilance shall be engaged on contractual basis.
- An office to monitor the activities shall be arranged
- Public awareness programmes shall be organized; training camps shall be conducted; pamphlets, brochures, hoardings etc. shall be prepared for distribution/display.
- Fire lines within critical areas to protect the forest from accidental fires shall be provided.
- Check posts and watch towers equipped with camera, wireless, binoculars

and other minor equipment (spot scope, search lights, sleeping bags, health kits etc) shall be set up for better vigilance to check poaching.

- Construction of bridges, roads, inspection paths for more effective and meaningful patrolling of the staff shall be undertaken.
- Field vehicles and motorbikes shall be provided for effective vigilance.
- Creation of veterinary facilities and rescue camps for healthcare of wild animals and for controlling diseases with a mobile-rescue-cum-publicity-van and adequate stock of medicines shall be planned.

ii) Safeguards during Construction Phase: During the construction phase, various adverse impacts on the forests and wildlife are anticipated in the concerned reaches of the proposed project in terms of increased noise levels, land vibrations during controlled blasting, air pollution etc. In order to avoid or minimize the negative impacts from these activities, project authorities can formulate 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 can be kept to a minimum in the adjacent forest areas and it may 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 shall 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. shall be housed in enclosed structures to cut off the noise.
- The heavy equipment like rotating or impacting machines shall be mounted on anti-vibration mountings.
- Wherever combustion engines are required they shall be fitted with silencers.
- The traffic (trucks etc) used by the project works shall be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training / orientation shall be provided to the traffic operators /

drivers. Sounding of loud horns etc. in the forest areas shall be banned. Project authorities shall 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 shall 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 shall 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.

iv) 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 in the concerned reaches of the project area, which will be assessed during the CEIA studies of the link project.

v) Eco-Tourism: The storages will have great tourism potential and it can create 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 water body. For tourism development, brochures, pamphlets, signages, models, opening of the tourism information centres, telescopes, binoculars, trekking routes and their stay arrangements etc shall be required.

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

- Creating interest for birds by Bird watching
- Developing infrastructure for various water sports activities such as Boating etc.
- Developing 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.

This way, all the proposed enroute storages can be developed as Eco-tourist spots.

Green Belt Development Plan

Forest loss due to submergence under four storages and other project appurtenances is compensated as a part of compensatory afforestation. However in addition to above, it will be 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 will address 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. The plantation for this purpose shall be carried out by Forest Department of Maharashtra. A provision of Rs. 550 lakh for green belt plantation on the periphery of the proposed reservoirs and along the link canal has been kept.

Environmental Management in Labour Camps

The aggregation of large number of workers about 4000 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 total number of people including the family members of workers may be about 8000. 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 therefore to minimize these stresses. A community toilet must be provided for 20 persons. A lump sum provision of Rs. 275 lakh towards providing sanitation facilities in the labour camps is made.

The construction activities are likely to be concentrated at various locations at storage sites and along the canal alignment. Community kitchens shall be provided to worker families and the kerosene / Liquefied Petroleum Gas will be provided at subsidised rates. The provision for supply of subsidised kerosene/LPG to the labour is about Rs. 500 lakh.

Adequate facilities for housing and water supply shall also be provided. The wastewater generated from the colonies shall be collected and disposed in specifically designed soak pits and septic tank. The wastewater and sewage generated shall not be allowed to flow into the rivers and streams of the area. Efforts shall be made to ensure that treated effluent is disposed only in those 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 will need to be put to service. A lump sum provision of Rs. 300 lakh is made for solid waste management.

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 exit 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. All facilities to be constructed shall be fully equipped with the fire

protection equipments as per IS standards. Thus, a total provision of Rs.1075 lakh is kept for Environmental Management in labour camps.

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 incidence 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 reasons of the anopheline mosquito (malaria vector) are sunshine or moderate shade. Mosquito control and mosquito proofing measures shall be taken up to control malaria. The anti-malarial operations will be coordinated by various Primary Health Centres located in villages close to the submergence area of the storages.

ii) Development of Medical Facilities: It is proposed to develop first-aid posts manned by a doctor each and supporting staff during construction phase. The first-aid posts shall be located close to major construction sites. The doctor posted at the first-aid posts shall also coordinate the anti-malarial campaign to be carried out. A systematic campaign shall be conducted in the months of March and Sept which are usually 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.

iii) Health Extension Activities: The health extension activities will be carried out in the villages situated close to the storages 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 dispensaries to be set up as part of the project and other dispensaries in various villages in the project area shall 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 will be implemented for controlof water-borne diseases:

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

v) Disposal of Bio-Medical Waste: The Bio-medical waste generated from Health Care Facilities (HCFs) like hospitals, clinics, dispensaries, blood banks, health camps, medical or surgical camps, vaccination camps, blood donation camps and first aid rooms shall be treated and disposed of in compliance with the standards of the Bio-medical Waste Management Rules, 2016 of the State.

A lump sum provision of Rs. 170 lakh is made towards public health, health delivery system and disposal of bio medical waste.

Catchment Area Treatment Plan

Data Acquisition

Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, all areas may not contribute equally to the erosion problems. Satellite data shall be used for deriving latest and accurate land use data and ground truth studies shall be conducted.

The various data layers of the catchment area useful for the study are as follows.

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

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 a 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- 11.17**

Table- 11.17

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

Catchment Area Treatment Measures

The Objective of the SYI method is to prioritize sub-water shed in a catchment area for treatment. The erosion category of various watersheds in the catchment area as per SYI index for the proposed enroute storages shall be arrived at in the CEIA study of the link project and areas of each storage under different erosion categories shall be identified accordingly. Various engineering and biological measures shall be suggested in EIA studies for catchment area treatment categorised in the high erosion category of watersheds in the catchments upto the respective storages.

Silt Transfer

The yield received from rains in the catchment area would be stored in Gosikhurd reservoir and then let out into the link canal through the head regulator. 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.

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 locations. Even after providing silt excluders and silt escapes, some quantity of suspended silt shall still get deposited on the bed of link canal. Every year during the closure period of the canal, the deposited silt will 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. In case of enroute storages, the catchments are not big and hence silt problem is not anticipated much, which will of course, be duly assessed during the CEIA study of the project.

Command Area Development/Management

Wainganga (Gosikhurd) – Nalganga (Purna Tapi) link project envisages to provide irrigation to an extent of 371277 ha in six districts of western Vidarbha in Maharashtra State viz. Nagpur, Wardha, Amravati, Yeotmal, Akola and Buldhana in Wainganga & Wardha sub-basins of Godavari basin and Tapi basin. New command area is proposed mainly under 40 enroute storages/tanks to be integrated with the link canal. Topography of the command area is undulating and is of moderate slope. Isolated hill tops/hillocks and continuous hill ranges in small stretches with valleys dominate the command area.

The command area development would include land leveling, shaping, construction of field channels and drainage systems. Land leveling is essential in undulating area of the command for equitable distribution of water and prevention of soil loss due to erosion. To prevent stagnation of water in the command, field drains would drain into subsidiary drains to be constructed at right angle to natural drains. The field boundaries will be made use of in digging these subsidiary drains. Field drains shall be at least 30 cm deep with side slope ranging between 4:1 and 8:1. Drains shall be as straight as possible with cross section of trapezoidal shape.

A provision of Rs. 25989 lakh has been kept in the estimate towards improvement of existing drains and construction of new drains in the command area @ Rs. 7000/- per ha of CCA. At the time of implementation of the link project, detailed survey of each command will be done and based on the actual requirement, appropriate land development works will be taken up by the state Govt.

Impact on Water Quality Downstream of Storage Tanks

The enroute storage tanks are proposed mostly on small natural streams. No major water retaining structures are constructed or contemplated downstream of the proposed storages on these streams. The water to the storages are mainly fed from the Wainganga –Nalganga link project. The natural flow of these small streams is not being planned for any utilisation in the present project proposal and would be let off. Hence, there will be no adverse impact on the water quality downstream of storage tanks.

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 inhabitations in the 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; Evacuation plans; Evacuation teams; Public awareness for disaster mitigation; Notifications; Notification procedures and Management after receding of flood water.

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation from time to time. The District Magistrate is to monitor the entire operation. The Disaster Management Plans might be well in place in respect of existing Gosikhurd, Lower Wardha, Katepurna and Nalganga projects. Appropriate Disaster Management Plans for mitigation and prevention of hazards will be drawn wherever necessary in respect of the proposed enroute storages.

Energy Conservation Measures

Various construction and other activities of the proposed Wainganga (Gosikhurd) - Nalganga (Purna Tapi) 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 5 years, a large influx of labour will be at the project site. 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 shall 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 shall also be provided to the labourers by the contractors. In addition to above, efforts can be made towards energy conservation by installing non-conventional energy sources. Energy conservation measures shall 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 can be included as part of the Construction and Operational EMPs. The Energy Management Action Plan shall be consistent with the energy conservation measures during both construction and operation phases.

Energy Conservation during Construction Phase

The following energy conservation measures can 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 operation and fuel efficiency.
- The specification of energy efficient construction equipment.

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. Canal top/bank solar power generation is already included in the project components.
- Designing roads on site to reduce transportation distances.

An amount of Rs. 250 lakh has been earmarked for implementation of Energy Conservation measures.

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 reservoir areas and areas benefited and impacted by the project
- To check 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 can 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 shall be as in **Table- 11.18**:

Table- 11.18
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

As indicated above, the parameters to be monitored in water are pH, BOD, COD, total dissolved solids. A provision of Rs.120 lakh is made for environmental monitoring programme during construction phase.

The Environmental monitoring programme during project operation phase can be as at **Table- 11.19.**

Table- 11.19

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	Storages
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	Storages
5	Incidence of water-related diseases	Cause and control measures for various diseases.	Once in a year	Settlements around storages and in command area

Sl. No.	Particulars	Parameters	Frequency	Location
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 storage sites

A provision of Rs. 40 lakh is made towards implementing environmental monitoring programme during operation phase. Further, a provision of Rs. 10 lakh is made for monitoring meteorological parameters. Thus, a total of Rs. 170 lakh is provided for implementation of the above listed activities in the environmental monitoring programme during construction as well as operation phases.

Cost of Environmental Management Plan

The total estimated cost for implementation of Environmental Management Plan is Rs. 61 crore (excluding the cost of R & R Plan). Details are given at **Table- 11.20**:

Table- 11.20
Details of Cost for Implementation of Environmental Management Plan

Sl. No.	Item	Total (Rs. in lakh)
1	Compensatory afforestation	2030
2	Green belt development on reservoir periphery and along link canal	550
3	Environmental Management in Labour camps including storages and canal	1075
4	Public health and health delivery system and disposal of Bio medical waste	170
5	Restoration of Quarry sites and land scaping including restoration of Colony and Office Complex	415
6	Stabilisation of Muck disposal management / Land management	1350
7	Implementation of water pollution control measures	25
8	Implementation of Air pollution control measures	65
9	Implementation of Energy conservation measure	250
12	Implementing Environmental Monitoring Programme	170
	Grand Total	6100