

Technical Note on Compliance to JICA Draft Report communicated through Chief Engineer's Letter No. CNH/TA4/AE2/NH-48/ FS Tunnel/ Env Study/ 2015-16/ 4749 dated 15th February, 2016:

We would like to appraise you that the points mentioned by JICA would be addressed properly and it will be included in the EMP prepared by Environmental expert of Geoconsult. The Environment and Social team is carrying out environmental and social study. This would include the specific mitigation measures for all the environmental factors namely Air, Water, Ecological, Social, Noise, Land use, Flora and Fauna, wild life, labour, muck management, blasting and other relevant issues related to this project. The team is in touch with the milestone studies of Gadgil and Kasturirangan committees report and taking full note of that.

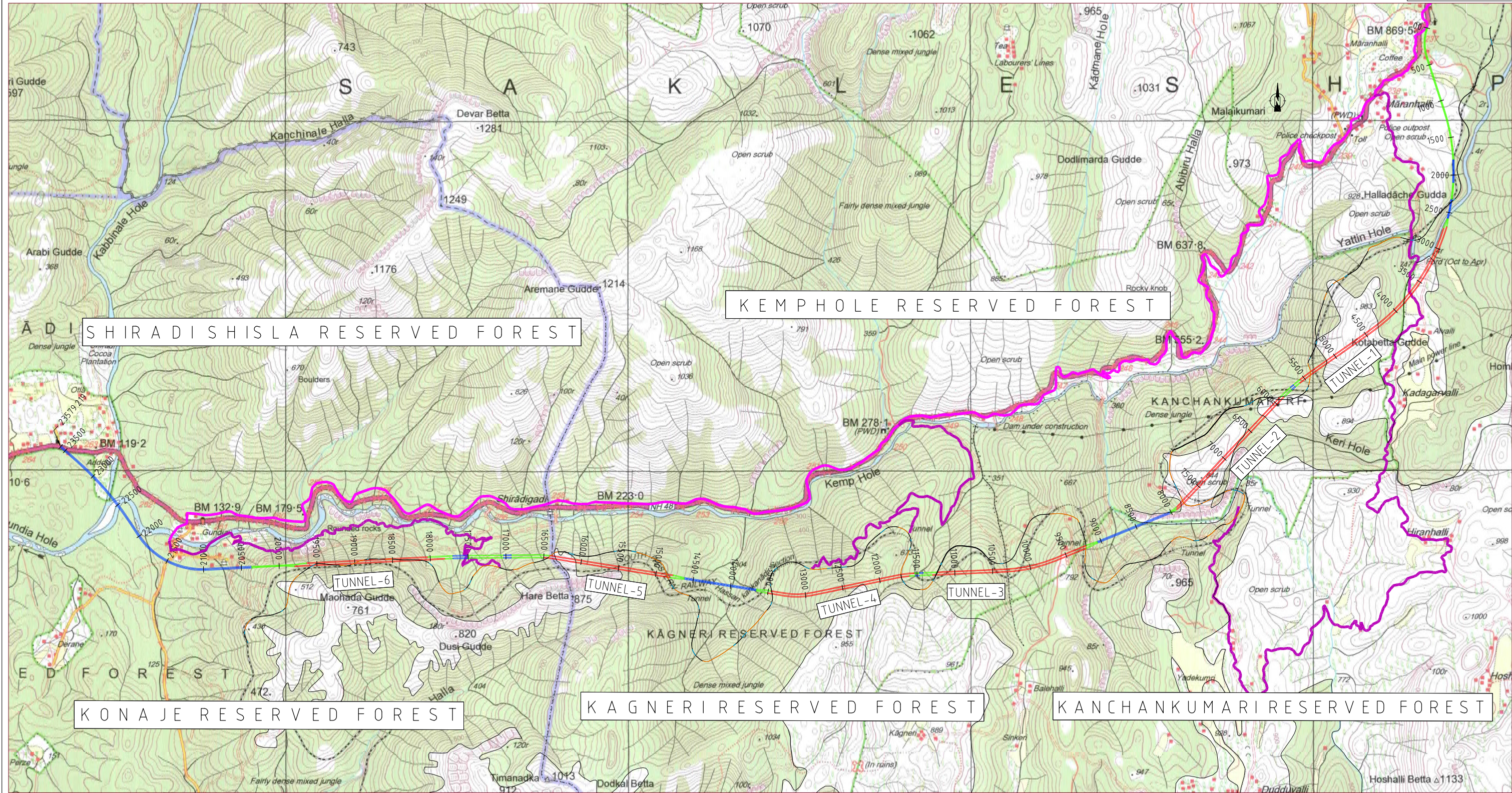
Both the key points raised by the JICA team would be fully mitigated with measures included in the construction plan. The project team would also suggest the best practices in the sector.

A. The Cut and fill section proposed at the eastern part of the alignment where no other possibilities workout economically and the area is fully under Private Land. The area is surveyed and no major flowing stream/ nala/ river occurs in proposed cut & fill area. Please refer annexure 1 where alignment has been superimposed on the contour map for better understanding of the topography of the area. The minor gulley's and drains shall be provided with cross drainage structures for effective flow which are there only during monsoon. The effect of construction road and construction would be mitigated through hard fencing at the stream side and identified habitat places for the wild life. The water quality would remain unchanged as no possibility of entrance of the project staff in the stream. Also any construction water may require to discharge at all directly to the stream/ Nala should undergo sedimentation process. The air borne dust could be controlled through effective water sprinkling at the work places.

B. Yes, the blast could affect the behaviour of animals in the project cycle but this can be significantly reduced and controlled by controlled blasting technique available. Also there are technics like Presplitting by using chemical which is non pollutant and noiseless, which would help in fragmentation of hard rock and mechanical excavation can be carried out. The excavation procedure also suits the proposed tunnel construction methodology "NATM".

C. Please refer Annexure-1, As advised the reserve forest boundaries, location of streams, existing road path in the forest area that is being used by the Railways for their network improvement, railway lines with existing structures and proposed bypass alignment is shown in the drawing.

D. For unrestricted ground water flow path, suitable measures have already taken in the tunnel design. Please refer to attached annexure 2 which is also a part of our KD-6 submission. Suitable drainage measure with waterproofing system is already in place to mitigate the hazard.



LEGEND:

EXISTING NH-48 (AS PER TOPO SHEET)	RAILWAY LINE (AS PER SURVEY)	EXISTING VILLAGE/ FOREST ROAD	BRIDGES (B) (AS PER PROPOSED ALIGN.)
EXISTING NH-48 (AS PER SURVEY)	RAILWAY TUNNEL (AS PER SURVEY)	FOREST	TUNNELS (T) (AS PER PROPOSED ALIGN.)
RAILWAY LINE (AS PER TOPO SHEET)	RAILWAY BRIDGE (AS PER SURVEY)	RESERVED BOUNDARY	CUT/FILL (C/F) (AS PER PROPOSED ALIGN.)

REFERENCE DRAWINGS:

TOPO SHEET-SURVEY OF INDIA-NO. D43V9

NOTE:

1. THIS DRAWING IS MEANT TO SHOW EXISTING TOPOGRAPHIC FEATURES ALONG WITH PROPOSED ACCESS ROADS AND RAILWAY LINE, IN PROXIMITY TO PROPOSED ALIGNMENT. FOR ALL OTHER DETAILS RELEVANT DRAWINGS MUST BE REFERRED TO.

REVISION

REV.	DATE	PARTICULARS	Drawn	Checked	Approved
A	MAR 2016	FIRST DRAFT (PRELIMINARY)	PRa	SGa	AKg

QUALITY ASSURANCE

Date (FIRST ISSUE)	PRa	RMe	SGa	AKg
MAR 2016	PRa	RMe	SGa	AKg

DESIGN CONSULTANTS:

GEOCONSULT India Pvt. Ltd., Plot No. 473, Industrial Estate, Udyog Vihar, Phase V, Gurgaon-122016, (India)

PROJECT TITLE

CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780

SCALE

1:25'000

CLIENT

GOVERNMENT OF KARNATAKA

DRAWING TITLE

LAYOUT PLAN

DRAWING NUMBER

SHGA-FS-GEN-005

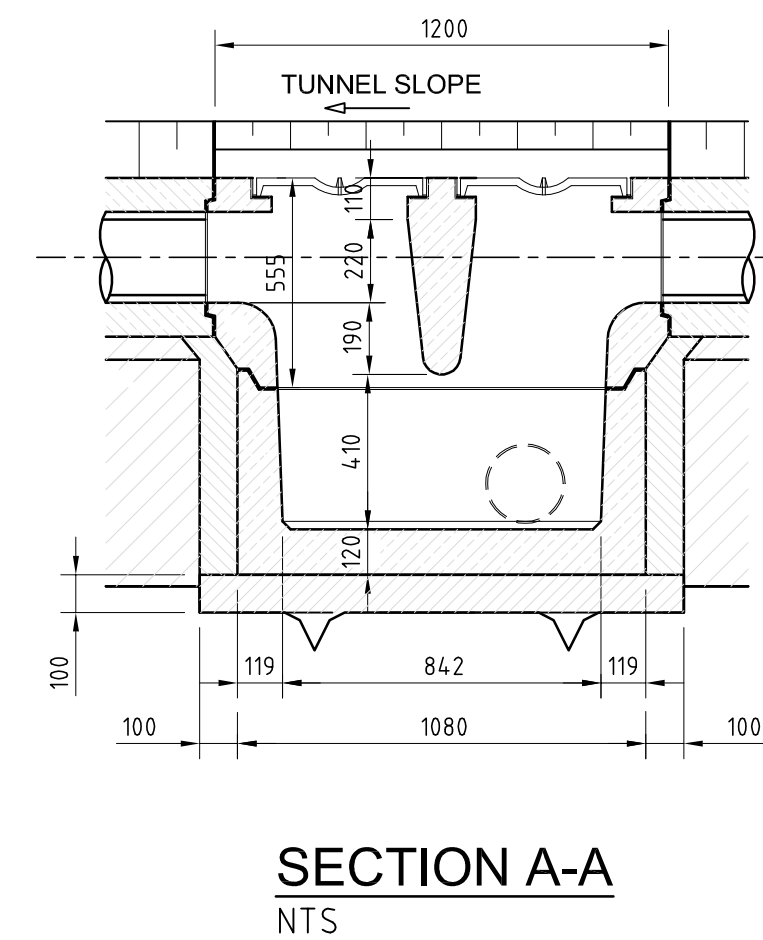
SCALE

1:25000

MONTH


MAR 2016

PRELIMINARY



1. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.

PRELIMINARY

REFERENCE DRAWINGS: SHGA-FS-LAY-1001 TO 1016 (16 SHEETS) SHGA-FS-LAY-1061 TO 1098 (38 SHEETS)	LEGEND: <div><div></div> LINING / INVERT CONCRETE</div> <div><div></div> PAVEMENT QUALITY CONCRETE (PQC)</div> <div><div></div> DRY LEAN CONCRETE (DLC)</div>	REVISION					QUALITY ASSURANCE					DESIGN CONSULTANTS : GEOCONSULT India Pvt. Ltd. Plot No. 473, Industrial Estate, Ud yog Vihar, Phase V Gurgaon-122016, (India)			CLIENT GOVERNMENT OF KARNATAKA										
		The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.										PROJECT TITLE CONSULTANCY SERVICES FOR FEASIBILITY-CUM-GEO TECHNICAL STUDY FOR BYPASS TO SHIRADI GHAT FROM Km 238.00 TO 261.45 ON NH-48 IN THE STATE OF KARNATAKA- JOB NUMBER NH-48-KNT-2015-16-780			DRAWING TITLE MAIN TUNNEL REGULAR CROSS SECTION 2 DRIVING LANES+ 1 EMERGENCY LANE										
		E	DEC 15	MINOR CORRECTIONS / RESUBMITTED (KD-6)			RMe	BRs	FKr	Date (FIRST ISSUE)	22.07.15	22.07.15	22.07.15	22.07.15	22.07.15	Name	RMe	RMe	BRs	FKr	FKr	DRAWING NUMBER SHGA-FS-GEN-012		REV E	
		D	DEC 15	SECTION WITH ARCH INVERT ADDED (KD-5)			RMe	BRs	FKr																
		C	SEP 15	CP HEIGHT MODIFICATION & RESUBMISSION (KD-4)			PRa	BRs	FKr																
		B	AUG 15	MINOR MODIFICATION			PRa	BRs	FKr																
		A	JULY 15	FIRST DRAFT (INCEPTION STAGE)			RMe	BRs	FKr	Drawn		Drafting Chk	Designed	Design Chk	Approved										
		REV	DATE	PARTICULARS					Drawn	Checked	Approved	Originators					This document should not be relied on or used in circumstances other than those for which it was originally prepared and for which Geoconsult was commissioned. Geoconsult accepts no responsibility for this document to any other party other than the person by whom it was commissioned. GEOCONSULT, PRa, R/16000 Projects\16060-Shiradi Ghat\CURRENT\1601-6\SHGA-FS-GEN-012_E.dwg, 2015-12-18					SCALE 1:50		MONTH (Current Issue) DEC 15	



Government of Karnataka
(Public Works, Ports and Inland Water Transport Department)

No: CNH/TA4/AE2/NH48-Tunnel /2016-17/3454

Office of the Chief Engineer,
National Highways, KR Circle
Bangalore. Dated: 26 NOV 2016

To:

Mr. D.KIYOTO,
M/S CTI Engineering International Co. Ltd
TOKYO,
JAPAN.

Sir,

Sub: Submitting details of Tunnel regarding.

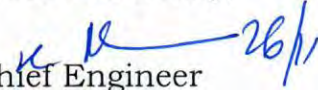
Ref: 1.Report of Ecological Surveys between Sakaleshapura
and Gundya region.
2. Data collection survey on Natural Environment of the
western ghats in the republic of India. (Draft Final
Report)

The response from the Public Works Department to the above report is given in detail at Annexure-A. The litigation, observations, clarifications are given in the enclosure.

A brief note giving the details of necessity and viability of bypass to Shiradighat is enclosed as Annexure-B.

The necessity of the project is enlightened in Annexure-B. If the tunnel is considered, then the surface road from Maranahally to Gundya will be closed. This will have positive impact on of the environment. Hence , it is requested to consider all these points while recommending the report.

Yours faithfully,


Chief Engineer
National Highways,
Bangalore

Copy to:

1. Chief Engineer, (P6), MORT&H, No 1 Parliament Street, Transport Bhavan, New Delhi for kind information.
2. Regional Officer, MORT&H, Bangalore for kind information.
3. Superintending Engineer, NH Circle, Bangalore for information
4. Executive Engineer, Shiradighat Tunnel Division, Sakaleshapura for information.

Japan International Cooperation Agency (JICA)

“DATA COLLECTION SURVEY ON NATURAL ENVIRONMENT OF THE WESTERN GHATS IN THE REPUBLIC OF INDIA”

DRAFT FINAL REPORT : November 2016

Submitted Report has been studied and reviewed with reference to under prepared “Detailed Project Report (KD7 & KD8)” by the Design Consultant “Geoconsult India Pvt Ltd.

Major Findings, Observations and Clarifications are as follows:

1. General:

Shiradi Ghats area in which the project is in the planning stage, is adjacent to the Western Ghats Mountains. This site is not yet designated as a UNESCO World Heritage site as brought out in the report. The collected literature indicates the inhabitation of many rare and endangered species, such as Elephant, Tiger, Wild dog, Doles and Macaque as mammals, various frogs as amphibians and some tropical trees as plants. No negative orientation was observed for the Shiradi Ghats Bypass Project. Several organizations consider the Project positive because the bypass could improve the discontinuity of Western Ghats Ecosystems disturbed by existing National Road No. 48. On the other hand, not a small number of organizations showed a negative orientation toward the Yethinahole Project mistrusting the submitted data for calculating possible intake from the region.

2. Shiradi Ghat Bypass Project

- Planned alignment is on the Southern side of existing NH-48 as describe as following figure. The alignment starts near Heggade Village (km 236.400) traverses through Greenfields, bypassing Heggade, Maranhally Kadagaravalli, Yedakumari and Gundya, villages and ends at Adda Hole (km263.400) of NH-48. The total length of alignment under this option is 23.579 km, and the route consists of 6 tunnels (length 12.631km varying from 1660 to 2960 m), 6 bridges, One RoB and One Viaduct (length 6.327km, varying from 50 to 3217m), and 4.621km long cut & fill sections.
- The route has low gradient (roads & bridges: 0 to 3.5%, tunnels: 3.0 to 3.5%) and gentle curves (R=500m to 2000m). The height of bridge piers in the deep valleys is restricted to 120m that makes the early implementation of the project possible. Also, tunnel lengths are limited to 3.0km that makes the scale of ventila 95% tion/emergency facilities ordinary in size. Only 4.621km out of total length of 23.579km is planned as “cut and fill” that requires deforestation of the construction area.
- Karnataka is regarded as one of the foremost and biggest habitats of the Asian elephant in India. Among the 2,855 forests in Karnataka, the elephant has been found in 972 forests. According to Dr. Raman Sukumar, professor of IISC, the elephant’s habitat on the south side of the bypass project site is currently saturated, and it is a concern that the bypass may hinder the northward movement of the elephants.

- The project proposals comprise of tunnels and high level bridges for 95% of the total length. Due to that existing flora & fauna will not be disturbed to the maximum extent after construction of the project.
- **3.2.1 Preparations to Acquire Environmental Clearance:** As per MoEF Norms EC is not required to obtain as length of the project is less than 30km and Elevation below 1000m. Only Forest Clearance is needed to obtain for construction.
- **3.2.3 Preparation of Budget for Land Acquisition :** There is NIL Habitation along the road alignment and proposed 60m Road Corridor in Forest Area. Land Acquisition and re-habitation will be required in Private Land Area near Maranhally (km 0 to km 1 intermittently).
- **5.1.5 Considering Construction Roads:** Logitudinal Grade will be flattened for carrying out heavy machineries & equipment wherever possible without felling of trees.
- **5.1.6 Construction period of Construction Roads:**
 - 2) **Calculation of Construction Periods :** Construction Periods is between December to April five months only because incessant rain in Shiradi ghat in that season.
- **5.1.7 Possible Mitigation Measures:**
 - 1) **B) Measures for Intersections with Mountain Streams :** For intersection of construction roads and mountain streams cannot be disturbed and hence usage with temporary culverts using Hume pipe with proper Hydraulic calculations.
 - C) Reduction of Slope Areas of Fill by Geo textile Walls and Gabion Mattress will be taken into Reinforced earth techniques and geogrids can also be used to minimize the Slope areas.
 - 2) **B) Controlled Blasting :** Korian technology (Pulse plasma blasting technology) will be used for Blasting ,Eco Friendly Non Explosive Pulse Plasma Technology for Rock fragmentation technology is very useful for twin tunnel project in Shiradi Ghat Bypass project. Advantages of Pulse Plasma Technology in front of Sound & vibration velocity combine with low dust generation due to exothermic reaction between two metal powder under Plasma stage. also notice that rock excavation by Plasma Technology is carried out to a depth of 250 meter due to highly sensitive zone.
- **5.1.9 Challenges in the Future :** Detailed Study on Construction Roads: Already identified and collected details of various existing routes possible for utilization during construction. Same will be incorporated in KD7 & KD8.
- **Possibility of Utilization of Existing Railway:** Meetings and Presentations had been held with Top officials DMR Mysore office. They are highly positive & supportive professionally.
- **Disposal Sites of Construction Generated Soil :** Disposal sites have been identified beyond Forest Area near Sakleshpur & Hassan Railway Station and Near Subramanya Railway station.
- **Management of Construction Roads after Construction:** Existing roads shall be non-bituminious and maintained well during construction.

These same will be re-established as same as in prior of construction. Temporary CD structures will be dismantled and removed.

➤ **Mitigation Measures Suggested (Page 45 & 46)**

Following alterations to the existing habitats, however, this may not be exhaustive list:

1. Habitat modification (Conversion)
2. Habitat fragmentation
3. New Access Roads
4. Dumping yards
5. Stream degradation
6. Stream diversion
7. Heavy Vehicle traffic during construction
8. Increased frequency of vehicles
9. Human settlement (temporary vs. permanent)
10. Pre- and post-project impacts

1. Habitat modification or conversion is one among the major threats to endemic amphibians of the Western Ghats. Mitigation measures suggested for habitat modification or conversion is to maintain immediate surroundings of a converted habitat as a buffer zone with least use. This reduces edge effects on amphibians.

NOTED, will be recorded in the EMP report as mandatory action.

2. Habitat fragmentation or attrition that happens during the construction phase will lead to extinction of a frog population locally. The fragmentation must be to the least possible measure. To maintain the connectivity with the fragmented habitats native species of trees or with bridges and tunnels must be constructed to allow easy movement of amphibians.

NOTED, will be recorded in the EMP report as mandatory action.

3. Find alternative routes if the proposed alignment is going through intact forest patches. This might escalate financial burden on the proponents of the project; however, the damage to ecosystem by constructing through intact forests are much more than the financial equations. In the present study, areas on the right side of the highway (Kadumane estate) can be looked at as an alternative plan.

Alternate Alignment Studies already have been carried out and most optimum, economic and feasible alignment had been approved.

4. Construction activity must be carried out in the lean period of activity for amphibians.

Noted.

5. It would also be useful to limit the road construction adjacent to hill-streams particularly for fishes and amphibians.

Noted, Slope Protection measures are proposed towards valley and Nalla sides

6. Access roads and new roads that are not in use should be deactivated or abandoned after their stipulated usage. This should be carried out in a systematic manner (replanting, removal of asphalt, and so on) and without leaving any trace of construction mark.

Yes, unused roads will be abandoned after their stipulated usage time to time.

7. Tunnels (underpasses) and fencing, specifically designed for amphibians, must be installed to help in easy movement of amphibians across roads and streams. These structures should also be installed in known cross over regions along amphibian corridors (streams/wetlands); places of frequent roadkills and heavy traffic areas. Design culverts, underpasses, and overpasses to accommodate a variety of species.

Noted, All Cross Drainage Structures are high levels with sufficient span/openings & vertical clearances.

8. During construction, minimize the use of contaminants (e.g. salts, petrochemicals, and herbicides) and unnecessary spill overs. It is highly recommended to use materials that are biodegradable. There shall not be any dumping of muck and debris of construction materials in streams and forest valleys. Utmost care should be taken in construction activities near streams to minimize any damage to amphibians, in particular, and stream ecosystem in general.

NOTED, will be recorded in the EMP report as mandatory action. Railway Services will be utilized as much as possible

9. There must be a systematic and objective monitoring of activities during construction phase and operation phase. Monitoring should not be biased towards construction and it should be done to minimize damage to ecosystem.

NOTED, will be recorded in the EMP report as mandatory action.

10. Settlements for construction workers should be eco-friendly and must be dismantled immediately after stipulated use.


NOTED, will be recorded in the EMP report as mandatory action.

4. Environmental Study Related :

It is our responsibility to promote conservation of environment and preserve the endangered species and endemic species in its own habitat in a responsible manner.

ENVIRONMENTAL ATTRIBUTES IMPACTING THE FLORA AND FAUNA OF THE REGION	PROBABLE IMPACT	PROPOSED MITIGATION MEASURES
AIR	Air quality may affect the water quality and its aquatic fauna due to increased turbidity	No activity which can disturb the river course, its flow, and resources would not be allowed during construction and operation
NOISE	The increased noise level during construction phase can disturb the resident bird population	The construction sites would be away from the faunal habitation included the aquatic and amphibians habitations
WATER	Water resources may be depleted during construction	The water course and its tributaries would not be interrupted during construction and it has been taken into consideration during planning stage
EARTH	The filling material may be taken from its habitat	It has been ensured that no habitat would be disturbed whether land or aquatic.
HABITAT	Habitat of the Wild life in the region	The habitat of the flora and fauna would be taken care of during construction and operation.

The disturbance envelope for landside infrastructure and construction activities for the proposed Development has been developed to allow for flexibility in locating support infrastructure during construction. In the construction phase an Environmental Expert would be taking care of the biodiversity management plan and its implementation.


Chief Engineer
National Highways Zone
Bangalore

Cost Aspects

- Based on the alignment study, geotechnical investigations, structures, and bidding parameters for the brand-new, green-field Shiradi Ghat Bypass with tall bridges Rough cost works out to Rs 10000 crores.

Traffic Risk - Present Traffic Volume

- It is very important to evaluate the traffic risk for green-field, toll expressway projects. It is supposed to require at least more than 10.000 long-trip travels per day to make a PPP(80T) project feasible. According to the data available ADT at Gundiya on NH48 is approximately 8000 that is the total amount of traffic in both directions. The ADT of long-trip vehicles observed is about 800. Thus the traffic appears to be only short trip traffic on NH48. As a result, the traffic volume should be insufficient to adopt a project implementation mode of PPP(80T).
- The improvement of the East-West connectivity between Mangalore-Bangalore Chennai should go ahead of the enhancement of Old and New Mangalore Ports and is likely to give a huge socio economic impact on the State and improve the feasibility / needs for the enhancement projects of Mangalore Ports
- The New Mangalore Port is owned and operated by the Central Government. The New Mangalore Port is one of the largest ports in the west coast of India and natural liquid gas and fertilizer produced by chemical plants located near the Port are dealt with. New Mangalore Port, it regarded as a backup port of the JNPT Port in Mumbai. Maharashtra. According to the Port Trust, the destination of most goods unloaded at the new Mangalore Port were originally scheduled to be the JNPT Port in Mumbai. but they ended up coming to New Mangalore Port because of timings and availability of the JNPT Port. The railways and NH17 are directly connected to the New Mangalore Port that are connected to the Mumbai-Pune area.

K 12 26/11
Chief Engineer
National Highways
Bangalore

Compliance for the JICA team Observations

SL NO.	OBSERVATIONS	COMPLIANCE
1	<p><u>Precipitation data which connects to Inflow estimation.</u></p> <p>The calculation of the inflow has been estimated by only one rainfall monitoring station owned by private plantation which has not been checked directly by WRD.</p> <p>Besides, WRD did not utilized existing rainfall monitoring data of KSDMC: Karnataka State Disaster Monitoring Centre allocated to the area close to the Project Site.</p> <p>There is huge discrepancy between above precipitation amount, more than 6,000 mm/year to that of KSDMC around 1,500 mm to 2,000 mm/year. Immediate evaluation shall be conducted regarding the validity of the utilized data while no evaluation has been made so far. Supporting data such as cross section with its calibration record, flow rate, H-Q curbs and other shall be evaluated too.</p>	<p>Regarding the availability of Yield The National Institute of Hydrology (NIH), Belgaum, Govt. of India was entrusted to estimate the dependable yield of the proposed project. According to NIH, 23.41 TMC of water is available at 50% dependability in the catchment area with annual rainfall of 4880 mm for the period 1993-2012.</p> <p>Three existing rain gauge stations at Hongadalla, Kadumanehalla and Kottanahalli were considered while calculating the yield estimations. Therefore, the data used for yield calculation is in order. Correlations with actual stream flow measurements by KPCL shows that the yield calculations is conservative.</p> <p>Further, Karnataka State Natural Disaster Monitoring Centre (KSNDMC) in their letter dated: 12.02.2016 stated that “the weighted average rainfall for the entire Yettinahole catchment is 5138 mm”, detailed report is enclosed as Annexure-1. KSNDMC has only recently established some telemetric rain gauge stations in the Yettinahole catchment, data for which are available only for 2015, which is not sufficient.</p> <p>Further, CWC under letter dated: 10-4-2015 stated that “The approach adopted by the project authorities for assessing the yield stress based on observed data of Bantwal G&D site maintained by CWC and three G&D sites maintained by KPCL near weir sites appear to be in order”.</p>
2	<p><u>Transportation Loss</u></p> <p>Open canals are proposed to transport water toward the destination for vast distance and the loss of the water calculated as 10% while no evaporation, infiltration, nor the possibility of illegal utilization of water. Those shall be counted as evaluated for the feasibility of the project.</p>	<p>During the calculation for requirement of water, 5% losses for Transmission & storage and 5% losses for Treatment & Distribution was considered.</p> <p>Further, open canals are lined canals the infiltration rate is nil and in this canal water will flow only during the monsoon season during this period the evaporation loss is very meagre. This meagre evaporation quantum will be analysed in future while during the filling the tanks.</p>

3	<p><u>Baseline data without the Sampling term</u></p> <p>No information has been given regarding sampling term of baseline data such as existing species and water quality. At least two term samplings such as during monsoon and off-monsoon for aquatic life form as well as water quality.</p> <p>Besides, not sufficient secondary information regarding fauna and flora has been given in the DPR. There is discrepancy regarding the confirmed species to the other conducted survey.</p>	<p>It is respectfully submitted that, the existing species and data on water quality pertaining to the project area (weir site) was collected and presented in Chapter 3 of the Environmental Management Plan. The extract of the same is enclosed as Annexure-2.</p> <p>There are plenty of secondary details, published literature and reports available for the entire western ghats or pockets where different institutes or individuals conducted the research studies. However, the published secondary data for western ghats may not be the representative data for the project sites. Hence, data was collected pertaining to weir locations and wherever necessary secondary data pertaining to weir locations was incorporated in the report. Further, the experts involved in preparation of the EMP was well aware of the western ghats and conducted plenty of research works in the area. Also, published papers in peer reviewed journals on Western Ghats. Therefore, the comments of JICA are noted for further guidance if necessary.</p> <p>The aquatic ecology studies was conducted by Shri. M F Rahman, Scientist (Retd.), Central Inland Fisheries Research Institute, Govt. of India who is renowned expert in the field of aquatic ecology and has got immense experience in the field. He was worked for many projects across India and also in Western Ghats since 40 years and involved with the Fisheries Dept., Govt. of Karnataka in identifying fish sanctuaries in Western Ghats as well as in Karnataka.</p> <p>The biodiversity studies of the project was conducted by Dr. B C Nagaraj who is renowned expert in the field of ecology and biodiversity and obtained his post doctoral degree from Indian Institute of Science, Bangalore. He was worked with many infrastructure projects across Karnataka and also in Western Ghats since 20 years.</p> <p>The publications of the above experts is enclosed under Annexure-3.</p>
4	<p><u>Legal issues against the project</u></p> <p>Several legal actions against this project have been taken and no correct information has been reached to the study team. The team would like to ask the proponent to supply relevant information in a mutual way.</p>	<p>Legal Note enclosed separately as Annexure-4.</p>

**COMMENTS ON JICA STUDY REPORT IN RESPECT OF
YETTINAHOLE INTEGRATED DRINKING WATER SUPPLY PROJECT**

1. The study report mainly focus on Shiradi Ghat by-pass and associated activities by and large.
2. Chapter - 3, Pg 3-1, obtaining Environmental clearance shall only be restricted to Shiradi Ghat bypass specifically. Modification required to para "*Therefore..... is as follows*".
3. No mention on Forest Clearance already obtained for the project.
4. Table - 3.2.1 Most of the scientific organisations expressed their neutrality in view sustainable development in respect of the project. However, certain organizations with meager information on project and those organizations which are having political motive showed negative response to the project.
5. Chapter 6 and 7 clubbed together to avoid confusions.
6. The baseline ecological status of the project is not specific to Yettinahole project and current report is not succeed in emphasizing whether diversion of water for drinking water leads to endemism in Western Ghats?
7. As per the conditions of Forest Clearance, various mitigation measures have been suggested by the Forest Dept., Chief Wildlife Warden, MoEF, Govt. of India, etc while granting approval for the project. All those mitigation measures will be implemented in the interest of project. Further, Govt. of Karnataka through a Govt. order constituted a high level monitoring committee under the Chairmanship of Additional Chief Secretary, Forest, Ecology and Environment, Govt. of Karnataka to monitor the effectiveness of implementation of the laid down conditions. Furthermore, KNNL entrusted the work of detailed ecological study of Yettinahole project including post project mitigation measures to EMPRI and IISc. The suggestions / mitigation measures from the study report will be incorporated and implemented.
8. The project also aims at fill up of MI tanks. The report doesn't emphasize on how this project helpful to restore tank ecosystem services in the semi-arid zone of Karnataka.

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Karnataka State Natural Disaster Monitoring Centre

(A Regd. Society and Autonomous Body, Affiliated to Dept. of Revenue, GoK)

**KNNL Annex1****KSND M C/Tech/2/20 15-161'9-6 t,****Dated: 12.02.2016**

To,
Office of the Chief Engineer,
Karnataka Neeravari Nigam Limited,
NNL, Upper Bhadra Project Zone,
Chitradurga.
Ph No: 08194-230018
Email ID:ubpchief@gmail.com

Sir,

Sub: Regarding rain gauge details of Yettinahole Drinking Water Project.**Ref:** No: CE/KNNL/UPBZ/CTA/TA-10/2015-16/2749 dated on 10.02.2016.

With reference to the above subject, please find herewith attached a detailed note on the rainfall pattern in Yettinahole Project catchment area, for your needful action.

Thanking you.

Yours sincerely

A handwritten signature in black ink, appearing to read "Sandeep", written over a light blue horizontal line.

DIRECTOR
KSNDMC

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Major Sandeep Unnikrishnan Road. Near Attur Lavout. Yalahanka RAnnrlh 1n1 - !,)Rn nR.d.

Note on Rainfall Pattern over the Yettinahole Project Area

Rainfall pattern map given in Fig-1 is prepared by using Taluk Headquarters normal annual rainfall values (1951-2000) provided by India Meteorological Department (IMD).

Historical rainfall data in and around Yettinahole project is available for the following stations.

Sl.No.	Name of the Raingauge location	Source	Availability of Data (missing years)	Mean
1.	Hangal	DES	1993-2014 (1996,2002 & 09)	2624
2.	Hongadahalla	Irrigation Dept (collected from Planters)	1980-1991	6079
3.	Kadamane Estate	Irrigation Dept (collected from Planters)	1986-2000	6652
4.	M aranah ally	DES	1993-2014 (1996,2000)	4879
5.	Sakleshpura	DES	1951-2000	2220
6.	Sukravara santhe	DES	1993-2008 (1996)	2908
7.	HOSAKERE	DES	1993-210 (1996,2003,2004,2005,2007,2009)	5119
8.	Byrapura Estate	DES	1993-1999 (1996)	6565
9.	Kottanahalli	Irrigation Dept (collected from Planters)	1980-1991	6024
10.	Chandrapura Estate	DES	1993-1999 (1996)	2224
11.	Shiradi	DES	1993-2014 (1995,1996,1997,2002,2003,2004,2005,2009)	5061

*DES: Department of Economics and Statistics

Perusal of the above table indicates that long term historical rainfall data for Yettinahole project area is not available as most of the area forms the part of forest area or estate area. In the past, Raingauges established by WRDO are mostly in Taluka and Hobli Headquarters.

None of the hobli headquarters or taluk headquarters are falling in these project catchments and hence historical data is not available with DES.

However, whatever data available with DES records and the data provide by the Irrigation Department has been used in the generation of isohyetal map using GIS software (Fig-2). Map depicts the high variability' of rainfall pattern in the area, which ranges from more than 6000 mm to 2500 mm. By using the isohyetal map, area and percentage falling under the different rainfall range with coefficients have been calculated. Weighted average rainfall under different rainfall range along with weighted average for the entire Yettinahole catchment was calculated.

Yettinabloe Catchment					
Weighted average Rainfall (mm)					
Sl.No.	Rainfall Range	Area in Sq.Km	of area	Co-efficient	Wet. Avg. Rainfall
1	<2500mm	5.1	2.9	0.0286	72
2	2500-3000	10.3	5.8	0.0582	175
3	3000-4000	31.6	17.9	0.1787	715
4	4000-5000	52.3	29.6	0.2960	1480
5	5000-6000	56.7	32.1	0.3207	1924
6	>6000mm	20.8	11.8	0.1177	773
	Total	176.7	100.0		5138

Perusal of the above table indicates that the weighted average rainfall for the entire Yettinahole catchment is 5138 mm. The above table is prepared on the basis of isohyets drawn in Fig.2. It should be noted that isohyets in the eastern half of the catchment are likely to lead to underestimation of catchment rainfall since they use rainfall readings of stations like sakalshpur and shukravara santhe which are in the rain shadow area.

Existing Rainfall monitoring network at KSNDMC:

KSNDMC has established Solar powered GPRS enabled Telemetric Raingauges in the state under different phase commencing from 2009-10.

In I Phase - All the Taluk Headquarters and Hobli Headquarters (Total-747) during 2009-10.

In II Phase - Selected GP's (2000 nos.) - 2013-] 4

In III Phase - Remaining GP's (3131 nos.) - 2015-16

In the project area i.e., Sakleshpura taluk under phase-I during 2009-10 four hobli head quarters stations viz., Belagodu, Hanbalu, Hetturu and Yasaluru and Sakleshpura- taluk head - quarter have covered. Rainfall data of these five stations has given in Annexure-I.

In phase-II during 2015-16 all the 21 grampanchayaths in the taluk have been covered and the list of the stations is given in Annexure-H.

Reasons for variation in the rainfall pattern in the vicinity of the study area:

The Kadumane Estate and Byrapura Estate are highest rainfall locations in the study area, the both stations recorded above 6500mm of annual normal rainfall. Due to the orographic effect the amount of rainfall is very high. They are situated in windward side of the mountain having elevation of 1044 & 670 above mean sea level respectively.

Geographically, the continuous mountain range presents a greater barrier to rain-bearing winds, and where the slope is gradual. Hongadahalla and Kotanahalli stations received above 6000 mm of annual normal rainfall, which are also located in windward side of the Western Ghats. Due to the gradual slope, the air parcel will retain its energy and speed for a longer time and the resultant is having high amount of rainfall.

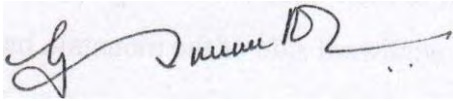
In Western Ghats in Karnataka State, due to the greater width of the mountains, the rain bearing winds have to necessarily travel a longer distance and have more time for the drops to coalesce and precipitate as rainfall, resulting in higher rainfall. The slope of the mountains has a direct bearing on the magnitude of precipitation.

As Shukravara Santhe and Sakleshpura are situated in leeward side of the mountains, the amount of rainfall is reduced to 3000 to 2000 mm respectively. Rainfall decreased about 3000 mm within 15 kms away from the highest rainfall (Kadumane Estate) location. However, the rainfall is considerably high, from the high point of the mountains. The precipitation amounts drop significantly on the leeward side. But, due to greater depth, the moisture in the clouds join together into big drops which finally reaches the ground and gives precipitation.

Conclusions:

3. As Western Ghat area is mostly covered with forest and coffee / tea estates, there are only a few rain gauge stations established by the departments and hence no historical rainfall data available.
4. Using the available data isohyetal map has been drawn and area under different ranges has been delineated.

3. The rainfall is highly variable and it varies from more than 6500 mm to 2500 mm within east west distance of 15 kms.
4. The weighted average rainfall for the entire Yettinahole catchment area is found to be 5138 mm. This is likely to be an underestimate since rain gauges on the eastern side of the catchment are in rain shadow area.
5. KSNDMC has established Telemetric Rain Gauges (TRG) in the study area up to Grampanchayat level only during 2015, and hence not much data for the study is available.



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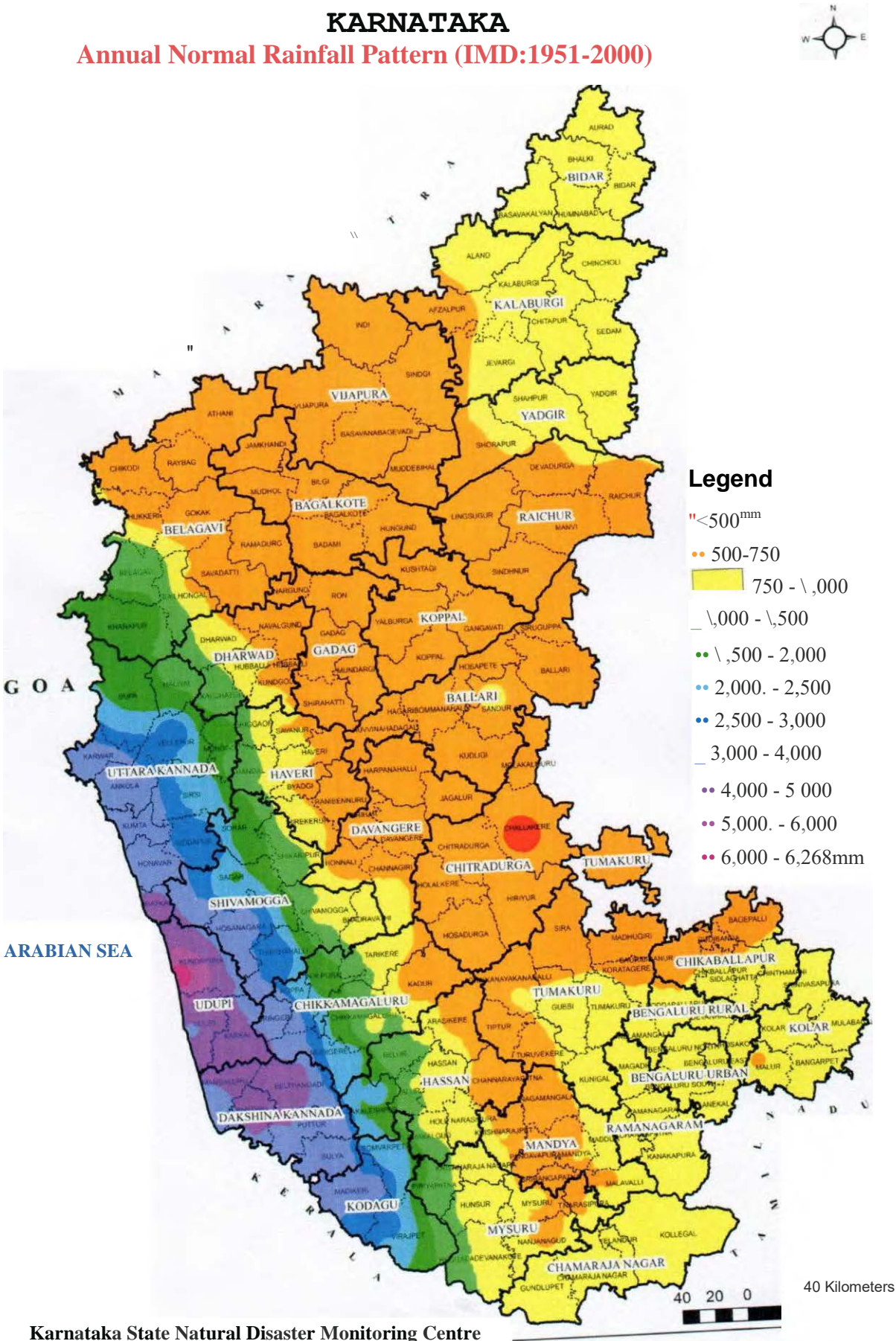


Fig-I: Taluk wise Normal rainfall for the State.

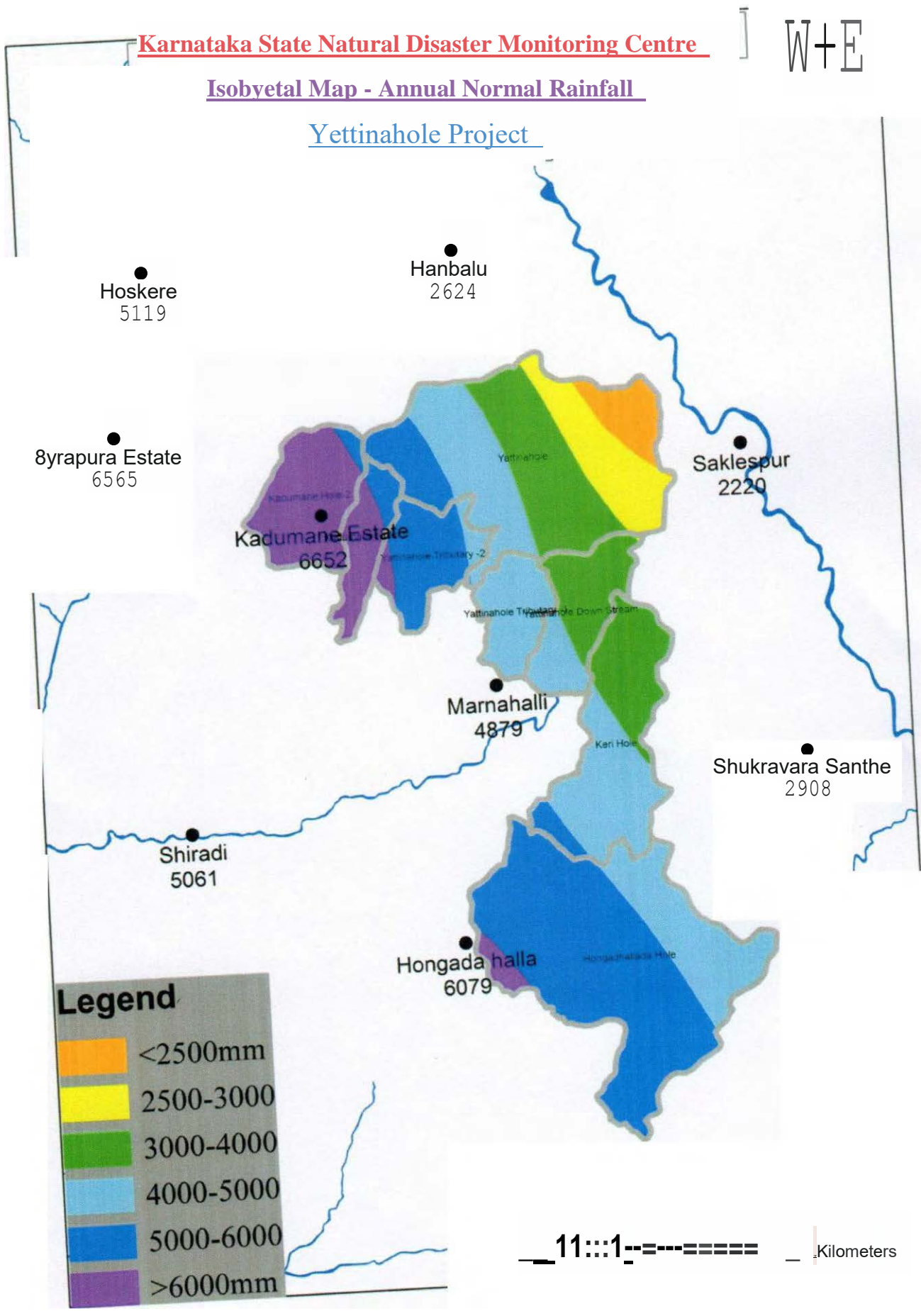


Fig-2: Isohyetal map for the project area

Sakaleshpura Taluk and Hobli wise Actual Annual Rainfall (mm)							
Sl.No	HobJi	2010	2011	2012	2013	2014	2015
1	Sakaleshpura	2018	2261	2096	2791	2835	2222
2	Hanbalu	2315	2303	2131	2393	3279	1889
3	Hettur	2292	2656	2927	4311	3996	2475
4	Yaslur	1618	2332	1901	2523	2566	1364
5	Belagoud	Not Installed	1162	742	1608	1322	1224

Table-L: Hobli wise rainfall data for last 5 years for Sakleshpura Taluk.

Annexure-II

Sl.No	Taluk	Hobli	GP	Year of Installed
1	Sakaleshpura Taluk	Belgodu	Belgodu	2011
2			Baage	2015
3			Ballupete	2015
4			Kuniganahalli	2015
5			Udevara	2015
6		Hanbalu	Hanbalu	2010
7			Kaymanahalli	2015
8			Devalkere	2011
9		Hetturu	Hetturu	2009
10		Hetturu	Vanagur	2011
11			Hogadahalla	2015
12			Kurubhattur	2015
13			Valalahalli	2015
14		Sakaleshpura	Sakaleshpura	2009
15			Kyanhalli	2011
16			Anemahal	2015
17			Biradahalli	2015
18			Byakaravalli	2015
19			Halasulige	2015
20			Hebbasale	2015
21			Malali	2015
22		Yasaluru	Yasaluru	2009
23			Hosur	2011
24			Uchangi	2011
25			Changadihalli	2015
26			Igoor	2015

Table-2: List of TRG stations installed in Sakleshpura Taluk.

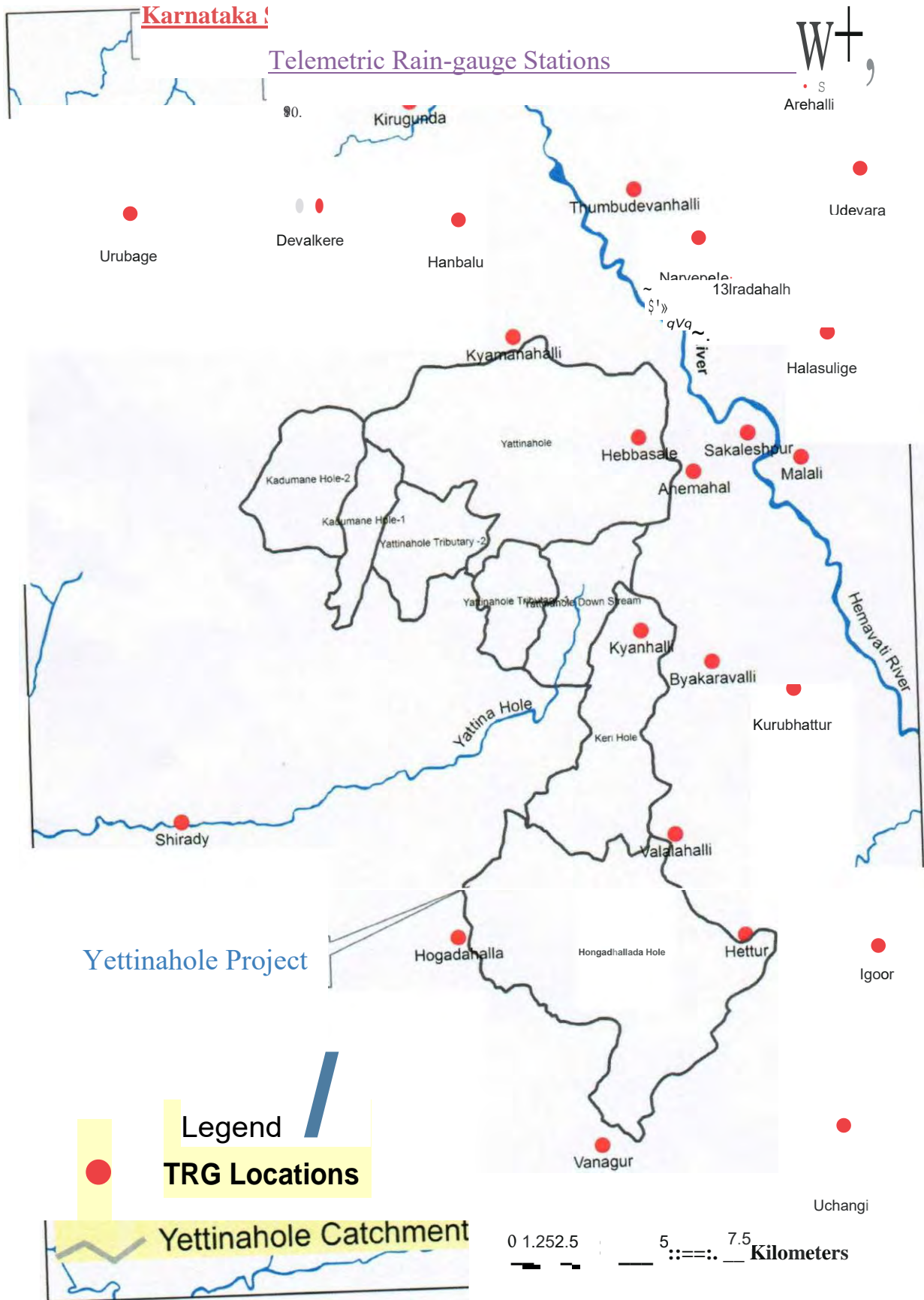


Fig-3: Indicates the TRG locations available in and around the Yettinahole project area.

3.1.9 Surface and Ground Water Quality

Ground and surface water quality in the study area were carried out. Ground water and surface water samples were collected at 6 and 2 locations respectively to assess the water quality parameters in and around the project vicinity.

Table 18 Details of Surface and Ground Water Locations

Sl.No	Name of the location	Geographical Coordinates		Source
		Latitude	Longitude	
1	Gundia	12°49'32.83"N	75°34'10.53"E	Surface Water
2	Hemavathy river	12°56'44.88"N	75°46'35.22"E	Surface Water
3	Yattinahole	12°54'29.50"N	75°44'11.03"E	Surface Water
4	Hongadahalla	12°47'34.66"N	75°41'46.46"E	Surface Water
5	Kempuhole Dam	12°50'32.93"N	75°40'37.40"E	Surface Water
6	Kerihole	12°50'4.30"N	75°43'2.69"E	Surface Water
7	Meghatavalli	12°59'13.39"N	75°53'31.64"E	Ground Water
8	Maranahalli	13°14'42.96"N;	76°13'30.28"E	Ground Water
9	Durgadahalli	13°23'14.95"N	77°12'1.69"E	Ground Water
10	Chelur	13°26'31.81"N	76°54'26.75"E	Ground Water
11	Doddaballapur	13°17'37.89"N	77°32'12.56"E	Ground Water
12	Hegdehalli	13°21'34.44"N	77°38'59.91"E	Ground Water
13	Devanahalli	13°14'55.99"N;	77°42'43.54"E	Ground Water

Composite surface and ground water samples were collected at each location by following CPCB guidelines. Climate influenced physical parameters such as Temperature, DO and pH were recorded at site itself. Surface water samples were collected from well-mixed section of the lake 30 cm below the water surface using a weighted bottle. Ground water samples from the production tube wells were collected after running the well for about 5 minutes. Adequate parameter wise preservatives were added to the samples and collected samples were brought to the laboratory by maintaining 4°C in the insulated ice boxes. Separate sterilised bottles were used for collection of water samples for microbial analysis. The results are as shown below.

The results of surface and ground water quality reveals that, all the samples analysed confirm to IS 10500 standards.

Table 19 Surface Water Quality Results -1

Sl. No	Parameters	Test Methods	Unit	Gundia River	Hemavati River	Yettinahole River(weir 1)
1.	pH	4500H+ B	-	7.10	7.10	8.06
2.	Temperature	2550 B	0C	26	26	26
3.	Dissolved Oxygen	4500-O- C	mg/L	6.2	6.2	6.4
4.	Total Suspended Solids	2540 D	mg/L	4	4	7.0
5.	Total Dissolved Solids	2540 C	mg/L	74	74	96
6.	Alkalinity	2320 B	mg/L	40	40	48
7.	Total Hardness	2340 C	mg/L	28	28	44
8.	BOD	5210 B	mg/L	Not Detectable	Not Detectable	Not Detectable
9.	COD	5220 B	mg/L	12	12	8.0
10.	Nitrate as NO3	4500-NO3 E	mg/L	0.41	0.41	0.9
11.	Phosphate	4500-P D	mg/L	<0.02	<0.02	<0.02
12.	Chloride	4500-Cl B	mg/L	13.49	13.49	11.57
13.	Sulphate as SO4	4500-SO42-	mg/L	<1.0	<1.0	<1.0
14.	Sodium	3500-Na B	mg/L	5.6	5.6	6.4
15.	Potassium	3500-K	mg/L	1.4	1.4	1.2
16.	Calcium as Ca	3500-Ca	mg/L	6.4	6.4	9.6
17.	Magnesium as Mg	3500 Mg B	mg/L	2.91	2.91	4.86
18.	Fluoride as F	4500F D	mg/L	0.4	0.4	0.02
19.	Silica	4500-SiO2 C	mg/L	0.48	0.51	0.83
20.	Oil & Grease	5520 B	mg/L	<1.0	<1.0	<1.0
21.	Phenolic Compounds	5530 C	mg/L	<0.001	<0.001	<0.02
22.	Turbidity	2130 B	NTU	0.11	0.49	0.25
23.	Residual Na2CO3,	IS 3025 (P 45)-1993	mg/L	<0.5	<0.5	<0.5
24.	PAH*	GCMS Method	mg/L	BDL	BDL	BDL
25.	Pesticides*	GCMS Method	mg/L	Absent	Absent	Absent
26.	MPN Coliforms*	K R Aneja	CFU/100 ml	8	9	02
27.	Arsenic as As*	3114 B	µg/L	<0.05	<0.05	<0.05
28.	Mercury as Hg*	3112 B	µg/L	<0.06	<0.06	<0.06
29.	Lead as Pb*	3111 B	mg/L	<0.013	<0.013	<0.01

Sl. No	Parameters	Test Methods	Unit	Gundia River	Hemavati River	Yettinahole River(weir 1)
30.	Cadmium as Cd*	3111 B	mg/L	<0.0028	<0.0028	<0.0028
31.	Chromium Hexavalent	3500 Cr B	mg/L	<0.02	<0.02	<0.02
32.	Total Chromium*	3111 C	mg/L	<0.0054	<0.0054	<0.0054
33.	Copper as Cu*	3111 B	mg/L	<0.0045	<0.0045	<0.0045
34.	Zinc as Zn*	3111 B	mg/L	<0.0033	<0.0033	<0.0033
35.	Iron as Fe	3500-Fe B	mg/L	0.24	0.5703	0.37

Table 20 Surface Water Quality Results - 2

Sl. No	Parameters	Test Methods	Unit	Hongadahalla	Kempahole	Kerehole River
1.	pH	4500H+ B	-	7.02	7.84	7.25
2.	Temperature	2550 B	0C	26	26	25
3.	Dissolved Oxygen	4500-O- C	mg/L	6.7	6.5	5.7
4.	Total Suspended Solids	2540 D	mg/L	5	7	6
5.	Total Dissolved Solids	2540 C	mg/L	94	84	52
6.	Alkalinity	2320 B	mg/L	52	48	6
7.	Total Hardness	2340 C	mg/L	40	44	0.33
8.	BOD	5210 B	mg/L	Not Detectable	Not Detectable	Not Detectable
9.	COD	5220 B	mg/L	4	12	10
10.	Nitrate as NO3	4500-NO3 E	mg/L	0.7	0.8	0.59
11.	Phosphate	4500-P D	mg/L	<0.02	<0.02	0.09
12.	Chloride	4500-Cl B	mg/L	11.57	9.64	5.1
13.	Sulphate as SO4	4500-SO42-	mg/L	<1.0	<1.0	25.72
14.	Sodium	3500-Na B	mg/L	4.4	5.2	11.2
15.	Potassium	3500-K	mg/L	2.0	1.2	1.6
16.	Calcium as Ca	3500-Ca	mg/L	8.0	8.0	0.064
17.	Magnesium as Mg	3500 Mg B	mg/L	4.86	5.83	0.14
18.	Fluoride as F	4500F D	mg/L	0.17	0.09	0.261
19.	Silica	4500-SiO2 C	mg/L	0.41	0.57	0.84
20.	Oil & Grease	5520 B	mg/L	<1.0	<1.0	<1.0

Sl. No	Parameters	Test Methods	Unit	Hongadahalla	Kemphele	Kerehole River
21.	Phenolic Compounds	5530 C	mg/L	<0.001	<0.001	<0.001
22.	Turbidity	2130 B	NTU	0.31	0.10	0.40
23.	Residual Na ₂ CO ₃	IS 3025 (P 45)-1993	mg/L	<0.5	<0.5	<0.5
24.	PAH*	GCMS Method	mg/L	BDL	BDL	BDL
25.	Pesticides*	GCMS Method	mg/L	Absent	Absent	Absent
26.	MPN Coliforms*	K R Aneja	CFU/100 ml	03	07	03
27.	Arsenic as As*	3114 B	µg/L	<0.05	<0.05	<0.05
28.	Mercury as Hg*	3112 B	µg/L	<0.06	<0.06	<0.06
29.	Lead as Pb*	3111 B	mg/L	<0.01	<0.013	<0.01
30.	Cadmium as Cd*	3111 B	mg/L	<0.0028	<0.0028	<0.0028
31.	Chromium Hexavalent	3500 Cr B	mg/L	<0.02	<0.02	<0.02
32.	Total Chromium*	3111 C	mg/L	<0.0054	<0.0054	<0.0054
33.	Copper as Cu*	3111 B	mg/L	<0.0045	<0.0045	<0.0045
34.	Zinc as Zn*	3111 B	mg/L	<0.0033	<0.0033	0.06
35.	Iron as Fe	3500-Fe B	mg/L	0.51	0.27	0.49

Table 21 Ground Water Quality Results

Sl.No	Parameters	Test Methods	Unit	Meghatavalli	Maranahalli	Std. IS 10500:2012 (Second Revision)	
						DL	PL
1.	pH	4500H ⁺ B	-	6.60	8.36	6.5-8.5	
2.	Temperature	2550 B	⁰ C	26	26	--	
3.	Dissolved Oxygen	4500-O- C	mg/L	6.5	6.5	--	
4.	Turbidity	2130 B	NTU	0.13	0.11	1	5
5.	Total Dissolved Solids	2540 C	mg/L	512	56	500	2000
6.	Total Hardness	2340 C	mg/L	224	28	200	600
7.	Calcium as Ca	3500- Ca	mg/L	62.4	8	75	200
8.	Magnesium as Mg	3500 -Mg B	mg/L	16.52	1.94	30	100
9.	Sulphate as SO ₄	4500-SO ₄ ²⁻	mg/L	23.6	<1.0	200	400
10.	Fluoride as F	4500-F D	mg/L	0.5	0.04	1	1.5
11.	Nitrate as NO ₃	4500-NO ₃ E	mg/L	31.53	0.7	45	
12.	Chloride as Cl	4500-Cl B	mg/L	113.7	9.64	250	1000

Sl.No	Parameters	Test Methods	Unit	Meghatavalli	Maranahalli	Std. IS 10500:2012 (Second Revision)	
						DL	PL
13.	Iron as Fe	3500-Fe B	mg/L	0.11	0.10	0.3	
14.	Total Suspended Solids	2540 D	mg/L	13	4	--	
15.	Phenolic Compounds	5530 C	mg/L	<0.001	<0.001	0.001	
16.	Chromium Hexavalent	3500-Cr B	mg/L	<0.02	<0.02	0.05	
17.	Alkalinity	2320 B	mg/L	128	44	200	600
18.	Sodium	3500-Na B	mg/L	41.2	3.6	--	
19.	Silica	4500-SiO ₂ C	mg/L	0.96	0.61	--	
20.	BOD	5210 B	mg/L	Not Detectable	Not Detectable	--	
21.	COD	5220 B	mg/L	20	12	--	
22.	PAH*	GCMS Method	mg/L	BDL	BDL	0.0001	
23.	Oil & Grease	5520 B	mg/L	<1.0	<1.0	--	
24.	Mercury as Hg*	3112 B	µg/L	<0.06	<0.06	0.001	
25.	Lead as Pb*	3111 B	mg/L	<0.01	<0.01	0.01	
26.	Cadmium as Cd*	3111 B	mg/L	<0.0028	<0.0028	0.003	
27.	Residual Na ₂ CO ₃ ,	IS 3025 (P 45)-1993	mg/L	<0.5	<0.5	--	
28.	Arsenic as As*	3112 B	µg/L	<0.05	<0.05	0.01	
29.	Total Chromium	3111 B	mg/L	<0.005	<0.005	0.05	
30.	Potassium	3111 B	mg/L	2.0	0.6	--	
31.	Copper as Cu*	3111 B	mg/L	<0.0045	<0.0045	0.05	1.5
32.	Zinc as Zn*	3111 B	mg/L	<0.0033	<0.0033	5	15
33.	Pesticides*	GCMS Method	mg/L	Absent	Absent	Absent	
34.	Phosphate	4500- P D	mg/L	0.19	<0.02	--	
35.	MPN Coliform	K R Aneja	CFU/100ml	04	05	10	

DL – Desirable Limit, PL – Permissible Limit, BDL – Below Detectable Limit

Table 22 Ground Water Quality Results (contd...)

Sl.No	Parameters	Test Methods	Unit	Durgadahalli	Chelur	Doddaballapura	Std. IS 10500:2012 (Second Revision)	
							DL	PL
1.	pH	4500H ⁺ B	-	6.70	7.72	7.53	6.5-8.5	
2.	Temperature	2550 B	⁰ C	26	26	26	--	
3.	Dissolved Oxygen	4500-O- C	mg/L	6.8	6.7	6.6	--	
4.	Turbidity	2130 B	NTU	0.02	0.08	0.11	1	5

Sl.No	Parameters	Test Methods	Unit	Durgadahalli	Chelur	Doddaballapura	Std. IS 10500:2012 (Second Revision)	
							DL	PL
5.	Total Dissolved Solids	2540 C	mg/L	992	390	504	500	2000
6.	Total Hardness	2340 C	mg/L	472	184	208	200	600
7.	Calcium as Ca	3500- Ca	mg/L	115.2	38.4	65.6	75	200
8.	Magnesium as Mg	3500 -Mg B	mg/L	44.7	21.3	10.69	30	100
9.	Sulphate as SO ₄	4500-SO ₄ ²⁻	mg/L	51.1	15.1	18.9	200	400
10.	Fluoride as F	4500-F D	mg/L	0.42	<0.02	0.53	1	1.5
11.	Nitrate as NO ₃	4500-NO ₃ E	mg/L	51.7	10.94	15.70	45	
12.	Chloride as Cl	4500-Cl B	mg/L	168.7	53	81.9	250	1000
13.	Iron as Fe	3500-Fe B	mg/L	0.06	0.02	0.042	0.3	
14.	Total Suspended Solids	2540 D	mg/L	13	4.0	12	--	
15.	Phenolic Compounds	5530 C	mg/L	<0.001	<0.001	<0.001	0.001	
16.	Chromium Hexavalent	3500-Cr B	mg/L	<0.02	<0.02	<0.02	0.05	
17.	Alkalinity	2320 B	mg/L	320	156	220	200	600
18.	Sodium	3500-Na B	mg/L	41.2	19.2	39.6	--	
19.	Silica	4500-SiO ₂ C	mg/L	1.9	1.5	1.2	--	
20.	BOD	5210 B	mg/L	Not Detectable	Not Detectable	Not Detectable	--	
21.	COD	5220 B	mg/L	Not Detectable	Not Detectable	Not Detectable	--	
22.	PAH*	GCMS Method	mg/L	BDL		BDL	0.0001	
23.	Oil & Grease	5520 B	mg/L	<1.0	<1.0	<1.0	--	
24.	Mercury as Hg*	3112 B	µg/L	<0.06	<0.06	<0.06	0.001	
25.	Lead as Pb*	3111 B	mg/L	<0.013	<0.013	<0.013	0.01	
26.	Cadmium as Cd*	3111 B	mg/L	<0.0028	<0.0028	<0.0028	0.003	
27.	Residual Na ₂ CO ₃ ,	IS 3025 (P 45)-1993	mg/L	<0.5	<0.5	<0.5	--	
28.	Arsenic as As*	3112 B	µg/L	<0.05	<0.05	<0.05	0.01	
29.	Total Chromium	3111 B	mg/L	0.03	0.0659	0.40	0.05	
30.	Potassium	3111 B	mg/L	<0.0054	<0.0054	<0.0054	--	
31.	Copper as Cu*	3111 B	mg/L	3.4	10.4	3.8	0.05	1.5
32.	Zinc as Zn*	3111 B	mg/L	<0.0045	<0.0045	<0.0045	5	15
33.	Pesticides*	GCMS Method	mg/L	Absent		Absent	Absent	

Sl.No	Parameters	Test Methods	Unit	Durgadahalli	Chelur	Doddaballapura	Std. IS 10500:2012 (Second Revision)	
							DL	PL
34.	Phosphate	4500- P D	mg/L	<0.02	<0.02	<0.02		--
35.	MPN Coliform	K R Aneja	CFU/100ml	07	13	03		10

Table 23 Ground Water Quality Results (contd...)

Sl.No	Parameters	Test Methods	Unit	Hegdehalli	Devanahalli	Std. IS 10500:2012 (Second Revision)	
						DL	PL
1.	pH	4500H ⁺ B	-	6.60	7.30	6.5-8.5	
2.	Temperature	2550 B	⁰ C	26	26	--	
3.	Dissolved Oxygen	4500-O- C	mg/L	6.7	6.5	--	
4.	Turbidity	2130 B	NTU	0.15	0.21	1	5
5.	Total Dissolved Solids	2540 C	mg/L	1260	317	500	2000
6.	Total Hardness	2340 C	mg/L	572	168	200	600
7.	Calcium as Ca	3500- Ca	mg/L	160	35.2	75	200
8.	Magnesium as Mg	3500 -Mg B	mg/L	41.7	19.4	30	100
9.	Sulphate as SO ₄	4500-SO ₄ ²⁻	mg/L	65.1	9.5	200	400
10.	Fluoride as F	4500-F D	mg/L	0.56	0.04	1	1.5
11.	Nitrate as NO ₃	4500-NO ₃ E	mg/L	82.45	1.16	45	
12.	Chloride as Cl	4500-Cl B	mg/L	260.3	33.74	250	1000
13.	Iron as Fe	3500-Fe B	mg/L	0.03	0.08	0.3	
14.	Total Suspended Solids	2540 D	mg/L	8.0	10	--	
15.	Phenolic Compounds	5530 C	mg/L	<0.001	<0.001	0.001	
16.	Chromium Hexavalent	3500-Cr B	mg/L	<0.02	<0.02	0.05	
17.	Alkalinity	2320 B	mg/L	288	144	200	600
18.	Sodium	3500-Na B	mg/L	43.6	14.8	--	
19.	Silica	4500-SiO ₂ C	mg/L	0.64	0.58	--	
20.	BOD	5210 B	mg/L	Not Detectable	Not Detectable	--	
21.	COD	5220 B	mg/L	Not Detectable	8	--	
22.	PAH*	GCMS Method	mg/L	BDL	BDL	0.0001	

Sl.No	Parameters	Test Methods	Unit	Hegdehalli	Devanahalli	Std. IS 10500:2012 (Second Revision)	
						DL	PL
23.	Oil & Grease	5520 B	mg/L	<1.0	<1.0	--	
24.	Mercury as Hg*	3112 B	µg/L	<0.06	<0.06	0.001	
25.	Lead as Pb*	3111 B	mg/L	<0.01	<0.013	0.01	
26.	Cadmium as Cd*	3111 B	mg/L	<0.0028	<0.0028	0.003	
27.	Residual Na ₂ CO ₃ ,	IS 3025 (P 45)- 1993	mg/L	<0.5	<0.5	--	
28.	Arsenic as As*	3112 B	µg/L	<0.05	<0.05	0.01	
29.	Total Chromium	3111 B	mg/L	0.04	0.09	0.05	
30.	Potassium	3111 B	mg/L	<0.0054	<0.0054	--	
31.	Copper as Cu*	3111 B	mg/L	1.8	2.4	0.05	1.5
32.	Zinc as Zn*	3111 B	mg/L	<0.0045	<0.0045	5	15
33.	Pesticides*	GCMS Method	mg/L	Absent	Absent	Absent	
34.	Phosphate	4500- P D	mg/L	<0.02	<0.02	--	
35.	MPN Coliform	K R Aneja	CFU/100ml	09	05	10	

3.2 Biological Environment

The Sakaleshpur region encompasses in the magnificent hills of the biodiversity hotspot, the Western Ghats, is surrounded with lofty green hills where cash crops such as coffee, cardamom, pepper and areca are being cultivated. These crops which contribute mainly to the economy of the region are grown in the surrounding areas are brought to Sakleshpur town of Hassan district of Karnataka State for marketing. The sub-tropical climate and heavy rains during the wet season create an environment where several unique plant and animal species flourish.

3.2.1 Types of forest and its importance

3.2.1.1 Flora in catechment region

The forests in the catchment area (Sakleshpur region) are broadly classified as south Indian tropical forests. According to the classification of Champion & Seth (1968), the forest area comprises of the following types.

1. Southern Tropical Wet Evergreen Forests – IA/C4
2. Southern Tropical Semi-evergreen Forests – 2A/C2
3. South Indian Tropical Moist Deciduous Forests – 3B/C2
4. Southern Tropical Dry Deciduous Forests – 5A/C2

The evergreen and semi-evergreen forests in Hassan Forest Division are concentrated in the Western Ghats region of Sakaleshpur Forest Range and are commonly known as Ghat forests. The proposed project locality falls in semi-evergreen and evergreen forests of Sakaleshpur forest ranges. There are four distinct canopy layers which consists of;

1. Hopea wightiana, Holigarna arnottiana, Holigarna grahamii, Mesua ferrea, Litsea wightiana, Bischofia javanica, Artocarpus hirsutus, Lagerstroemia lanceolata and several others.
2. Moderately large trees which will fill up the bulk of the bulk of the bulk of space within the forest with their abundance and individuals such as *Artocarpus lakoocha*, *Litsea sp*, *Garcinia cambogia*, *Syzygium cumini* and a host of others.
3. Under wood, consists of smaller trees. Among these are *Heynea trijuga*, *Glochidion sp.* and *Memecylon edule*.

4. The fourth layer is shrubby growth and generally covers the ground where there is some light through and in such places, shrubs like *Ixora nilgircans*, *Psychotria trincata* etc. can be seen. Among the erect palms, *Caryota urens*, *Pinanga dicksonii* are common. The climbing palms are represented by *Calamus species*.

3.2.1.2 Flora in canal region

Forests of canal portion (Tumkur, Kolar, Chickballapur, Bangalore (Rural), etc) are comprising of deciduous tree species topping with thorny undergrowth. According to Champion and Seth's classification, these fall under two sub-groups namely, 5A-Southern tropical dry deciduous forests and 6A-Southern tropical thorn forests.

Major tree species found in the region are *Cassia fistula*, *Azadirachta indica*, *Euphorbia antiquorum*, *Anogeissus latifolia*, *Diospyros melanoxylon*, *Hardwickia binata*, *Cassia fistula*, *Terminalia alata*, *Chloroxylon swietenia*, *Santalum album*, *Acacia catechu*, *Diospyros montana*, *Acacia leucophloea*, *Albizia amara*, *Dalbergia paniculata*, *Lantana camara*, *Opuntia dillenii*, etc.

The National Forest Policy, 1988 has laid emphasis on conservation of biodiversity, restoration of ecological balance and meeting the demands of the local people. Accordingly the objects of management of the forests have been fixed. To achieve these objects, new approach has been adopted in the management of the forests. Conservation of ecologically sensitive and biodiversity rich forest area will be achieved by affording adequate protection and by carrying out habitat improvement works including soil and moisture conservation, fire protection etc. The Sakaleshpur region as well as canal portion does not have National Park or Wildlife Sanctuaries. Since wildlife is not confined to any particular area, forests of the region in general have to be managed in such a way as to conserve these as ideal habitats for wildlife. This will help in long run in mitigating the man-animal conflict so prevalent in the habitations adjoining forest areas.

3.2.2. Past forest management in the region

3.2.2.1 Flora in catechment region

The Sakaleshpur region has seen large scale land cover changes with the overexploitation of forest during the last two centuries. It was probably during the direct British rule of the district from 1831 to 1881 that several parts of Malnad was thrown open to the British planters often ex-army men who had changed over to civilian occupation at the end of the

Anglo-Mysore wars. Kadumane, Biccodu, Cognur, Karadi-betta, Barchinhullu, Matsagar are only few of the estates dating from this period. The early planters gradually cleared forest tracks and planted them with the shade loving coffee and cardamom, the tall areca and the bushy orange. Tea was introduced at Kadumane in the early twentieth century and now it constitutes one of the major produces in the area (Saldanha, *et al.* 1978).

Since 1945 there has been a spurt in the plantation industry so that the original vegetation had been greatly altered. There is scarcely any virgin forest in private hands. Major state forests have also been subjected to selective felling of hard structural timbers as well as soft woods for the plywood and matchstick industries. Large tracts of revenue lands with dense evergreen to semievergreen forests are being swiftly and completely logged to pave way for other land uses such as Acacia plantations (Gururaj *et al.* 2010).

3.2.2.2 Flora in canal region

Though the canal region possess deciduous type of forests, many places of the forests are connected with mythology and history viz-a-viz Devarayanadurga forests, Shivaganga hills, Savandurga forests, Kaivara hills, etc. During 1865 and 1900, forest produce were removed constantly. Further, lot of fire wood was supplied to Dept., of Railways towards meeting the huge coal demand. During 1900 - 1920, heavy growth of Lantana occupying major forest areas and suppress the growth of trees. Later, Lantana were removed by adopting various silvicultural methods (KFD, Working Plans).

3.2.3 Biodiversity

The flora and fauna survey was conducted during pre-monsoon and post-monsoon along the tributaries of Yettinahole, Keri-hole, Hongadahalla and Kadumane areas where up- and downstream areas of these tributaries were studied for vegetation and wildlife. Whereas, in canal areas qualitative surveys were also conducted at various places.

The forest represented by distinct formations of evergreen forest, semi evergreen forest, wet and dry deciduous forest overlapping with shola forest, dry deciduous forests, etc. The forests of the track correspond to the types of revised classification of Indian Forest types by Champion and Seth, 1968.

3.2.4 Flora in the proposed Project area (Sakleshpura region)

The total vegetation coverage of the catchment area in Sakleshpura region is represented by distinct formations of evergreen forest, semi- evergreen forest, wet and dry

deciduous forest mingled with shola sub ecosystems. The plant species observed at various site locations are given below.

Table 24 Flora recorded in proposed site locations in Sakaleshpur region

<i>Sl.No</i>	<i>Name of Species</i>	<i>Habit</i>	<i>IUCN Status 2014.1</i>
1	<i>Abrus precatorius L</i>	Herb	Common
2	<i>Aerides maculosa Lindl.</i>	Epiphyte	Common
3	<i>Alangium salvifolium</i>	Tree	Common
4	<i>Algaia barberi</i>	Shrub	Common
5	<i>Alteranthera sesilis (L.) R. Br. & DC.</i>	Herb	Common
6	<i>Ameranthus pungens H.B.K.</i>	Herb	Common
7	<i>Ammania baccifera (L.) Wt.</i>	Herb	Common
8	<i>Apama Siliquosa Lamk</i>	Shrub	Common
9	<i>Apodytes dimidata Meyer</i>	Shrubs	Common
10	<i>Aporosa lindleyana (wt.) Baill.</i>	Shrubs	Common
11	<i>Arenga Wightii Griff</i>	Tree	Vulnerable
12	<i>Ardisia solanacea Roxb.</i>	Shrub	Common
13	<i>Areca Catechu L</i>	Tree	Common
14	<i>Argemone mexicana L.</i>	Herbs	Common
15	<i>Artabotrys zeylanicus Hook & Thoms</i>	Shrub	Common
16	<i>Artocarpus hirsutus Lam.</i>	Tree	Rare, medicinal
17	<i>Bergia ammanioides Roxb</i>	Hydrophytes	Common
18	<i>Bombax malabaricum D. C.</i>	Tree	Common
19	<i>Borreria articularis (L.f) F.N.Willd.</i>	Herbs	Common
20	<i>Bridelia crenulata Roxb.</i>	Shrubs	Common
21	<i>Cadaba fruticosa L.</i>	Shrub	Common
22	<i>Caesalpinia coriaria wild</i>	Shrub	Common
23	<i>Calbergia lanceolaria Linn.f.</i>	Tree	Common
24	<i>Callicarpa tomentosa (L.) Roxb.</i>	Shrubs	Common
25	<i>Calophyllum apetalum Willd</i>	Tree	Common
26	<i>Calycopteris floribunda (Roxb.) Poir.</i>	Tree	Common
27	<i>Caralia brachiata (Lour.) Merill.</i>	Shrub	Common
28	<i>Careya arborea Roxb</i>	Tree	Common
29	<i>Cassia fistula L.</i>	Tree	Common
30	<i>Cinumomum camphora Nees</i>	Tree	Common
31	<i>Citrus decumana L</i>	Shrub	Common
32	<i>Crotalaria berteriana DC.</i>	Shrubs	Common
33	<i>Cynoglossum furcatum Wall.</i>	Herbs	Common
34	<i>Cyperus pillosus Vahi</i>	Herbs	Common
35	<i>Dalbergia latifolia L.</i>	Tree	Common
36	<i>Dalbergia volubilis Roxb</i>	Tree	Common
37	<i>Dedrothoe gibbosa (Talb) Razi</i>	Semi parasite	Common

Sl.No	Name of Species	Habit	IUCN Status 2014.1
38	<i>Dendrocalamus brandissi</i> Kurz.	Bamboo	Common
39	<i>Dendrophthoe falcata</i> (L.f) Etting (Epiphyte)	Parasitic herb	Common
40	<i>Derris scandens</i> (Roxb.) Benth.	Climber	Common
41	<i>Desmodium triquetrum</i> (L.) D.C.	Herb	Common
42	<i>Dicliptera cuneata</i> Nees	Climber	Common
43	<i>Dicraea stylosa</i> Wt.	Herbs	Common
44	<i>Dillenia pentagyna</i> Roxb.	Tree	Common
45	<i>Dioscorea pentaphylla</i> L.	Climber	Common
46	<i>Diospyros angustifolia</i>	Tree	Common
47	<i>Diospyros Candolleana</i> Wt.	Tree	Common
48	<i>Diospyros saldanhae</i> Koster	Tree	Common
49	<i>Diospyros crumenata</i> Thw.	Tree	Common
50	<i>Dipterocarpus bourdillonii</i>	Tree	Common
51	<i>Dipterocarpus indicus</i> Bedd.	Tree	Endangered
52	<i>Elaeocarpus munronii</i> (Wt.) Masters	Tree	Common
53	<i>Elaeocarpus serratus</i> L.	Herb	Common
54	<i>Elephantopus scaber</i> L.	Herb	Common
55	<i>Elettaria cardamomum</i> (L.) Maton	Herb	Common
56	<i>Emblica officianalis</i> Gartn.	Tree	Common
57	<i>Haldina cordifolia</i> (Roxb.) Ridsdale	Tree	Common
58	<i>Hemidesmus indicus</i> (L.) R. Br.	Herbs	Common /Medicinal
60	<i>Hibiscus aculeatus</i> (Roxb.)	Shrubs	Common
61	<i>Hopea parviflora</i> Bedd.	Tree	Endangered
62	<i>Hoya retusa</i> Dalz.	Climber	Common
63	<i>Hybanthus enneaspermus</i> (L.) Muell	Shrub	Common
64	<i>Hypericum japonicum</i> Thunb. Ex.Murray	Shrub	Common
65	<i>Hyptis suaveolens</i> (L.) Poit.	Herbs	Common
66	<i>Impatiens balsamina</i> L.	Herb	Common
67	<i>Ixora polyantha</i> Wt.	Shrubs	Common
68	<i>Juncus prismatocarpus</i> R. Br.	Herbs	Common
69	<i>Kingidiodendron pinnatum</i> (D.C.) Harms	Tree	Threatened
70	<i>Knema attenuate</i> (Hook.f) Warb	Tree	Rare
71	<i>Knoxia sumatrenensis</i> (Retz) DL	Herbs	Common
72	<i>Kydia calycina</i> Roxb.	Tree	Common
73	<i>Lagerstroemia paniculata</i> Willd	Tree	Common
74	<i>Lagerstromia parviflora</i> Roxb.	Tree	Common
75	<i>Lantana camara</i> L.	Shrub	Common
76	<i>Leea indica</i> (Burm.f) Merr.	Shrub	Common
77	<i>Lepianthes umbellate</i> (L.) Raf.	Shrub	Common
78	<i>Limnophila chinensis</i> (Osborn) Merr.	Hydrophytes	Common
79	<i>Limnophila heterophila</i> Benth	Hydrophytes	Common

Sl.No	Name of Species	Habit	IUCN Status 2014.1
80	<i>Limonia alata</i> wt.	Shrub	Common
81	<i>Lobelia alsinoides</i>	Shrub	Common
82	<i>Macaranga peltata</i> (Roxb.) Muell	Tree	Common
83	<i>Madhuca longifolia</i> Bedd.	Tree	Common
84	<i>Maesa indica</i> (Roxb.) DC	Tree	Common
85	<i>Mallova spicata</i>	Tree	Common
86	<i>Mangifera indica</i> Linn.	Tree	Common
87	<i>Mastixia arborea</i> Bedd	Tree	Common
88	<i>Mimosa pudica</i> L	Tree	Common
89	<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Tree	Common
90	<i>Murraya exotica</i> L	Tree	Common
91	<i>Murraya koenigii</i> (L.) Sp.	Shrub	Common
92	<i>Neolitisia foliosa</i>	Tree	Common
93	<i>Ochlandra scriptoria</i> (Dennst.) Fisch.	Bamboo	Common
94	<i>Oldenlandia caerulea</i> (W & A) Royle.	Herbs	Common
95	<i>Olea dioica</i> Roxb.	Tree	Common
96	<i>Oxalis corniculata</i> L.	Herbs	Common
97	<i>Pandanus canaranus</i> Warbury	Tree	Common
98	<i>Phoenix sylvestria</i> , Rox	Tree	Common
99	<i>Pinanga dicksonii</i> (Roxb.) Seheffer	Tree	Common
100	<i>Pittospermum dasycaulon</i> Miq	Tree	Common
101	<i>Polygonum barbatum</i> L.	Herbs	Common
102	<i>Pongamia Pinnata</i> (L) Pierre	Tree	Common
103	<i>Portulaca oleracea</i> L.	Herb	Common
104	<i>Psychotria dalzielii</i> Hk.	Shrub	Common
105	<i>Randia dumetorum</i>	Shrubs	Common
106	<i>Salix tetrasperma</i> Roxb.	Tree	Common
107	<i>Sapindus emarginatus</i>	Tree	Common
108	<i>Saraca asoca</i> (Roxb.) de Wilde.	Tree	Common
109	<i>Solanum torvum</i> Sw.	Shrub	Common
110	<i>Spondias mangifera</i> Wild	Tree	Common
111	<i>Sterculia guttata</i> Roxb	Tree	Common
112	<i>Striga angustifolia</i> (Don) Sald	Parasitic herb	Common
113	<i>Symplocos racemosa</i> Roxb.	Shrub	Common
114	<i>Syzygium cumini</i> (L.) Skeels	Tree	Common
115	<i>Syzygium heyneanum</i> Wall. Ex. Gamble	Tree	Common
116	<i>Tephrosia candida</i> (Roxb.) D.C.	Shrub	Common
117	<i>Termanalia tomentosa</i> Roxy.	Tree	Common
118	<i>Terminalia arjuna</i> (Roxb.) W & A	Tree	Common
119	<i>Terminalia Chebula</i> (Gaertn) Roxb.	Tree	Common
120	<i>Terminalia paniculata</i> Roth	Tree	Common

Sl.No	Name of Species	Habit	IUCN Status 2014.1
121	<i>Themeda tremula</i> (Steudl) Hackel	grass	Common
122	<i>Tinospora cardifolia</i> (Willd). Hook f. & Thomas	Climber	Common
124	<i>Torenia bicolor</i> Dalz	Herb	Common
125	<i>Trewia polycarpa</i> Benth.	Tree	Common
126	<i>Triumfetta rhomboidea</i> Jacq.	Tree	Common
127	<i>Utricularia caerulea</i> L.	Moist riches	Common
128	<i>Vateria indica</i> L.	Tree	Critically Endangered
129	<i>Vernocia indica</i> CL.	Herb	Common
130	<i>Withania somnifera</i> (L.) Dunal	Shrubs	Common
131	<i>Xylia xylocarpa</i> (Roxb.) Taub.	Tree	Common
132	<i>Ziziphus oenoplia</i> (L.) Mill	Climber	Common
133	<i>Ziziphus rugosa</i> Lam.	Climber	Common

Table 25 Commercially Important species observed in Sakleshpur region

Sl.No	Name of Species	Habit	IUCN Status 2014.1
1	<i>Lagerstromia perviflora</i>	Tree	Common
2	<i>Dalburgia latifolia</i>	Tree	Common
3	<i>Dendrocatamus brandini</i>	Tree	Common
4	<i>Tectona grandis</i> L. f	Tree	Common
5	<i>Vateria indica</i>	Tree	Critically Endangered
6	<i>Pongamia pinnata</i>	Tree	Common
7	<i>Gmelina arborea</i>	Tree	Common
8	<i>Ochlandra scriptoria</i> (Dennst.) C.E.C.Fisch.	Tree	Common
9	<i>Terminalia peniculata</i>	Tree	Common
10	<i>Garcinia gummi-gutta</i> <i>Garcinia gummi-gutta</i> (L.) N. Robson	Tree	Common

Table 26 Important Medicinal Plants observed in Sakleshpur region

SI No	Species	IUCN Status 2014.1
1	<i>Abrus precatorius sensu Baker</i> <i>Abrus</i>	Common
2	<i>Anthocephalus kadamba</i>	Common
3	<i>Calotropis gigantea</i> (L.) W. T. Aiton	Common
4	<i>Calophyllum apetalum</i> Willd.	Common
5	<i>Caralia brachita</i>	Common
6	<i>Caryota urens</i>	Common
7	<i>Chukrasia tabularis</i>	Common
8	<i>Cinnamomum zeylanicum</i> Bl	Common
9	<i>Dalbargia latifolia</i>	Common
10	<i>Gmelina arborea</i> Roxb.	Common

11	<i>Hopea parviflora</i>	<i>Endangered</i>
12	<i>Centrosema macrocarpum</i>	<i>Common</i>
13	<i>Madhuca nerifolia</i>	<i>Common</i>
14	<i>Mangifera indica</i>	<i>Common</i>
15	<i>Mesua ferrea</i> L.	<i>Common</i>
16	<i>Ochlandra scriptoria</i> (Dennst.) C.E.C.Fisch.	<i>Common</i>
17	<i>Olea dioica</i> Roxb	<i>Common</i>
18	<i>Phyllanthus urinaria</i> L.	<i>Common</i>
19	<i>Piper nigrum</i> L	<i>Common</i>
20	<i>Santalum album</i>	<i>Vulnerable</i>
21	<i>Solanum torvum</i> Sw.	<i>Common</i>
22	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	<i>Common</i>
23	<i>Tinospora cardifolia</i>	<i>Common</i>
24	<i>Vateria indica</i> L	<i>Critically Endangered</i>
25	<i>Vitex negundo</i> L	<i>Common</i>
26	<i>Xylia xylocapra</i>	<i>Common</i>

3.2.5 Flora in the proposed Project area (Tumkur & Kolar region)

The total vegetation coverage of the distribution area (Tumkur & Kolar region) is represented by deciduous forests with thorny undergrowth. The plant species observed at various site locations are given below.

Table 27 Flora recorded in proposed site locations in Tumkur & Kolar region

Sl.No	Name of Species	Habit	IUCN Status 2014.1
1	<i>Abutilon indicum</i>	<i>Shrub</i>	<i>Common</i>
2	<i>Acacia auriculiformis</i>	<i>Tree</i>	<i>Common</i>
3	<i>Acacia leucophloea</i>	<i>Tree</i>	<i>Common</i>
4	<i>Acacia nilotica</i>	<i>Tree</i>	<i>Common</i>
5	<i>Aegle marmelos</i>	<i>Tree</i>	<i>Common</i>
6	<i>Agave americana</i>	<i>Shrub</i>	<i>Common</i>
7	<i>Ailanthus excelsa</i>	<i>Tree</i>	<i>Common</i>
8	<i>Albizia amara</i>	<i>Tree</i>	<i>Common</i>
9	<i>Albizia odoratissima</i>	<i>Tree</i>	<i>Common</i>
10	<i>Alstonia scholaris</i>	<i>Tree</i>	<i>Common</i>
11	<i>Anogeissus latifolia</i>	<i>Tree</i>	<i>Common</i>
12	<i>Artocarpus integrifolia</i>	<i>Tree</i>	<i>Common</i>
13	<i>Azadirachta indica</i>	<i>Tree</i>	<i>Common</i>
14	<i>Bridelia retusa</i>	<i>Tree</i>	<i>Common</i>
15	<i>Buchnanania latifolia</i>	<i>Tree</i>	<i>Common</i>
16	<i>Butea frondosa</i>	<i>Tree</i>	<i>Common</i>
17	<i>Calophyllum tomentosum</i>	<i>Tree</i>	<i>Vulnerable</i>
18	<i>Calotropis gigantea</i>	<i>Shrub</i>	<i>Common</i>
19	<i>Canthium parviflorum</i>	<i>Tree</i>	<i>Common</i>
20	<i>Carissa carandas</i>	<i>Tree</i>	<i>Common</i>

Sl.No	Name of Species	Habit	IUCN Status 2014.1
21	<i>Cassia auriculata</i>	Shrub	Common
22	<i>Cassia fistula</i>	Tree	Common
23	<i>Cassia siamiae</i>	Tree	Common
24	<i>Chloroxylon swietenia</i>	Tree	Vulnerable
25	<i>Cissus quadrangularis</i>	Shrub	Common
26	<i>Crotalaria retusa</i>	Herb	Common
27	<i>Cymbopogon citratus</i>	Herb	Common
28	<i>Delonix regia</i>	Tree	Common
29	<i>Dendrocalamus strictus</i>	Herb	Common
30	<i>Diospyros montana</i>	Tree	Common
31	<i>Diospyros melanoxylon</i>	Tree	Common
32	<i>Dodonaea viscosa</i>	Shrub	Common
33	<i>Emblica officinalis</i>	Tree	Common
34	<i>Erythroxylon monogynum</i>	Tree	Common
35	<i>Eucalyptus hybrid</i>	Tree	Common
36	<i>Ferronea elephantum</i>	Tree	Common
37	<i>Ficus bengalensis</i>	Tree	Common
38	<i>Ficus glomerata</i>	Tree	Common
39	<i>Ficus infectoria</i>	Tree	Common
40	<i>Gliricidia maculata</i>	Tree	Common
41	<i>Gloriosa superba</i>	Creeper	Common
42	<i>Grevillea robusta</i>	Tree	Common
43	<i>Hardwickia binata</i>	Tree	Common
44	<i>Hibiscus rosa sinensis</i>	Shrub	Common
45	<i>Holoptelea integrifolia</i>	Tree	Common
46	<i>Ixora arborea</i>	Shrub	Common
47	<i>Jacaranda mimosaeifolia</i>	Tree	Common
48	<i>Lagerstroemia lanceolata</i>	Tree	Common
49	<i>Lagerstroemia parviflora</i>	Tree	Common
50	<i>Lantana camara</i>	Shrub	Common
51	<i>Leucaena leucocephala</i>	Tree	Common
52	<i>Mangifera indica</i>	Tree	Common
53	<i>Melia dubia</i>	Tree	Common
54	<i>Ocimum sanctum</i>	Herb	Common
55	<i>Passiflora foetida</i>	Creeper	Common
56	<i>Plumeria alba</i>	Tree	Common
57	<i>Polyalthia longifolia</i>	Tree	Common
58	<i>Pongamia pinnata</i>	Tree	Common
59	<i>Pterocarpus marsupium</i>	Tree	Vulnerable
60	<i>Pterolobium indicum</i>	Tree	Common
61	<i>Ricinus communis</i>	Shrub	Common
62	<i>Samanea saman</i>	Tree	Common
63	<i>Santalum album</i>	Tree	Vulnerable
64	<i>Sapindus trifoliatus</i>	Tree	Common
65	<i>Semecarpus anacardium</i>	Tree	Common
66	<i>Solanum indicum</i>	Herb	Common

Sl.No	Name of Species	Habit	IUCN Status 2014.1
67	<i>Syzygium cumini</i>	Tree	Common
68	<i>Tamarindus indica</i>	Tree	Common
69	<i>Tectona grandis</i>	Tree	Common
70	<i>Terminalia bellarica</i>	Tree	Common
71	<i>Terminalia chebula</i>	Tree	Common
72	<i>Terminalia paniculata</i>	Tree	Common
73	<i>Terminalia tomentosa</i>	Tree	Common
74	<i>Vitex altissima</i>	Shrub	Common
75	<i>Wrightia tinctoria</i>	Tree	Common
76	<i>Zizyphus jujuba</i>	Tree	Common

Field studies along the upstream and rivulets in Sakleshpura region have been made to evaluate the status of ecosystems at species level. Most of the species found in the proposed project site belong to common category, which are found in the neighboring areas. Altogether 133 species were recorded, of which, 2 species are rare, 2 species are endangered, 1 threatened, vulnerable and critically endangered and others are common category. Further, 56 species are trees, 17 shrubs, 60 herbs, grasses, hydrophytes, epiphytes, sedges and climbers. Besides, 26 species are of medicinal and ethno-botanically importance and about 10 species are economically important. Main cultivated plants are paddy, coffee, citrus, mango, pineapple, coconut, arecanut, pomgranates, cardamom, etc.

Field studies were also carried out for canal portion and 76 species were recorded. Out of which most of them are common to the region and 4 vulnerable species were observed. Further, out of 76 species, 2 creepers, 5 herbaceous species, 11 shrubs and 58 species of trees.

3.2.6 Fauna

The study on faunal aspects has been carried out, which are reported to be present in the evergreen, moist and dry- deciduous forests in the catchment and canal region and also a few in the proposed weir sites. The occurrence of animals and the avian fauna was observed / reported with the help of local people and available literature, journals and records of the Zoological Survey of India. Birds were identified with the help of the Handbook of Birds of India (Ali S. and Ripley S.D. 1967 -72). During the field visits following animals were observed;

Table 28 Mammals, reptiles and amphibians observed/ reported for the study area

Sl. No.	Common name	Scientific name	Schedule
Mammals			
1	Elephant	<i>Elephas maximus</i>	I
2	Wild boar	<i>Sus scrofa</i>	III

3	Wild dog	<i>Cuon alpinus</i>	II
4	Porcupine	<i>Hystrix indica</i>	IV
5	Bonnet macaque	<i>Macaca radiata</i>	II
6	Striped squirrel	<i>Funambulus palmarum</i>	V
7	Common grey mongoose	<i>Herpestes edwardsii</i>	IV
8	Indian Hare	<i>Lepus nigricollis</i>	IV
9	Rat	<i>Rattus rattus</i>	V
10	Common leopard	<i>Panthera pardus</i>	I
11	Sloth bear	<i>Melursus ursinus</i>	I
12	Black buck	<i>Antilope cervicapra</i>	I
13	Spotted deer	<i>Axis axis</i>	III
Amphibians			
11	Common Indian toad	<i>Duttaphrynus parietalis</i>	
12	Bamboo tree frog	<i>Polypedates leucomystax</i>	
13	Common tree frog	<i>Polypedates maculatus</i>	
14	Indian bull frog	<i>Hoplobatrachus tigerinus</i>	
Reptiles			
15	Indian Rock Python	<i>Python molurus molurus</i>	I
16	Indian rat Snake	<i>Ptyas mucosa</i>	II
17	Cobra	<i>Naja naja</i>	I
18	Common krait	<i>Bungarus caeruleus</i> (Schneider, 1801)	
19	Common Indian cat snake	<i>Boiga trigonata</i>	
20	Russell's Viper	<i>Daboia russelii</i>	
21	Bamboo Pit Viper	<i>Trimeresurus gramineus</i>	

Table 29 List of birds reported and observed for the region

Sl. No.	Common name	Scientific name	W(P)A schedule
1	Little Cormorant	<i>Phalacrocorax niger</i>	R/IV
2	Great Cormorant	<i>Phalacrocorax carbo</i>	M/IV
3	Darter	<i>Anhinga melanogaster</i>	RV/IV
4	Little Egret	<i>Egretta garzetta</i>	R/IV
5	Grey Heron	<i>Ardea cinerea</i>	RM/IV
6	Median Egret	<i>Mesophoyx intermedia</i>	M/IV
7	Cattle Egret	<i>Bubulcus ibis</i>	R/IV
8	Indian Pond-Heron	<i>Ardeola grayii</i>	R/IV
9	Chestnut Bittern	<i>Ixobrychus cinnamomeus</i>	M/IV
10	Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	U/IV
11	Black Kite	<i>Milvus migrans</i>	R/IV
12	Shikra	<i>Accipiter badius</i>	R/IV
13	Indian Peafowl	<i>Pavo cristatus</i>	R/I
14	Yellow-wattled Lapwing	<i>Vanellus malarbaricus</i>	M/IV
15	Spotted Dove	<i>Streptopelia chinensis</i>	R/IV
16	Blue-winged Parakeet	<i>Psittacula columboides</i>	RE/IV
17	Indian Cuckoo	<i>Cuculus micropterus</i>	U/IV
18	Drongo Cuckoo	<i>Surniculus lugubris</i>	R/IV
19	Forest Eagle-Owl	<i>Bubo nipalensis</i>	U/IV

Sl. No.	Common name	Scientific name	W(P)A schedule
20	House Swift	<i>Apus affinis</i>	R
21	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	R/IV
22	Small Bee-eater	<i>Merops orientalis</i>	R
23	Blue-tailed Bee-eater	<i>Merops philippinus</i>	M
24	Chestnut-headed Bee-eater	<i>Merops leschenaultia</i>	R
25	Crimson-throated Barbet	<i>Megalaima rubricapilla</i>	R/IV
26	Yellow Wagtail	<i>Motacilla flava</i>	M/IV
27	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	R/IV
28	Red-vented Bulbul	<i>Pycnonotus cafer</i>	R/IV
29	White-browed Bulbul	<i>Pycnonotus luteolus</i>	R/IV
30	Oriental Magpie-Robin	<i>Copsychus saularis</i>	R
31	Indian Robin	<i>Saxicoloides fulicata</i>	R
32	Spotted Babbler	<i>Pellorneum ruficeps</i>	R/IV
33	Jungle Babbler	<i>Turdoides striatus</i>	R/IV
34	Common Tailorbird	<i>Orthotomus sutorius</i>	R
35	House Sparrow	<i>Passer domesticus</i>	R
36	Common Myna	<i>Acridotheres tristis</i>	R/IV
37	Jungle Myna	<i>Acridotheres fuscus</i>	R/IV
38	Common Hill-Myna	<i>Gracula religiosa</i>	R/IV
39	Black Drongo	<i>Dicrurus macrocercus</i>	R/IV
40	Indian Tree pie	<i>Dendrocitta vagabunda</i>	R/IV
41	White-bellied Tree Pie	<i>Dendrocitta leucogaster</i>	U/IV
42	House Crow	<i>Corvus splendens</i>	R/IV
43	Jungle Crow	<i>Corvus macrorhynchos</i>	R/IV

Note : M - Migratory, R - Resident, U – unclear WPA Schedule –I - IV

Among the wild-life population in the catchment area, there are Elephants, Wild Boars, at inaccessible niches. Most of the animals rarely appear in the forest area during the day time. The overall status of wildlife in the catchment ranges from poor to fair. However the proposed water spread area would quench their thirst in times of need. In this context, it is safe to conclude that the catchment area would become a core area for their well being and the water spread area would be an excellent source for life supporting resources.

Wildlife population in canal portion are sparsely distributed and are common to the region. The overall status of wildlife in the canal portion is poor. However, filling up of minor irrigation tanks in the region will improve the wildlife populace and also meets the drinking water demands of wildlife during the summer season.

Sampling for birds was done by walking along the fixed transects. During every sampling survey, each one hectare 100 x 100 m² plot was uniformly covered in five transects. While walking along the transects, a range of 10 m on either side of the site was the zone of actual

counting and thus the entire hectare was covered without any overlap. Birds were identified (Ali and Riply, 1983) based on sightings, calls and overhead flights. Thus the sampling was done over the 5 hectares of each locality for 5 hours in the morning on three consecutive days, during the study.

In the catchment area, it appears that there is no evidence as to whether the proposed site is an important resting site for birds. The birds observed or reported, are found to build nests along the interior trees and most of the species do not rest or breed close to water bodies. In addition, also observed in the catchment area, especially in the semi evergreen forest, fairly rich avian fauna like Paradise Fly Catcher, Black Headed Oriole, Hill Myna and Dove. The birds were observed in the vicinity of tree tops which are away from the proposed weir locations. Majority of them are of residential types commonly seen all over the catchment area and also in other parts of the Western Ghats. Whereas in canal area, most common birds were recorded and majority of them are local residents.

The animals found in the project area are of common category and also well represented in the catchment and canal area. The birds which have been identified in the project sites are found to be ubiquitous. Most of the birds in project area have their niches in the adjacent areas. The presence of animals and birds in the catchment and canal area will in no way be affected by the proposed scheme development as they are inhabited in the well forested niches of the catchment adjoining the project sites.

3.2.7 Aquatic Life

3.2.7.1 Biological Features (Biodiversity Aspects)

The diversity of aquatic communities, in terms of quality and quantity, is determined based on the productive potential of a given water body. The extent to which a biotope can support the aquatic life, in varied forms, depends on the available food spectrum and also by the turn-over of the nutrients by multiple actions and influences of factors/parameters operating in the environment. Aquatic communities, as a rule, are constituted by both floral and faunal species. These include all important constituents engaged in trophogenic, tropholytic and biotic activities in a given eco-system. Plankton, benthic/littoral faunal elements and the fish germplasm community. The nature and composition of flora and fauna depends on the source of the river and the land environment in their respective flow regime. Human activities and their needs, directly or otherwise, are responsible for the alterations in the nature of lotic water bodies. In evaluating the situation in the right perspective, the actual

and potential impacts on both the up and down stream stretches, as also on the impounded areas are to be considered for the safe-guarding the aquatic life inhabiting it.

The 'preliminary' study undertaken is to assess, depending on the data generated and evaluate the environmental impact on the commissioning of the weirs and stabilized continuous flow-regime systems across the Yettinahole, Kadumanehole, Kerihole and Hongadahalla streams/rivers located in the Sakaleshpur Taluk, Hassan District.

3.2.7.2 Scope of Study

Sampling stations for the collection of hydrobiological samples and fish and fisheries investigations were fixed considering the location where the weirs/flow-regimes, channels and related structures for plankton biomass, benthic/littoral fauna, Survey of streams/rivers located within the 'Project' site/s to record the aquatic life, fish in particular, present, 'rare, threatened or endangered' fish species and to assess the ecological impacts by commissioning weirs/connecting channels and related structures on the aquatic life- fish species, in particular present within its peripheral limits and suggest 'appropriate management measures' to protect the aquatic life, fish species in particular present in the habitat

3.2.7.3 Methodology

- Plankton

For 'plankton' biomass samples, at each station, 100 lts stream/river water from different representative portions was strained through plankton net made of 21xxx nylobolt silk cloth. The samples, so obtained, were preserved in 5% formaldehyde solution. Biomass of the plankton sample was determined from each station, both qualitatively and quantitatively, by employing a Microscopic and Sedgewick-Rafter plankton counting cell.

- Littoral Fauna

Littoral fauna were collected by operating a 'D' net at each station in the shallow marginal areas of each stream/river. The collections were sieved through a No.40 sieve and the faunal elements obtained were fixed in 5% formaldehyde solution and subjected to systematic analysis.

- Fish Species

Fishing, by employing castnets, dragnet made of velon screen and scoop net were operated in different pockets of the stream/rivers. The fish specimens collected were systematically

analysed. Additional data on the subject was obtained on local enquiries and by studying the published records.

3.2.7.4 Observations

Plankton: The micro-biotic population in a given water body is composed of phyto and zoo plankton communities. The plankton, in turbulent and hill streams in particular, depends on local conditions, seasonal variations and incidence of discharge of water. The plankton, in general, forms food of scores of planktivorous fish species- be they minnows or the major food fishes.

Table 30 Biomass near the weir sites.

Weir-1: Plankton Biomass of Yettinahole			
The Plankton in the river studies is inherently 'poor' and appears to have little role to play in the ecological niche			
PHYTOPLANKTON			Nos/l
	Division	MYXOPHYCEAE	
	Family	OSCILLATORIACEAE	
	Genus	Oscillatoria Vaucher	
	1	<i>Oscillatoria princeps</i> Vaucher ex Gomont	3
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Zygnematales	
	Family	DESMIDIACEAE	
	Genus	Cosmarium Corda	
	2	<i>Cosmarium granatum</i> Brebbison	1
	Order	Ulotrichales	
	Family	ULOTRICHACEAE	
	Genus	Ulothrix Kutzing	
	3	<i>Ulothrix zonata</i> (Web et Mohr) Kutzing	3
	Division	Chrysophyta	
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Family	COSCINODISCACEAE	
	Genus	Melosira Kutzing	
	4	<i>Melosira ambigua</i> (Grun.) Mull.	1
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Sub-Family	Fragilarioideae	
	Genus	Fragilaria Lyngb.	
	5	<i>Flagilaria capucina</i> Desmaziars	17

	Genus	Synedra Ehrenberg	
	6	<i>Synedra ulna</i> (Nitzsch) Ehrenberg	1
	Suborder	Biraphidineae	
	Family	NAVICULACEAE	
	Subfamily	Naviculoideae	
	Genus	Navicula Bory	
	7	<i>Navicula crucicula</i> (W.Sm) Donkin	2
	Genus	Pinnularia Ehrenberg	
	8	<i>Pinnularia major</i> W.Sm	3
	Family	CYMBELLACEAE	
	Genus	Cymbella Ag.	
	9	<i>Cymbella ventricosa</i> Kutzing	2
	Family	SURIPELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirela Temp.	
	10	<i>Surirella novolis</i> Smith	3
	Genus	Denticula Kutzing	
	11	<i>Denticula thermalis</i> Kutzing	3
ZOOPLANKTON			
	Class	Granulosa-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	12	<i>Arcella mitrata</i> Leidy	5
	Family	DIFFLUGIDAE	
	Genus	Diffflugia Leclere	
	13	<i>Diffflugia coresa</i> Wallich	2
	Order	Flosculariaceae	
	Family	TESTUDINELLIDAE	
	Genus	Brachionus Pallas	
	14	<i>Brachionus rubens</i> Ehrenberg	3
	Subclass	Branchiopoda	
	Order	Cladocera	
	Suborder	Eucladocera Eriksson	
	Family	DAPHNIDAE Straus	
	Genus	Daphnia O.F Muller	
	15	<i>Daphnia carinata</i> King	1
MISCELLANEOUS			
	16	Vegetative parts	4
	17	Insect remains	2

Weir-1: Systematic list of littoral fauna of Yettinahole			
INSECTS			
	Order	Hemiptera	
	Family	GERRIDAE	
	1	<i>Gerris spinolae</i> Leth. & Sev.	
MOLLUSCS			
	Class	Gastropoda	
	Order	Mesogastropoda	
	Family	THIARIDAE	
	Sub Family	Thiarinae s.str.	
	Genus	Thiara Roding	
	Sub-Genus	Thiara s.str.	
	2	<i>Thiara (Thiara) scabra</i> (Muller)	
Qualitative analysis of the littoral fauna is very 'poor' in its representation. Only G.spinolae (Insect) and T(T)scabra (Molluscs) represent each group.			
Weir-1: Systematic list of fish species of Yettinahole			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (= Rasborinae)	
	Tribe	Danionini	
	Genus	Danio Hamilton-Buchanan	
	1	<i>Danio aequipinnatus</i> (McClelland)	
	Genus	Rasbora Bleeker	
	2	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	
	Subfamily	Oreinae	
	Genus	Garra Hamilton-Buchanan	
	3	<i>Garra gotyla stenorhynchus</i> (Jerdon)	
The fish species constituted by larvicidal and detritus feeding are the ones recorded. The species are equally important from ornamental considerations. However, the species vary in their respective representations.			
Weir-2: Plankton biomass of the tributary of Yettinahole			
The plankton concentrate of the stream s 'poor' in representation.			
PHYTOPLANKTON			
	Division	Myxophyceae	
	Family	RIVULARIACAE	
	Genus	Rivularia Agardh	
	1	<i>Rivularia minutula</i> (Kutzing) Bornat and Flahault	1

	Family	OSCILLATORIACEAE	
	Genus	Oscillatoria Vaucher	
	2	<i>Oscillatoria obscura</i> Bruhlt Biswas	48
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Zygnematales	
	Family	ZYGNEMATACEAE	
	Genus	Spirogyra Link	
	3	<i>Spirogyra varians</i> (hassall) Kutzing	37
	Order	Cladophorales	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kutzing	
	4	<i>Cladophora glemerata</i> (L.) Kutzing	5
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngby	
	5	<i>Fragilaria capucina</i> Desmazieres	62
	Genus	Synedra Ehrenberg	
	6	<i>Synedra ulna</i> (Nitzsch) Ehrenberg	7
	Suborder	Biraphidineae	
	Family	GOMOPHONEMACEAE	
	Subfamily	Gomophonemoideae	
	Genus	Gomophonema Hust.	
	7	<i>Gomophonema germinatum</i> B (Lyngb.)	3
	Family	SURIELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirella Turp.	
	8	<i>Surirella striatula</i> Turp.	6
ZOOPLANKTON			
	Class	Granulo-reticulosa	
	Order	Amoebaea	
	Suborder	Amastigogenina	
	Family	HARTMANNELLIDAE	
	Genus	Acanthamoeba Vjedovsky	
	9	<i>Astramoeba radiosa</i> Ehrenberg	4
	Order	Centrohelidia	
	Suborder	Chalarothoraca	
	Genus	Acanthocystis Carter	

	10	<i>Acanthosystis sptinibera</i> Greef	2
	Order	Testacealabosa	
	Suborder	Amastigogenina	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	11	<i>Arcella mitrata</i> Leidy	6
	12	<i>Vegetative parts</i>	4
MISCELLANEOUS			
The total plankton count ranged between 1 and 62 u/l and is 'poor' in its representation.			
Weir-2: Systematic list of Littoral fauna of Tributary of Yettinahole			
INSECTS			
	Order	Ephemeroptera	
	Family	BAETIDAE	
	1	<i>Caenis spp.</i>	
	2	<i>Cloeon spp.</i>	
	Order	Hemiptera	
	Family	GERRIDAE	
	3	<i>Gerris spinolae</i> Leth. And Sev.	
	Family	CORIXIDAE	
	4	<i>Micronecta merope</i> (Dist.)	
MOLLUSCS			
	Class	Gastropoda	
	Order	Mesogastropoda	
	Family	THIARIDAE	
	Subfamily	Thiarinae s.str.	
	Genus	Thiara Roding	
	Subgenus	Thiara s.str	
	5	<i>Thiara (Thiara) scabra</i> (Muller)	
	Subclass	Pulmonata	
	Order	Bessomorphora	
	Family	LYMNAEIDAE	
	Genus	Lymnaea Lamarck	
	6	<i>Lymnaea (Pseudosuccina) luteola</i> Lamarck	
AMPHIBIA			
	Phylum	Chordata	
	Class	Amphibia	
	Order	Salentia	
	Suborder	Phaneroglossa	
	Family	RANIIDAE	
	7	<i>Rana cynophlctes</i> Schneider	
Weir-2: Systematic list of Fish species of Tributary of Yettinahole			

	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (= Rasborinae)	
	Tribe	Danioninae (= Rasborinae)	
	Genus	Danio Hamilton-Buchanan	
	1	<i>Danio aequipinnatus</i> (McCelland)	
	Genus	Rasbora Bleeker	
	2	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	
	Family	BALITORIDAE	
	Subfamily	Nemacheilinae	
	Genus	Schistura McCelland	
	3	<i>Schistura denisoni denisoni</i> (Day)	
The fish species collected comes under larvicidal and detritus feeding categories. The fish species composition is very poor in its representation			
Weir-3: Plankton biomass of Kadumanehole-I			
PHYTOPLANKTON			
	Division	Myxophyceae	
	Family	OSCILLATORIACEAE	
	Genus	Oscillatoria Vaucher	
	1	<i>Oscillatoria princeps</i> Vaucher ex Gomont	11
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Zygnematales	
	Family	ZYGNEMATACEAE	
	Genus	Spyrogyra Link	
	2	<i>Spyrogyra varians</i> (hassall) Kützing	228
	Order	Ulotrichales	
	Family	ULOTRICHACEAE	
	Genus	Ulothrix Kützing	
	3	<i>Ulothrix zonata</i> (Web et Mohr) Kützing	13
	Order	Cladophorales	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kützing	
	4	<i>Cladophora glomerata</i> (L.) Kützing	16
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngb	
	5	<i>Fragilaria capucina</i> Desmazieres	103
	Genus	Synedra Ehrenberg	

	6	<i>Synedra ulna</i> (Nitzsch) Ehrenberg	475
	Suborder	Biraphidineae	
	Family	NAVICULACEAE	
	Subfamily	Naviculoideae	
	Genus	Gyrosigma Hass.	
	7	<i>Gyrosigma kutzinghi</i> (Grun.) Cl.	27
	Family	SURIELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirella Turp.	
	8	<i>Surirella striatula</i> Turp.	2
ZOOPLANKTON			
	Class	Granulosa-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	9	<i>Arcella mitrata</i> Leidy	2
	Class	Monogononta	
	Order	Flosculariaceae	
	Family	TESTUDINELLIDAE	
	Genus	Brachionus Pallas	
	10	<i>Brachionus rubens</i> Ehrenberg	2
MISCELLANEOUS			
	11	Nematodes	1
	12	Chironomids	3
The total plankton concentrate ranged between 1 and 475 u/l. Phytoplankton was in dominant position compared to Zooplankton and the Miscellaneous groups. The plankton biomass, however, could be termed in 'poor' concentration in its representation.			
Weir-3: Systematic list of Littoral fauna of Kadumanehole-I			
INSECTS			
	Order	Ephemeroptera	
	Family	BAETIDAE	
	1	<i>Cloeon spp.</i>	
	Order	Odonata	
	Suborder	Anisoptera	
	Family	LIBELLULIDAE	
	2	<i>Urothemis signata</i> (Rambur)	
	Family	AESHNIDAE	
	3	<i>Anax spp</i>	
	Order	Hemiptera	
	Family	GERRIDAE	
	4	<i>Gerris spinolae</i> Leth. And sev.	
	Family	NOTONECTIDAE	

	5	<i>Notonecta glauca</i> Linnaeus	
	Family	CORIXIDAE	
	6	<i>Corixa hieroglyphica</i> Dug.	
	7	<i>Micronecta merope</i> dist	
	Order	Diptera	
	Family	CHIRONOMIDAE	
	8	<i>Chironomus</i> spp	
MOLLUSCS			
	Class	Gastropoda	
	Order	Mesogastropoda	
	Family	THIARIDAE	
	Subfamily	Melanatriinae	
	Genus	<i>Sulcospira</i> Troschel	
		<i>Thiara</i> s.str	
	9	<i>Sulcospira heugeli</i> (Philipi)	
	Subclass	Pulmonata	
	Order	Bessomorphora	
	Family	LYMNAEIDAE	
	Genus	<i>Lymnaea</i> Lamarck	
	10	<i>Lymnaea</i> (<i>Pseudosuccinea</i>) <i>acuminata</i> Lamarck	
	11	<i>Lymnaea</i> (<i>Pseudosuccinea</i>) <i>luteola</i> Lamarck	
AMPHIBIA			
	Phylum	Chordata	
	Class	Amphibia	
	Order	Salientia	
	Suborder	Phaneroglossa	
	Family	RANIIDAE	
	12	<i>Rana cynophlctes</i> Schneider	
Weir-3: Systematic list of fish species in Kadumanehole- I			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Oxygasterini	
	Genus	<i>Salmostoma</i> Swainson	
	1	<i>Salmostoma acinaces</i> (Valenciennes)	
	Tribe	Danionini	
	Genus	<i>Rasbora</i> Bleeker	
	2	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	
Weir-4: Plankton Biomass of kadumanehole-II			
PHYTOPLANKTON			
	Division	Myxophyceae	

	Family	OSCILLATORIACEAE	
	Genus	Oscillatoria Vaucher	
	1	<i>Oscillatoria obscura</i> Brohlot Biswas	164
	Division	Chlorophyceae	
	Class	Chlorophyceae	
	Order	Zygnematales	
	Family	DESMIDIACEAE	
	Genus	Closterium Nitzsch	
	2	<i>Closterium leibleinii</i> Kutzing	24
	3	<i>Closterium venus</i> (Kutz.) Brebisson	4
	Family	ZYGNMATAACEAE	
	Genus	Spirogyra Link	
	4	<i>Spirogyra varians</i> (hassal) Kutzing	536
	Order	Ulotrichales	
	Family	ULOTRICHASCEAE	
	Genus	Ulothrix Kutzing	
	5	<i>Ulothrix zonata</i> (web et Mohr) Kutzing	168
	Order	Cladophora	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kutzing	
	6	<i>Cladophora glomerata</i> (L.) Kutzing	192
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngb.	
	7	<i>Fragilaria capucina</i> Desmaziers	324
	Genus	Synedra Ehrenberg	
	8	<i>Synedra Ulna</i> (Nitzsch) Ehrenberg	8
ZOOPLANKTON			
	Class	Granulosa-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	9	<i>Arcella mitrata</i> Leidy	12
	Order	Actinophryia	
	Genus	Actinophrys Ehrenberg	
	10	<i>Actinophrys sol</i> Ehrenberg	4
	Subclass	Branchipoda	

	Order	Cladocera Calmon	
	Suborder	Eucladocera Eriksson	
	Super-family	Sidoidea (=Ctenopoda Sars)	
	Family	DAPHNIDAE Straus	
	Genus	Daphnia O.F Muller	
	Subgenus	Daphnia sensu stricte	
	11	<i>Daphnia carinata</i> King	4
	Family	CYPRIDAE	
	Subfamily	Cyprinae	
	Genus	Cypris OF Muller	
	12	<i>Cypris subglobosa</i> Sowerby	3
	Family	DIAPTOMIDAE	
	Genus	Diaptomus	
	Subgenus	Aglaodiaptomus	
	13	<i>Mesocyclops leuckart</i>	12
MISCELLANEOUS			
	14	Vegetative parts	8
	15	Insect remains	8
Weir-4: Systematic list of Littoral fauna of kadumanehole-II			
INSECTS			
	Order	Hemiptera	
	Family	GERRIDAE	
	1	<i>Gerris spinolae</i> Leth. & Sev.	
	Family	NEPIDAE	
	2	<i>Laccotrophes maculatus</i> Fabricius	
	Family	CORIXIDAE	
	3	<i>Micronecta merope</i> Dist	
	Order	Coloptera	
	Family	DYTISCIDAE	
	4	<i>Dytiscus limbatus</i> Fabricius	
Weir-4: Systematic list of Fish species of kadumanehole-II			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Danionini	
	Genus	Danio Hamilton-Buchanan	
	1	<i>Danio sequipinnatus</i> (McClelland)	
	Genus	Rasbora Bleeker	
	2	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	
Weir-6: Plankton biomass of Keri-hole			
PHYTOPLANKTON			

	Division	Myxophyceae	
	Family	OSCILLOTORIACEAE	
	Genus	Oscillatoria Vaucher	
	1	<i>Oscillatoria princeps</i> Vaucher ex gomont	1
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Chlorococcales	
	Family	SCENEDESMACEAE	
	Genus	Actinastrum Lagerheim	
	2	<i>Actinastrum gracillimum</i> GM Smith	1
	Order	Zygnematales	
	Family	DESMIDIACEAE	
	Genus	Closterium Nitzsch	
	3	<i>Closterium leibleinii</i> Kutzing	2
	Family	ZYGNEMATACEAE	
	Genus	Spirogyra Link	
	4	<i>Spirogyra varians</i> (hassal) Kutzing	4
	Order	Ulotrichales	
	Family	ULOTRICHASCEAE	
	Genus	Ulothrix Kutzing	
	5	<i>Ulothrix zonata</i> (web et Mohr.) Kutzing	6
	Order	Cladophorales	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kutzing	
	6	<i>Cladophora glomerata</i> B (L.) Kutzing	9
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Discineae	
	Family	COSCINODISCACEAE	
	Subfamily	Melosiroidea	
	Genus	Melosira Kutzing	
	7	<i>Melosira ambigua</i> (Grun) Muller	2
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngb	
	8	<i>Fragilaria capucina</i> Desmazieres	27
	Genus	Synedra Ehrenberg	
	9	<i>Synedra ulna</i> (Nitzsch) Ehrenberg	2
	Suborder	Rapidioidineae	
	Family	EUNOTIACEAE	
	Subfamily	Eunotioideae	

	Genus	Eunota Ehrenberg	
	10	<i>Eunota praerupta</i> var. <i>bidens</i> (Ehre.)Grun	1
	Suborder	Biraphidineae	
	Family	NAVICULACEAE	
	Subfamily	Naviculoideae	
	Genus	Navicula Bory	
	11	<i>Navicula radiosa</i> Kutzing	3
	Genus	Pinnularia Ehrenberg	
	12	<i>Pinnularia major</i> Kutzing	1
	Family	NITZCHIAEAE	
	Subfamily	Nitzchlioideae	
	Genus	Nitzschia Hass	
	13	<i>Nitzschia sigmoidea</i> (Nitzsch) W.Sm.	1
	Family	SURIRELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirella Turp.	
	14	<i>Surirella striatula</i> Turp.	1
ZOOPLANKTON			
	Class	Granulo-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	15	<i>Arcella mitrata</i> Leidy	5
	Family	DIFFLUGIIDAE	
	Genus	Diffugia Leclere	
	16	<i>Diffugia corona</i> Wallich	3
	Class	Monogononta	
	Order	Flosculariaceae	
	Family	TESTUDINELLIDAE	
	Genus	Keratella Bory de St.Vincent	
	17	<i>Keratella tropica</i> Apstein	1
	Genus	Brachionus Pallas	
	18	<i>Brachionus ferficula</i> Wierzeski	1
	Family	DAPHNIDAE straus	
	Genus	Ceriodaphnia Dana	
	19	<i>Ceriodaphnia reticulata</i> (Jurine)	3
	Family	DIAPTOMIDAE	
	Genus	Diaptomus	
	Subgenus	Agladiaptomus	
	20	<i>Mesocyclops leuckart claus</i>	2
Weir-6: Systematic list of Littoral Fauna of Keri-hole			

INSECTS			
	Order	Ephemeroptera	
	Family	BAETIDAE	
	1	<i>Caenis spp.</i>	
	2	<i>Cloeon spp.</i>	
	Order	Odonata	
	Suborder	Anisoptera	
	Family	LIBELLULIDAE	
	3	<i>Urothemis signata (Rambur)</i>	
	Family	COENAGRIONIDAE	
	4	<i>Enallagma spp</i>	
	Order	Hemiptera	
	Family	GERRIDAE	
	5	<i>Gerris spinolae Leth. & Sev.</i>	
MOLLUSCS			
	Order	Mesogastropoda	
	Family	THIARIDAE	
	Subfamily	Melanatriinae	
	Genus	Sulcospira Treschel	
	6	<i>Sulcospira heugeli (Philipi)</i>	
AMPHIBIA			
	Phylum	Chordata	
	Class	Amphibia	
	Order	Salientia	
	Suborder	Phaneroglossa	
	Family	RANIDAE	
	7	<i>Rana cynophlyctes Schneider</i>	
Weir-6: Systematic list of fish species of Keri-hole			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Danionini	
	Genus	Danio Hamilton-Buchanan	
	1	<i>Danio aequipinnatus (McClelland)</i>	
	Genus	Rasbora Bleeker	
	2	<i>Rasbora daniconius (Hamilton-Buchanan)</i>	
	Subfamily	Cyprininae	
	Tribe	Systomini	
	Subtribe	Systomi	
	Genus	Puntius Hamilton- Buchanan	

	3	<i>Puntius fasciatus fasciatus</i> (Day)	
	4	<i>Puntius puckelli</i> (Day)	
	5	<i>Puntius ticto</i> (Hamilton-Buchanan)	
	Family	BALITORIDAE	
	Subfamily	Nemacheilinae	
	Genus	Schistura McClelland	
	6	<i>Schistura denisoni denisoni</i> (Day)	
Weir-6: Plankton biomass of Hongadahalla			
Systematic list			Nos/l
PHYTOPLANKTON			
	Division	Myxophyceae	
	Genus	Oscillatoria Vaucher	
	1	<i>Oscillatoria princeps</i> Vaucher ex. Gomont	1
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Ulotrochales	
	Family	ULOTRICHASCEAE	
	Genus	Ulothrix Kutzing	
	2	<i>Ulothrix zonata</i> (web et Mohr.) Kutzing	5
	Order	Cladophorales	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kutzing	
	3	<i>Cladophora glomerata</i> B (L.) Kutzing	2
	Division	Chrysophyta	
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngb	
	4	<i>Fragilaria capucina</i> Desmazieres	6
	Suborder	Biraphidineae	
	Family	NAVICULACEAE	
	Subfamily	Naviculoideae	
	Genus	Navicula Bory	1
	5	<i>Navicula radiosa</i> Kutzing	
	Genus	Pinnularia Ehrenberg	
	6	<i>Pinnularia nobilis</i> Ehrenberg	1
	Family	SURIRELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirella Turp.	
	7	<i>Surirella novilis</i> Smith.	2

ZOOPLANKTON			
	Class	Granulo-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	15	<i>Arcella mitrata</i> Leidy	2
	Superclass	Actinopoda	
	Class	Granulo-reticulosa	
	Order	Amoebaea	
	Suborder	Amastigogenina	
	Family	HARTMANNELLIDAE	
	Genus	Acanthamoeba Vejdovsky	
	9	<i>Astramoeba radios</i> Ehrenberg	1
	Order	Cladocera Calmon	
	Suborder	Eucladocera Eriksson	
	Family	DIAPTOMIDAE	
	Genus	Diaptomus	
	subgenus	Aglaodiaptomus	
	10	<i>Mesocyclops leuckart</i> Claus	5
MISCELLANEOUS			
	11	Insect appendages	4
Weir-7: Systematic list of Littoral Fauna of Hongadahalla			
INSECTS			
	Order	Ephemeroptera	
	Family	BAETIDAE	
	1	<i>Caenis spp.</i>	
	Order	Odonata	
	Suborder	Anisoptera	
	Family	LIBELLULIDAE	
	2	<i>Urothemis signata</i> Rambur	
	Order	Hemiptera	
	Family	GERRIDAE	
	3	<i>Gerris spinolae</i> Leth. & Sev.	
MOLLUSCS			
	Order	Mesogastropoda	
	Family	BITHYNIDAE	
	Subfamily	Bithyniinae s.str.	
	Genus	Gabbia Tryon	
	4	<i>Gabbia stenothyroides</i> Dohrn	
	Subfamily	Thiarinae s.str.	
	Genus	Thiara Roding	

	Subgenus	Melanoides Olivier	
	5	Thiara (<i>Thiara</i>) <i>scabra</i> Muller	
	Subfamily	Melanatriinae	
	Genus	Sulcospira Treschel	
	6	Sulcospira <i>heugeli philipi</i>	
AMPHIBIA			
	Class	Emphibia	
	Order	Salientia	
	Suborder	Phaneroglossa	
	Family	RANIDAE	
	7	Rana <i>cynophlyctes</i> Schneider	
FISH			
	Order	Cypriniformes	
	Family	BALITORIDAE	
	Subfamily	Nemacheilinae	
	Genus	Schistura McClelland	
	8	Schistura <i>denisoni denisoni</i> (Day)	
Weir-7: Systematic list of fish species of Hongadahalla			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Danionini	
	Genus	Rasbora Bleeker	
	1	Rasbora <i>daniconius</i> (Hamilton-Buchanan)	
	Subfamily	Cyprininae	
	Tribe	Systomini	
	Subtribe	Systomi	
	Genus	Puntius Hamilton- Buchanan	
	2	Puntius <i>fasciatus fasciatus</i> (Day)	
	3	Puntius <i>ticto</i> (Hamilton-Buchanan)	
	Subfamily	Oreinae	
	Genus	Garra Hamilton-Buchanan	
	4	Garra <i>Gotyla stenorhynchus</i> (Jerdon)	
	Family	BALITORIDAE	
	Subfamily	Nemacheilinae	
	Genus	Schistura McClelland	
	6	Schistura <i>denisoni denisoni</i> (Day)	
Weir-6: Plankton biomass of Yettinahole			
PHYTOPLANKTON			
	Division	Myxophyceae	
	Family	OSCILLOTORIACEAE	
	Genus	Oscillatoria Vaucher	

	1	<i>Oscilloatoria princeps</i> Vaucher ex gomont	4
	Division	Chlorophyta	
	Class	Chlorophyceae	
	Order	Zygnematales	
	Family	DESMIDIACEAE	
	Genus	Closterium Nitzsch	
	2	<i>Closterium leibleinii</i> Kutzing	3
	Genus	Cosmarium Corda	
	3	<i>Cosmarium granatum</i> Brebisson	7
	Family	ZYGNEMATACEAE	
	Genus	Spirogyra Link	
	4	<i>Spirogyra varians</i> (hassal) Kutzing	22
	Order	Ulotrichales	
	Family	ULOTRICHACEAE	
	Genus	Ulothrix Kutzing	
	5	<i>Ulothrix zonata</i> (Weber et Mohr.) Kutzing	5
	Order	Cladophorales	
	Family	CLADOPHORACEAE	
	Genus	Cladophora Kutzing	
	6	<i>Cladophora glomerata</i> B (L.) Kutzing	2
	Class	Bacillariophyceae	
	Order	Bacillariales	
	Suborder	Discineae	
	Family	COSCINODISCACEAE	
	Subfamily	Melosiroidea	
	Genus	Melosira Kutzing	
	7	<i>Melosira ambigua</i> (Grun) Muller	1
	Suborder	Araphidineae	
	Family	FRAGILARIACEAE	
	Subfamily	Fragilarioideae	
	Genus	Fragilaria Lyngb	
	8	<i>Fragilaria capucina</i> Desmazieres	11
	Genus	Synedra Ehrenberg	
	9	<i>Synedra ulna</i> (Nitzsch) Ehrenberg	5
	Suborder	Biraphidineae	
	Family	NAVICULACEAE	
	Subfamily	Naviculoideae	
	Genus	Gyrosigma Hass.	
	10	<i>Gyrosigma kutzingii</i> (Grun) Cl.	2
	Genus	Navicula Bory	
	11	<i>Navicula crucicula</i> (W.Sm.) Donkin	1

	Genus	Pinnularia Ehrenberg	
	12	<i>Pinnularia Major</i> W.Sm.	8
	Family	CYMBELLACEAE	
	Subfamily	Cymbelloideae	
	Genus	Cymbella Ag.	
	13	<i>Cymbella ventricosa</i> Kutzing	1
	Family	NITZCHACEAE	
	Subfamily	Nitzchloideae	
	Genus	Nitzschia Hass	
	14	<i>Nitzschia sigmoidea</i> (Nitzsch) W.Sm.	3
	Family	SURIRELLACEAE	
	Subfamily	Surirelloideae	
	Genus	Surirella Turp.	
	15	<i>Surirella striatula</i> Turp.	1
ZOOPLANKTON			
	Class	Granulo-reticulosa	
	Order	Testacealobosa	
	Suborder	Reticulo-lobosa	
	Family	ARCELLIDAE	
	Genus	Arcella Ehrenberg	
	16	<i>Arcella mitrata</i> Leidy	5
	Order	Flosculariaceae	
	Family	TESTUDINELLIDAE	
	Genus	Keratella Bory de St.Vincent	
	17	<i>Keratella tropica</i> Apstein	2
	Genus	Asplanchna Gosse	
	18	<i>Asplanchna priodonta</i> Gosse	2
	Genus	Brachionus Pallas	
	19	<i>Brachionus rubens</i> Ehrenberg	1
	Order	Cladocera Calmon	
	Suborder	Eucladora Eriksson	
	Superfamily	Sidoidea (=Ctenopoda Sars)	
	Family	DIAPTOMIDAE	
	Genus	Diaptomus	
	Subgenus	Agladiaptomus	
	20	<i>Mesocyclops leuckart</i> Claus	1
Weir-8: Systematic list of Littoral Fauna of Hongadahalla			
INSECTS			
	Order	Ephemeroptera	
	Family	BAETIDAE	
	1	<i>Caenis</i> spp.	
	2	<i>Cloeon</i> spp.	

	Order	Odonata	
	Suborder	Anisoptera	
	Family	LIBELLULIDAE	
	3	<i>Urothemis signata</i> (Rambur)	
	Family	AESHNIDAE	
	4	<i>Anax</i> spp.	
	Order	Hemiptera	
	Family	GERRIDAE	
	5	<i>Gerris Spinolae</i> Leth. & Sev.	
	Family	CORIXIDAE	
	6	<i>Corixa hieroglyphica</i> Duf.	
	7	<i>Micronecta merope</i> Dist.	
MOLLUSCS			
	Order	Mesogastropoda	
	Family	THIARIDAE	
	Subfamily	Thiarinae s. str.	
	Genus	Thiara Roding	
	Subgenus	Thiara s. str.	
	8	<i>Thiara (Thiara) scabra</i> (Muller)	
	Subfamily	Melanatriinae	
	Genus	Sulcospira Troschel	
	9	<i>Sulcospira heugeli</i> (Pjilipi)	
AMPHIBIA			
	Order	Salientia	
	Suborder	Phaneroglossa	
	Family	RANIDAE	
	10	<i>Rana cynophlyctes</i> Schneider	
CRUSTACEA			
	Class	Crustacea	
	Subclass	Malacostraca	
	Order	Decapoda	
	Family	PALAEMONIDAE	
	11	<i>Macrobrachium</i> spp.	
FISH			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Danionini	
	Genus	Danio Hamilton-Buchanan	
	12	<i>Danio aequipinnatus</i> McClelland	
	Family	BALITORIDAE	
	Subfamily	Nemachelilinae	

	Genus	Schistura McClelland	
	13	<i>Schistura denisoni denisoni</i> (Day)	
Weir-8: Systematic list of fish species of Yettinahole			
	Order	Cypriniformes	
	Family	CYPRINIDAE	
	Subfamily	Danioninae (=Rasborinae)	
	Tribe	Danionini	
	Genus	Danio Hamilton-Buchanan	
	1	<i>Danio aequipinnatus</i> McClelland	
	Genus	Rasbora Bleeker	
	2	<i>Rasbora daniconius</i> (Hamilton-Buchanan)	
	Subfamily	Cyprininae	
	Tribe	Systomini	
	Subtribe	Systomi	
	Genus	Puntius Hamilton- Buchanan	
	3	<i>Puntius ticto</i> (Hamilton-Buchanan)	
	Subfamily	Oreinae	
	Genus	Garra Hamilton-Buchanan	
	4	<i>Garra Gotyla stenorrhynchus</i> (Jerdon)	
	Family	BALITORIDAE	
	Subfamily	Nemacheilinae	
	Genus	Schistura McClelland	
	5	<i>Schistura denisoni denisoni</i> (Day)	

KNNL Annexure-3

1) Publications of Shri. M. F Rahman, Scientist (Retd.), CIFRI, Govt. of India

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Annexure-4

// Note //

Four Applications challenging the implementation of the Yettinahole Project questioning certain environmental aspects have been filed before the National Green Tribunal [SZ], Chennai of which one application No.303/2014 has been dismissed as not maintainable. The issues raised against the project commonly in these applications are the following;

- i. Commencement of work in non-forest area of the project without obtaining clearance for diversion of forest land required by the project under the Forest (Conservation) Act, 1980 as being violative of the guidelines issued by the MOEF (GoI).
 - ii. Doubts about availability of 24.01 TMC of water estimated for the project.
 - iii. Since filling-up of 527 minor irrigation tanks using 8.967 TMC of water had been envisaged in the DPR, this had to be construed as an irrigation project requiring environmental impact assessment under the Environment (Protection) Act before commencement of the project.
 - iv. The diminution in the water flow of the streams would impact the environment downstream.
2. The competent authority of the MOEF has, after detailed examination of the proposal and inspection of the project area, granted the first stage in-principle clearance for diversion of 13.93ha of forest land for the project subject to compliance with certain conditions for grant of final clearance. The first stage in-principle approval under the FC Act issued by the Central Government is to be treated as the working permission for commencement of work in the forest area if the required funds for compensatory afforestation, net present value, etc. and all such other compensatory levies specified

in the in-principle approval are realized from the user agency whereupon the competent authority in the State Government will issue an order for commencement of work in the forest area. KNNL is taking necessary steps in this regard. Therefore, the undertaking of work in non-forest area is now a non-issue. Moreover, the KNNL had been executing the work in the non-forest area prior to the first stage clearance based on the guidelines issued by the MOEF in respect of linear projects like construction of road, railway lines, canals, etc.,

3. The issues regarding water availability, filling-up of minor irrigation tanks and environmental impact downstream have been addressed by the MOEF while according in-principle approval for diversion of 13.93 ha of forest land after the opponents of the project who are also applicants before the NGT were heard by the Regional Empowered Committee[REC] of MOEF. The proceedings of the 7th & 8th meetings of the REC held on 18.12.2015 and 28.12.2015 respectively which deals with all these issues and the in-principle approval granted by the MOEF vide letter dated 6th January 2016 are **enclosed**. The following observations made by the REC at their 7th meeting held on 18.12.2015 may be taken note of with regard the sustainable improvement of the environment that this project will cater to.

"The project is being implemented by laying underground pipelines and also closed aquaducts in the valley portions in order to maintain the gradient. It is further observed that as stated in the project report, the Eastern part of Karnataka is frequently affected due to erratic rainfall and absence of any assured source of water for drinking purposes for the populace as well as livestock in the region, and the ground water table in these regions has reached alarming depths due to over exploitation, as a

consequence of which available ground water is contaminated with harmful salts like fluoride, nitrate, etc., in excess of permissible level. Implementation of the project will be beneficial for recharging of the ground water through which the dependant population and livestock will get portable water, thus overall health of the people is expected to improve and will also improve the ecosystem in the target area, which is much larger than the area being diverted for the project."



भारत सरकार
GOVERNMENT OF INDIA

पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
MINISTRY OF ENVIRONMENT, FORESTS & CLIMATE CHANGE
Regional Office (Southern Zone),
Kendriya Sadan, IVth Floor, E& F Wings, 17th Main Road,
IIInd Block, Koramangala, Bangalore – 560 034,
Tel.No.080-25635905, E.Mail: rosz.bng-mef@nic.in



BY SPEED POST

F.No.4-KRC 1064/2015-BAN/ 7829
Dated the 6th January, 2016

To

The Additional Chief Secretary to Government of Karnataka,
Forest, Ecology & Environment Department,
M.S.Building, Dr.Ambedkar Veedhi,
Bangalore – 560 001.

Subject: Diversion of 13.93 ha. of forest land in various forest areas of Sakelespura taluk in Hassan District for implementation of Yettinahole project in favour of Executive Engineer, Karnataka Neeravari Nigam Limited (KNNL).

Sir,

I am directed to refer to the State Government's letter No.FEE 136 FLL 2014 dated 19/08/2015 on the above mentioned subject seeking prior approval of the Central Government under Section'2' of the Forest (Conservation) Act, 1980.

The proposal was examined by the Regional Empowered Committee constituted under sub-rule (1) of rule 4A of the Forest (Conservation) Rules, 2003 in its meeting held on 28/12/2015 and Committee approved the proposal subject to certain conditions.

After careful examination of the proposal of the State Government and on the basis of the approval of the Regional Empowered Committee, the Central Government hereby conveys the in-principle approval **(Stage-I)** for diversion of 13.93 ha. of forest land in various forest areas of Sakelespura taluk in Hassan District as given in the following table for implementation of Yettinahole project in favour of Executive Engineer, Karnataka Neeravari Nigam Limited (KNNL):-

Sl.No.	Name of the Village & Survey No.	Legal status	Area (Ha)	Purpose
(1)	Doddanagara, Sy.No.45	Reserve Forest	0.96	Raising Main
(2)	Kadagarahalli Coffee Estate, Sy.No.1	Reserve Forest	0.89	Weir-6 & submergence
(3)	Aluvalli, Sy.No.47	Deemed Forest	0.75	Weir-6 & submergence
(4)	Aluvalli, Sy.No.24	Deemed Forest	1.15	Weir-6 & submergence
(5)	Nadahalli, Sy.No.197	Sec-4 notified area	0.56	Raising Main from DC-2 to DC-3

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(6)	Kadumane, Sy.No.88	Deemed Forest	3.11	DC-2, Raising Main from DC-2 to DC-3, Raising Main from Weir-3 to DC-24, BPT to DC-2.
(7)	Kadumane, Sy.No.68	Sec-4 notified area	2.72	Construction of Weir-3 & submergence, Electrical Substation & Pump House & Raising Main
(8)	Kadumane, Sy.No.76	Sec-4 notified area	0.80	Raising Main
(9)	Heggadde, Sy.No.385	Sec-4 notified area	2.17	Electrical Substation & Pump House.
(10)	Nadahalli, Sy.No.196	Deemed Forest	0.82	Raising Main from DC-2 to 3.
	TOTAL:		13.93	

This approval shall be subject to fulfillment of the following conditions:-

- (1) The legal status of forest land shall remain unchanged.
- (2) Demarcation of the proposed forest area shall be carried out by erecting cement concrete pillars duly numbered at an interval of 20 mts. at the cost of user agency, before Stage-II clearance.
- (3) The identified non-forest land over an area of 13.93 ha. in Sy.No.343 of Varavu Kaval village, Nayakanahatti Hobli, Challakere taluk, Chitradurga district for Compensatory Afforestation shall be transferred and mutated in favour of Forest Department. The sketch of the non-forest area selected for CA shall also be furnished, before Stage-II clearance.
- (4) The cost of raising Compensatory Afforestation over 13.93 ha. of non - forest land shall be deposited by the user agency.
- (5) Forest Department will realise the cost of raising Penal Compensatory Afforestation on 40 ha. of dumping area on either side of the raising main, both in the forest as well as non-forest area, which will be available on implementation of the project.
- (6) The State Government shall charge the Net Present Value of the forest land proposed for diversion of 13.93 ha. from the User Agency as per the orders of the Hon'ble Supreme Court dated 28.03.2008 and 09.05.2008 in IA Nos.826 in 566 with related IA's in Writ Petition (Civil) No.202/1995.

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- (7) Additional amount of the Net Present Value (NPV) of the diverted forest land if any, becoming due after revision of the same by the Hon'ble Supreme Court of India in future, shall be charged by the State Government from the User Agency. The User Agency shall furnish an undertaking to this effect.
- (8) The User Agency shall make online payment of the cost of CA, Penal CA and NPV with Adhoc- CAMPA through e-payment module of Forest Clearance portal- forestclearance.nic.in.
- (9) User Agency shall provide an undertaking on commencing the pumping operation from 15th June for facilitating ecological flow in the streams for free movement of aquatic fauna during the beginning of the monsoon and closing the pumping operation by October 31st.
- (10) An undertaking from User Agency for maintaining minimum continuous daily average flow of 15 cusecs from all the weirs be ensured during non-flooding days by adjusting the pumping capacity.
- (11) Flow of water through the weirs and quantity of water pumped out from each weir be continuously measured for a period of 2 years from the date of commissioning of the project. Conditions on maintaining the flow and drawal of water in the streams may be re-visited after analyzing the data.
- (12) A study on ecological impact of the project on the down stream ecosystem may be initiated through a reputed scientific institution simultaneously, so as to make any course correction on the conditions to be imposed, in future.
- (13) No trees standing on the forest land earmarked for dumping shall be cut.
- (14) The User Agency shall give an undertaking to plant up the land below the power line and along the rising main pipe with soil binding grass with necessary civil structures for the entire length of 78 kms. to protect from soil erosion, at the project cost.
- (15) An undertaking be given by the User agency for planting a minimum of 10,000 plants of tree species which are helpful to bird & bee population as per the advice of the Forest Department all along the pipeline and service road.
- (16) All pending dues under Forest (Conservation) Act, 1980 from the User Agency in respect of all earlier approved projects, if any, shall be realised before issue of Stage-II clearance.
- (17) While executing the project in forest area, the movement of men, vehicles and machinery should be limited to day-time and night camping in forest based worksites should not be permitted. Care should be taken against igniting and spread of fire to the forest vegetation in the project area.
- (18) The project construction works in forest area should be carried out between sunrise and sunset only.

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- (19) Blasting works inside forests should be limited to the barest minimum and carried out only during daytime.
- (20) No collection of sand from streambeds inside the forests for construction work shall be permitted.
- (21) Care should be taken to suitably dispose off the free excavated soil/ debris generated at work-sites, outside the river and its banks so as to avoid siltation of the river or its streams.
- (22) Water flow should be ensured downstream of all the weir locations during the period of water harvesting from June to October. Beyond this period the natural flows remain undisturbed as no water is to be pumped out.
- (23) During execution of project elements, for practical reasons, if such project elements become obstructive to the movement of animals, appropriate passage structure should be provided.
- (24) The power lines in the entire project area should be drawn as per the guidelines for drawing power lines in elephant habitats issued by the Ministry of Environment, Forests and Climate Change and other statutory authorities. Minimum height at the null point must be maintained according to these statutory provisions and court orders.
- (25) Automatic weather stations linked to the ICT Center of the Karnataka Forest Department at Bangalore may be established by the user agency at their cost at different locations preferably near existing facilities such as Protection Camps.
- (26) In order to benchmark the present status of ecology in the project area and particularly at the project work-sites survey and videography based study may be instituted at the cost of user agency. This will facilitate monitoring of project sites and decision-making in future.
- (27) Study proposed at condition No.(12) shall also include periodic assessment of cumulative impact of multiple projects in a forested landscape by the regulatory authority. It allows an adaptive management in the landscape and an opportunity to evaluate and re-align the mitigation strategies.
- (28) In view of the mitigation measures suggested, a mitigation plan for minimizing the impact of project on Eco-system, wildlife and its habitat should be prepared by the user agency with the help of scientific institutions having expertise in the matter. Such mitigation plan should be got approved by competent authority in the Forest Department within one year from the date of Stage-II approval to be implemented and enforced through the Forest Department.
- (29) The project authorities are also required to obtain all necessary approvals required under the law governing the project.
- (30) The total forest area utilized for the project shall not exceed 13.93 ha.

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- (31) Any other condition that the Additional Principal Chief Conservator of Forests (Central), Regional Office, Bangalore may impose from time to time for protection, improvement of flora and fauna in the forest area and public convenience, shall also be applicable.
- (32) The State Government will constitute a Committee headed by an officer, not below the rank of Chief Secretary to Government, for monitoring the compliance of conditions imposed in this clearance. This Committee shall also ensure that drinking and irrigation water requirement of the downstream population is not affected due to this diversion of water from the Netravati river basin.
- (33) Violation of any of the conditions shall invite penal action, as deemed fit by the Additional Principal Chief Conservator of Forests (Central), Regional Office, Bangalore.

After receipt of the compliance report on the fulfillment of the above conditions from the State Government, formal approval will be considered in this regard under Section-2 of the Forest (Conservation) Act, 1980. This in-principle approval shall be valid for a period of five years. In the event of non-compliance of the above conditions, this in-principle approval shall automatically stand revoked after five years.

Yours faithfully,

(S.M. Somashekar)

Chief Conservator of Forests (Central)

Copy to:-

- (1) The Director General of Forests & Special Secretary to Govt. of India, Ministry of Environment, Forests and Climate Change, Indira Paryavaran Bhavan, Agni Wing, Aliganj, Jor Bagh Road, New Delhi - 110 003.
- (2) The Principal Chief Conservator of Forests (HoFF), Forests Department, Govt. of Karnataka, Aranya Bhavan, 18th Cross, Malleswaram, Bangalore - 560 003.
- (3) The Additional Principal Chief Conservator of Forests/Nodal Officer (FCA), Office of the Principal Chief Conservator of Forests, Forests Department, Govt. of Karnataka, Aranya Bhavan, 18th Cross, Malleswaram, Bangalore - 560 003.
- (4) The Executive Engineer, Karnataka Neeravari Nigam Ltd., Yettinahole Project Division No.1, Sakaleshpur, Hassan District (Karnataka)
- (5) Guard file.

(S.M. Somashekar)

Chief Conservator of Forests (Central)

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