# Environmental Impact Assessment

Project Number: 43253-026
June 2019

# India: Karnataka Integrated and Sustainable Water Resources Management Investment Program – Project 2

## Vijayanagara Channels

Main Report

Prepared by Project Management Unit, Karnataka Integrated and Sustainable Water Resources Management Investment Program Karnataka Neeravari Nigam Ltd. for the Asian Development Bank. This is an updated version of the draft originally posted in June 2018 available on https://www.adb.org/India:Karnataka Integrated and Sustainable Water

KARNATAKA NEERAVARI NIGAM LTD

# Karnataka Integrated and Sustainable Water Resources Management Investment Program

ADB LOAN No. 3172-IND

# VIJAYANAGARA CHANNELS FEASIBILITY STUDY REPORT

## Volume 2a: Environmental Impact Assessment

**Project Management Unit, KISWRMIP**

Project Support Consultant

**SMEC International Pty. Ltd. Australia**

*in association with*

**SMEC (India) Pvt. Ltd.**

*May 2019*

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# ABBREVIATIONS

| | | |
|---|---|---|
| ADB | - | Asian Development Bank |
| ASI | - | Archaeological Survey of India |
| CADA | - | Command Area Development Authority |
| CCA | - | Culturable Command Area |
| CPCB | - | Central Pollution Control Board |
| CRO | - | Complaint Receiving Officer |
| EA | - | Executing Agency |
| EIA | - | Environmental Impact Assessment |
| EIRR | - | Economic Internal Rate of Return |
| EMP | - | Environmental Management Plan |
| FGD | - | Focus Group Discussion |
| FSR | - | Feasibility Study Report |
| GAP | - | Gender Action Plan |
| GoI | - | Government of India |
| GoK | - | Government of Karnataka |
| GRM | - | Grievance Redressal Mechanism |
| HWHAMA | - | Hampi World Heritage Area Management Authority |
| ICZ | - | Irrigation Central Zone |
| IEE | - | Initial Environmental Examination |
| IP | - | Inspection Path |
| IPPF | - | Indigenous People Planning Framework |
| IUCN | - | International Union for Conservation of Nature |
| KFD | - | Karnataka Forest Department |
| KNNL | - | Karnataka Neeravari Nigam Limited |
| KSPCB | - | Karnataka State Pollution Control Board |
| LARP | - | Land Acquisition and Resettlement Plan |
| MFF | - | Multi-tranche Financing Facility |
| MoEFCC | - | Ministry of Environment, Forests and Climate Change |
| OCR | - | Otter Conservation Reserve |
| PA | - | Protected Area |
| PIO | - | Project Implementation Office |
| PLGRM | - | Project Level Grievance Redressal Mechanism |
| PMU | - | Project Management Unit |
| PSC | - | Project Support Consultant |
| PUC | - | Pollution under Control |
| RBA | - | Rapid Biodiversity Assessment |
| REA | - | Rapid Environmental Assessment |
| RET | - | Rare, Endangered, Threatened |
| SDDR | - | Social due Diligence Report |
| SEIAA | - | State Environment Impact Assessment Authority |
| SPCB | - | State Pollution Control Board |
| SPM | - | Suspended Particulate Matter |
| SPS | - | ADB Safeguard Policy Statement 2009 |
| SR | - | Service Road |
| TB | - | Tungabhadra River |
| TLBC | - | Tungabhadra Left Bank Canal |
| TMC | - | one thousand million cubic feet in reference to volume of water |
| UNESCO | - | United Nations Educational Scientific and Cultural Organisation |
| VNC | - | Vijayanagara Channels |
| WALMI | - | Water and Land Management Institute |
| WLS | - | Wildlife Sanctuary |
| WUCS | - | Water Users Cooperative Society |

# EXECUTIVE SUMMARY

**Background:** Vijayanagara Channel (VNC) System is a run-of-the-river irrigation channel system built during the Vijayanagara Empire more than 600 years ago. Originally consisting of 19 channels, one channel (Rampura) caters to the irrigation needs of the neighbouring state of Andhra Pradesh. Among the rest 18 channels that serve the command area in Karnataka, Bennur Channel is in ruins, while Koregal Channel command receives water from the Tungabhadra Left Bank Channel. The VNC was constructed within the Tungabhadra basin in the reach starting from the Tungabhadra reservoir in Koppal District. Within the State, the VNC system spread across 3 districts, namely, Bellary, Raichur and Koppal lies between latitude 14°30' to 16°34' N and longitude 75°40' to 77°35' E.

The modernization (rehabilitation) program under *Karnataka Integrated and Sustainable Water Resources Management Investment Program (KISWRMIP)* assisted by Asian Development Bank (ADB) comprises modernization (rehabilitation) of three Projects-Gondi, VNC and TLBC initially under two tranches. The ongoing Gondi modernization under Project 1 has begun in July 2015 and has made significant progress towards its objectives. The Tranche 2 which initially comprised modernization (rehabilitation) of Vijayanagara Channels and Tungabhadra Left Bank Canal has been sub-divided into Projects 2 and 3 respectively under Tranches 2 and 3 as per aide memoire of ADB Mission of 12-19 February 2018. The multi-tranche facility for the three tranches is expected to close in the year 2024.

There are three outputs for each of these projects including VNC:

Output 1: State and Basin Institutions Strengthened for IWRM;
Output 2: Irrigation System Infrastructure and Management Modernized, and
Output 3: Project and Management Systems Operational.

VNC modernization aims at improving water use efficiency in the Culturable Command Area (CCA) of 11,154 ha. A total of 16 channels of the Vijayanagara Irrigation System located within the Karnataka State (excluding Bennur and Koregal Channels) are covered under modernization. Along with modernization (rehabilitation) works, installation of flow measurement and telemetry, command area development works, strengthening asset management and main system, Operation & Maintenance (O&M), and institutional strengthening and capacity building of WUCS are proposed to be taken up.

An Initial Environmental Examination (IEE) was carried out for VNC which revealed the presence of some areas falling in a notified Otter Conservation Reserve (OCR) and UNESCO Hampi World Heritage Area. This results the project to categorize as Category A project accoridng to the ADB Safeguard Policy Statement (SPS) 2009, hence, an Environmental Impact Assessment (EIA) was prepared. Subsequently, ADB has also suggested carrying out Rapid Biodiversity Assessment (RBA) and Tree Survey along the canals. The EIA aimed at assessing environmental issues arising due to modernization activities as also those from the notified OCR and the Hampi World Heritage Area (WHA). For all identified adverse impacts, mitigation measures have been suggested and an Environmental Management Plan (EMP) has been prepared.

**Implementation Arrangements:** Karnataka Neeravari Nigam Limited (KNNL), Bengaluru will continue to be the **Executing Agency (EA).** The Managing Director, KNNL will be the Project Director for Project 2 also comprising modernization (rehabilitation) of the VNC Irrigation

System and will be responsible for its successful execution. EA will be supported by a Project Management Unit (PMU) based in KNNL Bengaluru office headed by a full time senior engineer to ensure effective implementation of the project. ADB February 2018 Mission has accorded in principle approval to SMEC to continue as **Project Support Consultant (PSC)** to provide technical support as well as strengthening community participation. The **Project Implementation Office (PIO)** headed by the Chief Engineer will be based in the Munirabad Zonal office vested with the responsibility to ensure successful implementation. The PIO shall be supported by divisional offices and sub-divisional offices under the overall guidance and direction of the Superintending Engineer, Irrigation Central Zone (ICZ), Munirabad. The overall responsibility for environmental management and monitoring of the Project will lie with the Executive Engineers at the Divisional level.

**Categorization and Clearances:** The Project categorization has been carried out under the Government of India (GoI) regulations and ADB Safeguard Policy Statement (SPS) 2009. According to Paragraphs 1 and 4, section 2(ii) of the Govt. of India EIA Notification, 2006, modernization of irrigation projects does not require *Prior Environmental Clearance* as they are not new projects listed in Schedule 1; further, they do not contemplate any capacity addition (i.e., addition of command area) or change in process or technology. Hence, the proposed modernization (rehabilitation) of VNC does not attract the provisions of EIA Notification, 2006 and its subsequent amendments.

As per ADB SPS 2009 Environmental Safeguards Policy Principles, it should be noted that Policy Principle No. 8 requires avoiding execution of project activities in areas of critical habitats, unless: (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function; (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated.

A portion of the VNC project is located within the notified OCR and the project activities may likely cause environmental impacts within the OCR during construction. In order to determine the extent of the impacts, a Rapid Biodiversity Assessment (RBA) covering Otters and aquatic animals has been carried out. Based on the assessment, appropriate mitigation measures have been recommended in the RBA report (***Annexure 9***) and incorporated into the design for execution/adoption during construction.

Also, as per ADB SPS 2009, if a project is likely to have significant adverse environmental impacts that are *irreversible, diverse or unprecedented*, the project belongs to Category A, requiring an EIA. Through the mitigation measures that have been incorporated into the design based on the RBA, site-specific impacts to the OCR, limited to the construction period, are *reversible*. Further, these mitigation measures do not impair the ability of the OCR to function during the construction period and beyond, and there will be no reduction in the population of any recognized endangered or critically endangered species. Hence, the project can be executed in full conformity with the ADB SPS 2009 Policy Principles, despite portions of the project being located within the notified OCR.

Since there are portions of the project within the notified OCR the project requires *recommendation* of the National Board for Wildlife (NBWL), Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India through State Board for Wildlife (SBWL) under Wildlife (Protection) Act, 1972. KNNL submitted application to obtain the necessary recommendation from SBWL and NBWL of MoEFCC. Presently, KFD completed field visit to

all of the 9 anicuts located with the OCR. A report is due for submission to State Wild Life Board by KFD.

It should be noted that as per ADB SPS 2009 Environmental Safeguard Policy Principles, Policy Principle No. 11 requires project activities to conserve physical and cultural resources, avoid their destruction or damage, and include a pre-approved management and conservation approach. In this regard, it should be noted that ther are canals under the project within the UNESCO Hampi World Heritage Area (WHA). A drive-through along the length of the canals revealed that over 12 protected monuments are located along the lengths of the three canals. These include 2 Nos. along Anegundi, 1 No. along Raya and 9 Nos. along Turtha Canal. Also, about 19.3 km of the canal sections of Anegundi (8.95 km), Raya (1.23 km), Kalaghatta (0.55 km) and Turtha (8.57 km) are located in the core zone of the Hampi WHA. In addition, about 14.05 km of the canal sections of Anegundi (3.43 km), Raya (8.70 km), Kalaghatta (0.44 km) and Turtha (1.47 km) are located in the buffer zone of the Hampi WHA. Further, about 24.33 km of the canal sections of Anegundi (0.63 km), Raya (5.59 km), Basavanna (8.44 km), Kalaghatta (2.70 km) and Turtha (6.97 km) are located in the peripheral zone of the Hampi WHA. This imposes additional management demand on the Government and other entities to ensure high standards of protection and to comply with the requirements of the World Heritage processes. Accordingly, mitigation measures have been incorporated to ensure that the rehabilitated structures are integrated into the landscape of the heritage area. The measures also pre-empt damage to Hampi WHA resources by adopting a conservation approach approved by the Hampi World Heritage Area Management Authority (HWHAMA). The Authority already issued permission to carry out works within the Hampi WHA along with terms and conditions related to maintenance and protection of the heritage architectures.

**Project Scope:** The scope of VNC modernization includes rehabilitation of the anicuts, canal sections and other appurtenant structures. As per the Detailed Project Report (DPR), there are 12 anicuts and 215.31 km of canals.

The EIA is based on a careful review of the DPR, field visits, secondary data collected to characterize the environment, formal stakeholder and public consultation, and identification of potential impacts. The environmental assessment revealed no significant environmental impacts in the project areas other than those that generally occur during canal rehabilitation works. Major environmental impacts are during the construction stages arising from the establishment of the construction of campsites, material sourcing, and works carried out at the construction sites and closure activities. Additionally, the impacts arising from the locations of the project areas within the notified Otter Conservation Reserve and Hampi World Heritage Area are being considered.

**Baseline Environment:** The VNC System passes through three districts of Karnataka state, viz., Bellary, Koppal and Raichur. A portion of the project falls within the 10 km radius of the OCR notified under the Wildlife (Protection) Act, 1972.

*Air and Noise Quality:* Secondary data on ambient air quality in the project area indicates that air quality is well within the stipulated limits in respect of $SO_2$ and $NO_x$, and particulate matter concentration ($PM_{10}$). As per the advice of the ADB February 2018 Mission, primary air quality data was collected at five project sites-Basavanna canal, Hulugi anicut, Turtha canal, Kalaghatta canal and Anegundi canal. Results indicated that the concentration of the ambient air quality can be termed as “good”. Likewise, primary measurement of noise levels at five locations has also been found to be within the permissible limits.

*Surface Water Quality:* The average annual rainfall in the districts of Bellary, Koppal and Raichur is 611 mm, 572 mm and 376 mm respectively as against the State average of 1355 mm. Based on the primary water quality data collected from 5 project locations and comparison to water quality standards, all canal water samples (except for the Kalaghatta canal water) conform to 'D' criteria, viz., suitable for propagation of wildlife and fisheries. However, the Kalaghatta canal water quality conforms to 'E' criteria. This indicates the effluents inflow into canal from nearby community has affected the canal water quality. In spite of this, the overall quality of the canal water is found to be suitable for irrigation.

*Groundwater Quality:* In Bellary district, the pre-monsoon and post-monsoon groundwater levels lie in the ranges of 1.72-19.48 m bgl (average 4.77 m) and 1.22–17.61 m bgl (average 3.47 m) respectively. In Koppal district, the pre-monsoon groundwater level lies between 4.50-16.5 m bgl and 1.15–16.24 m bgl post-monsoon. In Raichur district, the pre-monsoon groundwater level occurs at 0.65–10.7 m bgl and post-monsoon groundwater level occurs in the range of 0.05–11 m bgl. The groundwater use in the tail-end reaches of the canal is high indicating non-availability of adequate canal supply. Based on the primary groundwater quality data collected from the project locations, it was found that the concentrations of the various parameters are within the range of the Acceptable and Permissible Limits.

The soil cover in the project districts of Bellary, Koppal and Raichur comprises reddish sandy soil, light green loamy soil and reddish-brown soil. While the general soil quality is good, a portion of the soils in the agricultural lands at the head-end of the canals have become saline due in intensive agriculture practices combined with excessive use of fertilizers and pesticides. The noise levels are within permissible limits as majority of the project area is located in a rural environment. The predominant land use in the project area is for agriculture. The three project districts experience an average temperature in the range of 14.1$^0$C during winter and 40.4$^0$C during summer season. While Karnataka State is categorized as moderate to low seismic risk zone, the project districts fall under Zone II (Low Damage Risk zone MSK VI).

**Biological Environment:** The Rapid Biodiversity Assessment documented different wildlife and conditions of the habitat. The Tungabhadra River hosts a range of animals including giant Turtles, Otters, Mugger Crocodiles and species of fishes. Smooth-coated Otter or Indian Smooth-Coated Otters (*Lutrogale perspicillata)* are found along the entire length of the river and in large numbers. Otters breed during late-winter-summer, litter in burrows made under the bushes on the river banks or inside the rocky caves within the river. In addition to smooth-coated Otters, three distinct species of soft-shelled turtles and seven species of fishes are found in the Tungabhadra River. Birds found include paddy bird, kites, sparrow, parakeets, coot, quail, cuckoo, water fowl, kingfisher, jungle dove, crow, pond heron and egrets.

Smooth-Coated Otters is listed as Schedule 1 species under the Indian Wildlife (Protection) Act, 1972 and categorized as Vulnerable (VU) by IUCN. Through the Act of 1972, the river stretches between Old Mudlapur Village (near Tungabhadra Dam) and Kampli Bridge has been notified as an Otter Conservation Reserve in 2015.

The flora in the project area can be characterized as upland thorn and scrub. An assessment of flora, that is, the tree survey, conducted as per the advice of ADB February 2018 Mission indicated the presence of 3,257 trees belonging to 55 species of 28 plant families. The Shannon_H diversity index for this is 2.693, which indicates rich diversity in terms of even distribution of different species in all VNCs. Except Arecaceae family which belongs to Monocotyledons, rest of the species belongs to Eudicots (previously known as dicots). When

the entire VNC system is taken into consideration in terms of species diversity and richness, the Shannon_H index for number of families is 1.89. Of the total 28 families of trees identified, species of each family is also moderately distributed in all the VNCs. Hence the species richness is moderate.

The largest number of the individual plants out of the entire major flora enumerated belongs to Coconut (*Cocos nucifera*), present along the canal. The second largest species distributed in abundance is Teakwood (T*ectona grandis*). A total of 280 trees have been identified in the surveyed 30% length of each of the 16 VNCs. This amounts to 8.60% of all trees enumerated. The indigenous tree Neem or *Azadirachta indica* found to be the 3rd largest tree species growing along the VNCs with 213 individuals (6.54%). This tree species is native to India and most of them grow wild due to seed dispersal by birds. A total of 207 *Eucalyptus (Neelagiri)*, 185 *Prosopis juliflora (Ballari jail),* 161 *Vachelia nilotica (Karijali or babool),* 144 *Borasssus flabellifer (Palmira or Taley mara),* etc. are found to occupy 4th to 7th positions with percentage of occurrences of 6.36%, 5.68%, 4.94%, 4.42% respectively.

**Socio-Economic Environment:** Population residing in the project area is scattered across rural and semi urban areas. According to the 2011 census, population of the three districts, viz., Bellary, Koppal and Raichur was 2.45, 1.39 and 1.93 million respectively with a decadal growth of about 15.6%. The literacy rate of the project area was fifty percent. Male and female literacy rates in the project area are 58.8 percent and 41.2 percent, respectively. Economy is predominantly agrarian-based. The Economic survey of Karnataka 2015-16 reports that population below poverty line is highest in Bellary and Raichur districts. Over the years, the state has made significant progress in poverty reduction due to implementation of various poverty alleviation programmes. Although there has been a decline in the State level poverty ratio, regional disparity within the state still exists.

A Social-Safeguard Due Diligence Study was conducted to make an assessment of: (a) the present status and condition of the channel system; (b) Social risks in anticipation of the proposed modernization (rehabilitation) works in terms of involuntary resettlement issues, and (c) Indigenous people. As part of the due diligence study, the public consultations and the focus group discussions (FGD) indicated the interests of the participants in the project as they expect enhancement of agrarian returns and livelihood stability. Further, they expressed their readiness to actively participate in the implementation of the project and perform their roles and responsibilities. The study found that the project intervention will be limited to the existing RoW and does not involve land acquisition or cause any adverse impacts on people's properties and livelihoods. However, during the civil works execution, there may be some amount of temporary disturbance caused due to excavation and lining works, machinery and equipment, limited access to agricultural land, and plots in the neighbourhood of the construction site. Additionally, a strip map was prepared for each of the canals (kilometre wise) to provide a reasonably good overview of the social and environmental assets along the canal lengths.

**Climate Change:** Major studies on climate change for the region project warming by an increment of above 2.0°C by 2030s for the project districts. As regards to rainfall, for kharif season, the percentage increase in rainfall in the project districts is predicted to be between 0 and 10% during 2021-2050 compared to the baseline 1960-1990. However, for the rabi season, all the project districts are expected to see a decrease in precipitation in the medium-term 2021-2050. The changing rainfall pattern is expected to increase the incidence of drought

in all the project districts in both Kharif and Rabi seasons in the medium-term. Major crops cultivated in the VNC command area are paddy and other grains, sugarcane, banana and other cash crops. These are all water-intensive crops and therefore the increasing water stress resulting from climate change is predicted to have a negative effect on these crops, creating possible changes in the cropping pattern and species cultivated.

**Description of EIA and EMP:** The EIA found that the environmental impacts will be local in nature and will be limited to the project areas. The proposed project will involve modernization (rehabilitation) of the existing systems only. Most the environmental impacts occur only during the construction period and the mitigation measures can be easily implemented as part of the construction works. Most critical environmental impacts occur while carrying out rehabilitation of 9 of the 12 anicuts located in the OCR. Equally important are the impacts occurring while working within the UNESCO recognized Hampi WHA.

Potential negative impacts, though temporary in nature, have been identified in relation to design, construction, operation and maintenance of the VNC system. No adverse environmental impacts have been identified due to the project design and location, however, there are risks and potential impacts within the notified OCR during the anicuts rehabilitation and canals improvement within the Hampi WHA. The EMP has been proposed as part of this EIA for adverse impacts identified during pre-construction, construction and operation phases. The EMP includes: (i) mitigation measures for adverse environmental impacts; (ii) environmental monitoring program, and entities responsible for mitigation, monitoring, and reporting; (iii) public consultation and information disclosure; (iv) EMP budget, and (v) grievance redressal mechanism. Specific measures stated in the EMP will address environmental impacts of the project for the notified OCR and the Hampi WHA and non-sestitve areas. In fact, utmost care should be taken to implement the mitigation activities proposed for work within the OCR and the UNESCO Hampi WHA. Additionally, bidding terms and conditions should ensure that potential contractors have necessary experience in carrying out works in conservation areas and heritage areas. The total cost of implementing the Construciton-Phase Environmental Management Plan for VNC Modernization Project in two packages, (i) OCR and the Hampi WHA and (ii) non-senstitve areas, is estimated to be **INR14.13 Crores (approximately US$ 2.17 Million).**

A positive impact is anticipated in terms of employment opportunity for many skilled, semi-skilled and un-skilled persons during project implementation.

**Consultation, Disclosure and Grievance Redressal:** Over 8 informal and two formal consultations were carried out during the preparation of the project proposal as well as EIA. One of the two formal consultations was held on April 24, 2018 which was attended by various state and central stakeholders including Archaeological Survey of India, Hampi World Heritage Area Management Authority, State Archaeological Department, Karnataka Forest Department, Karnataka State Pollution Control Board and Urban Local Bodies. The second formal public consultation was held on May 29, 2018. A newspaper ad was published and individual letters of invitation sent to all WUCS, farmer associations, NGOs and others. It was attended by a total of 265 persons, out of which 211 were farmers from most of the canals; rest were from KNNL, CADA and other departments and the PSC. The agenda included sharing details of the KISWRMI Program, VNC Packages 1 and 2, explaining about the OCR and the heritage areas, need for revival of all the WUCS through strengthening, and their participation both in the main canal and distributary works, as well as their readiness for taking

up field irrigation channels works, social and environmental safeguards, and the details of Environmental Impact Assessment.

The Gondi modernization and the key achievements both in terms of physical and WUCS, have been shared through videos. This was followed by open house discussions. The consultations revealed that the farmers were eagerly looking forward to the commissioning of the project which has been over-delayed according to them. There was some restlessness among some farmers at the delay. PSC explained the process for this ADB supported project, and the need for a comprehensive approach following global guidelines of ADB and standards of practice. Finally, all the farmers have assured full cooperation for execution of the project. To one query about knowing exact details of work of each canal, PSC has assured them that consultations will be held at each individual canal level prior to start of work and details will be shared. Other suggestions included taking up activities to minimize impact of urbanization on canal water quality, designing sections of the canal to accommodate the rainfall runoff from rocky terrain adjacent to certain canal sections and ensuring that the water and land rights of all farmers are maintained, thereby enhancing agricultural productivity, farmers income levels and conservation of fauna. One farmer expressed concern about ensuring continuous drinking water availability for birds of several species and some animals in the canals. He suggested making small pits without concrete so that birds can dig and take water when the canal dries up. PSC assured to examine this and come up with a technical arrangement. It was announced that a Grievance Redressal Mechanism shall also be established to ensure that public grievances are addressed quickly. A separate report is being prepared in Kannada language. In sum, the public consultation was a success.

**Monitoring and Reporting:** The Project Management Unit (PMU) in the KNNL RO shall be assisted by a Project Support Consultant (PSC). The PMU and PSC will be responsible for EMP implementation. In addition to periodic progress reports, PSC will submit safeguard monitoring reports every six months to KNNL/ADB. The PMU shall review and submit the final reports to ADB.

# 1. INTRODUCTION

## 1.1 Project Background

1. The Karnataka Integrated and Sustainable Water Resources Management Investment Program (KISWRMIP) is being implemented with the assistance of the Asian Development Bank (ADB). The program aims at enhancing water security through modernisation of existing irrigation projects/schemes, improved water resources management and other associated infrastructure activities in select river basins.

2. KISWRMIP is a multi-tranche financing facility (MFF) program of seven years-from 2014 to 2021-initially comprising two Projects with the aim of modernization of irrigation infrastructure on three irrigation subprojects within the Tungabhadra (K-8) sub-basin. Project 1 envisages Modernization (rehabilitation) of Gondi irrigation system whereas Project 2 envisaged Modernization of Vijayanagara and Tungabhadra Left Bank canal systems and the entire associated infrastructure including flow measurement & Telemetry system supply and installation, strengthening asset management and main system operation and maintenance (O&M) and capacity building of WUCS (Water User Cooperative Societies). As per aide memoire of ADB Mission of 12-19 February 2018, Project 2 has been divided into Projects 2 and 3 respectively under Tranches 2 and 3. The multi-tranche facility for the three tranches is expected to close by the year 2024.

3. The Vijayanagara Channel (VNC) System is spread across two states-Karnataka and Andhra Pradesh. The Modernization (Rehabilitation) of the VNC system proposed as part of Project 2 of the KISWRMIP in Karnataka portion is spread across 3 districts, namely, Bellary, Raichur and Koppal. The VNC irrigation channels are run-off-the river channels; they are historically important as they have had been serving the irrigation needs of the local population. They have been built during Vijayanagara dynasty more than 600 years ago. In all, there are 19 Channels taking off from Tungabhadra river of which 18 are in Karnataka and one (in Rampura) flowing to and serving Andhra Pradesh. Of these 18 Channels, Bennur channel is in ruins while Koregal channel command is supplied water from Tungabhadra Left Bank Channel. In view of this, presently, VNC system comprises 16 Channels only having CCA of 11,154 ha and is being taken up for modernization (rehabilitation). The present condition of these channels is generally poor.

4. A reconnaissance survey of the VNC system has revealed that the channels are lined partly with size stone masonry; they have also lost their shape over the years. The bed of the channels is scoured/silted up heavily in some reaches. Heavy weed growth is noticed in and around all the channels. Some of the structures are in a dilapidated condition and are non-functional. Due to heavy seepage and transmission losses, water is not able to reach the tail end areas. The entire system is in urgent need of rehabilitation.

5. To begin with, the Detailed Project Report (DPR) has been prepared, following which the VNC Feasibility Study Report has been finalized to meet with the requirements of Project 2. As part of the Feasibility Study Report, an Initial Environmental Examination (IEE) was performed. Through the screening process, the expected impacts of the Project on all relevant environmental components were identified. It revealed that of the 12 anicuts that regulate flow to the Vijayanagara Irrigation System, 9 (nine) have been built across river Tungabhadra along a stretch that has been notified as an Otter Conservation Reserve (OCR). Following the IEE, Environmental Impact Assessment (EIA) and Rapid Biodiversity

Assessment (RBA) were carried out as per guidance note of ADB Mission 17-24 November 2016 and 12-19 February 2018.

## 1.2 Purpose of the EIA

6. Implementation of modernization of the VNC System would have some environmental impacts during the construction phase of the project. This EIA assesses environmental impacts due to the proposed project and identifies mitigation measures for addressing the same. The mitigation measures relate to location and design, construction, operation, and maintenance. The EIA was based on a review of the project components and reports, field visits and secondary data to characterize the environment and identify potential impacts, and interviews and discussions with stakeholders. Additionally, data obtained through the RBA carried out in the OCR has been utilised to identify impacts and arrive at mitigation measures. An EMP outlining the specific environmental measures to be adhered to during implementation and operation of the project has been prepared and presented.

## 1.3 Extent of the EIA

7. ADB Policy and Indian laws require that the environmental impacts of development projects are identified and assessed as part of the planning and design process, and that action is taken to reduce those impacts to acceptable levels. This is done through the environmental assessment process, which has become an integral part of lending operations and project development and implementation worldwide. Chapter 2 provides an assessment of the Policy and Legal Framework under which the project is being implemented.

## 1.4 Scope of Study and Activities

8. This is the ***EIA report for the project, "Modernization (Rehabilitation) of Vijayanagara Irrigation System".*** The report discusses generic environmental impacts and mitigation measures relating to the location, design, construction and operation of physical works proposed under this project.

9. Data collection reflects the time and resources made available for the assessment. In fact, during the field trips, the PSC team had extensive consultation with local stakeholders and community representatives on environmental issues. Consultations were held in spite of the fact that Section 7(i) III (3)a of EIA Notification 2006 exempts canal rehabilitation projects from holding public consultations.

## 1.5 Report Structure

10. The EIA has been structured as per ADB's Environmental Assessment Guidelines (2003), Government of India's Environmental Impact Assessment Notification (2006) and the guidance note on EIA issued by the ADB Loan Review Missions of November 2016 and February 2018. This report contains nine sections: (1) Introduction; (2) Policy, Legal and Institutional Framework; (3) Description of the Project; (4) Description of the Environment; (5) Alternatives; (6) Anticipated Environmental Impacts and Mitigation measures; (7) Environmental Management Plan; (8) Grievance Redressal Mechanism; (9) Public Consultations and Information Disclosure, and (10) Conclusions.

# 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

## 2.1 ADB Policy

11. All projects implemented by ADB are to comply with the ADB's Safeguard Policy Statement (SPS, 2009). The Bank policy requires consideration of environmental issues in all aspects of the Bank's operations, and requirements for Environmental Assessment as described in its Operations Manual (OM). The SPS states that ADB requires environmental assessment of all project loans, program loans, sector loans, sector development program loans, financial intermediation loans and private sector investment operations. The nature of assessment required for a project depends upon the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost effective mitigation measures. Projects are screened for their adherence to the ADB Policy Principles and expected environmental impacts and are assigned to one of the following four categories:

    a. ***Category A:*** Projects that could have significant environmental impacts that are *irreversible*, *diverse or unprecedented*. An Environmental Impact Assessment (EIA) is required.
    b. ***Category B:*** Projects that could have some adverse environmental impacts, but of less significance than those in Category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not warranted, the IEE is regarded as the final environmental assessment report.
    c. ***Category C:*** Projects unlikely to have adverse environmental impacts. No IEE or EIA is required, although environmental implications are still reviewed.
    d. ***Category F1:*** Projects are classified as category F1 if they involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply for environmental management system, unless all projects result in insignificant impacts.

12. Determination of the environment category is based on the most environmentally sensitive component of the project. In the VNC project, this component comprises rehabilitation of 9 of the 12 anicuts located in the Otter Conservation Reserve under the Wildlife (Protection) Act, 1972. These anicuts are: *Bella, Turtha, Ramasagara, Kampli, Hulugi, Shivpura, Anegundi, Upper Gangavathi and Lower Gangavathi.*

13. Details related to the determination of the project category as per ADB Safeguard Policy Statement (2009) are given below.

    - As per ADB SPS 2009 Environmental Safeguard Policy Principles, it should be noted that Policy Principle No. 8 requires avoiding implementation of project activities in areas of critical habitats, unless: (i) there are no measurable adverse impacts on the critical habitat that could impair its ability to function; (ii) there is no reduction in the population of any recognized endangered or critically endangered species, and (iii) any lesser impacts are mitigated. A portion of the VNC project is located within the notified Otter Conservation Reserve (OCR) and the project activities cause adverse environmental impacts within the OCR during the construction period. In order to determine the extent of the impacts and design appropriate mitigation measures, a Rapid Biodiversity Assessment (RBA) was carried out. Accordingly, mitigation measures have been incorporated into the design for implementation during construction. Also, for works

within the OCR, the project seeks *recommendation* of the National Board for Wildlife (NBWL), MoEFCC, and Government of India through State Board for Wildlife (SBWL) under Wildlife (Protection) Act, 1972. Towards this, KNNL has already submitted application online to the MoEFCC for obtaining necessary approval/ recommendation from SBWL and NBWL of MoEFCC.

- As explained in the foregoing, as per para 50 of the ADB SPS 2009, to be classified as Category A, the project should likely have significant adverse environmental impacts that are *irreversible*, *diverse or unprecedented*. And that these impacts may affect an area larger than the sites or facilities subject to physical works. In that case, an EIA is required. In the VNC Project, the impact of rehabilitation of the anicuts located within the OCR affects less than 5% of the total area notified as an OCR. And, these impacts are *reversible*; i.e., the Otters and other aquatic species would come back to their habitats near the anicuts once the rehabilitation is completed. Also, the impacts are routine and not diverse and/ or unprecedented, as well. Moreover, KNNL is implementing the mitigation measures within the OCR (suggested in the EIA and RBA), including but not limited to construction of secondary ring bunds to create alternate habitation areas for Otters and other aquatic species within the OCR during the construction phase, scheduling construction only between 9 am and 5 pm during December and June every execution period, and selecting contractors who agree to scrupulously follow the guidelines specified in the Bid Document as well as in the VNC FSR. Most importantly, once rehabilitation of the anicuts is completed, Otters and other aquatic animals shall have a more congenial, favourable environment than existing at present, for thriving in the region with year-round storage water available, among other benefits.
- Also, these mitigation measures do not impair the ability of the OCR to function during the construction period and beyond and there will be no reduction in the population of any recognized endangered or critically endangered species. Since the impacts can be mitigated, the project can be implemented as per the ADB SPS 2009 Environmental Safeguards Policy Principles despite a portion of the project located within the notified OCR.
- Also, as per ADB SPS 2009 Environmental Safeguards Policy Principles, it should be noted that Policy Principle No. 11 requires project activities to conserve physical cultural resources and avoid destroying or damaging them and include a pre-approved management and conservation approach. In this regard, it should be noted that a portion of the project is located within the UNESCO Hampi WHA. Accordingly, mitigation measures have been incorporated such that the rehabilitated structures are integrated into the landscape of the heritage area and avoid destroying or damaging the Hampi WHA resources and adopt a conservation approach that is approved by the Hampi World Heritage Area Management Authority (HWHAMA).
- As explained above, a portion of the project area fall within the notified OCR and hence the Modernization (rehabilitation) of the VNC project is categorized as an ADB Category A Project.
- As per the ADB Review and Approval procedures for Category A projects deemed environmentally sensitive, EIA must be cleared by ADB before project approval. The EIA must be disclosed to the public at least 120 days before the project is approved. For these projects, ADB will review compliance with ADB environmental assessment requirements, including those related to consultation and information disclosure.

Completed report is made available worldwide by ADB, via the depository library system and the ADB website.

## 2.2 National Legal Framework

14. The Environmental Impact Assessment (EIA) Notification, 2006 (and its subsequent amendments till date) by the MoEFCC, GoI specifies mandatory environmental clearance requirements. All projects/ activities are broadly categorized into Category A and Category B for mandatory environmental clearance requirements based on the spatial extent of potential impacts and potential impacts on human health and natural and man-made resources. Projects included as Category A in the Schedule require prior environmental clearance from the MoEFCC, GoI whereas projects included as Category B in the Schedule require prior environmental clearance from the SEIAA. Any project specified in Category B will be treated as Category A, if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972; (ii) critically polluted areas as notified by the Central Pollution Control Board from time to time; (iii) notified eco-sensitive areas, and (iv) inter-state boundaries and international boundaries.

15. The proposed VNC project is screened for Environmental Regulatory Compliance as given in **Table 1**:

**Table 1: Indian Environmental Regulatory Compliance**

| Regulation | Applicability of Acts/Guidelines | Compliance Criteria |
|---|---|---|
| Water (Prevention and Control of Pollution) Act, 1974, Amendment 1988 and thereafter | This Act provides for Prevention & Control of Water Pollution by abating discharge of untreated trade and domestic effluents by industries and local bodies, maintaining or restoring wholesomeness of water in river, streams and ground water. Water Act also provides penalties. | Irrigation projects are not covered under KSPCB consent mechanism. However, contractors shall obtain due Consent for Operation (CFO) for labour camps. |
| Water (Prevention and Control of Pollution) Cess Act, 1977, Amendments 1992 and 2003. | This Act empowers the State Pollution Control Board (SPCB) constituted under the Water Act to collect cess on the basis of water consumed by persons carrying on certain industries and by local authorities, with a view to augment the resources of the Central Pollution Control Board (CPCB) and the SPCB for the prevention and control of water pollution. | Irrigation projects are not covered under KSPCB consent mechanism. However, contractors shall duly obtain the Consent for Operation (CFO) for labour camps. |
| Air (Prevention and Control of Pollution) Act, 1981 | This Act provides for Prevention & Control of Air Pollution from industrial plants and improvement in the quality of air. It empowers SPCB to lay down standards in consultation with CPCB having regard to the standards for quality of the air laid down by the CPCB, standards for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into the atmosphere from any source whatsoever other than ship or an aircraft. | Irrigation projects are not covered under KSPCB consent mechanism. However, contractors shall obtain Consent for Operation for operation for DG sets. |
| Environment (Protection) Act, 1986 and rules/ notifications framed under it | This is an umbrella Act concerning protection and improvement of environment and prevention of hazards to human beings, other living creatures, plant and property. The Act provides for laying down standards for the quality of environment in its various aspects, standards for emission or discharge of environmental pollutants from various sources whatsoever, having regard to the quality and composition of the emission or discharge of environmental pollutants from point sources. | |
| Indian Standards 2720 | With a view of establishing uniform procedures for the determination of different characteristics of soils and also for facilitating a comparative study of the results. | The parameters such as (i) pH, (ii) permeability, (iii) Organic Carbon, (iv) Organic Matter and (v) moisture content necessary for the soil (silt/sediment) characterization, mainly from the safety assessment considerations prior to constructions, are determined based on standrads outlined in IS: 2720. |
| Indian Standard 14767 2000 | This standard specifies an instrumental method for the routine determination of the specific electrical conductivity in an aqueous extract of soil. | The electrical conductivity of water extract of soil is proportional to its salt concentration |
| **Rules under EPA, 1986** | | |
| Hazardous Waste (Management, Handling, Trans-boundary Movement) Rules, 2008 | One of the main features of this Rule is that the occupier of the activities generating hazardous wastes or handling the hazardous wastes becomes legally responsible for taking all practical steps to ensure that such wastes are properly handled, labelled, stored and disposed of without any adverse impact on the environment. This Rule also regulates the import and export of hazardous waste. | Not applicable to the project |

| Regulation | Applicability of Acts/Guidelines | Compliance Criteria |
|---|---|---|
| Manufacture, Storage and Import of Hazardous Chemical Rules (2000) | This Rule provides the SPCBs and certain other Government Departments with necessary powers that hazardous chemicals covered in the Rules (above threshold limits) are imported, stored, transported and/or used in an environmentally safe manner. This rule provides legal provisions for safe handling of various hazardous chemicals with an overall objective to minimize the chemical accidents by taking adequate on-site and off-site measures. | Contractor should ensure that any hazardous chemicals used in the construction activity are managed in a safe and environmental-friendly manner as per the applicable rules under this act. |
| Plastic Waste (Management and Handling) Rules, 2011; Amendment 2016 | This Rule provides for regulating the manufacture of carry bags, stocking, distribution, sale, use of carry bags and sachets, regulation of manufacturers & recyclers. The Rule provides for environmental-friendly Plastic Waste Management. The Rule has also fixed the responsibility of producer or manufacture of plastic carry bags and multi-layered plastic pouches or packages for the environmentally sound management of the product until the end of its life. Municipal Authorities and Gram Panchayats are vested with the responsibility of enforcement of the provisions of this Rule while the SPCB role is related to issue of authorization to manufacturers, recyclers and disposal. The Generator is responsible for segregating the plastic waste and handing over the plastic waste to the ULB or GP, as appropriate. | Contractor should ensure that plastic waste generation at construction campsites and workers' camps is minimised, those that are generated should be segregated from other types of waste and dispose it in an environmental-friendly manner as directed by the ULB or GP, as appropriate. |
| Municipal Solid Waste (Management and Handling) Rules, 2000 | This Rule places responsibility on the municipal authority within their jurisdiction for the implementation of the provisions of this Rule, and for any infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid waste. The District Magistrate or Deputy Commissioner of concerned district is responsible for. The role of SPCB is to grant authorization for the setting-up of land fill facilities and to monitor the ground water, ambient air, leachate and compost quality. | Contractor should ensure that the solid waste generation at construction campsites and workers' camps is minimised, those that are generated should be segregated and dispose it in an environmental-friendly manner as directed by the ULB or GP, as appropriate. Further, the biodegradable waste should be composted and the compost utilised appropriately. |
| Construction and Demolition Waste Management Rules 2016 | The rules shall apply to every waste resulting from construction, re-modelling, repair and demolition of any civil structure of individual or organization or authority who generates construction and demolition waste such as building materials, debris and rubble. The rules require the generator to segregate the C&D Waste, develop a C&D Waste Management Plan and obtain approval from the ULB / GP prior to start of the construction activity. | Contractor should prepare the C&D Waste Management Plan, obtain approval from local authority such as ULB or GP and manage the C&D waste in an environmentally friendly manner. |
| Noise Pollution (Regulation and Control) Rules, 2000 and Amendment 2002 and 2006 | This Rule provides for abatement of noise pollution from the sources like industrial activity, construction activity, generator sets, loud speakers, public address systems, music systems, vehicular horns, and fire crackers other mechanical devices which have deleterious effects on human health and the psychological well-being of the people. This Rule regulates and restricts the use of loud speakers/public address system. The authority for enforcement is District | Monitoring to be done during construction phase of the project. |

| Regulation | Applicability of Acts/Guidelines | Compliance Criteria |
|---|---|---|
| | Magistrate, Police Commissioner, or any other officer not below the rank of the Deputy Superintendent of Police. | |
| Batteries (Management and Handling) Rules, 2001; Amendment 2010 | This Rule applies to every manufacturer, importer, re-conditioner, assembler, dealer auctioneer, consumer and bulk consumer involved in the manufacture, processing, sale, purchase and use of batteries or components thereof. It mandates the consumer to ensure that the used batteries are not disposed of in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler or at designated collection centres. | Not applicable for the project |
| Rules for manufacture, use, import, export and storage of Hazardous micro-organism, genetically engineered organisms or cells, 1989 | This Rule empowers the MOEFCC to regulate the activities involving license to manufacture, import and export of micro-organism and genetically modified organisms. For the implementation at the state level, State Bio-technology Committee and District level Bio-technology Committee have been set-up. | Not applicable for this project |
| E-Waste (Mgt. and Handling) Rules, 2011 | These Rules shall apply to every producer, consumer or bulk consumer involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components, collection centre, dismantler and recycler of e-waste. | Not applicable to this project. |
| Environmental Impact Assessment (EIA) Notification, 2006 | The EIA Notification 2006 is the replacement of the 1994 Notification. Activities covered under this Notification are grouped as Category A & B. Category 'A' requires prior environmental clearance from the MoEFCC, GoI; Category 'B' needs prior environmental clearance from the State Level EIA. | As per conditions specified in the EIA Notification 2006, prior environmental clearance is not required for the Modernization (Rehabilitation) of the VNC System because of the following reasons: |
| | Also, as per EIA Notification 2006, prior environmental clearance is required for the following conditions: | i. All new projects or activities listed in the schedule to the notification – In this regard, it should be noted that the Modernization of the VNC System is not a new project or part of the activities listed in the schedule to the notification. Hence, Prior Environmental Clearance is not applicable as per this condition. |
| | (i) All new projects or activities listed in the schedule to the notification | ii. Expansion or modernization of existing projects or activities listed in schedule of the notification with addition of capacity beyond the limits specified for concerned sector. In this regard, it should be noted that the Modernization of VNC System project does not result in addition of command area beyond what is existing in the project. Hence, Prior Environmental Clearance is not applicable as per condition, as well. |

| Regulation | Applicability of Acts/Guidelines | Compliance Criteria |
|---|---|---|
| | (ii) Expansion or modernization of existing projects or activities listed in schedule of the notification with addition of capacity beyond the limits specified for the concerned sector. | iii. Any change in the product mix in an existing manufacturing unit included in the Schedule beyond the specified range: In this regard, it should be noted that the Modernization of VNC System project is not manufacturing unit. Hence, Prior Environmental Clearance is not applicable as per this condition, as well. |
| | (iii) Any change in the product mix in an existing manufacturing unit included in schedule beyond the specified range | |
| Wildlife (Protection) Act, 1972, amended in 2003 and 2006, | This act provides for protection and management of Protected Areas. | Two notified protected areas i.e., Daroji Bear Sanctuary and the Otter Conservation Reserve are located in the region. |
| | | The Daroji Bear Sanctuary is located beyond 10 km radius and hence does not attract need for obtaining any additional clearances from any of the state or central agencies. |
| | | However, a portion of the project, especially 9 of the 12 anicuts are located in the Otter Conservation Reserve along the stretch of the River Tungabhadra River. Hence, as per the ADB requirements on such sensitive environmental impacts, a Rapid Biodiversity Assessment has been conducted and mitigation measures being identified and incorporated into the Environmental Management Plan. Also, as required under this Act, *recommendation* of the National Board for Wildlife (NBWL), MoEFCC, GoI, through State Board for Wildlife (SBWL) is being sought for carrying out works within the OCR. |
| Forest (Conservation) Act, 1980 | This act provides guidelines for conservation of forests and diversion of forest land for non-forest use and requires project proponents to obtain clearance prior to use of such forest areas for project activities. | This is not applicable as no forest areas are utilised for implementing the various components of the project. |
| Central Water Commission | The Authority to approve all technical aspects of tcanal modernization project | KNNL has to obtain NOC from the Central Water Commission. |
| UNESCO Heritage Site | As portion of the canal passes through the UNESCO recognized Hampi World Heritage Area, additional requirement emerges. | KNNL has to obtain NOC from the HWHAMA for works carried out within the heritage area (permission received). |
| APHA 23rd Edition 4500 CN | Dregded silt with the contamination and exceeds the limits of this regulation will be disposed in a landfill. | Range of cyanide in silt samples should be within 0.02-0.2 mg /L. |
| USEPA 3050B | There could be heavy metals in dredged silt such as Zinc, Chromium, Aluminum, Copper, Iron and Manganese. | Sets the method how to determine the type and amount of heavy metals in the dredge sediment/silt in the canals |

Note: *1: Anicuts falling in Otter Conserve Reserve are: Bella, Turtha, Ramasagara, Kampli, Hulugi, Shivpura, Anegundi, Upper Gangavathi and Lower Gangavathi.*
*2: Turtha anicut and Turtha canal come under Hampi Heritage Area.*

16. As per the analysis of environmental regulatory compliance provided in ***Table 1,*** Modernization (rehabilitation) of VNC Project does not require Prior Environmental Clearance either from the Ministry of Environment, Forests and Climate Change (applicable for Category A projects as per MoEFCC notification) or from the State Environmental Impact Assessment Authority (applicable for Category B projects as per MoEFCC notification) because canal rehabilitation projects do not attract the provisions of the EIA Notification that mandates obtaining Prior Environmental Clearance. In this regard, it is reiterated that though the project is titled "Modernization" of the VNC Project, it involves only "rehabilitation" of the anicuts, canals and appurtenant structures.

17. However, the project shall require *recommendation* of the National Board for Wildlife (NBWL), Ministry of Environment, Forests and Climate Change, Government of India through State Board for Wildlife (SBWL), Karnataka Forest Department for the portion of the work to be carried out in the notified OCR.

## 2.3 Overall Institutional Framework

18. The overall Institutional Framework proposed for the VNC project is as follows:

19. The ***Project Steering Committee (SC)*** headed by Chief Secretary of the State and comprising representatives from all relevant departments, will provide policy direction and strategic guidance on matters related to IWRM in Karnataka.

20. The ***Programme Coordination Committee (PCC)*** chaired by Principal Secretary, Water Resources Department (WRD), comprising representatives from concerned departments, will be responsible for coordination and project implementation including environment-related aspects.

21. The ***Executing Agency (EA)*** will be Karnataka Neeravari Nigam Limited (KNNL), Regional Office, Bangalore. The Managing Director, Karnataka Neeravari Nigam Limited (KNNL), who will also be the Project Director, shall be responsible for successful implementation and achievement of the project goals. The EA shall be assisted by the *Project Support Consultant (PSC)* recruited for the purpose.

22. The *Executing Agency* shall have the following roles and responsibilities: (i) The EA will be responsible for timely and smooth execution of the Project and reporting to the committees and ADB; (ii) engage adequate permanent or fixed-term staff to implement the Project; (iii) setup a state-level dedicated project management unit (PMU), and a Project Implementation Office (PIO) at ICZ Munirabad, and (iv) provide overall strategic guidance on technical supervision and project implementation.

23. The ***Project Support Consultant (PSC)*** for VNC sub project will support implementation of Outputs 2 and 3 and coordinate on relevant aspects of Output 1 for IWRM. The PSC will provide: close support to PMU and PIOs for all aspects of Program implementation; capacity building and strengthening of relevant institutions such as PIO and WUCS; monitoring institutional processes and arrangements, and support to monitoring and quality assurance for construction works for VNC subproject; coordination with relevant agencies and other consulting services; required support and technical expertise to the PMU for WUCS CAD activities; planning and coordination for facilitating project designs for Tungabhadra Left Bank Canal project, preparation of relevant feasibility reports, and required support and technical expertise to the PMU program performance management systems including

establishment and use of management information systems (MIS) database for planning and reporting, preparation of inception and periodic progress reports.

### 2.3.1 Project Level Institutional Framework

24. The Executing Agency KNNL Bangalore shall be supported by a Project Management Unit (PMU) headed by a full-time senior engineer not less than the rank of a Superintending Engineer for effective implementation of this project.

25. The ***Project Management Unit*** shall be responsible for: (i) project planning and budgeting; (ii) reviewing project and coordinating with VNC project-specific Project Support Consultants (PSC) and satisfy ADB's due diligence requirements; (iii) bidding, evaluation and contract award to select the contractors; (iv) managing and disbursing funds; (v) reviewing compliance with loan covenants, contract specifications, work plans and quality control; (vi) consolidating and submitting progress reports, finance and accounting/audit reports, and (vii) facilitating decisions within KNNL, WRD and coordinating with the financing agency. In addition to providing technical backstopping and coordination, the PMU shall also liaise with concerned state agencies on environmental management aspects. For this purpose, PMU may have to depute/hire social safeguard and environmental experts. Additionally, the services of a Biodiversity/Ecology Expert experienced with carrying out works in the heritage conservation areas and notified Otter Conservation Reserve also needs to be deputed/hired. The services of a Heritage Expert also need to be ensured especially when execution of works in the UNESCO Hampi Heritage Areas is scheduled.

26. The Executing Agency shall establish a ***Project Implementation Office*** (PIO) at the Zonal Level (Irrigation Central Zone, Munirabad) headed by the Chief Engineer who shall ensure execution of implementation plans approved by PMU. The PIO shall be supported by divisional offices and sub-divisional offices under the overall guidance and direction of the Superintending Engineer, ICZ Munirabad. The overall responsibility for the environmental management and monitoring for the Project will be with the Executive Engineers at the Divisional Level. Presence of an Executive Engineer with environmental management experience and Environmental Scientist will be an advantage. He / She may however be assisted by consultants hired by PMU. The EE will monitor, support, and guide operation of the Environmental Management Plan implemented through the designated organizations and contractors. To effectively manage environmental issues, KNNL's divisional staff and consultants will establish a coordination mechanism and ensure that EMP has been duly incorporated in the periodic activity plans. An environmental officer will be placed in the sub-division office to monitor and support the concerned mitigation activities and relevant indicators, with the assistance of the environmental team of the PSC.

27. KNNL shall appoint ***Project Support Consultants*** (PSC) for VNC who would be providing support to the PMU and PIO in effective monitoring and implementation project. Environmental Team members of the PSC consisting of Environmental Expert, Biodiversity Expert and Heritage Area Expert will support the PIO in coordination and monitoring and ensuring compliance with regard to environmental requirements. They will also help address implementation bottlenecks related to environment. The Terms of Reference of the Biodiversity Expert and the Cultural Heritage Area Expert is provided in the ***Annexure 8***.

28. The Project envisages management transfer of localized water management infrastructure within the command area to the ***Water Users Cooperative Societies*** (WUCS) after

modernization works are completed. The WUCS shall be provided necessary awareness and training to manage these assets sustainably. EMP activities associated with the infrastructure will be undertaken by the concerned WUCS during the O&M phase, with monitoring and support by the KNNL sub-division and Command Area Development Authority (CADA) sub-division.

# 3. DESCRIPTION OF THE PROJECT

## 3.1 Project Rationale

29. The Karnataka Integrated and Sustainable Water Resources Management Investment Program (KISWRMIP) aims to manage and sustain the increasingly scarce water resources in the selected water scarce river basins in the state. It aims to establish and strengthen state and basin level institutions, adopting the principle of integrated water resources management (IWRM) in the Tungabhadra sub-basin (of the Krishna basin). With agriculture utilizing over 80% of the State's water resources, investment support is being provided for sub-basin-wise planning to modernize and improve irrigation service delivery while strengthening relevant institutions–state departments and irrigation Water Users Cooperative Societies (WUCS). Accordingly, irrigation service delivery improvements are being undertaken for the Vijayanagar Channel (VNC) System through improved sub-basin and basin planning, and monitoring based on an IWRM roadmap. As a result of modernization (rehabilitation) of the VNC System, water management will improve and utilization of the water resource optimized in the VNC system whose overall efficiency has decreased over the years (presently 30-50%).

30. The project aims to:

- Enhance access to and security of water supply in the Tungabhadra sub-basins;
- Improve access to irrigation;
- Increase farm incomes and improve water management;
- Provide defined bulk water deliveries for major water users, including drought water management;
- Implement water monitoring systems;
- Improve productivity of water, and
- Promote irrigation management by WUCS with improved service quality for users.

31. The economic rationale for the Project is that introduction of river basin planning and volumetric monitoring of water flows in the sub-basin shall contribute to better understanding of the resource availability, efficient utilization and agriculture water productivity by increasing net benefits per unit of water. Simultaneously, the Water User Cooperative Societies (WUCS) will be strengthened to function as efficient, robust and competent organisations; through them, sustainable agricultural practices will be introduced so that farmers can achieve *"more crop per drop"*.

## 3.2 Description of the Existing VNC System

32. The technical aspects of the description of the existing VNC system including the proposed engineering improvements and the cost estimates have been taken from the Feasibility Study Report. In all, there are 19 Channels fed from Tungabhadra River. Eighteen (18) of these are in Karnataka and one is in Andhra Pradesh. During Vijayanagara dynasty, 18 channel networks (***Table 2***) were constructed in the reach from Tungabhadra Dam to Siruguppa.

**Table 2: Channels of Vijayanagara Irrigation System**

| A. On Right Bank of TB River | B. On Left Bank of TB River |
|---|---|
| 1. Raya | **11.Koregal** *(served by TLBC)* |
| 2. Basavanna | 12.Hulugi |
| 3. Bella | 13.Shivapura |
| 4. Kalaghatta | 14.Anegundi |
| 5. Turtha | 15.Upper Gangavathi |
| 6. Ramasagara | 16.Lower Gangavathi |
| 7. Kampli | 17.Bichal |
| 8. Belagodahala | **18.Bennur** *(out of operation)* |
| 9. Deshnur | |
| 10. Siruguppa | |

33. Of these eighteen Channels, Bennur Channel is out of operation due to lack of maintenance, while Koregal Channel command area is catered to by the Tungabhadra Left Bank Channel. In view of this, presently, Vijayanagara Channel system consists of 16 channels. The current modernization project deals with rehabilitation of these 16 channels and the appurtenant structures.

34. The Raya and Basavanna channels are located on the right bank of the Tungabhadra River and are directly fed by the Tungabhadra (TB) Dam through a sluice gate. Raya channel takes off directly from the TB dam while Basavanna channel takes off from Raya channel at 0.20 km chainage. All other channels, except Kalaghatta and Belagodhalla, take off from their respective anicuts constructed across Tungabhadra River at various locations downstream of TB Dam. These anicuts were constructed using huge boulders set in a zigzag manner. In view of this, the anicuts are subject to leakages exacerbated by the displacement of boulders during high floods. Over a period of time, the system has deteriorated, and is in dire need of improvements. There has been a long-standing demand for improvements to these anicuts from the local farmers.

35. Details of the VNC System are given in ***Table 3*** Irrigation schemes comprising seventeen (17) anicuts across Tungabhadra River, together known as Vijayanagara Channels. Out of these, Vallabhapur and Hosakote anicuts were submerged in the backwaters of Tungabhadra reservoir. In order to cater to the command of Vallabhapur and Hosakote anicuts, one vent of size 1.8 m x 3.6 m was constructed in the Tungabhadra Dam as a permanent sluice and these commands are fed through Raya and Basavanna channels.

36. The GPS coordinates of the canals and the anicuts are provided in ***Table 3.***

**Table 3: Details of the VNC**

| S. No. | Name of the Canal | Name of the Corresponding Anicut | GPS Coordinates | | | Length of the Canal (km) |
|---|---|---|---|---|---|---|
| | | | Anicut | Canal Head-end | Canal Tail-end | |
| | **Kamalapura Sub-Division (Right Bank)** | | | | | |
| 1 | Basavanna | Not Applicable | NA | 15°15'51.89"N 76°20'43.08"E | 15°16'38.28"N 76°27'45.91"E | 16.50 |
| 2 | Raya | Not Applicable | NA | 15°15'52.75"N 76°20'42.19"E | 15°17'56.59"N 76°26'47.13"E | 27.74 |
| 3 | Bella | Hosur | 15°17'15.90"N 76°20'54.90"E | 15°17'17.56"N 76°20'59.82"E | 15°19'12.05"N 76°22'38.96"E | 5.50 |
| 4 | Kalaghatta | Not Applicable | NA | 15°18'55.54"N 76°22'49.12"E | 15°19'16.91"N 76°25'40.84"E | 7.02 |
| 5 | Turtha | Turtha | 15°19'53.94"N 76°26'3.84"E | 15°19'50.04"N 76°26'6.00"E | 15°22'7.67"N 76°31'59.23"E | 18.69 |
| 6 | Ramasagara | Ramasagara | 15°22'4.30"N 76°31'31.64"E | 15°22'4.33"N 76°31'48.46"E | 15°23'53.66"N 76°36'9.59"E | 15.50 |
| 7 | Kampli | Kampli | 15°23'5.46"N 76°32'55.58"E | 15°23'18.67"N 76°33'12.26"E | 15°26'12.52"N 76°38'51.33"E | 23.55 |
| 8 | Belagodahalla | Not Applicable | NA | 15°23'31.04"N 76°34'11.71"E | 15°26'10.12"N 76°37'17.31"E | 11.22 |
| | **Oddarahatti Division (Left Bank)** | | | | | |
| 9 | Anegundi | Sanapura | 15°20'46.87"N 76°26'1.55"E | 15°20'47.68"N 76°26'7.23"E | 15°23'36.34"N 76°31'43.36"E | 19.44 |
| 10 | Shivapura | Shivapura | 15°20'5.10"N 76°21'39.23"E | 15°20'8.10"N 76°21'50.45"E | 15°20'8.31"N 76°24'26.93"E | 6.54 |
| 11 | Hulugi | Hulugi | 15°17'30.32"N 76°20'17.69"E | 15°17'34.78"N 76°20'24.86"E | 15°20'27.83"N 76°21'42.06"E | 10.69 |
| 12 | Upper Gangavathi | Upper Gangavathi | 15°22'38.34"N 76°31'50.50"E | 15°22'47.66"N 76°32'1.62"E | 15°25'25.26"N 76°33'5.47"E | 9.00 |
| 13 | Lower Gangavathi | Lower Gangavathi | 15°23'23.70"N 76°32'52.13"E | 15°23'33.20"N 76°32'48.90"E | 15°25'44.16"N 76°35'36.11"E | 9.54 |
| | **Siruguppa Sub-Division (Right Bank)** | | | | | |
| 14 | Siruguppa | Siruguppa | 15°36'51.88"N 76°50'24.61"E | 15°36'58.36"N 76°50'24.52"E | 15°39'2.04"N 76°53'37.06"E | 10.85 |
| 15 | Deshnur | Deshnur | 15°37'6.20"N 76°50'16.97"E | 15°37'17.06"N 76°50'19.28"E | 15°40'43.86"N 76°53'24.35"E | 9.03 |
| | **Manvi Sub-Division (Left Bank)** | | | | | |
| 16 | Bichal | Jukur | 15°57'33.24"N 77°13'41.18"E | 15°57'39.67"N 77°13'45.60"E | 15°57'29.05"N 77°20'53.44"E | 14.50 |

37. The location of the canals on a Topography Map is provided in the following three figures:

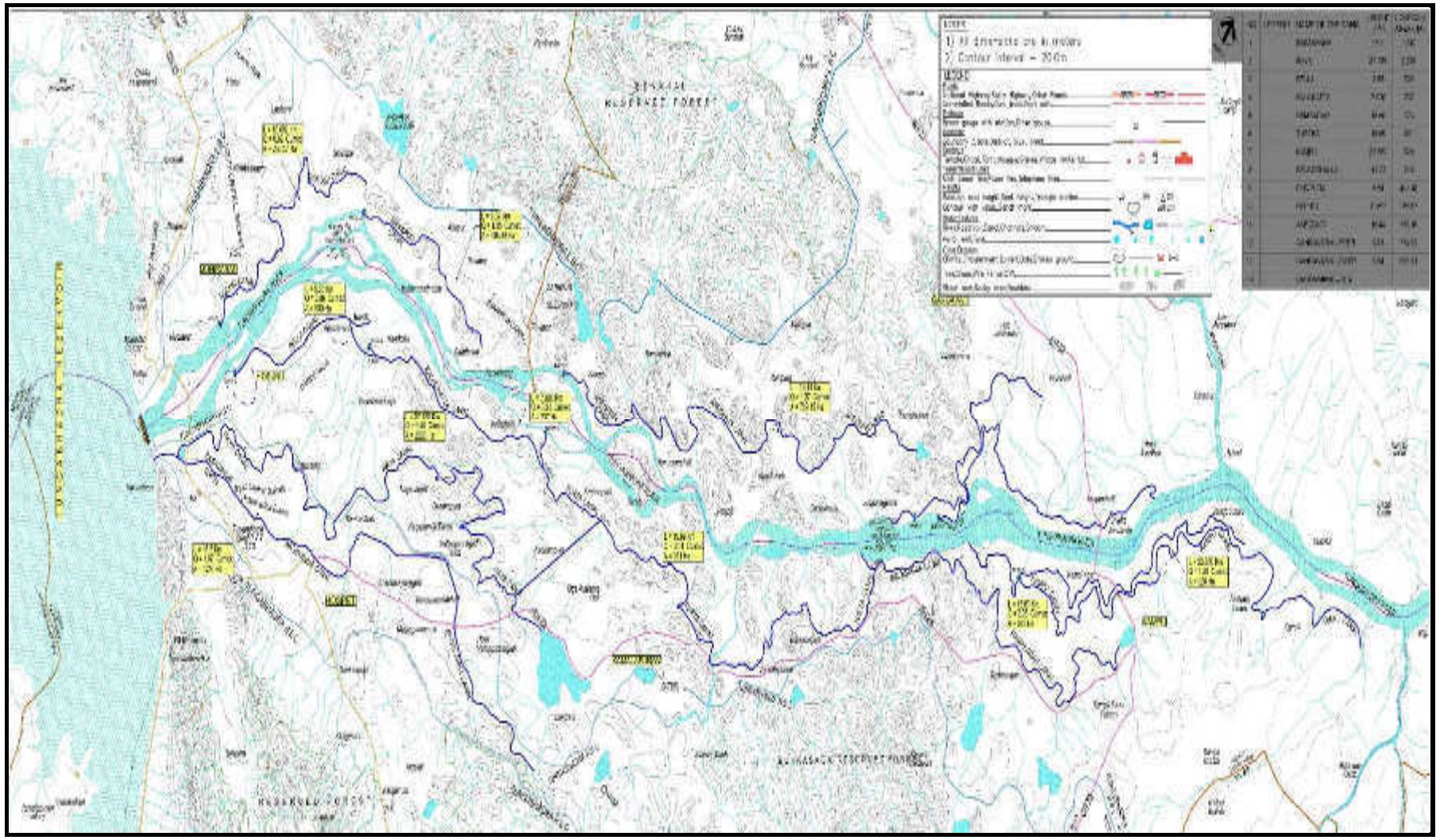


**Figure 1: Vijayanagara Channel System**

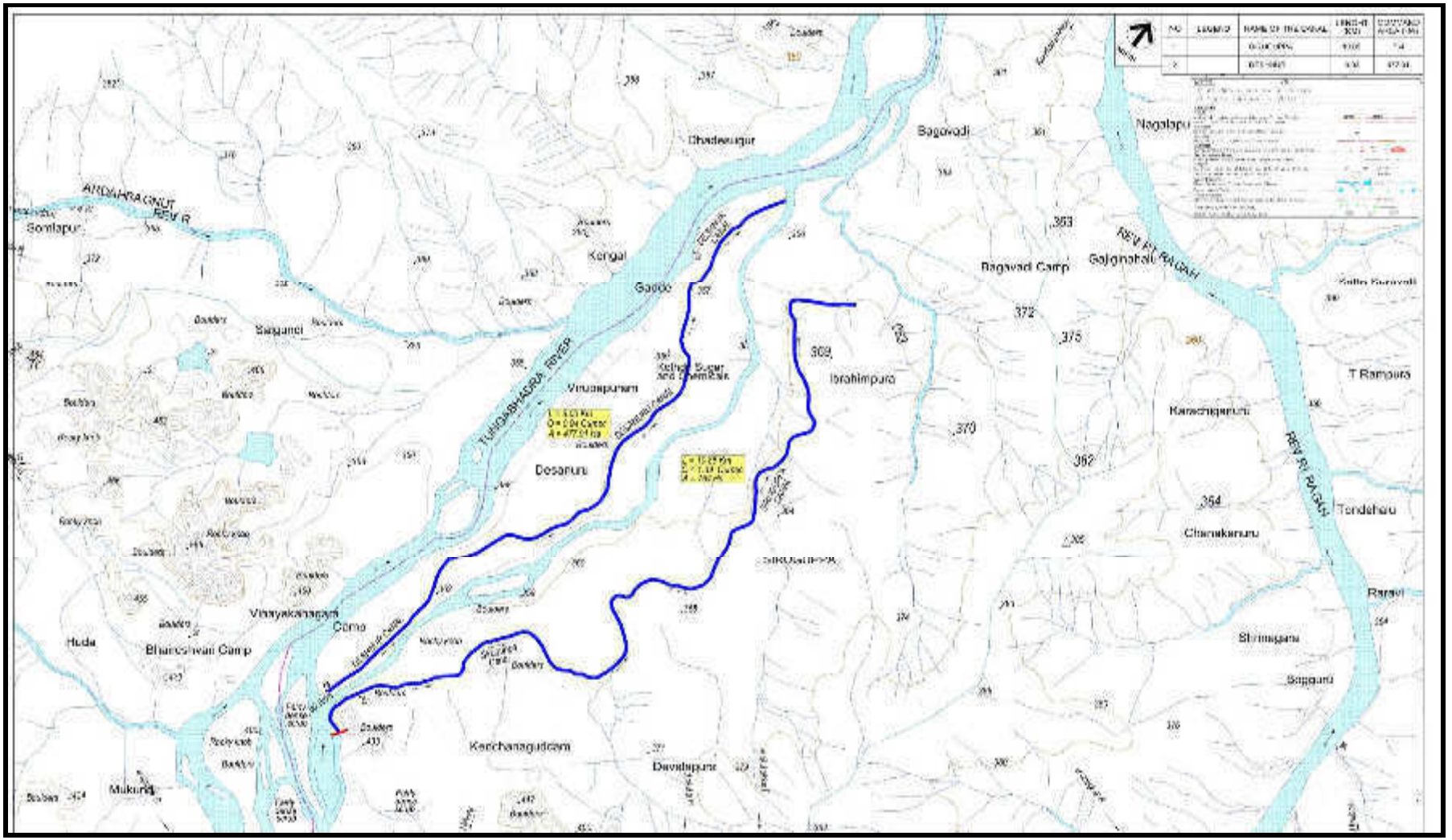



**Figure 2: Vijayanagara Channel System (Siruguppa and Deshnur Channels)**

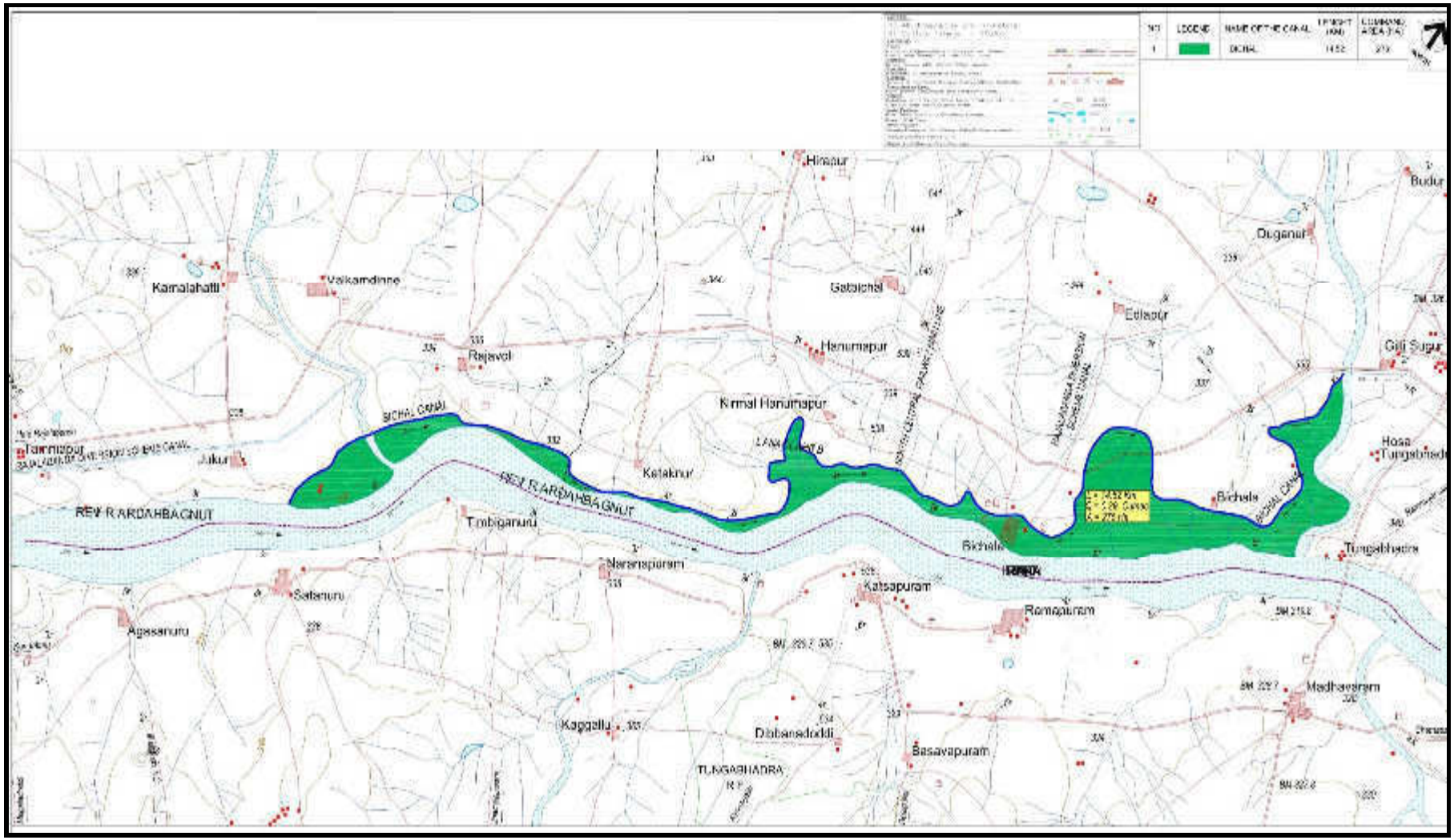



**Figure 3: Vijayanagara Channel System (Bichal Channel)**

## 3.3 Project Location and Layout

38. Execution of the modernization of VNC Project is across three districts, viz., Bellary, Koppal and Raichur of Karnataka. A portion of the project passes through the UNESCO recognized Hampi WHA. Also, certain components of the project are located in the notified OCR along River Tungabhadra.

### 3.3.1 Hampi World Heritage Area

39. United Nations Educational, Scientific and Cultural Organization (UNESCO) decided to consider the Group of Monuments in Hampi as a World Heritage Site in October 1986. A Hampi World Heritage Area Management Authority (HWHAMA) has been formed to manage the heritage area.

40. The Hampi World Heritage Area (Hampi WHA) is spread over two districts in Karnataka. More precisely, Hampi is located between 15°20'12" N latitude and 76°27'32" E longitude and is divided by the River Tungabhadra into two parts. One part is located in Gangavathi Taluk in Koppal District and the other part is located in Hospet Taluk in Bellary District. The Hampi WHA (see map below) comprises three zones; the core, buffer and the peripheral. The 'Core Zone' extends 41.8 sq.km and is protected by the 'buffer' and 'peripheral' zones. The 'Core Zone' contains four larger settlements namely Kamalapura, Anegundi, Hampi and Kaddiramapura.

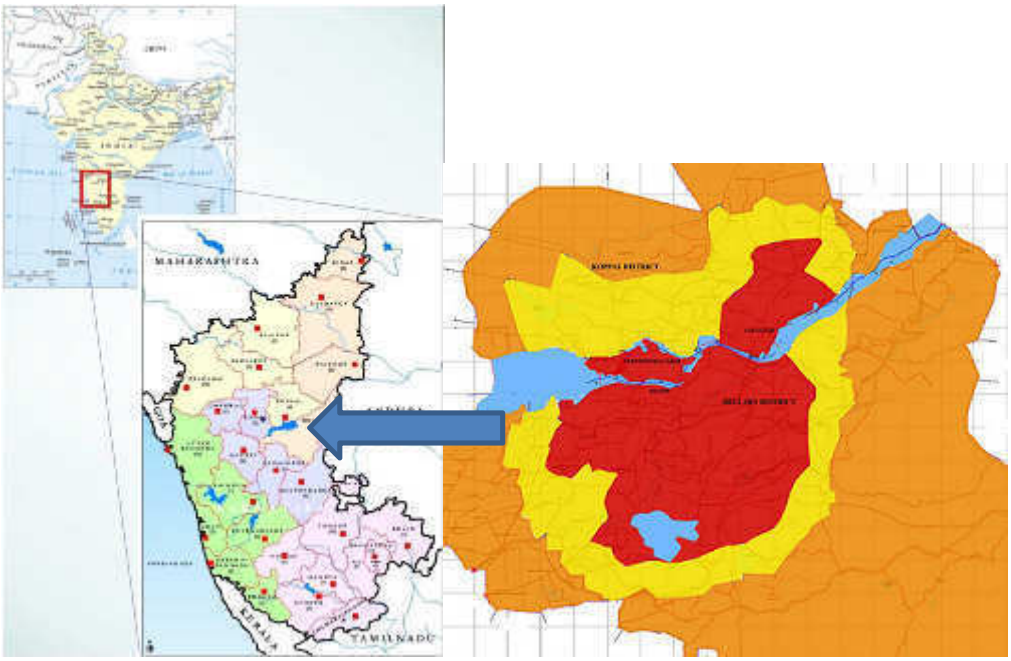



**Figure 4**: **Simplified image of the Hampi World Heritage Area-Core (Red), Periphery (Yellow), and Buffer (Orange) Zones (Adapted from whc.unesco.org)**

41. The HWHAMA governs the 'Core Zone' (see Figure 4) declared as 'Protected Area' under the provisions of the State Archaeology Act vide Notification No. ITY 137 KMU 84 dated 22nd Oct. 1988 which includes 8 villages of Hospet Taluk and 2 villages in Gangavathi Taluk. The schedule of the notification is given in ***Table 4***.

**Table 4: Schedule of Notification indicating jurisdiction of HWHAMA**

| District | Taluk | Village | Area |
|---|---|---|---|
| **Bellary** | **Hospet** | Hampi | Entire Village |
| | | Krishnapura | Entire Village |
| | | Kaddiramapura | Entire Village |
| | | Singanathahalli | Entire Village |
| | | Kamalapura | Part Village |
| | | Venkatapura | Part Village |
| | | Bukkasagara | Part Village |
| | | Nimbapura | Entire Village |
| **Koppal** | **Gangavathi** | Anegundi | Entire Village |
| | | Virupapuragudda | Entire Village |

42. A number of canals undergoing rehabilitation under the Modernization of VNC project are located in the Hampi WHA. The length of the canals located in the three zones are provided in the ***Table 5***.

**Table 5: Details of Channel Lengths located in the Hampi WHA**

| Name of Channel | Core Zone (in Km) | Buffer Zone (in Km) | Peripheral Zone (in Km) | Total (in Km) | % of Total Length located in Hampi WHA |
|---|---|---|---|---|---|
| Anegundi | 8.95 | 3.43 | 0.63 | 13.01 | 67 |
| Raya | 1.23 | 8.70 | 5.59 | 15.52 | 56 |
| Basava | 0 | 0 | 8,44 | 8.44 | 51 |
| Kalaghatta | 0.55 | 0.44 | 2.70 | 3.69 | 53 |
| Turtha | 8.57 | 1.47 | 6.97 | 17.01 | 91 |

43. The photographs below show the major monuments at the corresponding chainages along the canals:

| Channel and Chainage | Photograph |
|---|---|
| Aquaduct – a monument close to the Anegundi Canal at Ch. 3.20 Km |  |
| Monument at about 100 m along the IR side of the Anegundi Canal at Ch. 8.50 km |  |

| Channel and Chainage | Photograph |
|---|---|
| Monument at about 100 m away from the canal on IP side on Raya Canal at Ch 20 km |  |
| Monument along the SR on Turtha Canal at Ch. 4.20 km |  |
| Monument atop the hillock on Turtha Canal at Ch. 5.10 km |  |
| Monument along IP at Turtha Canal Ch. 6.30 km |  |
| Monument along IP at Turtha Canal Ch. 6.40 km |  |

| Channel and Chainage | Photograph |
|---|---|
| Monument along IP at Turtha Canal Ch. 7.50 km |  |
| Monument along IP at Turtha Canal Ch. 9.10 km |  |

44. The works within the Hampi World Heritage Area (WHA) have to be carried out as per the guidelines issued by the Hampi World Heritage Area Management Authority (HWHAMA) and Archaeological Survey of India (ASI). HWHAMA has already given clearance for modernization (rehabilitation) works along with guidelines to be followed vide letter no. HWHAMA/103/2017-18/29 dated 6 June 2018 (***Annexure 1***).

### 3.3.2 Otter Conservation Reserve

45. The Tungabhadra River is a unique habitat of smooth-coated otters listed in Schedule–1 of the Wildlife (Protection) Act 1972 (as Serial No. 31.B). However, these Otters are threatened by several factors like poaching, poisoning of water, mining of sand and discharge of untreated industrial effluents. Hence, the Government of Karnataka in its Notification No. FEE 66 FWL 2015 dated 25.04.2015, declared approximately 34 km length of the Tungabhadra River bed between Hole Mudlapura Bridge in Koppal Taluk, Koppal District and the bridge at Kampli Kote in Hospet Taluk in Bellary District as the Tungabhadra Otter Conservation Reserve (OCR). The OCR boundary comprises the river bed, islands inside, and area upto the high-flood level on both sides of the Tungabhadra river bank stretching along the entire 34 km length. The purpose of notifiying the area as an OCR is to protect, propogate and develop wildlife therein including breeding habits of Otters, Crocodile and Turtles and the environment.

46. The GPS coordinates of the OCR is given in ***Table 6***.

**Table 6: GPS Coordinates of OCR Boundary**

| Location | GPS Coordinates |
|---|---|
| Hale Mudlapur Village | 15° 29’ 10” N; 76° 33’ 76” E |
| Kampli Bridge | 15° 24’ 36” N; 76° 35’ 11” E |

47. Map showing the notified OCR is provided as ***Figure 5***.

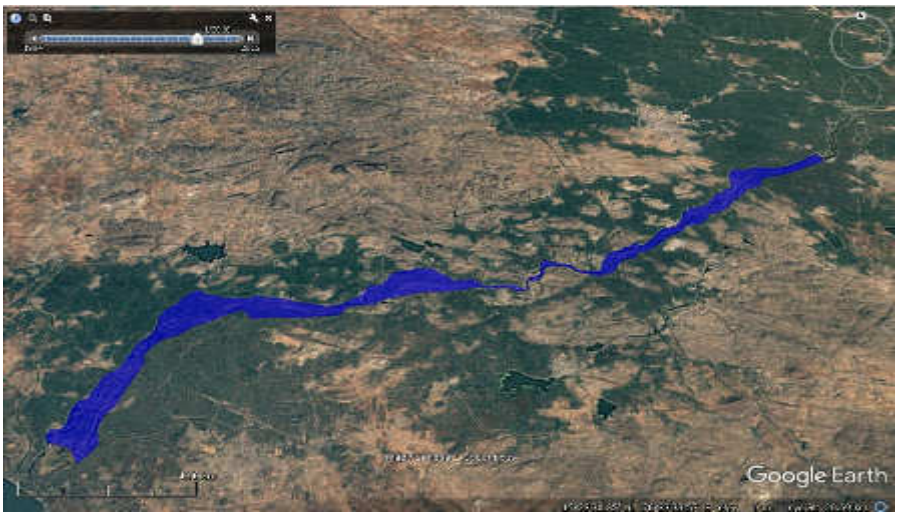



**Figure 5: Blue Highlighted Portion denotes the Notified Boundary of Otter Conservation Reserve**

48. The 9 anicuts located in the notified OCR are listed in ***Table 7***.

**Table 7: Details of Anicuts in the notified Tungabhadra Otter Conservation Reserve**

| S. No. | Name of the Channel | Name of corresponding Anicut | GPS Coordinates of the Anicut |
|---|---|---|---|
| | **Kamalapura Sub-Division (Right Bank)** | | |
| 1 | Bella | Hosur Anicut | 15°17'15.90"N 76°20'54.90"E |
| 2 | Turtha | Turtha Anicut | 15°19'53.94"N 76°26'3.84"E |
| 3 | Ramasagara | Ramasagara Anicut | 15°22'4.30"N 76°31'31.64"E |
| 4 | Kampli | Kampli Anicut | 15°23'5.46"N 76°32'55.58"E |
| | **Voddarahatti Subdivision (Left Bank)** | | |
| 5 | Anegundi | Sanapura Anicut | 15°20'46.87"N 76°26'1.55"E |
| 6 | Shivapura | Shivpura Anicut | 15°20'5.10"N 76°21'39.23"E |
| 7 | Hulugi | Hulugi Anicut | 15°17'30.32"N 76°20'17.69"E |
| 8 | Upper Gangavathi | Upper Gangavathi Anicut | 15°22'38.34"N 76°31'50.50"E |
| 9 | Lower Gangavathi | Lower Gangavathi Anicut | 15°23'23.70"N 76°32'52.13"E |

*A view of the Sanapura Anicut feeding the Anegundi Channel*

*A portion of the Hosur Anicut feeding the Bella Channel*

*A portion of the Hulugi Anicut*

*Kampli Anicut*

*Ramasagara Anicut*

*A section of the Turtha Anicut*

*A portion of the Upper Gangavathi Anicut*

*A portion of the Lower Gangavathi Anicut*

49. For execution of works within the OCR requires recommendation from the Wildlife Board as per the Wildlife Conservation Act (1972). Towards this, KNNL has already submitted an application along with necessary documents to Karnataka Forest Department.

### 3.3.3 Increased Habitation in the Command Areas

50. Over several centuries, the VNC System has been host to increasing number and population of habitations. Certain stretches of four canals passing through the boundaries of municipalities or villages have witnessed increased population and colonies. In the absence of proper drainage system, the inhabitants have started discharging solid wastes directly into the canal. The sewage has also been directly connected to the canals in these areas. ***Table 8*** gives details of the stretches of various canals passing through habitations.

**Table 8: Details of the VNC passing through habitations**

| S. No. | Name of the Canal | Location of Increased Habitation Areas | Total Canal Length (km) | Habitations starting From Chainage | Habitations ending at Chainage |
|---|---|---|---|---|---|
| 1 | Basavanna | Within Hospet Town | 16.50 | 3.26 km | 6.0 km |
| 2 | Raya | Within Hospet Town | 27.74 | 6.62 km | 9.62 km |
| 3 | Siruguppa | Within Siruguppa Town | 10.85 | 8.0 km | 10.0 km |
| | | One branch of canal from 8.25 km chainage goes into Siruguppa town in which the Command Area is completely converted to habitation areas | | | |
| 4 | Bichal | Within Bichal Village | 14.50 | 12.8 Km | 14.1 km |

## 3.4 Master Plan of 2003 and Proposed Modernization (Rehabilitation) Measures

51. In the 1993 Master Plan, an allocation of 12.05 TMC was made for the VNCs without channel-wise breakup. The revised Master plan of 2003 has an allocation of only 5.80 TMC for all the 16 VNCs. However, due to the deteriorated condition of the anicuts and channels, and lack of flow measurement structures, the GoK has not been able to implement the revised Master Plan of 2003. Table 3 presents the average cropped area for the last twenty years, which is about 16,241 ha. Considering the longstanding demand of the farmers of the VNC system, and with a view to implement strictly the Master Plan of 2003, the GoK has decided to take up modernization/rehabilitation of the VNC to improve water management.

52. Raya and Basavanna channels take off from Tungabhadra Dam, while all other channels, except Kalaghatta and Belagodahalla take off from anicuts. Raya channel runs for about 27.7 km and joins Turtha channel at km 4.0. There is a separate sluice at km 2.5 along Raya Channel to meet water requirements of Bella channel. The Bella Channel runs for about 5.55 km and joins Kalaghatta channel at 0.2 km. The Kalaghatta channel runs for about 7.02 km and joins Turtha channel at km 0.7. The Turtha channel runs for about 18.69 km and joins Ramasagar channel at km 1.4. The Ramasagar channel runs for about 15.5 km and joins Kampli channel. The Kampli channel runs for about 23.55 km and joins Belagodahalla channel.

53. Raya channel is designed by considering its peak discharge as per Modified Penman Method plus 10% extra for rush irrigation including discharges of downstream channels like Bella, Turtha, Ramasagar and Kampli. Likewise, the downstream channels Bella, Kalaghatta, Turtha, Ramasagar and Kampli are designed for peak discharge plus 10 percent for flood irrigation.

54. Belagodahalla and Basavanna channels are also designed considering Modified Penman method plus 10 percent extra for rush irrigation.

55. The channels on the left side of Tungabhadra River run parallel to the Left Bank Main Channel (LBMC) namely Hulugi, Shivpura, Anegundi, Upper Gangavathi, Lower Gangavathi and Bichal. There are a number of direct inlets to these channels. The channels are designed for peak discharge obtained from Modified Penman Method plus 10% rush irrigation requirement.

56. Based on this, channel sections are designed reach-wise considering the existing bed gradient with a rugosity coefficient (n) of 0.018 for concrete lined channels. Inlets are proposed based on the site conditions, and escape weirs are proposed at defined nalas. Annexure 13.1 of the DPR (2017) gives particulars of the VNC system.

57. Improvements proposed to these anicuts include:

- Providing 200 mm thick skin wall encasement to the anicut and grouting;
- Providing anchor rods at every 1 m interval on upstream and downstream of anicut for a width of 5 m all along the length;
- Providing concrete toe walls on both ends, and
- Provision of approach roads to the anicuts wherever required from the nearest road.

## 3.5 Details of the Existing Drainage System

58. In the command area of 11,154 ha under VNC system, an area of 340 ha was affected by waterlogging, salinity and alkalinity (DPR, 2017).

59. The Command Area Development Authority (CADA) of Tungabhadra project has taken up reclamation of these waterlogged areas. As part of curative and preventive measures, surface field drains were constructed under various schemes to drain excess water and lower the salt concentration in the root zone. These measures not only helped reclamation of water logged lands but also have improved crop yields.

## 3.6 Channel Condition Surveys

60. A channel condition survey as well as topographic surveys was carried out during the preparation of DPR (2017), and costs updated as per latest schedule of rates. The survey along the existing channel network identified the take-off points, alignment, various constraints along the existing channels, accessibility, topography, terrain and soil formation including crops being cultivated.

61. Due to the operation for two seasons in a year for several years, the channels have lost their shape in several stretches due to scouring effect and also accumulation of silt. This has resulted in reduction in the flow of water. As a result, standing crops at tail-end do not receive enough water. Hence it is necessary to redesign the channel section with

concrete lining. This will also help in improving channel efficiency and achieve desired savings in water.

62. Raya and Basavanna channels are quite lengthy channels which take-off from the Tungabhadra dam while other channels take off from pick-up weirs (PUWs), i.e., anicuts on Tungabhadra River.

63. Anicuts have been constructed with huge boulders/ cut stones dumped or set in a zigzag manner. The existing rip-rap boulders have a lot of voids that cause leakage and displacement of boulders during high floods. The channels taking off from PUWs across Tungabhadra River have no head regulators or control structures. Therefore, it is necessary to construct head regulators and flow measuring structures on the channels. It is observed that even the PUWs need major repairs.

## 3.7 Key Issues in the Vijayanagara Anicuts and Channels

64. The anicuts and channel systems of Vijayanagara Empire are still in operation. However, with passage of time, the system has deteriorated and improvements are critically needed. Farmers from the command area have been since long demanding improvements to anicuts and channels. The following provides a brief overview of the key issues observed by PSC team during site visits:

- Most anicuts are in deteriorated condition; also leaking and requiring immediate rehabilitation *(**Plate 1**).*
- The alignment of both Raya and Basavanna channels passes through municipal area of Hospet town where urban development has taken place right up to the channel boundary. Urban effluents are let into the channels at several locations and water appears to be contaminated.
- Channel water is extensively used by people residing around the channel for purposes of bathing, washing, cattle feeding, etc. *(**Plate 2**).*
- Several inlets in the form of well-constructed pipelines, open-channels etc. have been directly linked to the channels at several locations, and as such the channels are converted either as a seepage disposal point or a drainage line ***(Plate 3).***
- In most of the locations, the channels have been aligned to the restricted right of way due to presence of huge rocks and boulders.
- Some sections of the channels which pass through urban areas, have size stone masonry and concrete canal shaping ***(Plate 4).***
- Substantial seepage has been noticed from the channels at several locations indicating poor maintenance ***(Plate 5).***
- Thick vegetation growth has been noticed at several locations along the channels within the water spread area ***(Plate 6).***
- Most of the structures are in deteriorated condition ***(Plate 7).***
- The entire channel network lacks proper crossing and connection. The service roads are heavily damaged and it is difficult to carry out inspection of the channels *(**Plate 10**).*
- Channel water happens to be the lifeline for most of the villages en route since there is no dedicated water supply for meeting their day-to-day domestic water requirements.

- The top soil generally comprises black cotton. However, murrum, gravel and hard rock are also encountered at certain locations.
- Banana, sugarcane and paddy are the major crops in the command area *(**Plates 11 & 12).***
- Certain channels run in deep cut.
- There is debris and thick vegetation around the Head Regulator *(**Plate 13**).*
- There are breaches in channel section also *(**Plate 14**).*
- No sign boards or indicative marks, kilometre, hectometre, chainage stones etc. are provided along the channels.

**Plate 1: Deteriorating anicuts and other structures requiring immediate rehabilitation**

**Plate 2: Photos showing untidy channels**

**Plate 3: Channel used as a disposal point**


**Plate 4: Channel reaches with size stone masonry lining**


**Plate 5: Damage due to seepage and poor maintenance**


**Plate 6: Thick vegetation around channels**


**Plate 7: Damaged service road** **Plate 8: Poor crossing structure**

Plate 9: Channel running full with water

Plate 10: Service road

Plate 11: Banana plantation

Plate 12: Sugarcane plantation

Plate 13 : Debris around Head Regulator

Plate 14: Breach in channel section

## 3.8 Existing (Pre-Modernisation) Cropping Pattern

65. The Culturable Command Area (CCA) of each of the Vijayanagara Channels is as per the register maintained by the Tungabhadra Project Authorities. The cropped area under each channel for a period of 20 years, as per records available in the Tungabhadra Project, has been considered for studies. The historical average (gross) and minimum cropped area of the VNC system are, respectively, 16,241 ha and 13,124 ha. It should be noted that these cropped areas were achieved with an average annual water allocation of 12.05 TMC to the VNC system. With the Project, the annual water allocation is proposed to be scaled down to 5.8 TMC for the VNC system.

66. For fair comparison purposes, pre-modernization cropped area that would have been achieved with an annual allocation of only 5.8 TMC is required. The minimum cropped area of each channel during the last 20 years has been considered as the existing (or pre-modernization / rehabilitation) cropping pattern ***Table9***: Actual area cultivated (20 years average) where paddy is the dominant crop in both kharif and rabi seasons.

**Table 9: Actual area cultivated (20 years average)**

| S. No. | Name of the Channel | Length (km) | Cropped Area (ha) | Offtake |
|---|---|---|---|---|
| **On right bank of Tungabhadra River** | | | | |
| 1 | Raya Channel | 27.74 | 2855 | Tungabhadra Dam |
| 2 | Basavanna Channel | 16.50 | 1447 | Tungabhadra Dam |
| 3 | Bella Channel | 5.50 | 741 | Hosur Anicut |
| 4 | Kalaghatta Channel | 7.020 | 349 | Nala |
| 5 | Turtha Channel | 18.69 | 1171 | Turtha Anicut |
| 6 | Ramasagar Channel | 15.50 | 1024 | Ramasagar Anicut |
| 7 | Kampli Channel | 23.550 | 894 | Kampli Anicut |
| 8 | Belagodahala | 11.220 | 328 | Nala |
| 9 | Deshnur Channel | 9.03 | 815 | Deshnur Anicut |
| 10 | Siruguppa Channel | 10.85 | 1344 | Siruguppa Anicut |
| **On left bank of Tungabhadra River** | | | | |
| 11 | Hulugi Channel | 10.69 | 419 | Hulugi Anicut |
| 12 | Shivapura Channel | 6.54 | 717 | Directly from TLBC |
| 13 | Anegundi Channel | 19.44 | 1359 | Sanapur Anicut |
| 14 | Upper Gangavathi Channel | 9.00 | 1363 | Upper Gangavathi Anicut |
| 15 | Lower Gangavathi Channel | 9.54 | 1141 | Lower Gangavathi Anicut |
| 16 | Bichal Channel | 14.50 | 276 | Jukur Anicut |
| **Total** | | | **16,241** | |

**Table 10: System-wise existing cropping pattern in VNC project area**

| S. No. | Channel Name | CCA | Kharif Crop | | Rabi Crop | | Bi-Seasonal Crops | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Paddy | Jowar | Paddy | Groundnut | Sugar-Cane | Garden | |
| 1 | Basavanna | 1240 | 311 | 135 | 66 | 310 | 281 | 9 | 1112 |
| 2 | Raya | 2226 | 501 | 163 | 446 | 243 | 1349 | 78 | 2780 |
| 3 | Bella | 600 | 67 | 64 | 10 | 130 | 381 | 58 | 710 |
| 4 | Kalaghatta | 237 | 69 | 68 | 7 | 98 | 43 | 6 | 291 |
| 5 | Turtha | 931 | 175 | 42 | 109 | 110 | 119 | 545 | 1100 |
| 6 | Ramasagar | 673 | 202 | 91 | 248 | 215 | 2 | 96 | 854 |
| 7 | Kampli | 620 | 241 | 38 | 67 | 0 | 218 | 109 | 673 |
| 8 | Belagodahala | 210 | 89 | 12 | 74 | 44 | 12 | 65 | 296 |
| 9 | Siruguppa | 764 | 316 | 97 | 201 | 161 | 180 | 54 | 1009 |
| 10 | Deshnur | 478 | 141 | 6 | 104 | 30 | 312 | 26 | 619 |
| | **Total** | **7979** | **2112** | **716** | **1332** | **1341** | **2897** | **1046** | **9444** |
| 11 | Hulugi | 265 | 170 | 12 | 0 | 10 | 0 | 48 | 240 |
| 12 | Shivapura | 403 | 120 | 2 | 116 | 13 | 0 | 29 | 280 |
| 13 | Anegondi | 789 | 389 | 5 | 182 | 316 | 10 | 177 | 1079 |
| 14 | Upper Gangavathi | 775 | 666 | 0 | 134 | 53 | 43 | 45 | 941 |
| 15 | Lower Gangavathi | 667 | 590 | 0 | 49 | 165 | 51 | 12 | 867 |
| 16 | Bichal | 276 | 13 | 0 | 13 | 0 | 170 | 79 | 275 |
| | **Total** | **3175** | **1948** | **19** | **494** | **557** | **274** | **390** | **3682** |
| | **Total Area** | **11154** | **4060** | **735** | **1826** | **1898** | **3171** | **1436** | **13126** |

67. It is seen from the ***Table 4*** that against a physical area (CCA) of 11,154 ha, the minimum cropped area of the VNC System works out to be 13,126 ha. Thus, a cropping intensity of 117.67% was achieved during the pre-modernization period.

68. The overall cropping pattern of VNC system during pre-modernization period is in ***Table 11.***

**Table 11: Overall VNC existing cropping pattern and intensity**

| Season/Crop | Cropped Area (ha) |
|---|---|
| ***Kharif*** | |
| 1. Paddy | 4060 |
| 2. Jowar | 735 |
| ***Rabi*** | |
| 1. Paddy | 1826 |
| 2. Groundnut | 1898 |
| **Perennial (Bi-seasonal)** | |
| 1. Sugarcane | 3171 |
| 2. Garden (banana) | 1436 |
| **Total** | **13,126** |
| **Existing cropping intensity** | **117.67%** |

## 3.9 Proposed (Post-Modernization) Cropping Pattern and Cropped Area

69. As discussed in the preceding section, the pre-modernization/ rehabilitation cropped area that would have been achieved with a water supply of 5.80 TMC was 13,126 ha. Post-modernization (post-rehabilitation), the cropped area is expected to increase. The extent of increase in cropped area depends upon the cropping pattern, crop water requirements, amount of water savings achieved through rehabilitation, including improved irrigation practices and technologies. The post-modernization cropped area was estimated using the following factors: the historical average cropping pattern; modified Penman method for estimation of water requirements of different crops included in the cropping pattern; consultations with officials of the Department of Agriculture in the project area; estimated values of irrigation efficiency after modernization and capacity building of WUCS in improved irrigation practices; and the gross water allocation limit of 5.8 TMC for the VNC System. This required some trial and error. The proposed post-modernization cropped area and cropping intensity under each of the 16 channels of VNC are provided, respectively, in ***Tables 12*** and ***13.***

**Table 12: Channel-wise Proposed Cropping Area (in hectares)**

| S. No | Name of Channel | CCA | Kharif crops | | Rabi crops | | Bi seasonal crops | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Paddy | Jowar | Paddy | Groundnut | Sugarcane | Garden | |
| 1 | Raya | 2226 | 441 | 1285 | 250 | 429 | 400 | 50 | 2855 |
| 2 | Basavanna | 1240 | 100 | 740 | 20 | 388 | 170 | 29 | 1447 |
| 3 | Bella | 600 | 70 | 396 | 14 | 127 | 80 | 54 | 741 |
| 4 | Kalaghatta | 237 | 30 | 172 | 10 | 102 | 15 | 20 | 349 |
| 5 | Turtha | 931 | 110 | 461 | 75 | 165 | 100 | 260 | 1171 |
| 6 | Ramasagar | 673 | 98 | 440 | 75 | 276 | 50 | 85 | 1024 |
| 7 | Kampli | 620 | 152 | 301 | 152 | 125 | 60 | 104 | 894 |
| 8 | Belagodahala | 210 | 41 | 112 | 35 | 83 | 17 | 40 | 328 |
| 9 | Siruguppa | 764 | 165 | 476 | 202 | 381 | 90 | 30 | 1344 |
| 10 | Deshnur | 478 | 188 | 224 | 121 | 217 | 55 | 10 | 815 |
| | **Total** | | **1395** | **4607** | **954** | **2293** | **1037** | **682** | **10968** |
| 11 | Hulugi | 265 | 91 | 129 | 82 | 77 | 20 | 20 | 419 |
| 12 | Shivapura | 403 | 190 | 176 | 117 | 202 | 2 | 30 | 717 |
| 13 | Anegundi | 789 | 234 | 417 | 128 | 450 | 6 | 124 | 1359 |
| 14 | Upper Gangavathi | 775 | 217 | 453 | 195 | 412 | 56 | 30 | 1363 |
| 15 | Lower Gangavathi | 667 | 164 | 404 | 170 | 317 | 48 | 38 | 1141 |
| 16 | Bichal | 276 | 13 | 140 | 9 | 4 | 60 | 50 | 276 |
| | **Total** | | **909** | **1719** | **701** | **1462** | **192** | **292** | **5275** |
| **Total Area** | | **11154** | **2304** | **6326** | **1655** | **3755** | **1229** | **974** | **16243** |

70. Accordingly, against a CCA of 11,154 ha, the cropped area of the Vijayanagara Channel system works out to be 16,243 ha. Thus, a cropping intensity of 145.6% could be achieved post-modernization. System of Rice Intensification (SRI) technology is expected to be utilized at least partially in the post-modernisation scenario.

**Table 13: Overall VNC Proposed Cropping Intensity**

| Season/Crop | Cropped Area (ha) |
|---|---|
| ***Kharif*** | |
| 1. Paddy | 2304 |
| 2. Jowar | 6326 |
| ***Rabi*** | |
| 1. Paddy | 1655 |
| 2. Groundnut | 3755 |
| **Perennial (Bi-seasonal)** | |
| 1. Sugarcane | 1229 |
| 2. Garden (banana) | 974 |
| **Total** | **16,243** |
| **(Expected) Cropping** | **145.6%** |

71. A detailed description of agriculture assessment is provided in the DPR (2017).

## 3.10 Engineering Designs and Cost Estimates

72. Engineering designs and cost estimates have been prepared using IS standards, industry practices and Standard Schedule of Rates prevalent of Karnataka (see DPR, 2017 for details). Brief descriptions of structures considered as part of the project design and typical drawings are given in ***Annexure 2***.

73. The designs also include the outcomes of MASSCOTE training related to Modernization (such as lining of canals, rehabilitation/reconstruction of infrastructure, and installation of flow measurement devices), operation and maintenance (such as manual removal of weed, illegal withdrawals, and multiple services). The soft component of VNC estimates include modernization of field irrigation channels (FIC) to be executed directly by WUCS. It also includes capacity building of WUCS (institutional as well as irrigated agriculture aspects) and KNNL staff, construction management of FIC, and FIC O&M.

### 3.10.1 Conveyance Channels

74. Estimates are prepared based on the design section and cut-off statement of the channels. Design provisions made for conveyance channels are as follows:

- CC lining of 80 mm thickness is proposed using mechanical pavers where channel bed width is >1.2 m;
- Manual lining is proposed where channel bed width is <1.2 m;
- Cohesive Non-Swelling backing is provided as per BIS for the Black Cotton soil stratum;
- Provision of lugs and template walls made as per standards;
- Improvement of service road;
- Improvement of inspection path;
- Removal of silt;
- Earthwork excavation in ordinary soil;
- Constructing uncoursed rubble masonry;
- Tarfelt expansion joint for CC lining;
- Perforated GI pressure relief pipes for pressure relief arrangement, and

- Hectometre, kilometre and boundary stones.
- Designs in the Hampi WHA will reflect the terms and conditions put forth in the approval issued by HWHAMA for the works within the Heritage Area (***Annexure 1***).

### 3.10.2 Channel Structures

75. Design provisions made for channel structures are as follows:
    - Earthwork excavation in ordinary soil;
    - M10, 40 mm CC for foundation;
    - M15, 40 mm CC for abutment;
    - M15, 20 mm CC for sub-structure;
    - M20, 20 mm for deck slab, kerb and wearing coat for bridges;
    - Provision for steel reinforcement, and
    - Provision for stone pitching.

76. The cost of various works envisaged in the VNC works based on the latest schedule of rates of WRD, Bengaluru (2016-17) is **INR 4,351.00 million.** The project cost is classified into the following sub-headings:

#### a. Preliminary

77. A provision of **INR17.81 million** is made for charges towards consultancy services viz, detailed survey, investigation, preparation of DPR etc., and other preliminary works as required for the project.

#### b. Land

78. No provision is made in the estimate towards land acquisition.

#### c. Works (Anicuts)

79. A total of 12 anicuts have been proposed for modernization (rehabilitation)–Anegundi, Bella, Bichal, Deshnur, Lower Gangavathi, Upper Gangavathi, Hulugi, Kampli. Ramasagar, Siruguppa, and Turtha. Shivpura anicut is not proposed for rehabilitation because excessive siltation over the years has caused elevation changes between the anicut outlet and the canal head point at “0” chainage. These ancient anicuts constructed with huge boulders placed in a zigzag manner are have been displaced resulting in leakages. It is proposed to strengthen the anicuts by providing cement concrete M20 skin wall encasement.

80. The key requirements of the Archaeological Authority (provided in ***Annexure 1*** of the EIA Report) are as follows:
    - No damage shall be caused to the architecture / structures located on either side of the channel;
    - Any new evidences of architecture / sculptures should be reported to the local officer of the ASI stationed at Kamalapura;
    - The work within the Hampi Heritage Area should be carried out in such a manner that the Form, Design and Characteristics of the original sections of the channel / anicuts are not adversely affected.
    - The entire work running through the core zone should be carried out in the presence of the local officers and their guidance.

81. The following provisions are made for strengthening the anicuts:

- Providing anchor rods;
- Provision for curtain grouting;
- Providing skin wall to the entire length of anicut;
- Providing contraction joint;
- Providing concrete toe walls on both ends, and
- Formation of approach roads to anicuts wherever required from the nearest road.

82. In addition, provision for coffer dam to facilitate unhindered repair works is also made. A provision of INR615.329 million is made for improvements of the 12 anicuts. This involves providing anchor rods to the bed and skin walls with CC M20 throughout the length and width of the weir.

### d. Regulators and Measuring Devices

83. A provision of **INR 353.045 million** is made towards repair/reconstruction/new construction of head regulators, cross regulators and measuring devices under main channel and its network (***Table 14***).

**Table 14: Regulators and Measuring Devices**

| S. No. | Channel | Name of the Structure | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 1. | Raya | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | 2 | 50 |
| 2. | Basavanna | Head Regulator | - | 1 |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 20 |
| 3. | Bella | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | Distribution box | - | 1 |
| | | DPO | 1 | 31 |
| 4. | Kalaghatta | Head Regulator | - | 1 |
| | | Cross Regulator | - | - |
| | | Measuring Device | 1 | - |
| | | DPO | - | 32 |
| 5. | Turtha | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 99 |
| 6. | Ramasagar | Head Regulator | 1 | - |
| | | Cross Regulator | - | 2 |
| | | Measuring Device | 1 | - |
| | | DPO | 20 | 8 |

| S. No. | Channel | Name of the Structure | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 7. | Kampli | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | 34 | 4 |
| 8. | Belagodahala | Head Regulator | - | - |
| | | Cross Regulator | - | - |
| | | Measuring Device | 1 | - |
| | | DPO | 45 | 10 |
| 9. | Siruguppa | Head Regulator | - | - |
| | | Cross Regulator | 2 | 2 |
| | | Measuring Device | 1 | - |
| | | DPO | 2 | - |
| 10. | Deshnur | Head Regulator | - | - |
| | | Cross Regulator | - | 4 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 14 |
| 11. | Hulugi | Head Regulator | - | - |
| | | Cross Regulator | - | - |
| | | Measuring Device | - | 1 |
| | | DPO | - | 55 |
| 12. | Shivapura | Head Regulator | - | - |
| | | Cross Regulator | 1 | - |
| | | Measuring Device | 1 | - |
| | | DPO | 1 | 23 |
| 13. | Anegundi | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 66 |
| 14. | Upper Gangavathi | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | - | 1 |
| | | DPO | - | 30 |
| 15. | Lower Gangavathi | Head Regulator | - | 3 |
| | | Cross Regulator | 1 | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 26 |
| 16. | Bichal | Head Regulator | - | - |
| | | Cross Regulator | - | 1 |
| | | Measuring Device | 1 | - |
| | | DPO | - | 10 |

### e. Canal Drops (Falls)

84. A provision of **INR 10.467 million** is made towards construction of channel drops for different channels and also for construction of chambers for linked channels, where the higher-level channel joins the lower level channel (***Table 15***).

**Table 15: Canal Falls**

| S. No. | Name of the Channel | Name of Structures | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 1. | Raya | Canal drop | 9 | |
| 2. | Basavanna | Canal drop | 7 | |
| 3. | Bella | Canal drop | - | |
| 4. | Kalaghatta | Canal drop | 1 | |
| 5. | Turtha | Canal drop | 7 | |
| 6. | Ramasagar | Canal drop | - | |
| 7. | Kampli | Canal drop | - | |
| 8. | Belagodahalla | Canal drop | - | |
| 9. | Siruguppa | Canal drop | - | |
| 10. | Deshnur | Canal drop | - | |
| 11. | Hulugi | Canal drop | 1 | |
| 12. | Shivapura | Canal drop | 1 | |
| 13. | Anegundi | Canal drop | 2 | |
| 14. | Upper Gangavathi | Canal drop | - | |
| 15. | Lower Gangavathi | Canal drop | 1 | |
| 16. | Bichal | Canal drop | - | |

### f. Cross Drainage Works

85. A provision of **INR 93.763 million** is made towards construction of inlets with CC M15 and under tunnels (***Table 16)***.

**Table 16: Cross-drainage works in VNC**

| S. No. | Name of the Channel | Name of Structures | No, of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 1. | Raya | Inlet | 2 | - |
| | | Under tunnel | 2 | 1 |
| 2. | Basavanna | Inlet | 2 | - |
| | | Under tunnel | 1 | - |
| 3. | Bella | Inlet | 4 | - |
| | | Under tunnel | - | - |
| 4. | Kalaghatta | Trough | 2 | - |
| | | Under tunnel | - | - |
| 5. | Turtha | Inlet | - | - |
| | | Under tunnel | - | - |
| 6. | Ramasagar | Inlet | 11 | - |
| | | Under tunnel | - | - |
| 7. | Kampli | Inlet | 9 | - |
| | | Trough | 2 | - |

| S. No. | Name of the Channel | Name of Structures | No, of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 8. | Belagodhallala | Inlet | 2 | - |
| | | Under tunnel | - | - |
| 9. | Siruguppa | Inlet | - | - |
| | | Under tunnel | - | - |
| | | Super passage | 1 | - |
| 10. | Deshnur | Inlet | - | - |
| | | Under tunnel | - | - |
| 11. | Hulugi | Inlet | 2 | - |
| | | Under tunnel | - | - |
| 12. | Shivapura | Inlet | 6 | - |
| | | Under tunnel | 1 | - |
| 13. | Anegundi | Inlet | 10 | - |
| | | Under tunnel | 2 | - |
| 14. | Upper Gangavathi | Inlet | 17 | - |
| | | Under tunnel | - | - |
| 15. | Lower Gangavathi | Inlet | 4 | 1 |
| | | Under tunnel | - | - |
| 16. | Bichal | Inlet | - | - |
| | | Under tunnel | - | - |

### g. Bridges

86. A provision of **INR 206.690 million** is made towards construction of cart track crossings/village road bridges with deck slab of CC M20, Foot Bridges and Sopanams ***(Table 17).***

**Table 17: Bridges in VNC**

| S. No. | Name of the Channel | Name of Structure | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 1. | Raya | Cart track crossing | 12 | 7 |
| | | Major road bridge | 1 | 1 |
| | | Village road bridge | 1 | 2 |
| | | Foot bridges | 1 | - |
| | | Sopanams | 1 | - |
| 2. | Basavanna | Cart track crossing | - | 15 |
| | | Village road bridge | - | 8 |
| | | Foot bridges | - | 7 |
| | | Sopanams | 9 | - |
| 3. | Bella | Cart track crossing | 1 | 4 |
| | | Village road bridge | 1 | 1 |
| | | Foot bridges | 1 | - |
| | | Road Bridge | - | 1 |
| | | Cattle ramp | 4 | - |
| 4. | Kalaghatta | Cart track crossing | 1 | 7 |

| S. No. | Name of the Channel | Name of Structure | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| | | Village road bridge | - | 2 |
| | | Foot bridges | 1 | - |
| | | Sopanams | - | - |
| 5. | Turtha | Cart track crossing | - | 7 |
| | | Village road bridge | - | - |
| | | Foot bridges | - | - |
| | | Sopanams | 2 | - |
| | | Cattle ramp | - | - |
| 6. | Ramasagar | Cart track crossing | 6 | 4 |
| | | Village road bridge | - | - |
| | | Foot bridges | - | - |
| | | Sopanams | - | - |
| | | Cattle ramp | 1 | - |
| 7. | Kampli | Cart track crossing | 20 | 16 |
| | | Village road bridge | 3 | 2 |
| | | Foot bridges | 6 | 6 |
| | | Sopanams | 4 | - |
| 8. | Belagodahalla | Cart track crossing | 12 | 4 |
| | | Village road bridge | 1 | - |
| | | Foot bridges | 1 | - |
| | | Sopanams | - | - |
| 9. | Siruguppa | Cart track crossing | 2 | 3 |
| | | Village road bridge | - | - |
| | | Retaining Wall | 1 | - |
| | | Sopanams | 1 | - |
| 10. | Deshnur | Cart track crossing | 4 | 4 |
| | | Road bridge | 1 | - |
| | | Foot bridges | - | - |
| | | Sopanams | - | - |
| 11. | Hulugi | Cart track crossing | - | 8 |
| | | Village road bridge | - | 1 |
| | | Foot bridges | - | 1 |
| | | Sopanams | - | - |
| 12. | Shivapura | Cart track crossing | - | 3 |
| | | Village road bridge | - | 5 |
| | | Foot bridges | - | - |
| | | Sopanams | - | - |
| 13. | Anegundi | Cart track crossing | 2 | 9 |
| | | Service Road | 3 | - |
| | | Village road bridge | - | 1 |
| | | Road Bridge | 1 | - |

| S. No. | Name of the Channel | Name of Structure | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| | | Foot bridges | - | 1 |
| | | Sopanams | - | 5 |
| | | Cattle ramp | 3 | 1 |
| 14. | Upper Gangavathi | Cart track crossing | - | 8 |
| | | Village road bridge | - | 1 |
| | | Road bridge | - | 1 |
| | | Sopanams | 6 | - |
| 15. | Lower Gangavathi | Cart track crossing | - | 3 |
| | | Village road bridge | - | 1 |
| | | Road bridges | - | 1 |
| | | Sopanams | - | - |
| 16. | Bichal | Cart track crossing | - | 11 |
| | | Village road bridge | - | - |
| | | Foot bridges | - | - |
| | | Sopanams | - | - |

### h. Escapes

87. A provision of **INR 73.105 million** is made towards construction of escapes, relieving weirs, and scouring sluices with CC M15 *(**Table 18**)*.

**Table 18: Escapes in VNC**

| S. No. | Name of the Channel | Name of Structures | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| 1. | Raya | Escapes | 2 | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | 1 | 3 |
| 2. | Basavanna | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | - |
| 3. | Bella | Escapes | - | - |
| | | Relieving weirs | - | 1 |
| | | Scouring sluices | - | 1 |
| 4. | Kalaghatta | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | 1 |
| 5. | Turtha | Escapes | 2 | - |
| | | Relieving weirs | 1 | - |
| | | Scouring sluices | - | 1 |
| 6. | Ramasagar | Escapes | 2 | - |
| | | Relieving weirs | - | 1 |
| | | Scouring sluices | - | - |
| 7. | Kampli | Escapes | - | - |

| S. No. | Name of the Channel | Name of Structures | No. of Structures | |
|---|---|---|---|---|
| | | | Construction | Dismantling & Reconstruction |
| | | Relieving weirs | - | - |
| | | Scouring sluices | 5 | 1 |
| 8. | Belagodhallala | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | 3 | 3 |
| 9. | Siruguppa | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | 1 | - |
| 10. | Deshnur | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | 2 |
| 11. | Hulugi | Escapes | 1 | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | 7 |
| 12. | Shivapura | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | 1 |
| 13. | Anegundi | Escapes | - | 13 |
| | | Relieving weirs | 2 | 7 |
| | | Scouring sluices | - | - |
| 14. | Upper Gangavathi | Escapes | - | 1 |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | - |
| 15. | Lower Gangavathi | Escapes | - | 1 |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | 1 |
| 16. | Bichal | Escapes | - | - |
| | | Relieving weirs | - | - |
| | | Scouring sluices | - | - |

### i. Navigation Works

88. There are no navigation needs, hence no provision is made.

### j. Power Plant Civil Works

89. No power generation is involved; hence no provision is made in the estimate for power plant civil works.

### k. Buildings

90. A provision of **INR 32.900 million** towards buildings is made in the estimate.

### l. Earthwork, Lining and Service Road (Main Channel)

91. A provision of **INR 2147.622 million** is made for 16 channels with a total length of 215.93 km towards earthworks, lining and service road for main channels and its networks. CC mechanical paver lining 80 mm thick is proposed where the bed width is greater than 1.2

m, 75 mm thick for other reaches, manual lining with M15 grade. At every 15 m interval, CC template walls are proposed. Provision of CNS backing is made due to the presence of black cotton soil which is expansive in nature.

### m. Plantation

92. A provision of **INR 6.795 million** is made for plantation on either side of the main channel at 15 m c/c. The rate per km works out to be INR 31,500.

### n. Tanks and Reservoirs

93. No provision is made in the estimate for tanks and reservoir as it is not applicable to the current project.

### o. Maintenance

94. A provision of **INR 42.252 million** is made towards maintenance at 1% of cost of I-works less the cost of items A, B, O, M, P, Q and X as per CWC guidelines. This covers the cost of maintenance of roads and other structures during the period of construction.

### p. Miscellaneous

95. No provision is made in the estimate.

### q. Special Tools and Plants

96. A provision of **INR 4.046 million** is made in the estimate.

### r. Communications

97. No provision is made in the estimate.

### s. Power Plant and Electrical-Mechanical System

98. No provision is made in the estimate.

### t. Water Supply Works

99. No provision is made in the estimate.

### u. Distributaries, Minors and Sub-Minors

100. A provision of **INR 669.603 million** is made for modernization of 64.92 km of distributary networks and 161 km of minors coming under Vijayanagara Channels. Provision of CNS backing with 75 mm thick manual CC lining of grade M15 is made in the estimate.

### v. Water Courses

101. No provision is made in the estimate.

### w. Drainage

102. A provision of **INR 22.673 million** is made towards construction of surface drains as Raya and Basavanna channels run for some part in municipal areas.

### x. Environment and Ecology

103. No provision is made in the estimate.

### y. Losses of Stock

104. A provision of **INR 10.563 million** is made in the estimate at 0.25% of cost of I-works less the cost of items A, B, O, M, P, Q and X as per CWC guidelines.

### z. Provision for Power Generation

105. No provision is made in the estimate.

**Total of I – Works – INR 4306.663 million**

### aa. Establishment Charges

106. No provision is made in the estimate.

### bb. Tools and Plants

107. A provision of **INR 1.240 million** is made in the estimate.

### cc. Suspense

108. No provision is made in the estimate.

### dd. Receipts and Recoveries on Capital Account

109. No provision is made under this subheading.

**Total Direct Charges**

110. The total direct charges from the above sub-headings amount to **INR 4,307.903 million.**

**Total Indirect Charges**

| | | |
|---|---|---|
| A. Audit and accounts charges | 1% of cost of I-works as per CWC guidelines | INR 43.067 million has been made for this purpose |
| B. Miscellaneous unforeseen works | - | - |

111. Total indirect charges are **INR43.067** million.

**Total Project Development Cost**

112. Total project development cost including all direct and indirect charges has been estimated to be **Rupees 4350.970 million, say INR 4,351.00 million**. The abstract of the project cost is given in ***Table 19*** (DPR 2017).

**Table 19: Summary Cost of Modernisation (Rehabilitation) of VNC System in Tungabhadra project**

| S. No | Particulars | (INR in million) | | |
|---|---|---|---|---|
| | | UNIT I Headworks (Anicuts) | UNIT II Canal Works | Total |
| I | **Direct Charges of Works** | | | |
| 1 | A-Preliminaries | | 17.811 | 17.811 |
| 2 | B – Land | | - | - |
| 3 | C – Works | 615.329 | - | 6153.29 |
| 4 | D-Regulator | | 353.045 | 353.045 |
| 5 | E – Falls | | 10.467 | 10.467 |

| S. No | Particulars | (INR in million) | | |
|---|---|---|---|---|
| | | UNIT I Headworks (Anicuts) | UNIT II Canal Works | Total |
| 6 | F-Cross Drainage Works | | 93.763 | 93.763 |
| 7 | G – Bridges | | 206.690 | 206.690 |
| 8 | H – Escapes | | 73.105 | 73.105 |
| 9 | I-Navigation Works | | - | - |
| 10 | J-Power Plants and Civil Works | | - | - |
| 11 | K – Buildings | | 32.900 | 32.900 |
| 12 | L – Earthwork | | 2147.6.22 | 2147.6.22 |
| | L1 – Lining | | | |
| | L2-Service Road | | | |
| 13 | M – Plantation | | 6.795 | 6.795 |
| 14 | N-Tanks and Reservoirs | | - | - |
| 15 | O – Miscellaneous | | - | - |
| 16 | P-Maintenance (1% of cost of I-works except A, B, M, O, Q and X) | 6.153 | 36.099 | 42.252 |
| 17 | Q-Special Tools and Plants | | 4.046 | 4.046 |
| 18 | R – Communication | | - | - |
| 19 | S-Power Plant and Electrical Systems | | - | - |
| 20 | T – Water Supply Works | | - | - |
| 21 | U-Distributaries and Minors | | 669.603 | 669.603 |
| 22 | V-Watercourses and Field Channels | | - | - |
| 23 | W-Drainage | | 22.673 | 22.673 |
| 24 | X-Environment and Ecology | | - | - |
| 25 | Y-Loss of Stocks and Unforeseen (0.25% of cost of I-works except A, B, M, O, Q and X) | 1.538 | 9.025 | 10.563 |
| | **Total of I – Works** | **623.021** | **3683.643** | **4306.663** |
| II | Establishment Charges | | - | - |
| III | Small Tools & Plants | | 1.240 | 1.240 |
| IV | Suspense | | - | - |
| V | Receipts & Recoveries on Capital Accounts Deductions | | - | - |
| | **Total Direct Charges** | **623.021** | **3684.883** | **4307.903** |
| | **Indirect Charges** | | **-** | - |
| | b) Audit and Account Charges (1% of cost of I works) | 6.230 | 36.836 | 43.067 |
| | **Total Indirect Charges** | **6.230** | **36.836** | **43.067** |
| | **Total Direct and Indirect Charges** | **629.251** | **3721.719** | **4350.970** |
| | **Grand Total** | | | **4351.0 Millions** |
| VII | **Soft Component Requirements** | | | |
| **S. No.** | **Soft Components** | | | **Total Cost** |
| i | Command Area Development | | | 341.00 |
| ii | Flow Measurement & Telemetry system | | | 271.00 |

| S. No | Particulars | (INR in million) | | |
|---|---|---|---|---|
| | | UNIT I Headworks (Anicuts) | UNIT II Canal Works | Total |
| iii | Equipment and Supplies | | | 12.00 |
| iv | Training & Consultancy Services | | | |
| 1 | Training | | | 188.00 |
| 2 | Support Services Team for WUCs | | | 36.00 |
| 3 | Surveys and Studies | | | |
| a | Monitoring and Evaluation | | | 77.00 |
| b | Survey, Design and Studies | | | 616.00 |
| 4 | Support Consultants | | | |
| a | International Consultants | | | 106.00 |
| b | National Consultants | | | 121.00 |
| c | Consultancy Support | | | 30.00 |
| v | Staff Costs | | | 634.00 |
| vi | Physical Contingencies | | | 173.00 |
| vii | Price Contingencies | | | 198.00 |
| viii | Interest During Implementation | | | 123.00 |
| ix | Commitment Charges | | | 7.00 |
| | | | | 46442.70 |
| | **Grand Total** | | | **46443.00** |
| | | | | **Say Rs 464.43 Crores** |

## 3.11 Components of the Project

113. Modernization of VNC Project includes rehabilitation of the VNCs consisting of distributaries and associated structures, installation of flow measurement and telemetry, Command Area Development (CAD) works, strengthening asset management and main system Operation & Maintenance (O&M), capacity building of WUCS and Training on sustainable agriculture practices and Strengthening of Nigams and Command Area Development Authority (CADA).

## 3.12 Need of the Project

114. The VNC system is spread over 3 districts, namely, Bellary, Raichur and Koppal. Originally, VNC were originally designed as run-of-the river irrigation channels serving the irrigation needs of the local population over 600 years ago. The detailed survey and analysis has revealed that the channels are lined with size-stone masonry partly and have since lost their shape over the years. The bed of the channels has scoured in some reaches and is silted up heavily in some reaches. Heavy weed growth is noticed in and around the channels. Some of the structures are in dilapidated condition which requires to be rehabilitated to make them functional. The condition of the anicuts and the channels have deteriorated to such an extent that it has led to heavy seepage and transmission losses, thereby making it difficult for the command areas to get requisite quantity of water. Farmers have been resorting to temporary access to water from other sources such as the Tungabhadra High Level Canal and the TB Low Level canal. Such temporary access

is sometimes unauthorised. The variety of problems in the photographs the VNC system is depicted by the accompanying photographs.

A typical damaged VNC anicut

A structure on Raya Channel in need of rehabilitation

Degraded banks of the Siruguppa Channel

Silting in Anegundi Channel

Thick vegetative growth in Anegundi Channel hampering flow of water

115. Detailed survey and analysis has revealed that the VNC performance is quite poor due to following reasons:

    a. The overall efficiency of the VNC system may be between 30-50% decreasing the overall crop yields and water-use efficiency;

b. Inequity in the pattern of water distribution is common, causing excess water at the head-reach of the canals and inadequate quantity at the tail end.
c. In certain regions, environmental problems such as water logging and salinity have developed which adversely impact agricultural productivity.
d. Unreliable water supply discourages farmers from organizing themselves to take up managerial responsibilities including O&M of the tertiary distribution network. Further, they are reluctant to pay water charges when the service is poor.
e. Often, operational problems with many projects are aggravated when maintenance activities are deferred because of inadequate availability of maintenance funds. Lack of maintenance has resulted in rapid decline in public investments, failure of canal lining and under performance of control structures.
f. There is unanimous agreement among farmers on the need to improve operation of irrigation systems in order to increase agricultural and irrigation water productivity. Management solutions frequently recommended include improved water resources management, better coordination between agriculture and irrigation agencies, training, higher water charges and farmer participation.

116. As per clause IX-E of Krishna Water Disputes Tribunal Award (2010), 7 TMC of water from Tungabhadra reservoir is earmarked for Raya and Basavanna channels. An allocation of 2 TMC was made by way of assistance through other regulated discharges other than Raya and Basavanna channels from Tungabhadra reservoir. In the 1993 Master Plan, an allocation of 12.05 TMC was made for the VNC system without channel-wise breakup and river assistance. The revised Master plan of 2003 has an allocation of 5.80 TMC for all the 16 Vijayanagara channels. Hence, in order to improve channel efficiency and utilise the allocated water of 5.80 TMC, GoK has embarked on the Modernization of the VNC System to achieve savings of 6.25 TMC of water.

117. During consultations in the VNC command area, farmers expressed a desire for rehabilitation of the entire VNC system including anicuts with a view to restoring their water rights, as well.

118. The agricultural productivity of the area served by VNC has been on the decline because of leakages in the system. Under KSIWRMIP, the Modernization of the VNC System is expected to achieve improved crop yields, improved irrigation efficiency, reduced O&M costs, improved recovery of O&M costs, improved financial sustainability, increased cooperation and coordination among government agencies and the user community, and WUCS strengthening. Last but not the least is reduction in environmental degradation. It is proposed to establish WUCS in the VNC command area with a view to strengthen them to take care of sustainability aspects in terms of O&M of canals. In addition to canal modernization, capacity building of WUCS is critical to make investment sustainable over a long period of time.

## 3.13 Project Category

119. As explained in Chapter 2, since a portion of the project area fall within the notified OCR, the Modernization (rehabilitation) of the VNC project is categorized as an ADB Category A Project. As advised by the ADB Review Mission 17-24 November 2016, and as per ADB SPS 2009, an EIA and RBA have been carried out. The RBA assessed aspects of

the project that have significant adverse environmental impacts in the OCR. Appropriate mitigation measures are included as part of the Environmental Management Plan.

120. As per the ADB Review and Approval procedures for Category A projects deemed environmentally sensitive, EIA must be cleared by ADB before project approval. The EIA must be disclosed to the public at least 120 days before the project is approved. For these projects, ADB will review compliance with ADB environmental assessment requirements, including those related to consultation and information disclosure. Completed report is made available worldwide by ADB, via the depository library system and the ADB website.

121. Additionally, as per the analysis of environmental regulatory compliance provided in ***Table 1,*** Modernization of VNC Project does not require Prior Environmental Clearance either from the Ministry of Environment, Forests and Climate Change (applicable for Category A projects as per MoEFCC notification) or from the State Environmental Impact Assessment Authority (applicable for Category B projects as per MoEFCC notification) because canal rehabilitation projects do not attract the provisions of the EIA Notification that mandates obtaining Prior Environmental Clearance. In this regard, it is reiterated that though the project is titled "Modernization" of the VNC Project, it involves only "rehabilitation" of the anicuts, canals and appurtenant structures.

122. However, the project shall require *recommendation* of the National Board for Wildlife (NBWL), Ministry of Environment, Forests and Climate Change, Government of India through State Board for Wildlife (SBWL), Karnataka Forest Department for the portion of the work to be carried out in the notified OCR. Further, because a portion of the project passes through the Hampi WHA, an approval from the HWHAMA shall be required.

## 3.14 Status of Clearances

123. In view of the requirement of the recommendation of SBWL/NBWL, an application was submitted through online portal of the Ministry of Environment, Forests and Climate Change (MOEF&CC), Government of India on 12.10.2017 and also submitted the hard copy of the project documents to Deputy Conservator of Forests (DCF), Bellary and ACF, Hospet on 18.12.2017 for onward consideration. Subsequent to the submissions, the Koppal and Bellary Forest Divisions have completed the field visits to 7 of the 9 anicuts located within the OCR. The field visits to the remaining sites are expected to be completed in June 2018. Later, the Forest Divisions shall issue the report to the Principal Conservator of Forests, Karnataka Forest Department and the SBWL shall be constituted for issuing the recommendation. The constitution of the SBWL is expected to occur after August 2018.

124. Similarly, in November 2017, request for permission from the HWHAMA was submitted. Permission for rehabilitation works within the Hampi WHA has been obtained as on April 6, 2018 (***Annexure 1***).

# 4. DESCRIPTION OF THE EXISTING ENVIRONMENT

125. This section describes baseline information about various environmental components. This baseline helps to predict post implementation impacts, and in ascertaining impacts during construction and operational phases of the project. Primary monitoring of environmental data viz., air, surface water, groundwater and noise were conducted during April 2018. The results of the sampling and analysis of the primary environmental monitoring is presented in ***Annexure 3***.

## 4.1 Physical Environment

126. **Ambient Air Quality:** The ambient air quality is an issue to be taken care of during execution of the project. Air quality will get adversely impacted on account of vehicular movements and equipment use resulting in emissions adversely affecting ambient air quality.

127. The current levels of air pollutants in the three project districts, i.e., Bellary, Koppal and Raichur have not been monitored regularly either by the Karnataka State Pollution Control Board (KSPCB) or the National Ambient Air Quality Standards Program of the Government of India. However, JSW Steel Complex located in Hospet carries out both continuous and manual air quality monitoring at certain locations near their facility. Continuous monitoring is carried out at 4 locations while manual monitoring is carried out at 10 locations. Results from the JSW Half-Yearly Report 2013-14 are provided in ***Table 20.***

**Table 20: Ambient Air Quality at certain locations in Bellary and Koppal District**

| S. No. | Location | $PM_{10}$ in µg/m³ | | $PM_{2.5}$ in µg/m³ | | $SO_2$ in µg/m³ | | $NO_2$ in µg/m³ | |
|---|---|---|---|---|---|---|---|---|---|
| | | 12-13 | 13-14 | 12-13 | 13-14 | 12-13 | 13-14 | 12-13 | 13-14 |
| **Continuous Monitoring Locations** | | | | | | | | | |
| 1 | Vidhyanagar | 63 | 51 | 20 | 21 | 14 | 15 | 13 | 37 |
| 2 | SHT | 142 | 132 | 55 | 51 | 16 | 9 | 30 | 58 |
| 3 | Vaddu | 135 | 208 | 50 | 47 | 7 | 7 | 36 | 14 |
| 4 | 10 MT Gate | 181 | 161 | 92 | 36 | 9 | 13 | 13 | 62 |
| **Manual Monitoring Locations** | | | | | | | | | |
| 1 | Sultanpura | 129 | 124 | 16 | 64 | 12 | 5 | 14 | 13 |
| 2 | Talur | 93 | 79 | 12 | 57 | 15 | 3 | 14 | 9 |
| 3 | Vaddu | 159 | 96 | 16 | 60 | 14 | 8 | 18 | 13 |
| 4 | Gadiganur | 145 | 87 | 21 | 63 | 10 | 8 | 12 | 15 |
| 5 | Basapura | 136 | 91 | 37 | 57 | 12 | 9 | 13 | 15 |
| 6 | Kurekuppa | 86 | 89 | 8 | 60 | 10 | 11 | 12 | 15 |
| 7 | Kudithini | 43 | 77 | 12 | 65 | 24 | 5 | 22 | 19 |
| 8 | Karadidhama | 25 | 68 | 4 | 45 | 8 | 2 | 9 | 10 |
| 9 | Hampi | 109 | 55 | 14 | 36 | 12 | 3 | 14 | 10 |
| 10 | Toranagallu | 127 | 116 | Na | 77 | 4 | 7 | 5 | 17 |

**Source:** *Report of JSW Steel Complex, Hospet*

128. These parameters-PM10, PM2.5, $SO_2$ and NOx-are well within limits compared with National Ambient Air Quality standards and hence it can be concluded that the operation of the JSW Steel Complex has not adversely impacted the region's air quality.

129. Considering that limited secondary air quality data was available for the project region, primary environmental monitoring was conducted during April 2018 to ascertain air quality levels at various locations across the project area. The monitoring results are as provided in ***Table 21.***

**Table 21: Results of the Primary Monitoring of Air Quality in the Project Locations**

| S. No. | Parameters | Unit | NAAQA Standards | Sample 1 (Basavanna Canal) | Sample 2 (Hulugi Anicut) | Sample 3 (Turtha Canal) | Sample 4 (Kalaghatta Canal) | Sample 5 (Anegundi Canal) |
|---|---|---|---|---|---|---|---|---|
| 1 | Particulate Matter ($PM_{10}$) | $\mu g/m^3$ | 100 | 74 | 60 | 62 | 71 | 69 |
| 2 | Particular Matter ($PM_{2.5}$) | $\mu g/m^3$ | 60 | 18 | 12 | 15 | 17 | 14 |
| 3 | Sulphur dioxide ($SO_2$) | $\mu g/m^3$ | 80 | 7.64 | 6.68 | 7.32 | 8.01 | 7.58 |
| 4 | Nitrogen dioxide ($NO_2$) | $\mu g/m^3$ | 80 | 13.06 | 10.94 | 11.27 | 13.17 | 12.05 |
| 5 | Lead (Pb) | $\mu g/m^3$ | 1 (24 Hr. Average) | 0.079 | 0.052 | BDL | 0.023 | 0.080 |
| 6 | Nickel (Ni) | $ng/m^3$ | 20 (Annual Average) | BDL | BDL | BDL | BDL | BDL |
| 7 | Arsenic (As) | $ng/m^3$ | 6.0 (Annual Average) | BDL | BDL | BDL | BDL | BDL |
| 8 | Carbon monoxide (CO) | $mg/m^3$ | 4.0 (1 hr. Average) | 1.51 | 1.08 | 1.18 | 1.40 | 1.27 |
| 9 | Ozone ($O_3$) | $\mu g/m^3$ | 180 (1 hr. Average) | 3.44 | 2.91 | 2.83 | 3.05 | 3.30 |
| 10 | Ammonia ($NH_3$) | $\mu g/m^3$ | 400 (24 hr Average) | 5.77 | 4.78 | 4.83 | 5.27 | 5.43 |
| 11 | Benzene ($CH_6$) | $\mu g/m^3$ | 5 (Annual Average) | BDL | BDL | BDL | BDL | BDL |
| 12 | Benzo (a) pyrene (BaP) | $\mu g/m^3$ | 1 (Annual Average) | BDL | BDL | BDL | BDL | BDL |
| 13 | Non-Methane Hydro carbon (NHMC) | $\mu g/m^3$ | - | BDL | BDL | BDL | BDL | BDL |

130. A map indicating locations and GPS coordinates is provided in Figure 6. Also, concentration of all the parameters are well below the NAAAQA air quality limits and hence the air quality can be termed as “good” at the project locations.

131. Air emissions at the time of construction will be lower than the permissible limits at a majority of the construction locations identified for the project activity. However, higher emissions could occur at those canal locations that are within the city/ town limits.

132. **Water Resources:** Water resources constitute mainly surface and groundwater, with rainfall being the basic source. The mean annual rainfall in the state is 1355 mm with more than 73% contributed by the southwest monsoon. Annual rainfall variation across agro-climatic zones in the state is too wide, ranging from 585 mm in the northern dry zone to 3893 mm in the coastal zones. There are seven river systems in Karnataka, viz.,

Cauvery, Krishna, Godavari, West flowing rivers, North Pennar, South Pennar and Palar. VNC is part of Krishna basin. In Bellary District, the annual normal rainfall is 611 mm (1996–2005). In Koppal District, the annual normal rainfall is 572 mm. In Raichur District, the annual normal rainfall is 376 mm. The estimated yield of the Krishna Basin is provided in ***Table 22.***

**Table 22: Estimated yield of water from Krishna River Basin**

| Catchment Area | | Economically Available | | Utilisation | |
|---|---|---|---|---|---|
| km² | Share | TMC/annum | Share | TMC/annum | Share |
| 113,271 | 59.1% | 969.44 | 27.9% | 1156.00 | 68.4% |

*Source: Project Completion Report, Indian Hydrology Project II, National Institute of Hydrology – July 2014*

133. Groundwater utilisation for irrigation has grown over the past couple of decades. The groundwater availability in the three project districts is provided in ***Table 23.***

**Table 23: Groundwater Availability in the three project districts**

| District | Annual Recharge (Ha-m/annum) | | | | | Natural Discharge HAM/a | Net Water Availability Ha-m/annum |
|---|---|---|---|---|---|---|---|
| | Monsoon Season | | Non-Monsoon Season | | Total | | |
| | Rainfall | Other | Rainfall | Other | | | |
| Bellary | 27,547 | 17,745 | 7,618 | 12,700 | 65,610 | 2,135 | 63,476 |
| Koppal | 20,252 | 25,028 | 3,676 | 23,070 | 72,025 | 1,876 | 70,149 |
| Raichur | 21,247 | 20,754 | 3,941 | 21,940 | 67,883 | 1,525 | 66,358 |

*Source: Groundwater Information Booklet (Bellary, Koppal and Raichur), Central Ground Water Board, 2011*

134. In Bellary District, the major water bearing formations include shallow aquifers of alluvium up to 10 m and weathered zones of gneisses. Granites occur between 9 and 25 m bgl. Deeper aquifers of jointed and fractured gneisses, granites and Schists occur between the depths 30 and 197 m bgl. The pre-monsoon groundwater level occurs between 1.72 and 19.48 m bgl (average 4.77 m) and post-monsoon groundwater level occurs between 1.22 and 17.61 m bgl (average 3.47 m). In Koppal District, the major water bearing formations include weathered and fractured Granites, Gneisses and Schists. The pre-monsoon groundwater level occurs at 4.50-16.5 m bgl and post-monsoon groundwater level occurs at 1.15–16.24 m bgl. In Raichur District, the major water bearing formations include weathered /fractured Granitic Gneiss. The pre-monsoon groundwater level occurs at 0.65–10.7 m bgl and post-monsoon groundwater level occurs at 0.05–11 m bgl.

135. A portion of the irrigation water demand is also met from lakes and tanks. The relative contribution of tanks to the irrigation potential has declined over the years owing to development of surface water irrigation. However, these tanks do provide supplementary irrigation demand especially during periods of low-release from the storage reservoirs. Siltation of tanks due to lack of maintenance in addition to encroachment located closer to the urban areas has adversely impacted the agricultural productivity of the command under the VNC system. Kamalapura Tank located south of Kamalapura Town in the VNC area is one of the major water bodies located along Hospet-Kamalapura Road. The Kamalapura Tank is fed by the Raya Canal and utilised to irrigate about 290 ha of land. Other tanks in the VNC system include Sompura Tank and the Tank behind the Kannada University Campus at Hampi. There are other smaller tanks within the towns and villages

which also provide supplementary irrigation to the VNC command. These tanks are not part of the rehabilitation efforts under the project.

**Kamalapura Tank (fed by Raya Canal)**

136. While agriculture water demand comprises over 90% of Krishna Basin water, demand from other sectors is also growing simultaneously. Further, inefficiency in water use and management is inflating demand, resulting in inequitable distribution and under-utilisation of the irrigation potential. Unauthorised use of irrigation water in excess, particularly in the head reaches and illegal pumping from canals are depriving farmers of their due share especially at the tail-end areas. Excessive use of water for irrigation in the upper-reaches and increased exploitation of groundwater in the tail-end areas has often led to leaching of salts. Depletion of the groundwater table is further accentuated because of highly subsidised power for the agricultural sector. Hence, it is appropriate that the modernization project focuses on improving water productivity–that is crop yield per drop of water.

137. Environmental concerns pertaining to water resources centre around water resource management, specifically relating to both quantity and quality issues. Among the core environmental concerns is the conservation of existing water resources and prevention of further degradation and depletion. Issues include the rejuvenation of degraded traditional surface water bodies, enhancing the availability of water through water harvesting structures and recharge of groundwater. More important is the judicious and economic use of both surface and groundwater for agricultural, industrial and domestic purposes. Irrigation constitutes over 93.2% of the surface and groundwater in the Krishna Basin. Hence, it is laudable that the objective of the Modernization of the VNC Project is to achieve water use efficiency of the Vijayanagara Channel System while improving agricultural productivity.

138. Surface water bodies, particularly rivers and lakes, are highly polluted with increasing pollution load from agricultural discharge, industrial effluents and domestic waste. The report *"Status of River Water Quality in Karnataka Over a Decade 2005–2015"* prepared by the KSPCB shows that there was a change in the environmental quality of Tunga, Bhadra and Tungabhadra rivers especially in the stretches that are closer to major factories and towns. This implies that rivers are the common dumping sources for

untreated effluent release from various industries and municipal sewage. In fact, Hairhar Polyfibres Private Limited is one of the few industries in the state that are allowed to discharge the treated effluents directly on to the river. There are no other large industrial operation in the immediate vicinity of the the Tungabhadra River. However, the Tungabhadra river water quality downstream of the treated discharges of effluent from Harihar Polyfibres Private Limited, conforms to Class C (i.e., suitable as a drinking water source after conventional treatment followed by disinfection).

139. Mining industries involved in large scale mining of iron ore inflicted water pollution through discharging tailings in Bellary District. The major land use in the Krishna Basin is agriculture. Hence, a large quantity of agriculture related pollutants such as fertilizers and pesticides make its way into the surface waters, as well.

**Foam in the Kalaghatta Canal due to industrial effluents let into the canal**

***Surface Water Quality***

140. Considering that limited secondary surface water quality data was available for the project region, primary environmental monitoring was conducted during April 2018 to ascertain the surface water quality levels at various locations across the project area. The monitoring results are as provided in ***Table 24.***

**Table 24: Results of the Primary Monitoring of Surface Water Quality in the Project Locations**

| S. No. | Parameter | Unit | Sample 1 (Basavanna Canal) | Sample 2 (Hulugi Canal) | Sample 3 (Turtha Canal) | Sample 4 (Kalaghatta Canal) | Sample 5 (Anegundi Canal) |
|---|---|---|---|---|---|---|---|
| 1 | pH | | 7.50 | 7.72 | 7.75 | 7.64 | 7.62 |
| 2 | Conductivity | µs/cm | 564 | 406 | 510 | 1085 | 313 |
| 3 | Total Dissolved Solids | mg/L | 347 | 277 | 305 | 622 | 215 |
| 4 | Total Hardness | mg/L | 132 | 108 | 156 | 256 | 80 |
| 5 | Dissolved Oxygen | mg/L | 5.6 | 5.0 | 5.3 | 5.3 | 5.2 |
| 6 | Biological Oxygen Demand (3 days @ 27°C) | mg/L | 9.2 | 6.8 | 5.6 | 16 | 3.4 |
| 7 | Chemical Oxygen Demand | mg/L | 64 | 48 | 24 | 88 | 16 |

| S. No. | Parameter | Unit | Sample 1 (Basavanna Canal) | Sample 2 (Hulugi Canal) | Sample 3 (Turtha Canal) | Sample 4 (Kalaghatta Canal) | Sample 5 (Anegundi Canal) |
|---|---|---|---|---|---|---|---|
| 8 | Nitrate as $NO_3$ | mg/L | 4.29 | 4.19 | 3.24 | 8.38 | 2.43 |
| 9 | Chloride as Cl | mg/L | 57.85 | 40.49 | 44.35 | 109.92 | 28.92 |
| 10 | Sulphate at $SO_4$ | mg/L | 26.29 | 19.17 | 20.06 | 39.04 | 17.39 |
| 11 | Flouride as F | mg/L | 0.15 | 0.53 | 0.08 | 0.53 | 0.30 |

141. The surface water quality is characterized as per the criteria issued by the Central Pollution Control Board, Government of India. The details of the water quality criteria are provided in a box.

**Water Quality Criteria**

The concentrations of the various parameters decide the water quality standard, a particular water source belongs to. There are five water quality criteria as defined by the Central Pollution Control Board as follows:

A. Drinking water source without the conventional treatment but after disinfection;
B. Outdoor Bathing (organized);
C. Drinking water source with conventional treatment followed by disinfection;
D. Propagation of wild life, fisheries;
E. Irrigation, industrial cooling, controlled waste disposal.

142. The water quality standards for the rehabilitation should conform with to criterion D and E under the Indian water quality standards. Criterion D represents the water standards to maintain in the area of OCR. During construction, surface water in canals and anicuts should not exceed the guidelines set in Criterion E. The International Finance Corporation Environmental, Health and Safety (IFC EHS) guidelines for waste water and ambient water quality will only be used as indicative values for treated sanitary sewage discharges. As an example, waste water from campsites should comply in the IFC standards.

| Pollutants | unit | A | B | C | D | E | IFC EHS |
|---|---|---|---|---|---|---|---|
| pH | | | | 6.5 to 8.45 | | | 6 to 9 |
| Conductivity | uS/cm | - | - | - | 1500 | 2250 | - |
| Total TDS | mg/L | 500 | - | - | - | - | - |
| Total Hardness | mg/L | - | - | - | - | - | - |
| Dissolve Oxygen | mg/L | 6 | 5 | 4 | 4 | - | - |
| BOD | mg/L | 2 | 3 | 3 | - | - | 30 |
| COD | mg/L | - | - | - | - | - | 125 |
| $NO_3$ | mg/L | 20 | - | 50 | - | - | - |
| Cl | mg/L | 250 | - | 600 | - | 600 | - |
| $SO_4$ | mg/L | 400 | - | 400 | - | 1000 | - |
| F | mg/l | 1.5 | 1.5 | 1.5 | - | - | - |
| Total N | mg/l | - | - | - | - | - | 10 |
| Total P | mg/l. | - | - | - | - | - | 2 |
| TSS | mg/l. | - | - | - | - | - | 50 |
| Oil and Grease | mg/L | - | - | - | - | - | 10 |
| Total Coliform | MPN/100ml | - | - | - | - | - | 400 |

143. Comparing the concentrations of the various parameters as per the definition of the water quality criteria, it can be seen that except for the Kalaghatta canal surface water, all other

canal water samples conforms to 'D' criteria viz., suitable for propagation of wildlife and fisheries. However, the Kalaghatta canal water quality conforms to 'E' criteria signifying industrial effluent inflow that has deteriorated the water quality. Despite, the industrial effluents entering the Kalaghatta canal, the canal water quality is found to be suitable for irrigation.

***Groundwater Quality***

144. Ground water quality data has also been obtained from Central Pollution Control Board (CPCB) and shows that the groundwater has presence of certain chemical constituents that is more than the permissible limit. In Bellary District, the Nitrate and Chloride contents are found more in few pockets in Hospet, Siruguppa and parts of Hadagali, and south of Kudligi taluks. This is due to intensive irrigational activities in the command area especially in Hospet and in Siruguppa taluks where farmers use maximum Nitrogen, Phosphate and sulphate fertilisers. It is observed Nitrate concentrations are beyond 100 ppm in the range of 106 to 380 ppm and the average Nitrate concentration is 144.33 ppm. In Koppal District, the concentrations of Fluoride, Nitrates and Total Dissolved Solids is more than the permissible limits in a few pockets. This is especially true near the town of Gangavathi where the town effluent enters the canal system as well as leaches into the groundwater affecting its quality.

145. In Raichur District, higher amount of fluoride and electro-conductivity values are observed. The higher amount of fluoride and electro-conductivity values in groundwater is naturally occurring and can be attributed to the local geological conditions.

146. Considering the secondary data available on groundwater quality in the region are from 2014, one round of primary environmental monitoring was conducted during April 2018 to ascertain the ground water quality levels in the project area. The monitoring results are as provided in ***Table 25.***

**Table 25: Results of the Primary Monitoring of Groundwater Quality in the Project Locations (April, 2018)**

| S. No. | Parameter | Unit | Acceptable Limits | Permissible Limits | Sample 1 (Basavanna Canal) | Sample 2 (Hulugi Canal) | Sample 3 (Turtha Canal) | Sample 4 (Kalaghatta Canal) | Sample 5 (Anegundi Canal) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | | 6.5 | 8.5 | 7.62 | 7.75 | 6.96 | 7.10 | 7.75 |
| 2 | Alkalinity | mg/L | 200 | 600 | 388 | 264 | 260 | 308 | 180 |
| 3 | Conductivity | µs/cm | - | - | 1489 | 863 | 832 | 965 | 506 |
| 4 | Total Dissolved Solids | mg/L | 500 | 2000 | 905 | 595 | 571 | 710 | 352 |
| 5 | Total Hardness | mg/L | 200 | 600 | 432 | 300 | 236 | 356 | 172 |
| 6 | Turbidity | NTU | 1 | 5 | 0.48 | 0.22 | 0.06 | 2.96 | 3.22 |
| 7 | Chloride (Cl) | mg/L | 250 | 1000 | 167.77 | 80.99 | 75.21 | 92.56 | 36.64 |
| 8 | Sulphate ($SO_4$) | mg/L | 200 | 400 | 53.48 | 45.87 | 37.96 | 49,53 | 19.87 |
| 9 | Flouride (F) | mg/L | 1 | 1.5 | 0.49 | 0.55 | 0.64 | 0.84 | 0.13 |

147. The concentrations of the various parameters are within the range of the Acceptable and Permissible Limits and hence the groundwater quality does not seem to have significantly affected by the indiscriminate disposal of industrial and municipal effluents or increased use of chemical fertilizers and pesticides.

148. ***Noise Levels:*** The project covers both rural and urban environment. Considering that there was no secondary data available on the noise levels, a primary measurement of noise levels was carried out at over five locations spread across the project areas and have been found to be within the permissible limits. The results are tabulated in ***Table 26***.

**Table 26: Results of the Primary Measurement of Noise Levels in the Project Locations**

| S. No. | Sample Location | Time Frequency | Parameters | | | Standard |
|---|---|---|---|---|---|---|
| | | | Max | Min | $L_{eq}$ in dB(A) | |
| 1 | Basavanna Channel | 6.01am – 10.00pm | 74.5 | 32.4 | 53.97 | 55.0 dB(A) Day |
| | | 10.01pm – 6.00am | 72.1 | 30.0 | 42.32 | 45.0 dB(A) Night |
| 2 | Hulugi Anicut | 6.01am – 10.00pm | 84.2 | 42.7 | 54.17 | 55.0 dB(A) Day |
| | | 10.01pm – 6.00am | 66.5 | 36.6 | 41.77 | 45.0 dB(A) Night |
| 3 | Turtha Channel | 6.01am – 10.00pm | 80.5 | 45.1 | 52.41 | 55.0 dB(A) Day |
| | | 10.01pm – 6.00am | 70.2 | 39.4 | 43.01 | 45.0 dB(A) Night |
| 4 | Kalaghatta Channel | 6.01am – 10.00pm | 73.2 | 34.8 | 51.53 | 55.0 dB(A) Day |
| | | 10.01pm – 6.00am | 68.7 | 32.8 | 41.69 | 45.0 dB(A) Night |
| 5 | Anegundi Channel | 6.01am – 10.00pm | 77.1 | 48.9 | 53.08 | 55.0 dB(A) Day |
| | | 10.01pm – 6.00am | 74.1 | 46.7 | 42.74 | 45.0 dB(A) Night |

149. The map showing the locations of all the various sampling points for air, surface water, groundwater and noise are provided in ***Figure 6.***

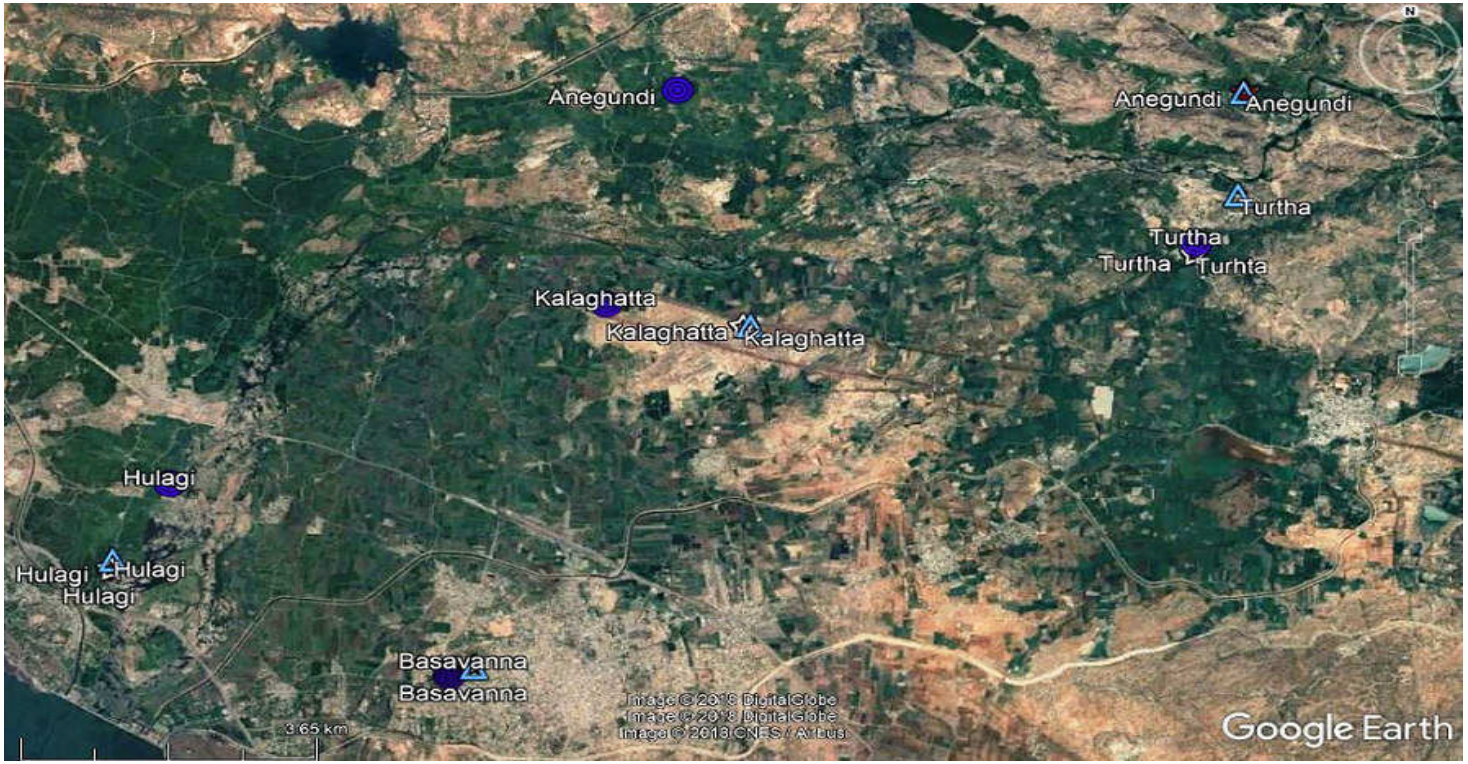



**Figure 6: Sampling Locations for Primary Environmental Monitoring of Air, Surface Water, Groundwater and Noise Quality**

| Legend | Environmental Parameter |
|---|---|
| ☆ | Air |
| ◎ | Surface Water |
| △ | Groundwater |
| ◈ | Noise |

150. ***Soil Quality:*** As per Groundwater Information Booklet prepared by the Central Ground Water Board, the districts of Bellary, Koppal and Raichur are covered by reddish sandy soil, light green loamy soil and reddish-brown soil. Quality is of importance as this has a direct impact on achieving the project objective of improved agricultural productivity. Soil in a portion of the agricultural lands located at the head-end of the canals have become saline due in intense agriculture coupled with excessive use of fertilizers and pesticides. No other soil quality data are available for the three districts.

151. ***Land Use:*** The predominant land use in the project area is agricultural. ***Table 27*** provides the existing land use in each of the three districts.

**Table 27: Land use pattern in Bellary, Koppal and Raichur Districts**

| Particulars | Bellary | Koppal | Raichur |
|---|---|---|---|
| Total Geographical Area | 813,196 | 552,495 | 835,843 |
| Forest | 97,017 | 29,451 | 18,167 |
| Non-agricultural | 68,657 | 39,003 | 20,563 |
| Barren Land | 53,477 | 16,627 | 20,084 |
| Cultivable Waste Land | 24,839 | 2,568 | 10,712 |
| Permanent Pasture | 5,472 | 14,675 | 198,116 |
| Trees and Grover | 3,606 | 210 | 13,684 |
| Current Fallow Land | 95,234 | 69,420 | 169,352 |
| Other Fallow Land | 28,827 | 0 | 49,785 |
| Net Area Sown | 436,067 | 380,541 | 513,680 |
| More than once area sown | 133,585 | 127,254 | 166,215 |
| Total Cropped Area | 583,616 | 429,124 | 664,274 |

*Source: DPR (2017)*

152. ***Meteorological Conditions:*** As per the Climate Section provided in the Groundwater Information Booklet prepared by the Central Ground Water Board, the climate of Bellary district is quite moderate and shows dryness in major part of the year and a hot summer from March to May months when mean maximum temperatures ranges from 23.2°C to 40.4°C. June to September is the southwest monsoon period when the temperature is 19.7°C to 35.1°C, October and November is the post-monsoon season with clear bright weather with the mean daily temperature ranging from 14.4°C to 31.1°C. During December to February, weather remains dry and comparatively cool. Relative humidity ranges from 48 to 74% in the morning and in the evening, it ranges from 27% to 61%. Bellary district receives rainfall from southwest monsoon from June to September and northeast monsoon from October to December. Overall on an average, there are 43 normal rainy days and normal rainfall in the district is 611 mm.

153. Koppal district experiences a semi-arid type climate characterised by hot summer and low rainfall. It is cool and pleasant during major part of the year except during the summer months of March to middle of June. The coldest period is December to January with minimum temperatures at 16°C and maximum reaching 45°C during hot summer district. The annual normal rain fall is 572 mm and normally rain commences from June and continues up to November. Heavy rainfall during the month of September and October, with normal average rain days of 40 in a year.

154. The climate of Raichur district can be termed as mild to severe, with mild winters and hot summers. December is the coldest month with mean daily minimum of 17. 7°C, while May is the hottest month with mean daily maximum temperature of 39.8°C. The day temperature in May often touches 45°C. Relative humidity of over 75% is common during monsoon period. Wind speeds exceeding 15km/h are common during the months of June and July. The recorded annual potential evaporation is around 1950 mm with May registering over 220 mm and December around 120mm. The normal annual rainfall of the district is 621 mm. The annual number of the rainy days is about 49 days. Nearly 67% of the rain is received during the southwest monsoon period (June-Sept) and the northeast monsoon contributes about 24%, during the post monsoon period.

155. ***Seismicity***: As per the Revised Earthquake Hazard Mapping, 22.13% of the total geographical area of the state of Karnataka is under Moderate earthquake damage risk zone and remaining area of the state is under low damage risk zone. The state has reported more than 500 earthquake tremors in the last three decades with most of them having low magnitude. It is found that the weak zones around the northern Karnataka bordering Maharashtra could cause heavy damages in future. The areas of southern part of Karnataka are also not free from frequent tremors. The Karnataka state is categorized as moderate to low seismic risk zone. The districts of Bellary, Koppal and Raichur fall under Zone II (Low Damage Risk zone MSK VI). The map that reproduces the Global Seismic Hazard Assessment Program (GSHAP) data of the seismic zones in Karnataka.

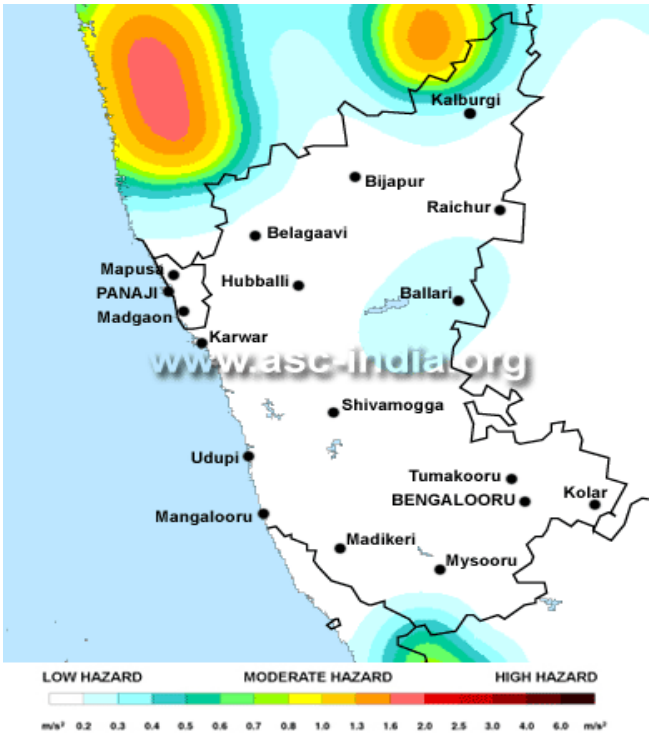



**Figure 7: GSHAP Map showing the seismic zones in the state of Karnataka**

## 4.2 Biological Environment

### 4.2.1 Major ecological features of the study area

156. Deccan Plateau is the oldest geographical landscape spread across parts of Maharashtra, Eastern Plains of Karnataka, Parts of Telangana and Tamil Nadu. The

plateau is located in a tropical zone comprising hot climate where dry scrub jungle exists as against green vegetation. The East flowing rivers that originate in the Western Ghats flow through the Deccan Plateau and cater to the needs of man and animal. Bellary and Koppal districts constitute Deccan Plateau areas in Karnataka and share similar ecosystem. River Tungabhadra itself acts as a boundary between these two districts. The Sandur hills stand out as a distinct geological feature in Bellary district well known for arid plains comprising black cotton soil and grasslands. The 48-kilometer stretch of spindle-shaped Sandur hill ranges starts from Tungabhadra reservoir in Hospet taluk to Swamihalli in Sandur taluk. The long and tall mountain range plays a key role in determining the climatic conditions of the north-eastern Karnataka. The thick dry deciduous forest in the plains and on the spindle-shaped hill ranges is entirely different from the rest of the Deccan Plateau ecosystem. The high altitude of the Sandur hill range plays a vital role in the distribution of flora and fauna of this region. According to the Gazetteer of Bellary, the hill above the famous Kumaraswamy Temple is 1,036 meters above mean sea level in the Southern part of Sandur, and 992 meters above the sea level at Ramagada in the Northern part. The biodiversity varies with elevation.

157. There is a mixed type of forest seen in the project area. The one adjoining Sandur hills is classified as *"Southern Tropical Dry deciduous Forest"* by Champion and Seth (Champion and Seth Classification of forest types of India, 1968) and further classified in the "mixed deciduous forest" sub category. The forest trees shed leaves during winter and remain bare and dry during summer. The flora in the higher altitudes is different from the rest of the vegetation in the low lands. Some flowers seen in the higher altitudes of Western Ghats like *Impatiens lawii, Clerodendrum serratum,* etc., are seen in the crests of the mountains. A rare flower like *Stobilanthes kunthiana* also called as Neelakurinji blooms in the steep slopes of mountains in the higher altitude in Swamimalai and Ramanamalai forests once in 12 years. Rare trees and trees of higher commercial value such as Red sanders, Sandal wood, Rose wood and teak wood grow here. The faunal diversity is also different compared to the rest of the Eastern Plains of Karnataka. Some birds of Western Ghats like Red-whiskered Bulbul, White Eye, Red Spurfowl, Puff-throated Babbler, Brown-headed Barbet etc. are also seen in Sandur hills.

158. But the forests in the plains of the study area are sub-classified as *'scrub, thorny jungle'* within the category of "Southern Tropical Dry deciduous Forest" by Champion and Seth, 1968. Rocky hills with scrub jungle found in the vicinity of Hampi, through which Tungabhadra River flows is a haven for Indian Sloth Bear, Indian Leopards, Indian Pangolin, rare birds like 'Yellow-throated Bulbul' etc. These are seen in the adjoining rocky forests and are listed as Vulnerable (VU) by IUCN.

159. ***The Aquatic Ecosystem:*** Fresh water ecosystem is one of the key aquatic ecosystems on earth. This ecosystem is the life-giver for the rest of the ecosystem that inhabits ponds, lakes, rivers, springs, streams, wetlands and marshes. About 97% of the water on Earth is saline occurring in Oceans and seas. Of the 3% fresh water, 69% is in the form of glaciers and ice caps. Of the remaining, 30% (out of 3% of the world's water) is in the form of ground water. Only 1% of the fresh water is available on the surface of the Earth in the form of lakes, rivers, ponds, streams etc. A typical ecosystem is evolved in and around the fresh water environment, where aquatic plants play a vital role in sustaining

the health and biodiversity of the riparian ecosystem. Fresh water plants also called as macrophytes have evolved by adapting to different strata of the aquatic ecosystem such as submerged, emergent, free floating, and rooted floating. The role of the submerged macrophytes is crucial to the maintenance of aquatic ecosystem. These submerged macrophytes as well as phytoplankton and algae produce oxygen for the aquatic faunal species. Abundance of species and faunal diversity depends upon the presence of submerged aquatic flora and Dissolved Oxygen.

160. ***Faunal diversity:*** The project area has a freshwater dominated environment inhabited by freshwater plants and animals. Agricultural activities, water resources development and fishing have already altered the biological environment and the entire ecosystem to a state totally dominated by human interventions. The biological environment covers flora and fauna. The canals are located close to habitation area. Hence, fauna is domesticated. However, there are two notified areas in the vicinity of the project area. These are the Daroji Bear Sanctuary and the Otter Conservation Reserve.

161. The Daroji Bear Sanctuary is located at a distance of about 25 km from the project canal locations and thereby not impacted by the rehabilitation works. However, a portion of the project components, primarily 9 of the 12 anicuts that feed the VNC System are located along a stretch of the River Tungabhadra that is a notified OCR. The presence of the notified OCR prompted the conduct of an RBA. The key findings along with the RBA report are provided in ***Annexure 9*** (and also Volume 2b of the VNC Feasibility Study Report). However, the salient features of the RBA are provided in the paragraphs below.

### 4.2.2 Salient Features of the RBA

162. The Rapid Biodiversity Assessment, conducted because a portion of the project areas are located in the notified OCR, identified some key species of aquatic flora in and around the OCR. While the submerged flora supplies oxygen and food for the faunal species, the emerged flora provides protection from exposure to animals such as smooth-coated otters and crocodiles. Otters make burrows in the thick bushes along the banks of the river while crocodiles hide under the marshes in the banks. Some fish species take refuge in the submerged flora to protect themselves from predators.

163. Though the aquatic flora is supporting the ecosystem, the hazardous growth of water hyacinth-*Eichornia crassipes* has covered the surface of water like a carpet in almost all *anicuts* and pools within the OCR. The thick carpet of water hyacinth on the water body does not allow sunlight to enter into water. Non-availability of sunlight hampers the process of photosynthesis of the submerged flora resulting in reduced dissolved oxygen. Lack of dissolved oxygen leads to death of planktons, and small and large aquatic fauna including crustaceans and fishes. The death and decay of underwater flora results in pollution of water, which later begins to petrify. The overgrowth of water hyacinth also helps sudden burst of mosquito population resulting in dreaded diseases such as Malaria, Dengue, Chikungunya, and Filariasis, especially among people living around the river. Excessive growth of water hyacinth also results in siltation of the *anicuts* and pools, leading to lack of storage of water.

164. In Upper and Lower Gangavathi *anicuts*, water spinach-*Ipomoea aquatica* is observed to have grown hazardously covering almost the entire surface of the anicuts. The hazards are similar to that of water hyacinth.

165. The river Tungabhadra hosts a repertoire of animals including giant turtles, otters, crocodiles and about 90 species of fishes and so on. Smooth-coated otter or Indian Smooth-coated otter (*Lutrogale perspicillata*) lives in the entire length of the river in considerable numbers. This riparian mammal is listed as Schedule-1 species under the Indian Wildlife (Protection) Act, 1972 and as Vulnerable (VU) by IUCN. The otters are facing threat from poachers as they trap the animal and club it to remove its skin intact. These otters breed during the late-winter-summer, litter in burrows made under the bushes on the river banks or inside the rocky caves within the river.

166. The Mugger Crocodile or the Indian Marsh Crocodile *(Crocodylus palustris)* is a fresh water crocodile that is commonly seen in the Indian rivers. Other crocodile species found in India are Gharials and Salt-water crocodiles. The Mugger crocodile is a medium-sized one that is seen in fresh water lakes, rivers, ponds, sluggish rivers, swamps, marshes etc. The male grows 13-16 feet in length. They are generally seen basking on the rocks surrounded by water in Tungabhadra River near Anegundi, Hampi, Kariyammanagadde and Bukkasagara river side. The crocodiles are killed by the villagers in vengeance for killing of their goats and sheep in the river. At times, the crocodiles are killed for their skin which is utilised for making shoes, bags etc. The crocodile lays eggs in the sand banks and islands in the river during summer. During monsoon, when fresh water flows into these sand dunes, the young ones come out and begin their own life in the river.

167. Three distinct species of soft-shelled turtles are found in the Tungabhadra River, viz., Leithi's soft-shell Turtle (*Nilssonia leithii)* also called as lagala by fishermen, Indian narrow-headed soft-shell turtle (*Chitra indica)*, Indian soft-shelled turtle *(Lissemys punctata)*. Another species of turtle, the Indian Black Turtle or the Indian Pond Terrapin (*Melanochelys trijuga*) is also found in the river Tungabhadra and is called tismurga by locals. Both, Lagala *(Nilssonia leithii)* and *Chitra indica* are hunted by poachers. Leith's soft-shell turtle (*Nilssonia leithii)* is listed as Vulnerable (VU) under Threatened category of IUCN red-list. In addition to otters, crocodiles and turtles, over 7 orders of fish species are recorded[1] in the Tungabhadra river basin and details are provided in ***Table 28.***

**Table 28: Fish species recorded in the Tungabhadra river basin**

| Order | Family | Classification / Species | |
|---|---|---|---|
| **Cypriniformes** | **Cyprinidae** | *Barilius Barna* | *Barilius Backeri* |
| | | *B. Bendilisis* | *B. Canarensis* |
| | | *Catla* | *Chela Untrachi* |
| | | *Cirrhinus cirrhosa* | *C Fulungee* |
| | | *C. Mrigala* | *C. reba* |
| | | *Ctenopharygdon idella* | *Cyprinus Carpio* |
| | | *Danio aquippinatus* | *D. devario* |
| | | *D malabaricus* | *Garra gotyla stenorynchus* |

[1] *Gangadhara Gowda et.at., "Fish Biodiversity of Tunga, Bhadra and Tungabhadra Rivers of Karnataka, India", Research Journal of Animal, Veterinary and Fishery Sciences, Vol. 3(10), 1-16 December (2015).*

| Order | Family | Classification / Species | |
|---|---|---|---|
| | | *Hypophthalmichthys molitrix* | *Labeo angra* |
| | | *L. bata* | *L. Calbasu* |
| | | *L. fimbriatus* | *L. porcellus* |
| | | *L. potail* | *L. rohita* |
| | | *P. amphibious* | *P. chola* |
| | | *P. fasciatus* | *P. filamentosus* |
| | | *Puntius jerdoni* | *Puntius melanostigma* |
| | | *P. pulchellus* | *P. Sahyadrensis* |
| | | *P. Sarana* | *P. Sophore* |
| | | *P. ticto* | *P. vittatus* |
| | | *Rasbora* | *R. daniconius* |
| | | *Salmostoma boopis* | *Tor putitora* |
| **Siluriformes** | **Bagridae** | *Aorichthys aor* | *A Seenghals* |
| | | *Mystus armatus* | *Mystus cavasius* |
| | | *M. gulio* | *M. Krishnesis* |
| | | *Rita gogra* | *R Pavimentata* |
| | **Clariidae** | *Clarius batrachus* | *C garipinus* |
| | **Siluridae** | *Ompak bimaculatus* | *O. pabo* |
| | | *Wallago attu* | |
| | **Pangasidae** | *Pangasius* | |
| **Belonoformes** | **Belonidae** | *Xenentodon cancila* | |
| | **Hemiramphidae** | *Hyporhampus xanthopterus* | |
| **Cyprinodontiformes** | **Cyprinodontidae** | *Aplocheilus lineatus* | |
| **Synbranchiformes** | **Mastacembelidae** | *Mastacembelus armatus* | |
| **Perciformes** | **Ambassidae** | *Paraambassis ranga* | |
| | **Channidae** | *Channa punctatus* | *C marulius* |
| | | *C. striatus* | |
| | **Chichlidae** | *Etroplus maculatus* | *Oreochromis mossambica* |
| | **Gobiidae** | *Glossogobius giuris* | |
| **Ostiglossiformes** | **Notopteridae** | *Notoptorus notopturus* | |

168. ***Fauna:*** Secondary data on the faunal aspects revealed the presence of mega animals and birds. Animals that have been recorded to be present in the project area include mongoose, snakes, jungle cats, wild pig, hare, frogs, rat snake, water snakes, green snakes and lizards. Birds that have been found to be present in the project area include paddy bird, kites, sparrow, parakeets, coot, quail, cuckoo, water fowl, kingfisher, jungle dove, crow, pond heron and egrets.

169. The RBA (***Annexure 9***) study that was carried out as part of the projects focused on the exploring the habitat use and spatial behaviour of the Smooth-coated Otter-*Lutrogale perspicillata*, Mugger Crocodile-*Crocodylus palustris* and other species. The Smooth-coated Otter is found more in abundance in the vicinity of the *anicuts* than outside of the *anicuts.* Assured availability of water in the *anicuts* helps Otters, crocodiles and other faunal species to hunt for fish and flourish.

170. The Smooth-coated Otters are shy creatures who avoid human beings. After a good hunt, they rest on the elevated rocky banks and bask in the sun. Sometimes, they play/groom on the sandbanks and on rocks. They defecate collectively in a given location as a mark of delineation of their territory. These sprint marks are generally found at the entrance to their nesting areas, near the basking/resting/grooming areas.

171. About 142 positive sites of Smooth-coated Otters were found in and around 9 *anicuts.* Among them, about 74 mass latrine sites (52.11%) and 21 den sites or holts (14.78%) and 47 resting/playing/ grooming sites (33.09%) were identified. It is also found that the Otters prefer rocky area (61.26%), to mud banks (23.23%) and sand banks (15.49%). The reason for this may be that most of the OCR stretch has rocky surface and banks as against mud and sand.

172. Mugger Crocodile-*Crocodylus palustris* is also found in abundance in the OCR in the ancient *anicuts.* Large water bodies and pools within the river in and around ancient *anicuts* surrounded with thick vegetation provide a safe haven for the *Mugger crocodiles*. Availability of large fish species like Deccan Masher *Tor khurdee,* introduced species like Ruhu, Catla, Tilapia etc. which provide sufficient food for them. During the rapid assessment, about 30 (40.54%) crocodiles were directly sighted in different locations of the TOCR; further, about 10 (13.51%) nests and nesting sites were found and 34 (45.94%) indirect signs and evidences were recorded. The study was conducted during hot summer, and water in all the *anicuts* had either reduced to the bottom or totally dried up and invaded by water hyacinth. Hence, sighting of a crocodile in such a hostile condition was very difficult. As the crocodiles are nocturnal hunters, it was planned to survey crocodiles during the night. Accordingly, a powerful torch was used to spot the crocodiles in selected locations and found gleaming reflections of crocodile's eyes in the water body. About 12 crocodiles were found near the newly built bridge between Bukkasagara and Kadebagilu, during one of the patrolling nights.

173. Apart from Otters and *crocodiles*, many rare faunal species have been recorded in the OCR. Among the 62 recordings of the other major faunal species were 17 Jackals (27.41%), 6 Jungle cats (9.6%), Small Indian Civet 9 (14.51%), Porcupine 2 (3.22%), Leopard 2 (3.22%), Sloth Bear 13 (20.96%), Monitor Lizard 4 (6.45%) and Black Turtle 9 (14.51%).

174. Some of the species of the study area fall under different categories of International Union for Conservation of Nature (IUCN) Red data book. Of 20 species of mammals, 14 listed as Least Concerned (LC) (70%), 2 species such as Striped Hyaena and Rusty-spotted Cat are listed under Near Threatened (NT) (10%), and 1 species of mammals is listed under Endangered (EN) category (5%), that is Indian Pangolin. Smooth-coated Otter, Indian Sloth Bear and Indian Leopard are listed under Vulnerable (VU) category (15%). Among the reptiles, Indian Narrow-headed Soft-shell Turtle is listed as Endangered (EN) (3%) and Indian Black Turtle-*Melanochelys trijuga* as Near Threatened (NT) (3%). 3 species are listed as Vulnerable (VU) such as Leith's Soft-shell Turtle-*Nilssonia Leithii*, Mugger Crocodile-*Crocodylus palustris*, and Starred Tortoise-*Geochelone elegans* which amounts to 11% of all species of reptiles in the study area. About 8 species of reptiles are listed under Least Concern (LC) (33%) and 13 species as Not Evaluated (NE) (48%). Most of the Not Evaluated (NE) species are Geckos and Lizards. The frogs and toads

found in the study area belong to the Least Concerned (LC) category. Among fishes, one species, i.e., Ray-finned Fish (Harigi menu)-*Hypselobarbus pulchellus* (1%) is listed as Critically Endangered (CR), 6 fishes species each (7%) listed under Endangered (EN) and Vulnerable (VU) category respectively, and 8 fishes (9%) under Near Threatened (NT) category. About 63 fishes (70%) are listed as Least Concern (LC) and while the rest of 6 fish species (6%) are listed under Not Evaluated (NE) and Data Deficient (DD). About 4 species of birds listed as Near Threatened (NT) 3% of the total number of birds present in the study area. 3 species of birds listed as Vulnerable (VU) category such as Woolly-necked Stork- *Ciconia episcopus*, Lesser Adjutant- *Leptoptilos javanicus,* Yellow-throated Bulbul-*Pycnonotus xantholaemus*, that amounts to 2% of the species of the birds found in the study area.

175. ***IUCN status of Faunal species found in and around the project area:*** Some of the faunal species of the study area fall under different categories of International Union for Conservation of Nature (IUCN) Red data book. Of the 20 species of mammals found, 14 are listed as Least Concerned (LC) (70%), 2 species such as Striped Hyaena and Rusty-spotted Cat under Near Threatened (NT), (10%) and 2 species of mammals-Indian Sloth Bear and Indian Pangolin-under Endangered (EN) category (10%). ***Table 29*** provides the IUCN status of various faunal species in the OCR.

**Table 29: IUCN status of various faunal species in the OCR**

| IUCN status | Mammals | Reptiles | Birds | Amphibians | Fishes | Total | % |
|---|---|---|---|---|---|---|---|
| Critically Endangered (CR) | 0 | 0 | 0 | 0 | 1 | **1** | 0.32 |
| Endangered (EN) | 2 | 1 | 0 | 0 | 6 | **9** | 2.91 |
| Vulnerable (VU) | 2 | 5 | 3 | 0 | 6 | **16** | 5.17 |
| Near Threatened (NT) | 2 | 1 | 4 | 0 | 8 | **15** | 4.85 |
| Least Concerned (LC) | 14 | 8 | 156 | 8 | 63 | **249** | 80.58 |
| Not Evaluated (NE) | 0 | 13 | 0 | 0 | 6 | **19** | 6.15 |
| | **20** | **28** | **163** | **8** | **90** | **309** | |

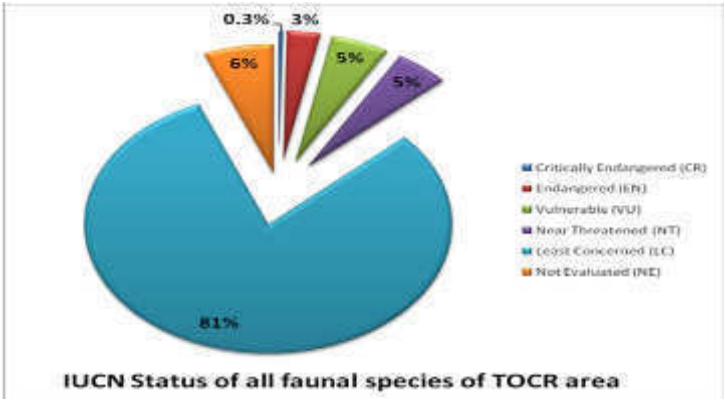



**Figure 8: IUCN Status of all faunal species of the OCR**

176. ***Flora:*** The flora in the project areas can be characterized as upland thorn and scrub. Several parts of Bellary, Koppal and Raichur districts have armed trees with tiny leaflets. Some remaining patches of these forests are made-up of Acacia, Albizia and Hardwickia (Jali, Bilwara, ennemara being local names). The maidan is dotted with numerous irrigation tanks usually supporting an interesting aquatic Jlora. Also, a systematic and rapid survey of trees was conducted between February and March 2018. This was the time when most of the trees shed leaves. The following section provides a detailed analysis of the tree survey.

## 4.3 Salient Features of the Tree Survey

177. The survey identified 3,257 individual trees in the 30% of the area covered of all the 16 channels. These trees belong to 55 species and 27 families. The highest number of species is found in Anegundi channel with 38 species 462 (14.18%) individuals. The total length of all the 16 Channels is 215 km of which Raya channel is the longest one with 27.74 km and has the 2nd highest number of species. Here, 32 trees species and 458 individuals are recorded. This amounts to 14.06% of the total trees recorded. Least number of tree species were recorded from Belagodhalla and Bichal Channels with 8 and 9 species of trees respectively. The Belagodhalla channel has only 139 individuals whereas Bichal VNC has 181 number of trees. Interestingly, Belagodhalla VNC has the highest number of Coconut trees. (4.27%). But, least number of individual trees were found in Hulugi and Shivapura Channels with 53 and 54 trees (01.63% and 1.66%) respectively. The same trend is also observed in paddy growing areas of Kampli Siruguppa, Deshnur and Bichal channels (***Table 2, Fig. 3***).

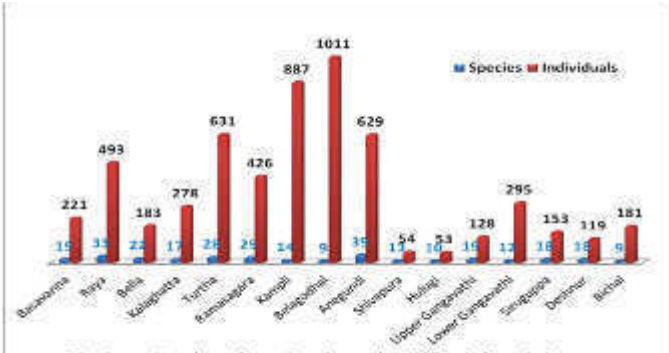


Fig- 3 Number of tree Species and individuals found along the 16 VNCs of Tungabhadra River

178. It is observed that abundance of trees is directly related to the length of the Channels and the type of crops grown in the farmlands adjacent to the Channels.

***Density and Diversity Index***

179. A diversity index is a mathematical measure of species diversity in a given tree community. Diversity index provides detailed information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundance of the various species into account (Wilhelm Barhlott et al).

180. The diversity is calculated on the basis of abundance and evenness of the species present in the given area using the following formula:

$$H = -\sum_{i=1}^{x} p_i \ln p_i$$

181. The proportion of species “i” relative to the total number of species (Pt) is calculated and multiplied by the natural logarithm of the resulted proportion (1npt). The result is summed

up across species and multiplied by -1. The typical values of Shannon_H index is between 1.5 to 3.5. Less than 1.5 index indicates poor diversity whereas index up to 3.5 indicates richness of diversity. The diversity rarely goes beyond 4. The Shannon_H index increases with increase in abundance and evenness of distribution of the species in a given community. Hence, this index is considered as one of the important indices of biodiversity measurement.

182. It may be noted that density of one or a few species dominating the rest of the species in a given community does not amount to Diversity. An *Even* distribution of species with average density of most of the species indicates rich diversity. Poor density is observed in monoculture plantations, orchards, farmlands, economically exploiting forests etc., where monoculture or cultivation of one or two species is given priority. Therefore, the community with even distribution and moderate density of species is considered rich in diversity.

**Table 30: Tree diversity indices along the 16 VNCs**

| S. No. | Index | No of Families and Species | Species and individuals |
|---|---|---|---|
| 1 | Taxa_S | 27 | 55 |
| 2 | Individuals | 3257 | 3257 |
| 3 | Dominance_D | 0.2373 | 0.1465 |
| 4 | Simpson_1-D | 0.7627 | 0.8535 |
| 5 | Shannon_H | 1.89 | 2.693 |
| 6 | Evenness_e^H/S | 0.2452 | 0.2686 |
| 7 | Equitability_J | 0.5735 | 0.672 |
| 8 | Fisher_alpha | 4.033 | 9.401 |

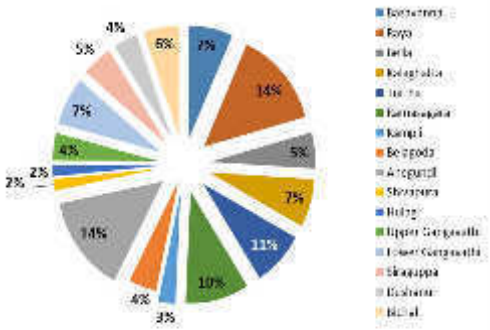



Fig-4 Density of Trees along the different VNCs of Tungabhadra River

***Vijayanagara Channels with rich diversity***

183. Anegundi channel runs for 19.44 km and has 462 trees belonging to 38 species along 30% of its length. This channel comprises about 14.18% of all the trees enumerated in all channels. Both cultivated trees such as Coconut and Mango, and naturally grown trees such as Borassus, Neem, pongamia are present here in good numbers. Other trees species such as *Terminalia arjuna* (Hole Matti)*, Vachellia nilotica (*Karijali), *Cardia myxa* (Challe Hannu) etc. grow here naturally. This is the only channel of the Vijayanagara System that has the largest variety of tree species with reasonable distribution and density. *Cocos nucifera*-coconut is found in large numbers here yet overpowering the others. Hence diversity is high.

184. Therefore, Shannon_H diversity index is 2.7898, indicating rich diversity of taxa in Anegundi VNC.

185. Basavanna Channel is one among the lengthy Vijayanagara channels which has 18 species of major fauna and 217 individuals. It has a very good diversity of flora. Hence Shannon_H diversity index of 2.414 is found to be the second richest in terms of diversity among all Channels.

186. Bella Channel is the shortest among all the Vijayanagara Channels with only 5.5 km of length. It has 21 different species with 171 individuals in 30% of its length. This indicates

rich diversity of flora. Shannon_H diversity index for Bella Channel is 2.294 indicating richness of diversity.

187. Other Channels with satisfactory diversity are Siruguppa with Shannon_H index of 2.365, Raya 2.064, Deshnur has 2.112 and Turtha 2.051.

188. When all Channels are considered for species diversity and richness, the Shannon_H index for a number of families is 1.89. Of the total 27 families of trees identified, the species of each family is also moderately distributed across all the Channels. Hence the species richness is moderate.

189. When all Channels are considered for species and their numbers for the purpose of diversity calculations, it is found that there are 3,257 trees belonging to 55 tree species. The Shannon_H diversity index for this is 2.693 indicating rich diversity in terms of even distribution of various species across all Channels. Some species such as *Cocos nucifera* (coconut) overpower other species in terms of density. Their number is quite high and hence diversity is affected (***Table 30***).

***Vijayanagara Channels with Poor Diversity***

190. Belagodhalla channel has the poorest diversity. This channel runs for 11.22 km but only 8 species of major flora were found during the rapid assessment along 30% of its length. A total of 139 individuals belonging to 8 floral species are found here. However, it has very poor diversity among all Channels. The Shannon_H index for this Channel is 0.6839% only. The reason for this poorest diversity is that out of 139 individuals belonging to 8 species found, 116 individuals belong to *Cocos nucifera* i.e. Coconut trees. This monoculture crop cultivated along the Channel by extending their farmlands is overpowering the other species and resulted in poor diversity.

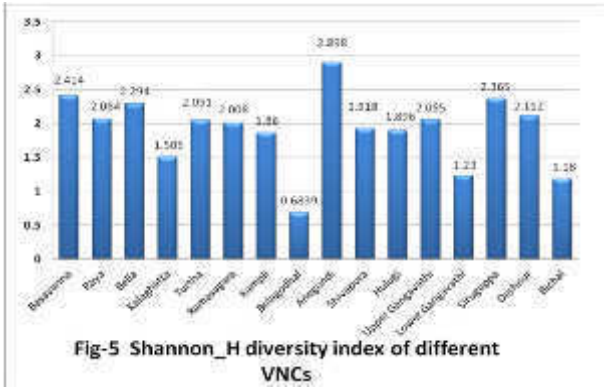


Fig-5 Shannon_H diversity index of different VNCs

191. Another Channel with least diversity is Bichal located in Raichur district. Here, 181 (5.56%) individuals belonging to 9 species are reported across 30% length of the Channel. The species over powering the diversity is *Prosopis juliflora* (*Ballari jali*). Out of trees belonging to 181 species, 124 individuals belong to this species. Hence Shannon_H index of Bichal Channel is 1.18, which indicates poor diversity.

192. A similar trend is observed along Kampli Channel also. There are mere 85 (2.61%) individual trees reported, which belong to 13 species only. Less number of species and more number of trees of a single species such as *Cocos nucifera*-Coconut and *Tectona grandis*-Teak wood trees. Out of 85 trees listed here, 31 coconut trees and 22 Teakwood trees are found; uneven distribution and diversity is observed.

193. Therefore, Shannon_H index of Kampli Channel is 1.86 which indicates low species diversity and uneven distribution of taxa.

194. Other Channels with average diversity are Lower Gangavathi and Kalaghatta which have Shannon_H index of 1.23 and 1.505 respectively (***Fig 5***).

195. Very low density of trees is observed in Shivapura and Hulugi Channel with only 54 and 53 trees recorded in 30% of the length of each canal. The Shannon_H index of both the Channels is 1.918 and 1.896 respectively. Reason for low diversity and distribution of trees is that when the trees grow to maximum height, the canopy also becomes wide shadowing the nearby farmlands which leads to reduction in crop area and crop yield. Therefore, paddy growing farmers never allow trees to grow to maximum height; they cut them from time to time to prevent their fields shadowing due to grow up trees. But, in Anegundi, Ramasagara and Kampli irrigated areas, tall growing crops such as sugarcane and banana are raised. In this case, the tall trees and the canopy helps to protect the crop from winds and storms. Hence, farmers in such areas allow trees to grow along these canals (***Table 31***).

**Table 31: Different diversity indices of Major flora of all VNCs**

| Major flora of all VNCs | | | | | Diversity Index | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S. No. | Name of the Channel | No. of Species | No. of Individuals | % occurrence | Dominance_D | Shannon_H | Simpson_1-D | Evenness_e^H/S | Equitability_J | Fisher_alpha |
| 1 | Basavanna | 18 | 217 | 6.66 | 0.115 | 2.414 | 0.885 | 0.621 | 0.8352 | 4.661 |
| 2 | Raya | 32 | 458 | 14.06 | 0.2498 | 2.064 | 0.7502 | 0.2463 | 0.5956 | 7.832 |
| 3 | Bella | 21 | 171 | 5.25 | 0.1672 | 2.294 | 0.8328 | 0.4722 | 0.7536 | 6.289 |
| 4 | Kalaghatta | 16 | 228 | 7.00 | 0.3286 | 1.505 | 0.6714 | 0.2816 | 0.4254 | 19.33 |
| 5 | Turtha | 27 | 261 | 8.01 | 0.2704 | 2.051 | 0.7296 | 0.2881 | 0.6224 | 7.564 |
| 6 | Ramasagara | 24 | 319 | 9.79 | 0.2063 | 2.008 | 0.7937 | 0.3103 | 0.6318 | 6.016 |
| 7 | Kampli | 13 | 85 | 2.61 | 0.2224 | 1.86 | 0.7776 | 0.4941 | 0.7252 | 4.279 |
| 8 | Belagodhalla | 8 | 139 | 4.27 | 0.7062 | 0.6839 | 0.2938 | 0.2477 | 0.3289 | 1.845 |
| 9 | Anegundi | 38 | 462 | 14.18 | 0.08103 | 2.898 | 0.4774 | 0.4774 | 0.7967 | 9.811 |
| 10 | Shivapura | 13 | 54 | 1.66 | 0.225 | 1.918 | 0.775 | 0.5235 | 0.7477 | 5.435 |
| 11 | Hulugi | 10 | 53 | 1.63 | 0.1905 | 1.896 | 0.8095 | 0.6657 | 0.8233 | 3.645 |
| 12 | Upper Gangavathi | 19 | 128 | 3.93 | 0.2302 | 2.055 | 0.7698 | 0.4107 | 0.6978 | 6.17 |
| 13 | Lower Gangavathi | 11 | 229 | 7.03 | 0.4563 | 1.23 | 0.5437 | 0.3109 | 0.5128 | 2.41 |
| 14 | Siruguppa | 18 | 153 | 4.70 | 0.1158 | 2.365 | 0.8842 | 0.591 | 0.8181 | 5.299 |
| 15 | Deshnur | 18 | 119 | 3.65 | 0.2102 | 2.112 | 0.7898 | 0.4592 | 0.7307 | 5.895 |
| 16 | Bichal | 10 | 181 | 5.56 | 0.491 | 1.18 | 0.509 | 0.3254 | 0.5124 | 2.279 |
| | **Total** | | **3257** | | | | | | | |

### *Families and Number of Species*

Coconut trees along L Gangavathi VNC

196. A total of 27 Families and 55 species of trees have been explored during the study. The largest number of species belongs to **Fabaceae**. It has 14 species of trees amounting to 25% of the total plants identified. With 743 individual trees recorded, this family has species like *Prosopis juliflora (*Ballari jali), *Leucaena leucocephala* (Subabul), *Grevellea robusta* (Silver oak) etc. **Moraceae** is the second largest family of occurrence with 5 species of trees (9.09%). A total of 103 individual trees belonging to five species of this family are recorded across all Channels. This family has species such as *Artocarpus heterophyllus* (Jack fruit), *Ficus amplissima* (Bili basari), *F. bengalensis* (Banyan tree), *F. racemosa* (Fig) and *F. religiosa* (Peepal tree). **Rutaceae** and **Aracaceae** families have 4 species each (7.27% each). Rutaceae family comprises species such as *Chloroxylon sweitenia* (Pacheri), *Limonia acidissima* (Wood apple), *Citrus limon* (Lemon) and *Aegle marmelos* (Bilva patre). Aracaceae has *Cocos nucifera* (Coconut), *Elaeis quineensis* (Oil palm), *Borassus flabellifer* (Palmira) and *Phoenix sylvestris* (Toddy palm).

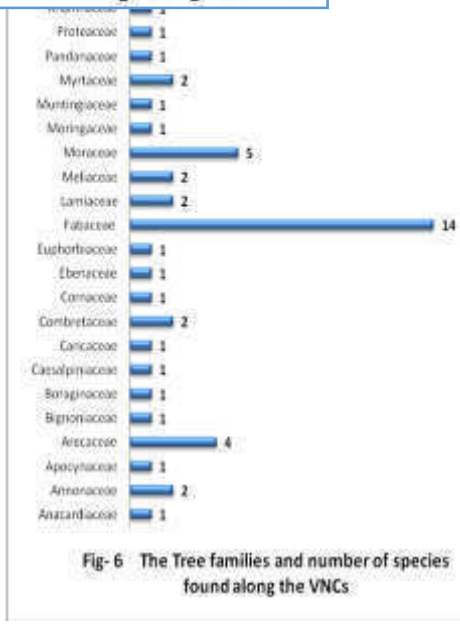
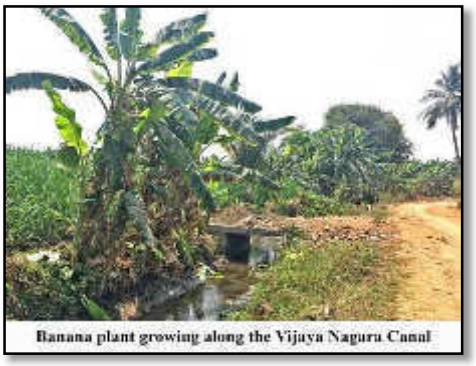



Fig- 6 The Tree families and number of species found along the VNCs

197. A total of 1,123 coconut trees are listed across all Channels amounting to 34.48% of all the trees enumerated. This is the largest tree species found in Channels. Moreover, this is the most common tree species found across all the 16 Channels. Almost all coconut trees are planted by the farmers thus extending their farmland into VNC area. Most of the Palmyra trees (*Borassus flabellifer)* are found along the Channels in Hampi vicinity such as Anegundi, Ramasagara, Upper and Lower Gangavathi and Siruguppa. This is the naturally growing species of wild flora flourishing along the channels. It is the fifth largest species of trees listed with 144 individuals (4.42%). Large number of *Phoenix sylvestris* (Toddy palm) is found along Siruguppa and Deshanur Channels only. This is also a naturally growing tree along the canals and wetlands. (***Table-32, Fig-6***)

**Table 32: Occurrence of Family, Species and number of trees in VNCs**

| S. No. | Family | No of Species | No of individuals | % occurrence of species |
|---|---|---|---|---|
| 1 | Anacardiaceous | 1 | 68 | 1.82 |
| 2 | Annonaceae | 2 | 4 | 3.64 |
| 3 | Apocynaceae | 1 | 2 | 1.82 |
| 4 | Arecaceae | 4 | 1321 | 7.27 |
| 5 | Bignoniaceae | 1 | 2 | 1.82 |
| 6 | Boraginaceae | 1 | 17 | 1.82 |
| 7 | Caesalpiniaceae | 1 | 1 | 1.82 |
| 8 | Caricaceae | 1 | 9 | 1.82 |
| 9 | Combretaceae | 2 | 7 | 3.64 |
| 10 | Cornaceae | 1 | 10 | 1.82 |
| 11 | Ebenaceae | 1 | 6 | 1.82 |
| 12 | Euphorbiaceae | 1 | 1 | 1.82 |
| 13 | Fabaceae | 14 | 743 | 25.45 |
| 14 | Lamiaceae | 2 | 311 | 3.64 |
| 15 | Meliaceae | 2 | 227 | 3.64 |
| 16 | Moraceae | 5 | 103 | 9.09 |
| 17 | Moringaceae | 1 | 29 | 1.82 |
| 18 | Muntingiaceae | 1 | 33 | 1.82 |
| 19 | Myrtaceae | 2 | 223 | 3.64 |
| 20 | Pandanaceae | 1 | 1 | 1.82 |
| 21 | Proteaceae | 1 | 54 | 1.82 |
| 22 | Rhamnaceae | 1 | 28 | 1.82 |
| 23 | Rubiaceae | 1 | 5 | 1.82 |
| 24 | Rutaceae | 4 | 22 | 7.27 |
| 25 | Santalaceae | 1 | 17 | 1.82 |
| 26 | Sapindaceae | 1 | 2 | 1.82 |
| 27 | Simaroubaceae | 1 | 11 | 1.82 |
| **Total** | | **55** | **3257** | |



Banana plant growing along the Vijaya Naguru Canal

***Banana-Musa species***

*A large number of banana plants belonging to Musaceae Family are observed along most of the Channels. Most of the plants are raised intentionally by the farmers by extending their farmlands towards the canal. Each banana tree yields 20-50 kilograms of Banana and is commercially viable. The canal with flowing water itself acts as a barrier for external threats to plants such as from cattle and monkeys. Hence, Banana plants grow well along canals that assure plenty of perennial water source. All these reasons result in flourishing of banana trees.*

*In fact, a Banana plant cannot be technically called a "Tree"; it is categorized as a herb. Banana tree does not have the "Woody Tissue". Moreover, it is an annual crop yielding plant. After 10-12 months of age, it bears Banana bunches and dies. Therefore, this species is not considered for the tree survey.*

**Table 33: Density of Tree species in all Channels**

| S. No. | Species | Numbers | % occurrence |
|---|---|---|---|
| 1 | *Cocos nucifera* | 1123 | 34.48 |
| 2 | *Tectona grandis* | 280 | 8.60 |
| 3 | *Azadirachta indica* | 213 | 6.54 |
| 4 | *Eucalyptus sps* | 207 | 6.36 |
| 5 | *Prosopis juliflora* | 185 | 5.68 |
| 6 | *Vachellia nilotica* | 161 | 4.94 |
| 7 | *Borassus flabellifer* | 144 | 4.42 |
| 8 | *Leucaena leucocephala* | 108 | 3.32 |
| 9 | *Millettia Pinnata* | 92 | 2.82 |
| 10 | *Mangifera indica* | 68 | 2.09 |
| 11 | *Albizia saman* | 64 | 1.96 |
| 12 | *Grevellea robusta* | 54 | 1.66 |
| 13 | *Phoenix sylvestris* | 47 | 1.44 |
| 14 | *Ficus religiosa* | 41 | 1.26 |

| S. No. | Species | Numbers | % occurrence |
|---|---|---|---|
| 15 | *Mutingia calabura* | 33 | 1.01 |
| 16 | *Vitex negundo* | 31 | 0.95 |
| 17 | *Albizia lebbek* | 30 | 0.92 |
| 18 | *Pithecellobium dulce* | 30 | 0.92 |
| 19 | *Ficus racemosa* | 29 | 0.89 |
| 20 | *Moringa olifera* | 29 | 0.89 |
| 21 | *Senna siamia* | 29 | 0.89 |
| 22 | *Ziziphus jujuba* | 28 | 0.86 |
| 23 | *Tamarindus indica* | 20 | 0.61 |
| 24 | *Ficus amplissima* | 18 | 0.55 |
| 25 | *Cardia myxa* | 17 | 0.52 |
| 26 | *Santalam album* | 17 | 0.52 |
| 27 | *Syzygium cumini* | 16 | 0.49 |
| 28 | *Chloroxylon sweitenia* | 14 | 0.43 |
| 29 | *Melia dubia* | 14 | 0.43 |
| 30 | *Ailanthus excelsa* | 11 | 0.34 |
| 31 | *Butea monosperma* | 11 | 0.34 |
| 32 | *Alangium salviifolium* | 10 | 0.31 |
| 33 | *Ficus benghalensis* | 10 | 0.31 |
| 34 | *Cariya papaya* | 8 | 0.25 |
| 35 | *Elaeis guineensis* | 7 | 0.21 |
| 36 | *Diospyros melanoxylon* | 6 | 0.18 |
| 37 | *Artocarpus heterophyllus* | 5 | 0.15 |
| 38 | *Cassia fistula* | 5 | 0.15 |
| 39 | *Morinda coreia* | 5 | 0.15 |
| 40 | *Prosopis cineraria* | 5 | 0.15 |
| 41 | *Terminalia catappa* | 5 | 0.15 |
| 42 | *Citrus limone* | 4 | 0.12 |
| 43 | *Annona reticulata* | 3 | 0.09 |
| 44 | *Limonia acidissima* | 3 | 0.09 |
| 45 | *Terminalia arjuna* | 3 | 0.09 |
| 46 | *Gliricidia sepium* | 2 | 0.06 |
| 47 | *Plumeria rubra* | 2 | 0.06 |
| 48 | *Sapindus trifoliatus* | 2 | 0.06 |
| 49 | *Spathodea campanulata* | 2 | 0.06 |
| 50 | *Aegle marmelos* | 1 | 0.03 |
| 51 | *Delonix elata* | 1 | 0.03 |
| 52 | *Euphorbia tirucalli* | 1 | 0.03 |
| 53 | *Pandanus odorifer* | 1 | 0.03 |
| 54 | *Peltophorum pterocarpum* | 1 | 0.03 |
| 55 | *Polyalthia longifolia* | 1 | 0.03 |
| | **Total** | **3257** | |

### *Abundance of Tree Species*

198. Among the entire major flora enumerated, the largest number of the individual plants belongs to *Cocos nucifera* i.e., Coconut species, grown along the canal by extending crop towards the canals. The second largest species distributed in abundance is *Tectona grandis* or Teakwood. A total of 280 trees have been listed in the surveyed 30% length of all the 16 Channels amounting to 8.60% of all trees enumerated. Almost all Coconut and Teak wood trees have been intentionally planted by the farmers by extending their crop towards the Channels. Most of the trees attain maximum height, yield coconuts in good quantities, thus bringing profit to the owners. A coconut tree needs adequate surface water to sustain because it is a monocotyledonous plant with fibrous roots. Such roots do not penetrate deep into the soil as in the case of dicotyledonous plants which have tap root system. Therefore, availability of sufficient water along the canals throughout the year sustains the coconut trees in all Channels (***Table-33***).

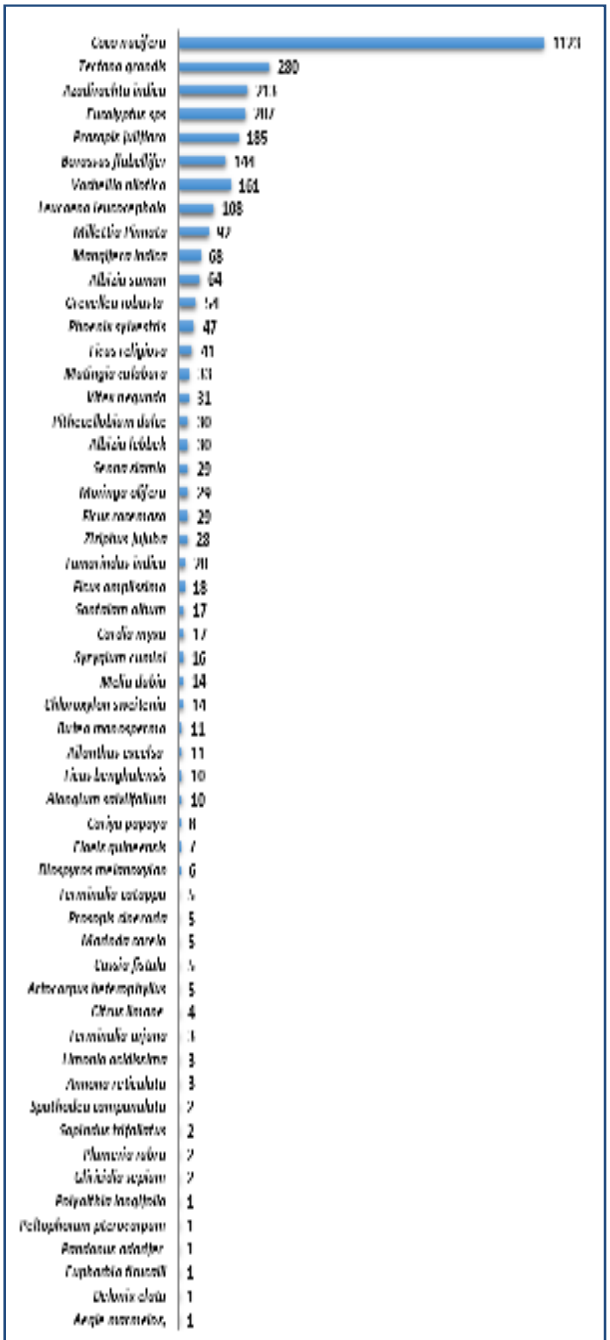


Fig - 7 Abundance of tree species in entire VNCs

199. An indigenous tree, Neem or *Azadirachta indica* is found to be the third largest tree growing along the Channels with 213 individuals (6.54%). This tree species is native to India, generally grown wild by seed dispersal by birds. A total of 207 *Eucalyptus (Neelagiri)*, 185 *Prosopis juliflora (Ballari jail),* 161 *Vachelia nilotica (Karijali or babool),* 144 *Borasssus flabellifer (Palmyra or Taley mara),* etc. are found to occupy fourth to seventh places with percentage of occurrences as 6.36%, 5.68%, 4.94%, 4.42% respectively (***Table 6, Fig.7***).

200. Some rare medicinal plants like, *Aegle marmelos (*Bilva*), Delonix elata (*Sankeshwari*), Euphorbia tirucalli, Pandanus odirifer (*Kewda*)* etc. are found one each in number. Some

fruiting trees such as *Mangifera indica* (Mango), *Syzygium cumini* (Black plum) *and* wild fruiting trees like *Alangium salviifolium* (Ankole), *Cardia myxa* (Challe Hannu) etc., grow naturally along the canal. Fruits of these forest plants are devoured by the wild animals such as Sloth bear, Wild Boar and Porcupine.

201. *Santalam album*–Sandal wood trees are found along some Channels such as Bella, Raya, Ramasagara and Siruguppa and are grown naturally due to dispersal of seeds by birds. 17 individuals are recorded in 30% of the length of all Channels, which amounts to only 0.52%. It is interesting to note that all the sandal wood trees found are very small having GBH of 12-24 inches only. No grownup Sandal Wood tree is seen elsewhere on any Channel. A Sandal Wood Tree which attains 25 to 40 years of age with the GBH of more than 36 inches is in great demand. After attaining proper size and age, a Sandal wood tree can yield fragrance oil and aroma after on cutting.

202. Hence, people generally do not cut sandal wood trees until it attains proper age so to reap full benefit. However, some people are also reportedly cutting pre-maturely and selling them illegally.

***Girth size of trees***

203. Trees growing along the Channels are either owned by farmers having land adjacent to the canal or have grown naturally. Trees owned by farmers are generally protected by them, whereas trees found in common land or in irrigation/forest departments land are not generally taken care of. Such unprotected trees are cut by people for various reasons. Hence, there are very less number of such old trees found along the canal except *Terminatlia arjuna* (Hole Matthi) in Anegundi Channel and *Borassus* in Ramasagara and Kampli Channels. But trees like neem, sandal wood etc. are cut before attaining their full maturity. Shepherds cut the branches of trees such as *Neem, Ficus* and *Babool (Karijali)* for feeding goats and sheep. Others cut the trees for making agricultural tools and for fuel wood. Therefore, the girth size of trees grown in unprotected areas is small. A total of 916 trees enumerated along all Channels are found to have Girth at Breast Height (GBH) between 12 inches and 24 inches. This amounts to 28% of the total trees enumerated. A total of another 807 trees have GBH of 24-36 inches amounting to 25% of total trees enumerated. About 1,534 trees have GBH of 36 inches and above amounting to 47% of all the trees enumerated. *Cocos nucifera* or Coconut trees fall under this category (***Fig-8***).

***Ficus racemosa-Fig***

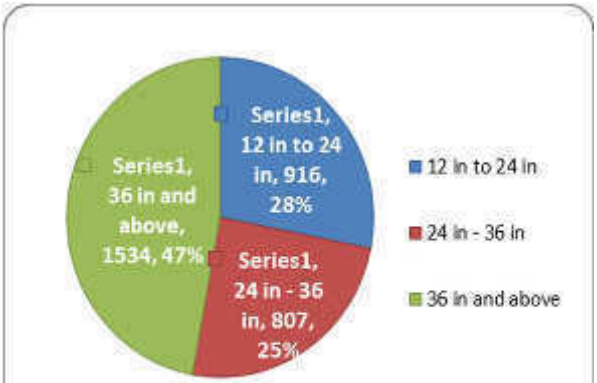



Fig-8 Trees with different GBH found along all VNCs

***Ecotone***

204. As part of the Tree Survey, causes were examined for the growth of trees along the canal banks. The bank of the canals is a transition zone between aquatic and terrestrial ecosystems. This also serves as a boundary between two types of communities. This transition zone between two communities or ecosystems is called as 'Ecotone'. The Ecotones are generally rich in species diversity, and in the case of these Channels too, the littoral areas play a role in profile of the Ecotone, hence richness of species diversity is observed. This transition area itself forms a separate community, that is different from aquatic and terrestrial ecosystems or communities.

***RET species of Flora***

205. The entire taxa enumerated do not fall under RET species, except for the Sandal Wood Tree–*Santalum album* (Sandal wood) which is listed as Vulnerable (VU) under IUCN Threatened species category. Rest of the trees are classified under Least Concerned (LC) or Data Deficient (DD) category by IUCN.

## 4.4 Structures or sites of Historical, Archaeological, Paleontological or Architectural Significance

206. Additionally, a portion of the VNC system passes through the Hampi Heritage Area that has secured a UNESCO Heritage tag. The modernization activities need to be managed in such a way that it protects the Outstanding Universal Value of the heritage area. In fact, the procedures call for obtaining necessary approvals from the HWHAMA located in Hospet for the work to be carried out within the heritage area.

## 4.5 Climate Change

207. Climate change refers to significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer. Tackling this phenomenon is of utmost importance given the pivotal role that climate plays in the formation of natural ecosystems and the human economies and civilizations on which they are based[2].

[2] *https://climatechange.ucdavis.edu/science/climate-change-definitions/*

208. The Inter-Governmental Panel on Climate Change (IPCC [3]) indicates that some of the catastrophic consequences of global warning, beyond a 2° Centigrade increase can result in: famines and droughts threatening millions of lives; worldwide drop in agricultural and horticultural crops; risk for up to three billion people of flooding and without access to fresh water supplies; destruction of half the world's nature reserves and a fifth of coastal wetlands; increasing global sea levels; significant effects on biodiversity and ecological productivity; potential for international conflicts, border disputes and wars due to water and food shortages, forced migration, extreme weather events, huge impacts on general health etc.

209. The IPCC's fifth assessment report (AR 5, 2014) has reiterated from the earlier reports that countries most affected by climate change would be predominantly agrarian, eco-sensitive economies and tropical countries such as India. India, because it has the world's second largest population, high population densities and disproportionately limited natural resources, agrarian-dominant livelihoods, and is projected to face many serious issues impacting every section of its society. India has already experienced several extreme weather events in just the last two years; its extensive coastline of 7,517 kilometres means that the country is highly vulnerable to rising sea levels and acidification of the Indian Ocean.

210. Climate change projections for Karnataka make it potentially serious for the state and hence needs as much policy intervention and support on mitigation and adaptation, as is possible. In fact, the state of Karnataka is the second most water stressed state in the country. However, it also has many heritage strengths, such as the rich and diverse agricultural, horticultural, animal husbandry and dairying practices, a continuously evolving services sector and the world heritage Western Ghats (a mountain range) which can assist with adaptation and mitigation. There are nearly 37,000 water bodies (tanks, reservoirs and lakes) with a total surface area of 69,000 hectares as well as more than 20,000 irrigation tanks. Society in general and the government in particular, need to take urgent, sustained and carefully drawn actions at various levels of the administration and all walks of life. Quicker response in terms of implementation of such actions would make it possible to mitigate and adapt at a minimum cost the adverse effects.

211. ***Climate Change–Projected Changes for Karnataka State:*** Climate change projections for any geographic region are made using GCMs (Global Circulation Models) and RCMs (Regional Climate Models).

212. For climate change projections, the World Bank funded study[4] conducted as part of the Bangalore Climate Change Initiative-Karnataka (BCCI-K study)-has used simulation data from the global climate model, HadCM3 from the Hadley Centre, UK. HadCM3 has also been used for generating climate change projections for various parts of the Indian

*[3] The Intergovernmental Panel on Climate Change is the leading international body for assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.*

*[4] Bangalore Climate Change Initiative – Karnataka, "Karnataka Climate Change Action Plan", submitted to Government of Karnataka, May 2011.*

subcontinent and it is found that the Indian subcontinent could be subjected to an average of over 4°C increase in temperature by 2085 for SRES A2 scenario.

213. In the BCCI-K study, data from the HadCM3 global climate model downscaled by PRECIS model, a regional climate model for downscaling climate projections, is used. The combination of HadCM3 and PRECIS models is known as the HadRM3 model. The pathways for atmospheric greenhouse gases (e.g. $CO_2$, $CH_4$, $N_2O$, CFCs) are prescribed from the SRES A1B mid-term (2021-2050) projections. Also, data derived from the PRECIS model outputs (which had a grid spacing of 0.4425° latitude by 0.4425° longitude) was re-gridded to 0.2° in latitude and 0.2° in longitude to calculate district level effects. This ensures that enough grids fall within each district. Then, the data was re-aggregated (as averages) at the district-level.

214. ***Temperature Variability:*** The projected change in the annual average temperature, minimum and maximum temperature for the three project districts for 2021-2050 compared to baseline (1961-1990) is given in ***Table 34.***

**Table 34: Projected Changes (2021-2050) in Temperature in the Project Districts**

| District | Increase Projected in $T_{Avg}$ (° C) | Increase Projected in $T_{Min}$ (° C) | Increase Projected in $T_{Max}$ (° C) |
|---|---|---|---|
| Bellary | 2.08 | 2.16 | 2.03 |
| Koppal | 2.14 | 2.21 | 2.09 |
| Raichur | 2.20 | 2.31 | 2.12 |

215. Key findings of the BCCI-K study revealed that:

- The projected increase for annual average temperatures for the northern districts is higher than the southern districts. These regions are expected to experience a warming above 2.0°C by 2030s;
- Most of the state is projected to experience a warming of 1.8 to 2.2°C;
- The northern part of the state is also projected to experience higher increases in minimum and maximum temperatures, and
- The increase in the minimum temperature projected is slightly more than that of the average and the maximum temperatures.

216. The results of the BCCI-K study revealed district-wise projected change in annual mean, maximum and minimum temperature in for the period 2021-2050 as compared to the baseline (1961-1990) and are provided in ***Figure 9***.

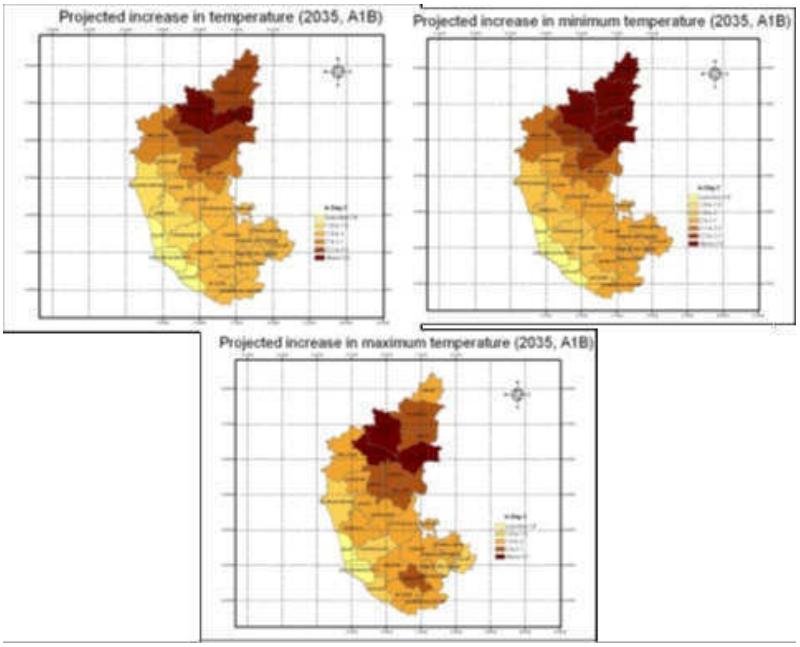



**Figure 9: District-wise projected change in annual mean, maximum and minimum temperature as projected by the HadRM3 model**

217. ***Rainfall Variability:*** On the rainfall front, the BCCI-K study reveals the projected changes in rainfall induced by climate change for various months (***Table 35).***

**Table 35: Projected Changes in Rainfall in the Project Districts**

| District | Change projected for JF months (%) | Change projected for MAM months (%) | Change Projected for JJAS months (%) | Change Projected for OND months (%) | Change in Projected Annual Mean (%) |
|---|---|---|---|---|---|
| Bellary | -14.47 | 36.16 | -8.11 | 6.87 | 0.52 |
| Koppal | -2.08 | 45.19 | -12.35 | 8.81 | -1.56 |
| Raichur | -4.17 | 20.50 | -10.99 | -7.59 | -6.79 |

218. ***Figure 10*** depicts the results of the BCCI-K study-district-wise projected change in annual rainfall (in %) and JJAS rainfall for the period 2021-2050 as compared to the baseline (1961-1990).

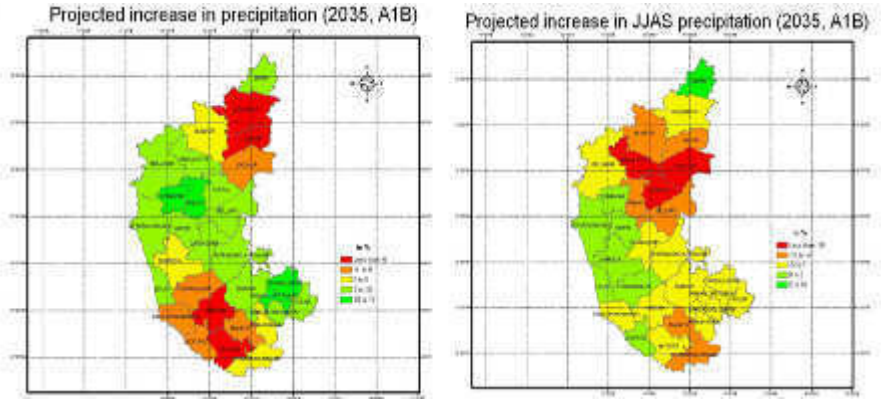



**Figure 10: District-wise projected change in annual rainfall (%) and JJAS rainfall as projected by the HadRM3 model**

219. The results of BCCI-K study reveal that:

- The north-eastern and south-western parts of the state are projected to experience decrease in the quantum of rainfall, annually. This roughly correlates with observed trends over the last 30 years.
- Over the JJAS season too, north-eastern and south-western parts of the state are projected to experience reduced amounts of rainfall.

220. ***Drought Incidence:*** Drought is defined as a period of absence of rainfall (daily rainfall < 2.5 mm) for 40 or more contiguous days. In Karnataka, there are two major growing seasons in Karnataka: Kharif (July to October) and Rabi (September to February). In the BCCI-K study, the number of incidences of severe droughts is estimated for 2021-2050 for each grid point and compared to the baseline.

221. ***Figure 11*** shows percentage increases in drought incidences in Kharif and Rabi seasons. Blue colours indicate that drought instances are projected to decrease, while the red colours indicate that such instances may increase.

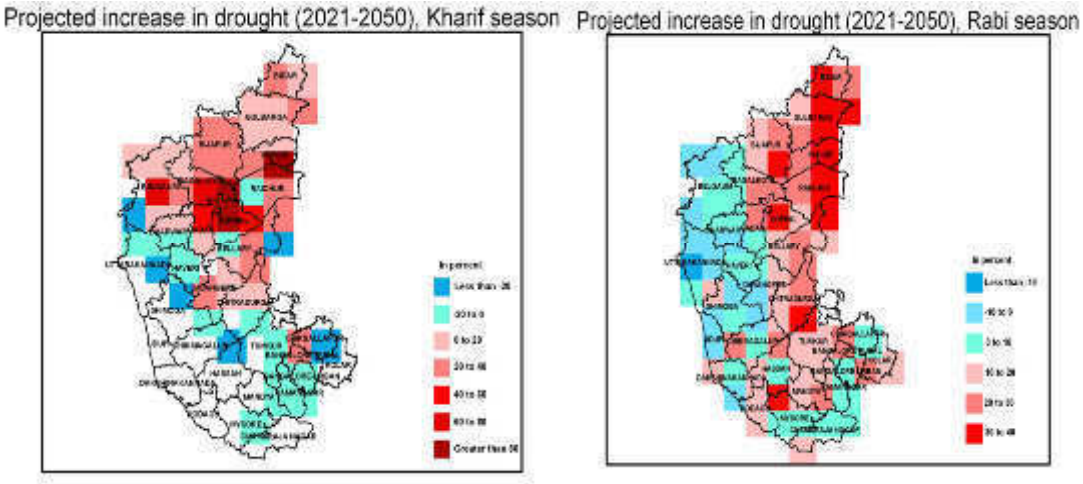



**Figure 11: Projected increase in drought incidences in the future Compared to the baseline (1961-1990)**

222. Analysis reveals that:

- In the Kharif season, most northern districts (all the project districts) are projected to have an increase in drought incidences by 10-80%;
- Districts of Koppal (project district) and Yadgir are projected to have almost a doubling of drought frequency in the Kharif season, and
- In the Rabi season, drought frequency is projected to increase in most of the eastern districts of the state.

**Climate Change–Impacts on the Water Sector in Karnataka**

223. IPCC in its Assessment Report while highlighting the impacts of climate change on water resources predicts an intensification of the global hydrological cycle, affecting both the ground and surface water supply. The report concludes that it is highly likely that *"the negative impacts of climate change on freshwater systems outweigh its benefits"*, with runoff declining in most streams and rivers. Each of the river catchments is expected to

respond differently to the same change in climate drivers, depending largely on catchment physio-geographical and hydrogeological characteristics and the amount of lake or groundwater storage in the catchment. The IPCC has predicted with high confidence that the drought affected areas will show increase in frequency as well as the severity of drought. The IPCC also predicts with high confidence that the area affected by drought will increase in South Asia, including India.

224. Karnataka State consists of seven river systems namely Krishna, Cauvery, Godavari, North Pennar, South Pennar and Palar. The VNC system is located in the Tungabhadra river basin and is part of the Krishna River Basin-an inter-state river basin covering the states of Maharashtra, Karnataka and Andhra Pradesh.

**Climate Change impacts on the Krishna Basin**

225. A study was conducted to assess the impact of climate change on water resources in the Krishna River Basin using the HadCM3 Global Circulation Model (GCM) to address the precipitation, runoff, evapotranspiration and drought issues. Krishna River basin at 59.60% is the largest river basin in Karnataka.

226. ***Impact of Climate Change on Precipitation: Figure 12*** shows the percentage change in precipitation by 2021-2050 with respect to the baseline for the Kharif and Rabi seasons.

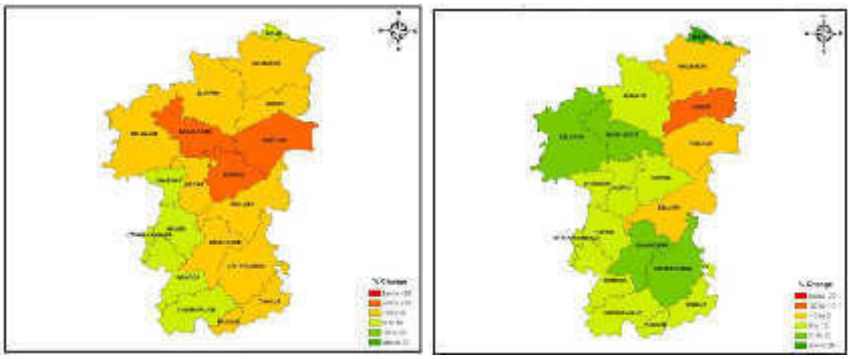


**Figure 12: Percent change in precipitation projected during 2021-50 w.r.t baseline for kharif and rabi seasons in Krishna Basin**

227. For the kharif season, the percentage increase in rainfall in the project districts of Koppal, Bellary and Raichur is expected to be between 0 and 10%. However, for the rabi season, all the districts within the Krishna basin are expected to see a decrease in precipitation.

228. ***Impact of Climate Change on Evapotranspiration:*** As per the BCCI-K study, it is observed that in both Kharif and Rabi seasons, in most of the districts within the Karnataka boundary of the Krishna basin, there is a decrease in evapotranspiration. ***Figure 13*** provides the range in which the evapotranspiration has been projected to decrease because of climate change.

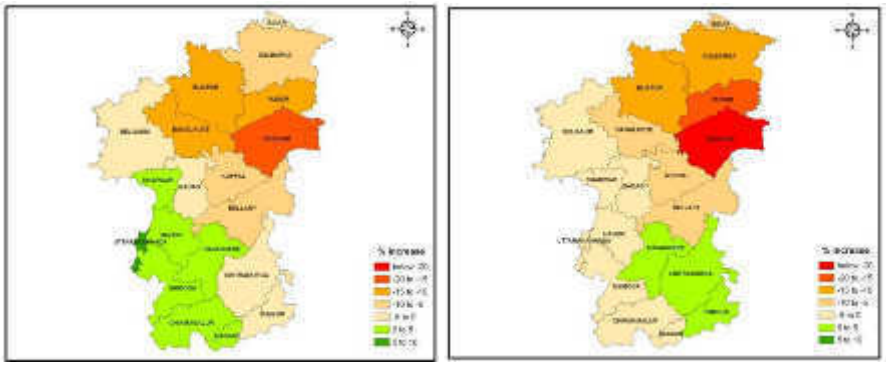


**Figure 13: Percent change in ET projected during 2021-50 w.r.t baseline for Kharif and Rabi seasons in Krishna Basin**

229. In Kharif season, the South-Western districts are projected to show an increase in evapotranspiration. In the districts of Shimoga, Chikmagalur, Hassan and Haveri, ET is projected to increase in the range of 5-10% by 2021-2050 in the Kharif season. Conversely, for the same districts, the ET is projected to reduce in the Rabi season. The evapotranspiration of Raichur district on the east of Krishna basin is expected to decline by 20% in Kharif season and by more than 20% for Rabi season.

230. ***Climate Change impacts on Runoff: Figure 14*** indicates the climate change impacts in the districts of the Krishna basin and the impact of climate change on total runoff during the Kharif and rabi season. The color scale ranges from red (upto 25% decrease in runoff) and pink (between 25%-0% decrease in runoff) to light green (between 0% and 25% increase in runoff) and dark green (between 25% and 50% increase in runoff).

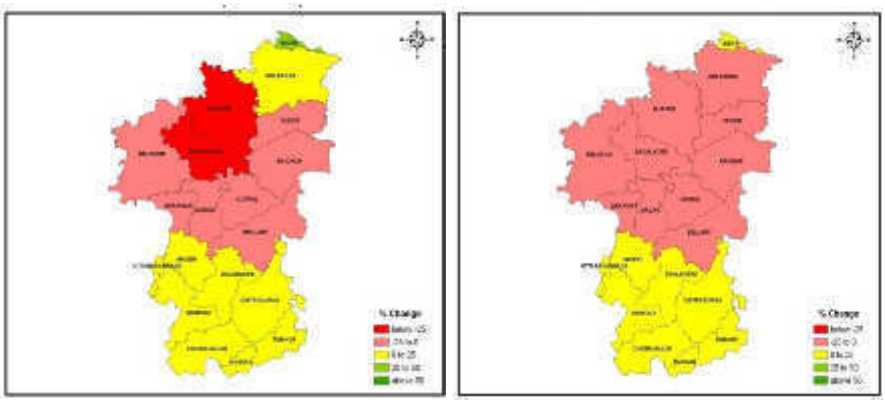


**Figure 14: Percent change in runoff projected during 2021-50 w.r.t baseline for the kharif and rabi season in Krishna Basin**

231. The study results revealed that during Kharif season, an increase in runoff by more than 50% is projected for the northern most district of Bidar. For districts on the south of Krishna basin, increase in runoff ranging between 0 and 25% is projected. It is observed that for the remaining districts in Krishna basin, runoff is not expected to increase significantly, especially for Bagalkote and Bijapur districts where a decline in runoff is predicted. The overall increase in runoff is likely to have serious implications for rain-fed crops in these districts. For the rabi season, it can be observed that a decline in runoff is predicted for the northern and central districts with the exception of Bidar where, along with the districts on the south of the Krishna basin, an increase in runoff is projected.

232. ***Impact of Climate Change on Water Yield***: Water yield is the amount of water leaving a watershed during a specified time period and is provided in ***Figure 15*** for the Krishna Basin:

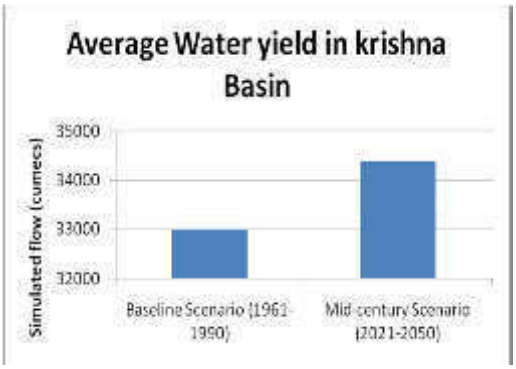



**Figure 15: Water Yield in Krishna Basin**

233. Water Yield can be used as a proxy variable for measuring runoff. As shown in ***Figure 15***, for Krishna basin, a marginal increase in the average water yield has been projected in the mid-century scenario, compared to the baseline scenario between1960-1990.

234. ***Impact of Climate Change on Drought:*** The drought prone districts in Krishna basin are Belgaum, Bellary, Bijapur, Chikmagalur, Chitradurga, Dharwar, Gulbarga, Hassan, Raichur and Tumkur. It is projected that during monsoon season, Raichur will be most affected with 10 to 20% decrease in rainfall projected for the future while the other drought prone districts show a marginal decrease in rainfall (0-10%). During the post-monsoon season, Raichur, Gulbarga and Bellary show a marginal decrease whereas other drought prone areas show an increase in rainfall. Decrease in rainfall in these regions, especially during monsoon, will increase the water stress which may affect crop yields negatively.

## 4.6 Socio-Economic Environment

235. The socio-economic pattern of the project districts viz., Bellary, Raichur and Koppal, indicates that the region has shown good progress in human development sectors. The data on the socio-economic environment has been presented taluk-wise in order to consistent with the 2011 Census data which is the most-recent census data that is available. The literacy rate of the project area is fifty percent. Male and female literacy rates of the project area accounted for 58.8 percent and 41.2 percent, respectively.

**Population of the project area**

236. The population of the project area is predominantly scattered over the rural and semi urban areas. Out of the total population, 50.1 percent are male and 49.9 percent female. The same trend reflects on the population of Hospet taluk; out of a total population of 188, 965, 50.1 percent comprise male while 49.9% percent are female. There is no significant difference in the male female population in Koppal, Gangavathi, Siruguppa and Manvi taluks. The population distribution, literacy and SC / ST Population distribution are provided in ***Tables 36 and 37.***

**Table 36: Population distribution and literacy in the Project Area**

| Taluk Wise | Population | | | Literacy | | |
|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total |
| **Hospet** | 94,673 | 94,292 | 188,965 | 55,639 | 39,527 | 95,166 |
| **Koppal** | 582,958 | 573,258 | 1,156,216 | 382,270 | 268,731 | 651,001 |
| **Gangavathi** | 172,397 | 172,866 | 345,263 | 109,179 | 81,994 | 191,173 |
| **Siruguppa** | 94,949 | 95,439 | 190,388 | 49,522 | 31,216 | 80,738 |
| **Manvi/Bichal** | 160,902 | 163,303 | 324,205 | 87,594 | 58,539 | 146,133 |
| **Total** | **1,105,879** | **1,099,158** | **2,205,037** | **684,204** | **480,007** | **1,164,211** |

**Table 37: SC/ ST Population distribution in the Project Area**

| Taluk-wise | SC Population | | | ST Population | | |
|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total |
| **Hospet** | 27,600 | 27,668 | 55,268 | 18,749 | 19,042 | 37,791 |
| **Koppal** | 111,858 | 111,077 | 222,935 | 76,987 | 75,576 | 152,563 |
| **Gangavathi** | 35,381 | 36,058 | 71,439 | 28,543 | 28,745 | 57,288 |
| **Siruguppa** | 21,391 | 21,853 | 43,244 | 18,977 | 19,223 | 38,200 |
| **Manvi/ Bichal** | 35,343 | 35,893 | 71,236 | 41,226 | 42,449 | 83,675 |
| **Total** | **231,573** | **232,549** | **464,122** | **184,482** | **185,035** | **369,517** |

237. The impact on Indigenous People has been examined during social and environmental assessment and consultation process as per ADB Safeguard policy document. Considering the nature of interventions proposed under the program, no specific adverse impacts are anticipated for the STs (Indigenous People) compared to other communities.

238. Manvi consists of highest indigenous population of around 25.8 percent and Koppal is the lowest at 13.2%. Siruguppa consists around 20%, Hospet at 20% and Gangavathi at 16%. Among the SC population (vulnerable) Hospet has the highest (29.3%) and Koppal the lowest (19.3%), followed by Siruguppa (21.4%), Gangavathi (20.7%) and Manvi (16%).

***Sex ratio***

239. Hospet has a total population of 188,965 out of which 50.1% is male and 49.9% female[5]. Koppal, Gangavathi, Siruguppa and Manvi[6] too have similar sex ratio. Among all the taluks, Manvi taluk has the highest sex ratio (1013) followed by Hospet (1006), Siruguppa (1005), Gangavathi (1003) and Koppal taluk (979)[7].

***Literacy***

240. Literacy rate among male category in Hospet is 58.5% and female 41.5%. Corresponding figures for Koppal are 58.7 and 41.3, Gangavathi 57.1 (Male) and 42.9 (female) respectively. In Siruguppa, female literacy is lowest at 38.7 compared to all the other places.

[5] *Population Census, 2011, Government of India*
[6] *District Hand book Bellary, 2014-15, Directorate of Economic and Statistics, Government of Karnataka*
[7] *Human Development Report 2014, Raichur District Panchayat, Government of Karnataka*

### Poverty

241. Economic survey of Karnataka 2015-168 reports that the percentage of people below poverty line is highest in Bellary and Raichur districts. Over the years, the state has made significant progress in poverty reduction. Although there has been a decline in the poverty ratio in the state, the regional disparity within the state still exists. The districts of Bellary (40.8%), Koppal (40.7%) and Raichur (37.7%) have the highest poverty levels, i.e., below poverty line ratio is much higher than the poverty ratio at the state level.

242. Historically, Self Help Groups (SHGs) and cooperative societies played an important role in improving livelihoods and living standards of the community, especially women groups in project villages. The SHG movement was not only about empowering women economically but also for social empowerment of women in rural areas. The SHGs have been instrumental in improving gender relationships in the society. Several poverty reduction programmes have been launched by the state government for the rural poor, comprising small and marginal farmers, landless labourers and rural artisans.

243. Contrary to this, the Civil Supplies Department of Government of Karnataka9 has come up with different criteria for issuing ration cards to the below poverty line category.

### Occupation

244. The work participation rate is defined as percentage of total workers to total population. According to 2011 census, the working population of Koppal district is 47.1 percent. The main worker population comprises 35.7 percent of the total population and a marginal worker is 11.4 percent. The non-working population of the district is 52.9 percent. The lowest working population is found in Gangavathi taluka.

245. In Koppal and Gangavathi, out of total workers, 24.1% are cultivators, 42.8% are agricultural labourers, 29.8% are other workers; 3.2% are involved in household level activities[10]. It is worth noting that women comprise 21% of cultivators and 60% agricultural labourers whereas men comprise 79% of cultivators and 40% agricultural labourers. In Manvi, 26.9% are cultivators, 53.9% agricultural labourers, 17.5% other workers while 1.7% are involved in household level activities. Overall, there is a decline in the percentage of workers engaged in agricultural activities (***Table 38***)[11]; this needs to be closely examined to understand the magnitude of the problem.

[8] *Economic survey of Karnataka 2015-16, Department of Planning, Programme Monitoring and Statistics, Govt. of Karnataka, March 2016*
[9] *Food and Civil Supplies and Consumer affairs department, Govt. of Karnataka- Taluk wise report on active ration cards, 2016;*
[10] *Population Census, 2011, Government of India*
[11] *Agricultural Census 2010-11 Report on Operational Holdings in Karnataka, Directorate of Economics & Statistics, Bangalore.*

**Table 38: Classification of workers in project talukas**

| Taluk Wise Details | Cultivators | | Agricultural labourers | | Household activities | | Other workers | | Total workers | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | |
| Hospet | 14,842 | 6,129 | 16,749 | 19,364 | 749 | 398 | 16,053 | 4,881 | 48,393 | 30,772 | 79,165 |
| Koppal | 113,228 | 36,282 | 76,992 | 97,727 | 6,405 | 3,408 | 75,789 | 24,712 | 272,414 | 162,129 | 434,543 |
| Gangavathi | 31,051 | 9,261 | 28,219 | 30,731 | 1,475 | 869 | 23,473 | 7,594 | 84,218 | 48,455 | 132,673 |
| Siruguppa | 21,203 | 11,854 | 23,324 | 29,986 | 472 | 279 | 7,462 | 2,948 | 52,461 | 45,067 | 97,528 |
| Manvi | 166,086 | 59,795 | 114,057 | 141,916 | 6,019 | 3,538 | 60,550 | 23,432 | 346,712 | 228,681 | 575,393 |

*Source: Population Census 2011, Govt. of India*

### *Crops and category of Farmers*

246. Agriculture is the main activity of the target population in the project villages. People are basically depending on rainfall, irrigation tanks, wells and streams for irrigation. In Hospet Taluk and nearby villages farmers are predominantly depending on canal water for agriculture. The farmers in Gangavathi Taluk are dependant mainly on Tungabhadra canal irrigation, while farmers in Koppal and other taluks depend mainly on rainfall, tanks and wells. Paddy is the predominant crop in Gangavathi taluk occupying 43.1% of the total sown area due to availability of irrigation facilities. In Hospet taluk and adjoining areas, sugar cane, banana, paddy, jowar, ajar etc are grown. Sugar cane is grown in 80% of Shivapura and Nantahala villages. In some parts of Koppal and Raichur districts, cotton is also grown along with other crops. The important pulses grown are Bengal gram, tur dal, groundnut, sunflower, etc. In Siruguppa and Deshnur channels of Bellary district, paddy is the main crop grown; only one crop per season is raised. In Raichur and Manvi taluks, crops grown under rain fed cultivation include jowar, cotton, groundnut, chilli, wheat and pulses. Irrigated crops comprise paddy, sugarcane, maize, wheat, chilli, cotton, pulses, onions, and plantains.

**Table 39: Category of Farmers**

| Taluk | Marginal farmers | Small farmers | Medium farmers | Large farmers | Total |
|---|---|---|---|---|---|
| Hospet | 19,302 | 8,999 | 5,690 | 81 | 34,072 |
| Siruguppa | 17,297 | 11,236 | 13,688 | 646 | 42,867 |
| Gangavathi | 28,002 | 18,421 | 15,012 | 280 | 61,705 |
| Koppal | 13,649 | 15,899 | 15,276 | 540 | 45,364 |
| Manvi | 25,484 | 23,135 | 24,628 | 1,058 | 74,305 |
| **Grand Total** | **103,734 40.2%** | **77,690 30.1%** | **74,294 28.7%** | **2,605 1.0%** | **258,313 100.0%** |

*Source: Agriculture Census, GoK (http://raitamitra.kar.nic.in/stat/12.htm)*

## 4.6.1 Key Features of the Social-Safeguard Due Diligence Study

247. A Social-Safeguard Due Diligence Study (SDDR) was conducted to make an assessment of: (a) the existing status and condition of the channel system; (b) social risks in anticipation of the proposed modernization (rehabilitation) works in terms of involuntary resettlement issues, and (c) indigenous people etc. Consultations and focus group discussions (FGD) were organised in different localities by ethnicity, type of farmers and other locally specific characteristics as part of the SDDR study. Overall, participants in the public consultations and focus group discussions expressed their keen interest in the

project which they felt would bring them enhanced agrarian returns and provide livelihood stability. Further, they expressed their readiness to take up their due role in the implementation of the project as they are aware of the merits of this project, and its effect on enhancing the living standards of farmers.

248. The study found that the project intervention will be limited to the existing RoW and does not involve any land acquisition or cause any adverse impacts on people's properties and livelihoods. The availability of land and adequacy of available right of way was confirmed from the Implementing Agency. This was further confirmed during consultation with farmers during field survey and assessment of impacts. From strictly physical and economic points of view, the project will not only imply an obstacle for accessing the embankments of the channel.

249. Lining work of the channel and other structures are planned based on the concept of implementing physical works involving no land acquisition and resettlement (LARR) impact. However, during the construction, there may be some temporary disturbance caused by the Contractors. Such a disturbance would possibly be incurred by excavation and lining works, mobilising machinery and equipment to the site, limited access to agricultural land, plots in the neighbourhood of the construction site.

250. In the absence of significant impacts over the main population settlements, there is no evidence that the project will cause any type of adverse reaction among the local communities. It is worthwhile noting here that during consultations with farmers and panchayats, no objections or concerns were raised; they promised all possible support for smooth implementation of the project. Around 70% of the active population are cultivators who work their own land, which is mostly distributed along the IP. They have extended cultivation in some portions of the land. Based on field assessment, a strip map has been prepared for each of the channels (km wise) and attached as an annexure to the Social Safeguard Due Diligence Report**.**

251. The findings of the social and environmental assessment of the channels are presented in ***Table 40***.

**Table 40: Findings of the Social and Environmental Impact Assessment of Channels in VNC**

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| Raya Channel (27.74 km) | • The Raya channel takes off from Tungabhadra Dam right bank. There is a separate sluice at km 2.5 of this channel to meet the requirements of water of Bella channel.<br>• Total length of the Raya Channel is 27.74 km, which covers around 2016 ha CCA.<br>• The urban area extends from Ch. 6.62 to 9.62.<br>• About 7 washing platforms are located at different locations of the channel. | • Access is available from service road throughout the length of the channel except for Ch. 2.2 to 2.3 km. Entry for construction work is from the chi 0.<br>• Out of 27.74 km 19.12 kms (68.9%) encroached in inspection path for cultivation.<br>• Urban area covers from Ch.6.62 to 9.62.<br>• From Ch. 6.62 to 9.62, inspection path is encroached with *20 permanent buildings (mostly residential buildings) and compound walls of a Hotel.* |

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| | • Main crops cultivated are jowar, paddy, sugar cane and banana.<br>• Total trees around the embankments are 458; details are given in the Tree survey report. | • Ch. 20.10 to 20.20 is part of Hampi heritage area along inspection path<br>Details are given in the strip maps. |
| Basavanna Channel (16.5 km) | • The Basavanna channel takes off from Tungabhadra Dam right bank. Total length of the channel is 16.5 km, which covers 1240 ha of CCA.<br>• Urban area (Hospet city) covers from Ch.3.26 to 6.00 km. No command in this location.<br>• The city sewerage connection is linked to the channel system and the water is polluted.<br>• At 6.8 kms distance, discharge from sugar factories mixes with channel water.<br>• 9 washing platforms along the embankments.<br>• In total, 23 permanent buildings and 16 semi-permanent buildings (mostly residential), 3 commercial units, 6 toilets, 3 temporary buildings and 1 school compound encroached along inspection path<br>• Approximately, 500 meters is not accessible from Ch.16 to 16.5 (no service road and inspection path).<br>• In service road -Ch.6.00- 6.38, 6.54-6.7, 7.00-7.14, 7.58-7.74 and in inspection path 6.38-6.54, 6.70-6.86 - Municipal waste dumping sites<br>• Total trees around the embankments are 217; details are provided in the Tree survey report. | • Access is available from service road throughout the length of the channel except for Ch. 16 to 16.5 km. Entry for construction work is from the Ch. 0.<br>• Out of 16.5 kms, only 3.5 kms in the inspection path is encroached for cultivation.<br>• Urban area (Hospet city) covers from Ch.3.26 to 6.00 km. No command in this location.<br>• Ch. 3.26 to 6.00 - 23 permanent and 16 semi-permanent buildings, 3 temporary buildings, 6 toilets, 3 commercial units and 1 school compound in the inspection path.<br>• Approximately 500 meters is not accessible from Ch.16 to 16.5 (no service road and inspection path).<br>• In service road -Ch.6.00- 6.38, 6.54-6.7, 7.00-7.14, 7.58-7.74 and in inspection path 6.38-6.54, 6.70-6.86 - Municipal waste dumping sites<br>Details are given in the strip maps. |
| Bella Channel (5.5 km) | • Total length of the channel is 5.5 km, which covers 600 ha CCA.<br>• Ch.3.32 to 3.9 - *22 structures* (*8 permanent, 10 semi-permanent and 4 temporary*) along the service road, belonging to mostly scheduled tribes and scheduled caste community.<br>• 0.8 kms (14.5%) of inspection path used for cultivation.<br>• Total trees around the embankments are 360; details are given in the Tree survey report. | • Anicut is accessible<br>• Full access from service road is available for modernization (rehabilitation) work, with the exception of Ch.3.3 to 3.9 km. However, access from parallel road is available for movement of vehicles, equipment and construction materials.<br>• Ch.3.32 to 3.9 - *22 structures* (*8 permanent, 10 semi-permanent and 4 temporary*) along the service road, mostly belonging to scheduled tribes and scheduled caste community.<br>• 0.8 kms (14.5%) of inspection path used for cultivation<br>Details are given in the strip maps. |

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| Kalaghatta Channel (7.02 km) | • Total length of the channel is 7.02 km, which covers around 237 ha of CCA.<br>• Around 3.58 km is under cultivation of seasonal crops such as Jowar, Groundnut, Paddy, Sugarcane and Banana.<br>• The quality of water is poor due to sewerage and drainage water, and also wastewater from the sugar factory.<br>• Total trees around the embankments are 228 and details are given in the Tree survey report. | • Full access from service road is available for modernization (rehabilitation) work, with the exception of Ch. 4.2 to 4.68 to 5.6 and 6.2 km.<br>• 1 permanent and 1 temporary building along service road<br>• 3.58 kms (51%) used for cultivation. Main crops are Jowar, Groundnut, Paddy, Sugarcane and Banana.<br>• The quality of water is poor due to sewerage and drainage water and also wastewater from the sugar factory.<br>Details are given in the strip maps. |
| Turtha Channel (18.69 km) | • Total length of the Channel is 18.69 km, which covers 931 ha of CCA.<br>• Turtha comes under Hampi Heritage area and the monuments listed are given in the Strip maps.<br>• Around 8.8 km of stretch are used for cultivation of seasonable crops such as Banana, Paddy, Groundnut, Sugar cane etc.<br>• Total trees around the embankments are 261 and details are given in the Tree survey report. | • Access is available from service road throughout the length of the channel with the exception of km. Entry for construction work is from the Ch. 0.<br>• Turtha comes under Hampi Heritage area. Monuments listed are given in the Strip maps.<br>• Ch. 9.8 km, 1 permanent building and Ch.15.82 to 16.5, 10 permanent building along inspection path<br>• 8.8 km (47.1%) used for cultivation. Main crops are Banana, Paddy, Groundnut, Sugar cane etc.<br>Details are given in the strip maps. |
| Ramasagara Channel (15.50 km) | • Total length of the channel is 15.50 km of which covers 673 ha of CCA.<br>• 2 washing platforms are located at 6.8 km and 7.6 km.<br>• 1 abandoned building on inspection path and 1 religious structure along service road<br>• Farmers are using 6.12 km stretch for cultivation of crops such as Jowar, Ground nut, Paddy, Banana, and Sugar cane.<br>• 0.16 km of inspection path and service road is used for waste dumping and open defecation<br>• Total trees around the embankments are 319 and details are given in the Tree survey report. | • Access is available from SR throughout the length of the channel. Entry for construction work is from the Ch 0.<br>• 6.12 km (39.5%) is encroached for cultivation; main crops are Jowar, Ground nut, Paddy, Banana, and Sugar cane.<br>• I abandoned building on inspection path and 1 religious structure along service road (not encroached)<br>• 0.16 km of inspection path and service road is used for waste dumping and open defecation<br>Details are given in the strip maps. |
| Kampli Channel (23.55 km) | • Total length of the channel is 23.55 km which covers 620 ha of CCA.<br>• Ch.10.00 km 1 temporary house at inspection path<br>• Waste disposal temporary shed at Ch.20.10 to 20.20 in inspection path | • No access to anicut<br>• Access is available from service road throughout the length of the channel with the exception of 2.5 km. Entry for construction work is from Ch. 0. |

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| | • 16 kms of inspection path is being used for cultivation of seasonable crops mainly Bananas, Paddy, Jowar, Groundnut and Sugar cane.<br>• Total trees around the embankments are 85 and details are given in the Tree survey report. | • Ch.10.00 km 1 temporary house at inspection path<br>• 16 km (67.9%) encroached for cultivation. Main crops are Bananas, Paddy, Jowar, Groundnut and Sugar cane.<br>• Waste disposal temporary shed at Ch.20.10 to 20.20 at inspection path<br>Details are given in the strip maps. |
| Belagodahala Channel (11.22 km) | • Total length of the channel is 11.22 km, which covers 210 ha of CCA.<br>• Entire length of inspection path of the channel is used for cultivation of seasonable crops such as Jowar, Groundnut, Banana and Paddy.<br>• Ch.10.69 to 11.00 is used for waste dumping and open defecation<br>• Total trees around the embankments are 139; details are given in the Tree survey report. | • Access is available from SR throughout the length of the channel except Ch. 1.7 at railway bridge. Entry for construction work is from Ch. 0.<br>• Entire inspection path (11.22 km - 100%) is encroached for cultivation.<br>• Ch.10.69 to 11.00 is used for waste dumping and open defecation<br>Details are given in the strip maps. |
| Siruguppa Channel (10.85 km) | • Total length of the channel is 10.85 km, which covers 764 ha of CCA.<br>• Ch.0.36 and 8.25 to 8.5, 21 permanent houses in inspection path<br>• 1 religious structure at Ch. 2.6 along service road<br>• Inflows from the city drainage system are leading to the channel water pollution.<br>• Total trees around the embankments are 153 and details are given in the Tree survey report. | • Anicut accessible through SR.<br>• Access is available from SR throughout the length of the channel except at Ch. 1.7 near railway bridge. Entry for construction work is from the Ch 0.<br>• 0.36 and 8.25 to 8.5, 21 permanent houses in inspection path<br>• 1 religious structure at Ch. 2.6 along service road<br>• 7.92 km (73%) encroached for cultivation<br>Details are given in the strip maps. |
| Deshnur Channel (9.03 km) | • Total length of the channel is 9.03 km, which covers 478 ha of command area.<br>• Entire length is free from any encroachments and readily available for modernization (rehabilitation) work.<br>• 1 permanent building and portion of small house at Ch.2.6 and 5.1 in inspection path<br>• Total trees around the embankments are 119; details are given in the Tree survey report. | • Anicut accessible through service road<br>• Access is available from service road throughout the length of the channel.<br>• Entry for construction work is from the Ch. 0.<br>• 1 permanent building and portion of small house at Ch.2.6 and 5.1 in inspection path<br>• 7.22 kms (80%) encroached for cultivation in inspection path<br>Details are given in the strip maps. |
| Hulugi Channel (10.69 km) | • Total length of the channel is 10.69 km, which covers 265 ha of CCA.<br>• Ch. 0.70 to 1.40 and 4.32 to 4.36 service road are not accessible due to silt dumping. | • Access to anicut is available from Ch.0.<br>• Access is available from SR throughout the length of the channel except at Ch. 1.7 near railway bridge. |

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| | • Solid wastes are dumped from Ch.2 to Ch.2.4 of the channels especially from the religious institutions and shops.<br>• Under Ground Drainage and sewerage system from the town is also connected to the channel.<br>• Total trees around the embankments are 53 and details are given in the Tree survey report. | Entry for construction work is from the Ch 0.<br>• Ch. 0.70 to 1.40 and 4.32 along 4.36 service road is not accessible due to silt dumping.<br>• Ch. 2.0 to 2.45 km is encroached by a compound wall of a religious structure along the inspection path embankment.<br>• Ch. 2.4 is encroached by religious structure in service road and a temporary building at Ch.2.5.<br>• Solid wastes are dumped from Ch.2 to Ch.2.4 of the channels especially from the religious institutions and shops.<br>• Under Ground Drainage and sewerage system from the town is also connected to the channel.<br>• 3.44 km (32.2%) is encroached for cultivation along inspection path.<br>Details are given in the strip maps. |
| Shivapura Channel (6.54 km) | • Total length of the channel is 6.54 km, which covers 403 ha of CCA.<br>• In and around Anicut area 2 acres of land is used for cultivation.<br>• 3.40 km are used for cultivation of seasonable crops such as paddy, ground nuts, Jowar and sugar cane.<br>• Total trees around the embankments are 54 and details are given in the Tree survey report. | • Access is available from service road throughout the length of the channel except for Ch. 0 to 2. Entry for construction work is from the Ch. 0.<br>• Ch.0 to Ch. 2, no accessibility of service road and inspection path<br>• 3.40 km (52%) is encroached for cultivation along inspection path.<br>• Ch.5.6 to 5.74, Ch.5.8 to Ch.6, Ch.6.14 to 6.3, 3 religious structures encroached along inspection path<br>Details are given in the strip maps. |
| Anegundi Channel (19.44 km) | • Total length of the channel is 19.44 km, with 789 ha of CCA.<br>• 10.44 km are used for cultivation of crops such as paddy, ground nuts, Jowar and sugar cane.<br>• Heritage area Ch. 0 to 8.5 km.<br>• *3 Shops and temporary shelters 6.62 to 6.8 km in SR.*<br>• *6 toilets and 3 temporary houses at Ch.15.0 15.50, boundary walls of Auxiliary Nurse Midwife (ANM) quarters (health department), rural bank and school compound at inspection path*<br>• Total trees around the embankments are 462; details are given in the Tree survey report. | • Access is available from SR throughout the length of the channel except for Ch. 1.22 to 1.44 (2 small shops). Entry for construction work is from the Ch 0.<br>• Heritage area Ch. 0 to 8.5 km.<br>• 10.44 km (53%) of inspection path encroached for cultivation.<br>• *3 Shops and temporary shelters 6.62 to 6.8 km in SR.*<br>• *6 toilets and 3 temporary houses at Ch.15.0 15.50, boundary walls of Auxiliary Nurse Midwife (ANM) quarters (health department), rural bank and school compound at inspection path*<br>Details are given in the strip maps. |

| Name of the Channel | Situation of Social and Environmental aspects | Findings and Observations |
|---|---|---|
| Upper Gangavathi Channel<br>(9 km) | • Total length of the channel is 9 km and the command area are 775 ha.<br>• 300 m in the beginning of service road occupied by crops like floriculture, bananas etc.<br>• The accessibility to service road is affected due to the dumping of the silt from the channel.<br>• 2.24 km (24.9%) is encroached for cultivation.<br>• Ch.8.6 to 8.8 – 8 temporary houses encroached along the inspection path<br>• Total trees around the embankments are 128 and details are given in the Tree survey report. | • No access to Anicut from Ch. 0 to 1.5 from both service road and inspection path<br>• Access is available from service road and alternate panchayat road throughout the length of the channel except for Ch. 0 to 1.50. Entry for construction work is from the Ch. 0.<br>• *Ch.2.18 to 2.32, one religious structure encroached on inspection path*<br>• *Ch.8.6 to 8.8 – 8 temporary houses encroached along inspection path*<br>• 2.24 km (24.9%) is encroached for cultivation.<br>Details are given in the strip maps. |
| Lower Gangavathi Channel<br>(9.54 km) | • Total length of the channel is 9.54 km, which covers 667 ha of CCA.<br>• Ch.6.6 to 6.82, 1 religious structure on the service road.<br>• Ch.8.0 to 8.32, 1 religious structure, 1 temporary cow shed, and 2 abandoned structures on service road<br>• *Ch.9.0 to 9.08 brick kiln and small house along inspection path*<br>• *Ch.9.8 to 9.9,1 temporary house encroached on inspection path*<br>• Ch.9.7 to 10.0 open defecation and solid wastes dumping<br>• Washing platform Ch. 3.7 (washing clothes, utensils, bathing etc.).<br>• Total trees around the embankments are 228 and details are given in the Tree survey report. | • Anicut accessible from Ch.0.<br>• The entire length of service road is free from any encroachments and readily available for modernization (rehabilitation) work.<br>• *Ch.6.6 to 6.82 religious structure along the service road*<br>• *Ch.8.0 to 8.32, 1 religious structure, cow shed, and a damaged stone structure on service road.*<br>• *Ch.9.0 to 9.08 brick kiln and small house along inspection path*<br>• *Ch.9.8 to 9.9,1 temporary house encroached on inspection path*<br>• Ch.9.7 to 10.0 open defecation and solid wastes dumping<br>Details are given in the strip maps. |
| Bichal Channel<br>(14.52 km) | • Total length of the channel is 14.52 km, which covers 276 ha of CCA.<br>• Except for initial 1 km stretch, entire area service road not accessible due to wild vegetations.<br>• Ch.13.38 to 13.68 encroachment of inspection path for private use (for fisheries).<br>• Total trees around the embankments are 181; details are given in the Tree survey report.<br>• 143 open wells constructed for irrigation purpose in the beginning.<br>• Entire inspection path is used for cultivation of seasonal crops such as Cotton, Chilly, Sugar cane, Paddy and Jowar. | • Anicut accessible from Ch.0.<br>• Access to SR available only for Ch.0 to 1 due to wild vegetations. Approach road construction is essential before starting construction work.<br>• *Ch.13.38 to 13.68 encroachment of inspection path for private use (for fisheries).*<br>• Entire inspection path is used for cultivation of seasonal crops such as Cotton, Chilly, Sugar cane, Paddy and Jowar.<br>**Details are given in the strip maps annexed to SDDR report.** |

### 4.6.2 Strip Maps

252. In the strip maps, green shade denotes for crops, vegetation and trees, yellow shade for infrastructure such as houses, religious institutions, schools, toilets etc. (permanent, semi-permanent and temporary structures along the embankments in service road and IP) brown shade for heritage and conservation areas, red shade for waste/drainage water, solid waste, open defecation etc. The blue shade denotes urban area in Raya, Basavanna, Gangavathi and Siruguppa channels.

**Table 41: Summary of Findings from Strip Maps**

| S. No | Channel Name | Detail | Chainage in km | Encroachment | | Channel wise encroachment (km) |
|---|---|---|---|---|---|---|
| | | | | SR in km | IP in km | Colour Code |
| 1 | Raya (27.74 km) | Inspection path encroached by Priyadarshini Pride Lodge including building of permanent wall | 9.00 | | | 3.00 |
| | | Wastewater drain from Nagenahalli Village entering channel | 12.60 | | | 0.08 |
| | | Hampi Heritage monument at about 100m away from inspection path | 20.10 to 20.20 | | | 0.1 |
| | | Urban area ((20 permanent buildings and hotel compound walls) | 6.62 to 9.62 | | 6.62 to 9.62 | 3.00 |
| | | Encroachment along inspection path for cultivation | | | | 19.12 |
| 2 | Basavanna (16.50 km) | Urban area (23 permanent, 16 semi-permanent buildings, 6 toilets, 3 commercial units,3 temporary and one School compound in the inspection path) | 3.26 to 6.00 | | 3.26 to 6.00 | 2.70 |
| | | Compound wall of a house in inspection path | 0.36-0.54; | | | 0.18 |
| | | Pump house and cultivation in inspection path | 10.2 | | | 3.53 |
| | | Municipal waste dumping on service road and inspection path | | | | 1.28 |
| 3 | Bella (5.50 km) | Inspection path (IP) encroached by religious institution for having their activities; however, the structure is outside the IP. | 0.60 to 0.82 | | 0.22 | 0.8 |
| | | Temporary hut and trees in service road | 1.70 to 1.88 | 0.18 km | | |
| | | 1 Small religious structure on the service road embankment and a temporary hut | 2.40 to 4.00 | 1.60 km | | 1.78 |
| | | 8 permanent and 10 semi-permanent and 4 temporary buildings along service road | 3.30 to 3.90 | 0.60 | | 0.60 |
| | | Cultivation along inspection path (mostly bananas and sugar cane) | 3.8 to 4.18 | | 0.38 | |
| | | Coconut Trees along inspection path | 4.82 to 5.00 | | 0.18 | |
| 4 | Kalaghatta (7.02 km) | Encroachment for cultivation along inspection path | | | 3.58 | 3.58 |
| | | 1 permanent and 1 temporary houses along service road | 4.68 to 5.60, and 6.30 to 6.50 | 4.68 to 5.60 and 6.30 | | |

| S. No | Channel Name | Detail | Chainage in km | Encroachment | | Channel wise encroachment (km) |
|---|---|---|---|---|---|---|
| 5 | Turtha (18.69 km) | Heritage area | 8.57 | | | 8.57 |
| | | Encroachment for cultivation along inspection path | | | | 8.82 |
| | | 1 permanent building on service road | 9.8 | | 9.8 | 0.08 |
| | | 10 permanent buildings on inspection path | 15.70 to 16.30 | | 15.70 to 16.30 | 0.60 |
| | | Waste strewn on SR side and wastewater entry into channel | 16.3 | | | 0.21 |
| 6 | Ramasagara (11.22 km) | Encroachment for cultivation along inspection path | | | 6.12 | 6.12 |
| | | Abandoned building structure on inspection path | 7.1 | | | 0.18 |
| | | Religious structure along service road | 8.9 | | | |
| | | No. 10 Muddapura village wastewater draining into the channel | 8.9 | | | 0.16 |
| | | Service road and inspection path converted into open-defecation and waste dumping area. | | 0.30 | 0.67 | |
| 7 | Kampli (23.55 km) | Encroachment for cultivation along inspection path | | | 16.00 | 16.00 |
| | | Waste disposal in service road and inspection path | | | 1.96 | 1.96 |
| | | Temporary shed in inspection path | 20.10 to 20.20 | | 0.10 | 0.10 |
| 8 | Belagodahalla (11.22 km) | Encroachment for cultivation along inspection path | | 0.31 | 10.91 | 11.22 |
| | | Waste dumped into channel by villagers, service road used for open defecation and solid waste disposal | 10.69 to 11.00 | | 0.31 | 0.31 |
| 9 | Siruguppa (10.85 km) | Urban area | 8.00 to 10.00 | | | 2.00 |
| | | Encroachment of religious structure along service road and 21 permanent buildings in inspection path | 2.6 and 8.25 to 8.50 | | 0.36 and 8.25 to 8.50 | 0.37 |
| | | Waste strewn on service road side and wastewater entry into channel | 8.5 to 8.70 | | | 0.46 |
| | | Encroachment for cultivation along inspection path | | | | 7.92 |
| 10 | Deshnur (9.03 km) | Encroachment for cultivation along inspection path | | | 7.22 | 7.22 |
| | | 1 Permanent building and portion of small house on inspection path | 2.6 and 5.1 | | | 0.28 |

| S. No | Channel Name | Detail | Chainage in km | Encroachment | | Channel wise encroachment (km) |
|---|---|---|---|---|---|---|
| | | Portion of brick factory encroaching inspection path | 5.3 | | | |
| | | Encroachment of service road for installing public water supply tank | 8.6 | | | |
| 11 | Hulugi (10.69 km) | Encroachment for cultivation along inspection path | | | | 3.44 |
| | | Boundary wall of religious structure along inspection path | 2.00 to 2.45 | | 0.6 | 0.72 |
| | | 1 religious structure and 1 temporary building in service road | | | | |
| | | Silt dumped in service road | 0.70 to 1.40 and 4.32 to 4.64 | | 0.32 | 2.00 |
| 12 | Shivapura (6.54 km) | Encroachment for cultivation along inspection path | | | 3.40 | 3.40 |
| | | Silt disposal, UGD and drainage water connected to the channel | | 1.40 | | 1.40 |
| | | 2 Religious structure extended to inspection path and 1 religious structure along service road | 5.58 to 5.74, 5.88 to 6.00 and 6.14 to 6.3 | 0.44 | | 0.44 |
| 13 | Anegundi (19.44 km) | Encroachment for cultivation along inspection path | | | | 10.44 |
| | | Silt disposal in inspection path | 0.02 | | 0.02 | 0.02 |
| | | Heritage area | 0 to 8.50 | | | 8.50 |
| | | 3 commercial units and temporary shed along service road | 6.60 to 6.80 | 0.02 | | 0.02 |
| | | 3 temporary houses, 6 toilets, compound walls of ANM quarters (health dept), cooperative bank and school at Basavadurga and Kuruma camp along Inspection path; | 15.00 to 15.50 | | 0.5 | 2.04 |
| 14 | Upper Gangavathi (9.00 km) | Encroachment for cultivation along inspection path | | | | 2.24 |
| | | Religious structure extended to inspection path | 2.18 to 2.32 | | 0.24 | 2.60 |
| | | Silt deposal in service road | 3.32 to 3.48 | 0.16 | | 2.38 |
| | | 8 temporary buildings extended to IP | 8.60 to 8.80 | | 0.20 | 0.20 |
| 15 | Lower Gangavathi (9.54 km) | Encroached for cultivation along inspection path | | 8.80 | | 8.80 |
| | | 1 Religious structure, 2 abandoned building, 1 temporary cow sheds along service road | 6.6 to 6.82<br>8.0 to 8.32 | 0.54 | | 0.57 |
| | | 1 brick kiln and small house along inspection path | 9.0 to 9.2 | | 0.03 | |

| S. No | Channel Name | Detail | Chainage in km | Encroachment | | Channel wise encroachment (km) |
|---|---|---|---|---|---|---|
| | | | 9.80 to 9.90 | | | |
| | | Waste dumped into service road and used for open defecation | Ch.9.7 to 10.0 | 0.64 | | 0.64 |
| 16 | Bichal (14.50 km) | Service road is accessible only upto Ch. 1.0 km; Later it is accessible only at certain locations. Service road has been encroached by farmers for cultivation purpose. | 1.00 to 14.50 | 13.50 | | 0.46 |
| | | Encroachment of inspection path for private use (fisheries) | 13.38 to 13.68 | | 0.30 | |
| | | Entire inspection path has been encroached by farmers for cultivation purposes. | | | 13.06 | 13.06 |

***Colour Legend used in Table 42:***

| | |
|---|---|
| Habitation Encroachment on KNNL Land | |
| Cultivation Encroachment on KNNL Land | |
| Drainage water entering channel; waste disposal and open defecation on service road and inspection path | |
| Heritage Area and monuments | |
| Urban area | |

# 5. PROJECT ALTERNATIVES

253. The available alternatives were considered: (i) from "conceptual level" with direct reference to recommendations of the National Water Policy (NWP) of 2012 (applicable at the time of the Project Preparatory Technical Assistance Report preparation) and compared with the Draft National Water Framework of May 2016 and the State Water Policy Framework, and (ii) from "engineering" level, with more emphasis on the implementation of the project concept.

254. The National Water Policy (NWP 2012) provides a comprehensive framework to guide water resources development at the State level. The Policy identifies a range of challenges related to traditional aspects of water management such as increasing costs of water delivery service and infrastructure deterioration. The policy also emphasizes addressing new challenges relating to environmental flows, deteriorating water quality, competing water demands, social equity, and participatory management. However, in the Indian context, responsibility of water resources planning and management falls within the realm of the State. Hence, the NWP does not set targets and is generally silent on needed institutional changes.

255. However, similar to the National Water Policy, the Karnataka State Water Policy envisages water resources planning, development and management in the State to be carried out using an integrated approach. The key policy elements that led to developing the project concept are: (i) its emphasis on improving the performance of water resources projects and (ii) improving productivity of irrigated agriculture by involving users in irrigation management.

256. The National Water Policy and the State Water Policy are in line with the National Water Framework, of May 2016 which identifies Integrated Water Resources Management and Participatory Irrigation Management as the guiding principles for achieving sustainable water use.

257. The alternatives considered included: (i) Without Project Alternative; (ii) Rehabilitation of Vijayanagar Channel System Only, and (iii) Rehabilitation of the VNC System along with Participatory Irrigation Management.

(i) ***Without Project Alternative:*** The Without Project Alternative would lead farmers to continue utilising the current practices. The current practices entail drawing water to the channels through a variety of sources. These include drawing a portion of the irrigation water demand from the existing anicuts feeding the channels and another portion of the irrigation water demand from the Tungabhadra High Level Canal and/ or Low-Level Canals, as the case may be. However, in a majority of cases, the irrigation water demand is met for only six months in a year, thereby decreasing the agricultural productivity of the command areas. This is because the entire VNC infrastructure consisting of anicuts and canal sections have degraded to such an extent that the anicuts have not been able to deliver the requisite quantity of water to channels; seepage and transmission losses within the channels have resulted in a majority of the command areas receiving either no water or inadequate quantity of water. In fact, the condition of the VNC infrastructure is such that cost-effective maintenance and repair

is no longer feasible. In the Without Project Alternative, the infrastructure would degrade further.

Positive trends and developments achieved, such as increase in food production will be jeopardized and the general situation will deteriorate in the project areas. Investments made will be lost through lack of maintenance. Agricultural production will decline. Road communication, commerce, livestock breeding and general social conditions such as water supply, sanitation and health will also deteriorate.

Additionally, discussions with farmers have revealed that the current practices deny them water rights as water from the Anicuts, Tungabhadra HLC and/ or LLC is available only for six months in a year, while lands have been categorized as those that have been irrigated throughout the year. Consequently, the option of doing nothing has been rejected by the stakeholders.

(ii) ***Rehabilitation of VNC System Only:*** The second alternative would be to Rehabilitate the Vijayanagar Channel Infrastructure and continue with the existing practice of the state agency performing the O&M function. However, this option would not address the diverse local water management problems in the command area. Moreover, the main infrastructure tends to be managed for the benefits of influential and powerful stakeholders living adjacent to the facilities, with little recognition for the concerns and interests of those who live in the tail end areas. So much so that the overall stakeholder interests and support in this option tends to be very weak due to inequitable distribution of water primarily, not addressing fully the integrated water resource management principles.

(iii) ***Rehabilitation of VNC System as part of Participatory Irrigation Management:*** The third alternative considered is rehabilitation of the Vijayanagara Channel Infrastructure along with promotion of Participatory Irrigation Management (PIM) principles. Promotion of PIM would involve formation of Water User Cooperative Societies (WUCS) and strengthening them to function as vibrant and robust grass root level institutions for irrigation water and infrastructure management. They shall have a prominent role in decision making in developing and maintaining irrigation infrastructure as part of the proposed VNC modernization and in future. For this, necessary capacity building will be carried out post WUCS formation. Post modernization, canal infrastructure management shall be transferred to WUCS who will also carry out their roles and responsibilities as per the society bye laws. Such an alternative would enable all the stakeholders to address more localized water problems within the sub-units. This alternative requires additional funds very small in comparison to the infrastructure cost. The advantages include sustainable and cost-effective O&M. The impacts will be significant and positive on agriculture, land and water resources, and enhanced agrarian returns with improved quality of life of farmers.

The alternative of ***Rehabilitation of the VNC System along with PIM*** is identified as the optimal solution and supported by the largest number of stakeholders during consultations. Strong ownership was shown by the concerned local stakeholders in terms of their willingness to participate in planning, implementation, and performing O&M of those local infrastructure. As such, the overall stakeholder interest in and

support for the entire water management infrastructure is also expected to be the strongest for this option.

The three alternatives have been evaluated and compared to the Proposed Project using an analysis that summarizes economic, social, and environmental consequences. The parameters that have been compared are the Physical Environment, Biological Environment, Human and Economic Development and the Quality of Life. The evaluation criteria are presented in the following ***Table 42.***

**Table 42: Evaluation Criteria for alternatives**

| Category | Description |
|---|---|
| Not Significant | When the changes in the parameter evaluated for the three alternatives is "not significant" as compared to the baseline situation. |
| Temporary Negative Impact | When the changes in the parameter evaluated for the three alternatives has an impact that is temporary in nature as compared to the baseline situation. In this case, the temporary impact shall result is either positive or not-significant at the end of the implementation of the alternative. |
| Negative | When the changes in the parameter evaluated for the three alternatives is creating a "negative" impact as compared to the baseline situation. |
| Positive | When the changes in the parameter evaluated for the three alternatives is creating a "positive" impact (also can be termed as improvement) as compared to the baseline situation. |

The summary of alternative analysis as given in ***Table 43***.

**Table 43: Evaluation of the Three Alternatives**

| Parameter | Sub-parameter | Without Project | Rehabilitation of VNC Infrastructure Only | Rehabilitation of VNC Infrastructure along with PIM |
|---|---|---|---|---|
| Physical Environment | River Hydraulics | Not Significant | Positive | Positive |
| | Flooding | Negative | Positive | Positive |
| | Drainage | Negative | Positive | Positive |
| | Irrigation | Negative | Positive | Positive |
| | Groundwater | Not Significant | Not Significant | Not Significant |
| | Water Pollution | Negative | Positive | Positive |
| Biological Environment | Otter Conservation Area | Not Significant | Temporary Negative Impact | Temporary Negative Impact |
| | Fisheries | Not Significant | Positive | Positive |
| | Terrestrial Habitat | Not Significant | Not Significant | Not Significant |
| | Flora | Not Significant | Not Significant | Not Significant |
| Human and Economic Development | Land use | Not Significant | Positive | Positive |
| | Resettlement & Rehabilitation | Not Significant | Temporary Negative Impact | Temporary Negative Impact |
| | Agricultural Land | Negative | Positive | Positive |

| Parameter | Sub-parameter | Without Project | Rehabilitation of VNC Infrastructure Only | Rehabilitation of VNC Infrastructure along with PIM |
|---|---|---|---|---|
| | Agricultural Productivity | Negative | Positive | Positive |
| | Sustainable Agricultural Development | Negative | Not Significant | Positive |
| Quality of Life | Education & Health | Not Significant | Positive | Positive |
| | Employment & Economic Activities | Not Significant | Positive | Positive |
| | Poverty | Not Significant | Positive | Positive |
| | Gender | Not Significant | Not Significant | Positive |
| | Equity | Not Significant | Not Significant | Positive |

# 6. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

## 6.1 Screening of Environmental Impacts and Mitigation Measures

258. A growing sensitivity towards addressing environmental impacts will be needed if the increasing utilization of natural resources towards irrigated food production, land reclamation, irrigation system maintenance/ rehabilitation and flood protection is to be sustainable in future. Generally, small farmers who tend to be the most dependent upon the environment and natural resources directly are the most affected when the environment is degraded or their access to natural resources is either limited or denied. In addition to rehabilitation/maintenance of existing systems in an environmentally-friendly manner, there is a need to educate the farmers, field functionaries and villagers to use water, fertilizers and pesticides optimally to safeguard the environment.

259. Preliminary screening was done by ADB using the Rapid Environmental Assessment (REA) form. Based on this assessment, this project is categorized as a "B" project. Scoping checklists were used to identify potential environmental stressors and receptors that may be subject to an impact. Subsequently, detailed assessment of the project carried out during the feasibility report stage revealed that the VNC Project is a "**Category A**" Project as per ADB SPS 2009 because portions of the project areas are located in a notified Otter Conservation Reserve (OCR). Accordingly, a Rapid Biodiversity Assessment has been carried out to identify the impacts on the OCR. Additionally, an assessment carried out as per the MoEFCC guidelines on EIA (provided in ***Table 1***) reveals that the VNC project does not attract the provisions of the EIA Notification 2006 and its amendments and does not require any Prior Environmental Clearance either from the MoEFCC or from the SEIAA. But, because portions of the project are located in the notified OCR, project requires *recommendation* of the NBWL, MoEFCC, GoI through SBWL, KFD, GoK.

260. In addition to the use of checklists, the PSC assessed potential impacts based on site investigations and assessments. The level of significance of the potential impacts was assessed and the hierarchy of mitigation measures were arrived at. Further, the Rapid Biodiversity Assessment was conducted by PSC to determine the impacts and identify mitigation measures for the rehabilitation work to be carried out in the notified OCR. The assessment criteria for evaluating and characterizing the impacts are as per ***Table 44.***

**Table 44: Assessment Criteria for Evaluating and Characterizing Environmental Impacts**

| Criteria | Category | Description |
|---|---|---|
| Extent or Spatial Influence of Impact | Regional | Beyond a 5-km radius of the subject site |
| | Local | Within a 5-km radius of the subject site |
| | Site-Specific | On-site or within 100mof the subject site |
| Magnitude of Impact at the indicated spatial scale | High | Natural and / or social functions are ***severely*** altered |
| | Medium | Natural and / or social functions are ***notably*** altered |
| | Low | Natural and / or social functions are ***negligibly*** altered |
| | Zero | Natural and / or social functions are ***not*** altered |

| Criteria | Category | Description |
|---|---|---|
| Duration of Impacts | Construction Period | Upto 2-years |
| | Short-Term | Upto 5 years after construction |
| | Medium-Term | Upto 5-15 years after construction |
| | Long-Term | Beyond 15 years after construction |
| Characterization of Impacts | Significant Adverse Impact | The impacts are widespread and some or the impact are ***irreversible***, which is defined "as the ecosystem cannot be brought to the original condition". |
| | Insignificant adverse impact | Less impact and limited to the construction site and most of them are ***reversible*** which is defined "as the ecosystem can be brought to the original condition". |

261. The hierarchy of mitigation measures were assessed as per ***Table 45.***

**Table 45: Mitigation Hierarchy of Environmental Impacts**

| Mitigation Type | Description |
|---|---|
| Avoid | The first step of the mitigation hierarchy comprises measures taken to ***avoid*** creating impacts from the outset, such as careful spatial or temporal placement of infrastructure or disturbance. |
| Minimise | Measures taken to ***reduce/ minimize*** the duration, intensity and/or extent of impacts that cannot be completely avoided. Effective minimization can eliminate some negative impacts. |
| Restoration / Rehabilitation | Measures taken to improve degraded or removed ecosystems following exposure to impacts that cannot be completely avoided or minimised. ***Restoration*** tries to return an area to the original ecosystem that occurred before impacts, whereas ***rehabilitation*** only aims to restore basic ecological functions and/or ecosystem services. Rehabilitation and restoration are frequently needed towards the end of a project's life-cycle, but may be possible in some areas during operation. |

262. The environmental impacts of canal modernization works are expected to occur during construction and operation phases. Certain impacts are occurring because of the location of the project and designs that have been adopted. These impacts have to be addressed during the planning and design phase of the project and have been identified as pre-construction phase impacts. ***Table 46*** provides the result of the screening of the environmental impacts occurring from the Modernization of the VNC Project and the details of the impacts are provided in the paragraphs below and followed up after the table:

**Table 46: Screening of Environmental Impacts for Modernization of VNC Project**

| Environmental Attributes/ Project Components | | Project Aspects and interventions | Impacts | Spatial Extent | Magnitude | Duration | Characterization of Impacts | Mitigation Hierarchy |
|---|---|---|---|---|---|---|---|---|
| Biological Environment | Aquatic Ecosystem | 12 Anicuts that are being rehabilitated are located on the banks of the Tunga bhadra River that has a unique aquatic ecosystem | Impacts occur during construction phase because of silt and vegetation removal, creation of dry construction area and carrying out of the rehabilitation works | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Otter Conservation Reserve | 9 of the 12 Anicuts that are being rehabilitated are located in the notified Otter Conservation Reserve | Impacts occur during construction phase because of silt and vegetation removal, creation of dry construction area, carrying out of the rehabilitation works and impacts on road access. Plans are drawn up with the assistance of Biodiversity Expert and Karnataka Forest Department to not only mitigate the impacts but also enhance the aquatic ecosystem within the OCR. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Tree Cover | Along the 215 km length of the 16 channels that are part of the project, over 3257 trees are located along the Service Road, Inspection Path and canal embankments. | Impacts occur during construction phase as some of the trees may need to be removed to make way for vehicle, equipment and to accommodate the proposed canal designs. Enumeration shall be done through the help of Karnataka Forest Department to draw up a plan for compensatory afforestation and increase tree cover. | Site-Specific | Medium | Short-term | Reversible, Insignificant Adverse Impact | Minimize |
| Ambient Air Quality | Construction Sites | Operation of vehicle and equipment at construction sites | Dust generation is a common air quality impact occurring during vehicle movement along the construction sites resulting in the increase in SPM levels in the vicinity of the construction site. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |

| Environmental Attributes/ Project Components | | Project Aspects and interventions | Impacts | Spatial Extent | Magnitude | Duration | Characterization of Impacts | Mitigation Hierarchy |
|---|---|---|---|---|---|---|---|---|
| | Construction Sites | Operation of vehicle and equipment at construction sites | GHG emissions from vehicle and equipment operation is a common air quality impact occurring during vehicle and equipment movement near the construction sites | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Material Transport | Operation of vehicles for transporting material from source point to the point of use. | A GHG emission from vehicle operation is a common air quality impact occurring during the use of vehicles for transporting materials. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Batching Plant Site | Operation of batching plant process for manufacture of ready-mix concrete | GHG emissions and increase in SPM levels is a common air quality impact occurring from batching plant process operations, | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Blasting Sites | Rock blasting done to clear the obstacles encountered during construction | While blasting shall be restricted to utmost minimum, increase in GHG emissions is a common air quality impact arising from blasting operations. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| Noise Quality | Construction Sites | Operation of vehicle and equipment at construction sites | Noise quality is impacted during vehicle movement along the construction sites | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Batching Plant Site | Operation of batching plant process for manufacture of ready-mix concrete | Noise quality is impacted during the operation of the batching plant process. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Blasting Sites | Rock blasting done to clear the obstacles encountered during construction | While blasting shall be restricted to utmost minimum, increase in noise is a common impact arising from blasting operations. | Site-Specific | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| Surface Water Quality | Construction Sites | Silt Disposal | Improper silt disposal would result in draining of the silt into surface waters and impacting turbidity of the surface waters including the river and the local tanks, as well. | Local | Medium | Short-term | Reversible, Insignificant Adverse Impact | Minimize |

| Environmental Attributes/ Project Components | | Project Aspects and interventions | Impacts | Spatial Extent | Magnitude | Duration | Characterization of Impacts | Mitigation Hierarchy |
|---|---|---|---|---|---|---|---|---|
| | Construction and Camp Sites | Waste Disposal | Improper waste disposal would result in draining of the waste into surface waters and impacting the quality of the surface waters including the river and local tanks, as well. | Local | Medium | Long-Term | Reversible, Insignificant Adverse Impact | Minimize |
| | Construction sites | Anicut and Canal rehabilitation | There is potential exposure of workers to contaminated and polluted water and sediments during construction. | Local | Medium | Construction period | Reversible, Insignificant Adverse Impact | Minimize |
| Groundwater Quality | Construction and Camp Sites | Waste Disposal | Improper waste disposal shall result in draining of the waste into surface waters and impacting the quality of the surface waters including the river and local tanks, as well. | Local | Medium | Long-Term | Reversible, Insignificant Adverse Impact | Minimize |
| Sediment Quality | Rehabilitation of Canals and Anicuts | Silt disposal | (i) Reuse of contaminated or polluted sediments for agricultural activity may deteriorate environment and human health. (iii) re-suspension of sediment on water quality (iii) Odour from dredged silts and temporarily dewatered anicuts and canals may create nuisance to nearby households. | Local | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Avoid/Minimize |
| Material Sourcing | Use of Quarry Material | Rehabilitation of anicuts and channels | Sand, Rock and Soil are sourced for the rehabilitation work that have significant impact on the resource availability | Local | Medium | Long-Term | Significant Adverse Impact but Irreversible | Minimize |
| | Use of Surface and Groundwater | Rehabilitation works as well as use at camp sites | Groundwater and surface water are sourced from identified pre-approved locations so as not to adversely impact the local community's water use | Local | Medium | Long-Term | Reversible, Insignificant Adverse Impact | Minimize |

| Environmental Attributes/ Project Components | | Project Aspects and interventions | Impacts | Spatial Extent | Magnitude | Duration | Characterization of Impacts | Mitigation Hierarchy |
|---|---|---|---|---|---|---|---|---|
| Land Use | Farmlands | Design of Channel sections located adjacent to the rocky terrain | Channel sections located adjacent to the rocky terrain receive storm water runoff directly into the channel and if it is not managed effectively, the runoff shall flood the farmlands | Local | Medium | Medium-Term | Significant Adverse Impact but Irreversible | Avoid |
| | Borrow Areas | Sourcing of soil for embankment | Local drainage will be impacted by improper soil removal and closure of borrow areas | Local | Medium | Medium-Term | Reversible, Insignificant Adverse Impact | Restoration |
| | Silt Disposal Area | Disposal of silt | Local drainage will be impacted by improper silt disposal | Local | Medium | Medium-Term | Reversible, Insignificant Adverse Impact | Minimize |
| | Waste Disposal Area | Disposal of construction waste | Local drainage and groundwater quality will be impacted by improper waste disposal | Local | Medium | Long-Term | Reversible, Insignificant Adverse Impact | Minimize |
| Cultural | Hampi World Heritage Area | Rehabilitation of anicuts and channel sections located within the Hampi World Heritage Area | Changes in landscape integrity along the channel sections within the Hampi World Heritage Area | Site-Specific | High | Long-Term | Significant Adverse Impact and irreversible | Minimize |
| | Hampi World Heritage Area | Blasting of rock for site clearance towards carrying out rehabilitation works | Possible damages to the monuments located close to the sections where the rehabilitation works are carried out | Regional | High | Long-Term | Significant Adverse Impact and irreversible | Avoid |
| Socio-economic | Fishing activity | Construction site for Anicuts | Access to local fishermen will be impacted because of drying up of the anicut area for carrying out rehabilitation. | Local | Medium | Construction Period | Reversible, Insignificant Adverse Impact | Minimize |
| | Urbanization | Rehabilitation of channel sections located within urban areas | Impacts land use practices in urban areas and access of channel sections to waste water and solid waste disposal | Local | Medium | Long-Term | Significant Adverse Impact and Reversible | Avoid |
| Health and safety | Community | Construction site and Campsites | Impact on health and safety of the local community arising from movement of workers', vehicles and equipment near | Site-Specific | Low | Medium-Term | Significant Adverse Impact and Irreversible | Avoid |

| Environmental Attributes/ Project Components | | Project Aspects and interventions | Impacts | Spatial Extent | Magnitude | Duration | Characterization of Impacts | Mitigation Hierarchy |
|---|---|---|---|---|---|---|---|---|
| | | | habitation areas and waste management at the sites. | | | | | |
| | Workers and Labourers | Construction site and Campsites | Impact on health and safety of workers arising from carrying out activities that lead to deterioration of quality of environmental media (Air, Water, Nosie) and use of vehicles, hazardous materials and heavy equipment leading to accident amongst the workers and laborer's | Site-Specific | Low | Medium – Term | Significant Adverse Impact and Irreversible | Avoid |

## Biological Environment

263. Nine out of the 12 anicuts feeding the VNC system are located along River Tungabhadra; they fall under Otter Conservation Reserve notified under the Wildlife (Protection) Act, 1972. The remaining anicuts are located outside the OCR but within an area that has sensitive aquatic biodiversity. In this context, *recommendation* of the National Board for Wildlife (NBWL), MoEFCC and Government of India through State Board for Wildlife (SBWL) is required. KNNL has already applied to the NBWL for recommendation to KFD. All the anicuts should be rehabilitated along with mitigation measures.

264. A tree survey conducted on the advice of the ADB February 2018 Mission resulted in identification of 3,257 trees belonging to 55 species of 28 plant families along the 215 km of the canal lengths. Some trees are located within the canal embankments and may need to be removed. As part of mitigation measures, enumeration of the trees shall be performed at the start of the project to identify trees that need to be removed. A Tree Management Plan should be developed so that either the tree is relocated or compensatory afforestation is taken up.

## Ambient Air Quality

265. Air quality will be potentially affected during the construction stage. Activities such as vehicle movement, equipment removing vegetation and silt, equipment laying the canal bed and the embankment, transportation of construction material from the source areas to construction sites and the use of earthmovers and heavy-duty trucks at all anicuts and canal construction sites would lead to dust generation in addition to GHG emissions arising from vehicle and equipment operations. Further, operating the batching plant in addition to vehicle movement and equipment operations shall cause a definite increase in presence of particulate matter as well as marginal increase in concentrations of SOx and NOx and hydrocarbons near the construction sites and the vehicle and equipment transportation areas.

266. Possible mitigation measures include: turning off engines and generators when not in use; equipment conformity to international standards; regular/routine servicing of all construction vehicles and machinery; and immediate replacement of defective equipment and removal from work sites. Measures to control dust emissions from construction sites or other locations include dust suppression by regular water sprinkling, halting work during excessive winds, and addressing verbal social complaints immediately.

## Noise Quality

267. Noise will occur during vehicle movements, equipment movement and operations, and batching plant operations. Additional though smaller noise sources will include land vehicles used to move material and equipment between staging areas and work-area access points. Noise will occur periodically over all the construction seasons.

268. Possible mitigation measures include identification of work timings and/or appropriate hours of equipment operation acceptable to the community through consultation, maintaining minimum noise levels in locations near dwellings and businesses, daily checks to improve potential sources of excessive noise and addressing complaints regarding noise immediately. Noise will also be minimized by turning off engines and

generators when not in use; equipment conformity to international standards; fitting all vehicles used in construction with silencers; and immediate replacement of defective equipment and removal from the site.

### Surface Water Quality

269. Surface water quality could be affected by draining of the silt/ fill material from construction sites into the surface waters including the Tungabhadra River and local surface water bodies causing increased turbidity. Turbidity has potential to impair photosynthesis of phytoplankton and other flora, feeding and migratory behaviour of fish and invertebrates, and aesthetic attributes The construction work should be avoided during fish breeding season. The surface water quality is also impacted when leaks or spills of operational material such as fuels, oils and hydraulic fluids drain into the surface water bodies. These contaminants have potential to affect ecological resources and human health; effects would be determined by amount of material released and degree of exposure by organisms and humans.

270. During construction period, workers could be exposed to possible pollution and contamination in the water and sediments of the canals and anicuts. The combination of water, sediments and possible chemicals from agricultural activities may lead to harmful mixture for workers. These unpleasant waters may cause environmental quality decline and risks to construction staff.

271. Mitigation measures include having secondary holding areas to avoid silt/ fill material draining directly in to the surface water bodies. In addition, uncontaminated soil shall be sourced from recognized borrow areas so as to avoid contamination of surface water where contaminated soil is used. Similarly, equipment inspection and repair shall be carried out at designated places that have secondary holding areas to handle spills. Standard measures to prevent, contain and clean up possible leaks or accidental spills of fuels, oils, hydraulic fluids shall be in place prior to start of construction.

272. In terms of protection of the workers, there are procedures to minimize the risks from harmful water and silt. The contractor shall have water and sediment analysis prior to the start of the construction. In this manner, the contractor shall be informed of the quality of the water and silt in the canals which they will be working on. As a standard operating procedure, workers will be provided with protective personal protective equipment (PPE).

### Groundwater Quality

273. Improper waste disposal shall result in draining of the waste into the surface waters and impacting the quality of the surface waters including the river and local tanks, as well. Further, this shall lead to impacting the groundwater quality as well. Also, groundwater quality will be impacted when silt and vegetation growth from various construction activities are disposed in an unscientific manner. The leachate from these disposal areas is laden with contaminants which contaminate groundwater. Indiscriminate storage of hazardous materials can also lead to contamination of ground water when spills occur.

274. Mitigation measures include disposing contaminated silt and construction wastes in an engineered landfill. However, the local authority or KSPCB will identify the engineered landfill or disposal areas during the submission of the Construction Waste and Debris Management Plan of the selected Contractor.Standard measures to prevent, contain and

clean up possible leaks or accidental spills of fuels, oils, hydraulic fluids shall be in place prior to start of construction.

### Sediment Quality

275. Sediment quality is impacted by the existing waste disposal and effluent discharge practices in the command. The silt that has been accumulated in the canals and the anicuts need to be disposed in an environmental-friendly manner. In the absence of scientific disposal of any contaminated silt, the groundwater quality ad soil quality shall be impacted.

276. Mitigation measures include testing the sediment quality (***Annexure 10***) prior to desilting and disposing silt in an engineered landfill whose location is identified by the government authority.

### Material Sourcing

277. Non-judicious exploitation of materials such as stones, sand and water may lead to denial for future needy uses; in addition, it may also to irreversible, environmental impacts. Further, over extraction of groundwater would also lead to decline in groundwater table giving rise to significant adverse impact on groundwater availability for the local community.

278. Mitigation measures include sourcing from licensed material vendors who are required not to obtain consent from Karnataka State Pollution Control Board to establish and operate mining but are also expected to follow norms for air and water pollution prevention and control. These norms that should be followed by the mining companies shall be defined in the consent obtained from the KSPCB.

### Land use

279. A major land use in the project area is for agriculture located along the canal. In certain sections, the canal runs alongside a rocky terrain that drains stormwater runoff directly into the canal. The sizing of the canals should be such that it accommodates increased temporary inflow of rainwater. If not, such inflows could lead to flooding of the farmlands. Mitigation measures include redesigning the sections of the canal where stormwater ingress is expected.

280. Another important land use is borrow area. Large quantities of soil are required for rehabilitating canal embankments. Soil is sourced from approved borrow areas which need to be closed in a right manner to ensure that they do not affect local drainage. At the start of the project, borrow areas will be identified and authorization provided to the Contractor.

281. Yet another land use is for silt disposal. An estimated 72,758 cu.m. of silt needs to be removed from canals and anicuts. The silt is rich in organic matter, and in a majority of cases, local farmers would like to carry it to their farmlands. However, any such disposal either on private or public lands should not impact the local drainage. Likewise, significant land area is required for disposal of construction waste and debris. Indiscriminate disposal of construction waste would lead to contamination of land, groundwater and surface water. Mitigation measures include disposing the silt and the waste in a pre-identified approved location where all norms of KSPCB are adhered to.

### Cultural Environment

282. A portion of the project is located within the UNESCO Hampi WHA. A drive-through along the length of the canals revealed that over 12 protected monuments are located along the lengths of the three canals. These include 2 along Anegundi, 1 along Raya and 9 along Turtha. Also, about 19.3 km of canal sections-Anegundi (8.95 km), Raya (1.23 km), Kalaghatta (0.55 km) and Turtha (8.57 km)-are located within the core zone of the Hampi WHA. In addition, about 14.04 km of canal sections-Anegundi (3.43 km), Raya (8.70 km), Kalaghatta (0.44 km) and Turtha (1.47 km)-are located within the buffer zone of the Hampi WHA. Further, about 24.33 km of canal sections-Anegundi (0.63 km), Raya (5.59 km), Basava (8.44 km), Kalaghatta (2.70 km) and Turtha (6.97 km) are located in the peripheral zone of the Hampi WHA. This portion of canal rehabilitation has to be carried out in accordance with internationally-accepted processes especially with regard to preserving extant canal designs, materials utilized and construction and operational procedures. Towards this, the mandatory permission has already been obtained from the Hampi Area World Heritage Management Authority.

### Socio-Economic Environment

283. Fishing is an important economic activity of certain sections of the population in the region. Rehabilitation of anicuts and the canals would impact fishing activity. In such a case, mitigation measures include exploring alternative sites for fishing by KNNL.

Certain canal sections pass through urban centres such as Hospet, Kampli, Siruguppa and Gangavathi towns. There are steel industries proximate to Hospet. In Gangavathi and Siriguppa, rice mills are the major industrial activity. However, in Kampli there is no major industrial activity that would pose risk to surace water quality.The untreated wastewaters from households are discharged directly into the canals thereby affecting the quality of water. Also, open canals are used as dumping areas for solid waste resulting in blocked canals at various stretches. Moreover, increased urbanization is resulting in changes in land use, and in certain cases, surface water bodies within the towns are encroached upon. Earlier, these surface water bodies used to act as supplementary sources of water for the VNC command area. Hence, it is necessary to manage urbanization in such a way that it does not impact water availability for the VNC command area in terms of both quantity and quality. Towards this, the Project Implementation Agency has to directly work with the urban stakeholder departments such as the Municipality and other state/ district level planning agencies and ensure that actions are taken to mitigate adverse environmental impacts.

### Health and Safety

284. Health and safety of the community in which the project is taken up and the workers is of utmost importance. Towards this, it shall be ensured that the local community is taken into confidence while deciding on the schedule for movement of vehicles and heavy equipment and location and operation of borrow areas, waste disposal areas, construction camp sites and the batching plant. In addition, it shall be ensured that all the workers are covered under a comprehensive insurance coverage (as applicable under the laws), and are provided with PPE, gloves and other safety equipment. Further, it shall be ensured that periodic health monitoring shall be carried out of workers to ensure health and productivity.

## Environmental Benefits Associated with the Project

285. The Project has a potential for considerable *positive environmental impacts* in the VNC area. The lining and shaping of canals and the various structures will result in restoration of canal capacity, reduction in water losses and consequent improvement in water availability leading to a positive impact on all aquatic lifeforms.

286. The Project will support strengthening of water resources management through installation of a modern control and communication system, capacity building and improved Operation and Maintenance procedures, strengthening of WUCS and development of a Sustainable Integrated Water Resources Management Model. The improved water resources management component would optimize use of available water resources in the Tungabhadra Basin and will result in more water available while adhering to abstractions as per Krishna Water Tribunal award.

287. The rehabilitation of on-farm infrastructure will improve water management at farm level resulting in reduced wastage of water and drainage requirements. WUCS involvement for executing the CAD works (field irrigation channels) will enhance their capacity to carry out O&M in a sustainable manner. Additionally, extension services provided to WUCS members in terms of water management and agricultural practices will conserve water, improve soil management and introduce sustainable cropping practices.

288. The project will also lead to improvement in water-use efficiency in the command area. Additionally, through the WUCS, the project will ensure that farmers adopt sustainable agricultural practices. Thus, the project will enable the command area farmers to tackle projected climate change related impacts for the region during the years 2021-2050, namely, increase in temperature, changing rainfall patterns and rise in the incidence of droughts. As such, the VNC modernization project can also be termed as a climate-resilient project.

## Impacts due to climate change

289. Climate change projections for the region include a decrease in precipitation, slight increase in runoff and water yield and decrease in evapotranspiration in the short–term (2020-2050). This is indicative of additional water stress in the future. The major crops cultivated in the region are rice and other grains, sugarcane, banana and other cash crops. These are all water-intensive in nature, and therefore increasing water stress is predicted to have negative effect on these crops. The VNC rehabilitation and modernization project aims at improving water-use efficiency in the command area through reduction of leakages from the canal surfaces and minimal seepage from the anicuts. Additionally, farmers are being trained in softer issues so as to promote optimum use of pesticides and fertilizers, follow diversified cropping patterns that also improve soil quality, water-use efficiency and improved agricultural productivity. These measures are planned to be implemented through the WUCS and will greatly help the VNC command area farmers to overcome the additional water stress that climate change is projected to have on the basin. As such, the project can be considered as a climate-change adaptation project that will greatly benefit the VNC command area farmers in sustaining their agricultural income.

## 6.2 Impacts and Mitigation Measures during the Project

290. All impacts and mitigation measures identified in this chapter relate to three phases; viz., pre-construction phase, construction phase and operation phase. These mitigation measures conform to best national and international practices, and as per the requirements of Central Water Commission and MoEFCC, GoI. In the following chapters, the institutional framework for carrying out the mitigation measures, monitoring protocol and the cost of implementation of mitigation measures are presented.

291. Activities and responsibilities are identified for the project phases of Pre-Construction, Construction and Operation Phases. All mitigation and monitoring measures proposed are those commonly recommended for the range of potential impacts assessed.

### 6.2.1 Impacts and Mitigation Measures during Pre-Construction

292. The pre-construction phase includes checking design requirements and ensuring that EMP conditions are incorporated into the bid and contract documents. This will be done by the Implementation Agency. During this phase, it should be ensured that the required designs are incorporated in the DPR and the bid documents and the costs are included into the overall project budget.

**Developing designs for OCR Impact Mitigation Structures**

293. As mentioned earlier, 9 of the 12 anicuts to be rehabilitated under the VNC modernization project are located within the notified OCR. In order to safeguard the aquatic eco-system in the OCR, it is necessary to design the structures required to safeguard the food availability, habitation, nesting areas, breeding areas and areas used for regular activities by the aquatic animals. KNNL is developing the designs for these structures and the designs will be part of the bid documents.

***Developing designs for preserving the continuing landscape of the Hampi World Heritage Area***

294. Hampi, the erstwhile capital of the Vijayanagara Kingdom, figures in the UNESCO's World Heritage List. The inscription of a property on the World Heritage List signifies that the World Heritage Committee has deemed that the site has cultural and natural values of Outstanding Universal Value. A portion of the VNC system passes through the Hampi Heritage Conservation Area. This imposes additional demand on the Project to secure high standards of protection and to comply with the requirements of the World Heritage processes during rehabilitation.

**Figure 16: A glimpse of a canal stretch in the Hampi WHA: Challenges to maintain its unique identity**

295. Of late, the heritage sector has undergone a shift from simple physical protection of the heritage area/ monument to a more layered approach to management that takes into account social, economic and environmental concerns. Recent heritage management practices acknowledge the fact that heritage places cannot be protected in isolation or as museum pieces, independent of natural and man-made disasters or from land-use planning considerations. They cannot be separated from developmental activities and social changes, nor concerns of the communities ignored. This is especially true in Hampi where the heritage area is interspersed with rural habitational sites privately owned and agrarian land pieces farmed for crops fed from the VNC system. Hence, the portion of the VNC that passes through the heritage area should be rehabilitated in a holistic manner that meets socio-economic and environmental parameters of UNESCO guidelines. The UNESCO Operational Guidelines indicate a range of types of attribute[12] which conveys "Outstanding Universal Value" which includes the form and design, materials and substance, use and function and traditions, and techniques and management systems. For VNC modernization, it is important to address the range of types of attributes during the rehabilitation process especially at the planning and design phase. Proposals for canal modernization include desilting the canals and strengthening the canal banks while retaining the heritage characteristics. KNNL is committed to having such appropriate designs aimed at preserving the continuing landscape[13] that symbolizes the region which will be part of the bid document.

***Developing designs for addressing direct entry of storm water runoff into the canal sections***

**Figure 17: Location along Anegundi Canal where stormwater runoff directly enters the canals**

296. A review of the designs for the VNC canal modernization project shows that canal sections were much smaller than the extant sections and were designed to achieve water-use efficiency. While designs may be appropriate for normal flow conditions, these canal sections become inadequate at times when rainfall runoff combines with the flow in the canals. This has been particularly observed in certain canal lengths along Anegundi, Hulugi, Upper Gangavathi and Lower Gangavathi Canals. In these stretches, run off from rocky hillocks adjacent to the canals during rainy season enters the canals leading to

*[12] Attribute are aspects of a property which are associated with or express the Outstanding Universal Value. Attributes can be tangible or intangible.*

*[13] Continuing landscape is one which retains an active social role in contemporary society closely associated with the traditional way of life and exhibits significant material evidence of its evolution over time.*

quick flooding. If the canal sections are not designed to accommodate the runoff, the runoff would flood the adjoining command area and will damage the service road in addition to inundating farmlands at places. The designs have been revisited by KNNL and mitigation measures incorporated in the revised designs.

***Developing a Plan of Action to address discharge of industrial effluents into Kalaghatta Canal***

297. Kalaghatta canal is fed as a branch of the Ramasagara Canal. However, a factory in the vicinity discharges effluents into the Kalaghatta Canal. The quality of the canal water has deteriorated over the years because of this industrial discharge. However, farmers have no option but to continue using the canal water for irrigation. The contaminated water has led to skin diseases among the farm workers. KNNL has approached the concerned industry and also requested KSPCB to ensure that untreated industrial effluents are not discharged into the Kalaghatta Canal.

**Figure 18: Infected hands of a Farm-Worker due to Contaminated water in Kalaghatta Canal**

***Developing a plan of action to address wastewater and solid waste disposal into certain canal sections***

298. Further, during pre-construction stage, KNNL should work with town municipalities of Hospet (Basavanna Canal), Kampli (Kampli Canal), Gangavathi (Lower Gangavathi Canal), and Siruguppa (Siruguppa Canal) as liquid and solid waste is released into these canals at various locations due to which both the flow regime and the quality of water are affected. In addition to contamination, these areas serve as a perfect breeding ground for mosquitoes thereby threatening the health of the community. In Siruguppa Town, for instance, the canal stretches are used as drains and are even maintained by the Town Municipality. Hence, for these canal stretches, KNNL has written to the municipalities to develop an action plan for implementation.

Garbage in Basavanna Canal within Hospet Town limits

Town sewage directly draining into Basavanna Canal within Hospet Town limits

Sewage Entry into Basavanna Canal Stretches within Hospet Town limits

Waste strewn into the Hulugi Canal near Hulugiamma Temple

Municipality sewage in some stretches of Kampli Canal

Siruguppa Canal within Siruguppa Town used as part of Town Sewerage System

Solid waste dumping and sewage ingress into Upper Gangavathi Canal in Gangavathi Town

**Incorporating Environmental Management Plan and Health & Safety Requirements into Contractor Bid Document**

299. It is also necessary to ensure incorporation of Environmental Management Plan and Health and Safety requirements into the bidding and contract documents.

300. Under the requirements, the Contractor should develop a Site-Specific Contractor's Environmental Management Plan that addresses the specific environmental impacts of each of the sites. In addition, the Contractor should address the EMP for each of the project activities.

301. Basic staff facilities need to be provided by the contractor at all construction sites including but not limited to a changing area for staff, a place to take meals and relax, washrooms and proper toilets connected to an acceptable disposal system. Portable chemical toilets may be installed at work sites, wherever necessary. During bid evaluation, capacity of the Contractor to carry out construction activities as per the proposed Environmental, Health and Safety Standards should be checked and verified.

302. As noted in the earlier paragraphs, mitigation measures for all pre-construction impacts will be addressed by KNNL at the planning, design and/ or bidding phases of the project to ensure sustainability of the project. The impacts and mitigation measures for all pre-construction activities are provided in the ***Table 47***.

**Table 47: Impacts and Proposed Mitigation Measures for Pre-Construction Phase**

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | **PRE-CONSTRUCTION** | | | | | |
| P.1 | Long-Term Sustainability | Ensure long-term sustainability of improvements and protection of assets created. | Regional | High | Long-Term | The design will include provisions for ensuring effective maintenance and protection of assets created so as to ensure long-term sustainability, especially with regard to defining and preparing WUCS for carrying out its role in O&M of the assets. |
| P.2 | Addressing the Design and Bid Requirements for work in the OCR | Impact on the aquatic eco-system; especially in terms of food availability, habitation, nesting areas, breeding areas and areas used for regular activities of the aquatic animals, arising from the rehabilitation of the anicuts located in the stretch within the OCR should be addressed adequately and effectively. | Local | High | Long-Term | • Planning and Design of rehabilitation of anicuts located in the OCR should be taken up in such a manner that there are no negative impacts.<br>• Towards this, the design of the necessary structures to be constructed prior to the rehabilitation of the anicuts within the OCR, the implementation schedule and other key issues as suggested by the Biodiversity Expert and the KFD will be included in the bid document. |
| | | Implementation of work in the Conservation Areas | NA | NA | Construction Period | The bid documents should incorporate the necessary conditions to select a contractor who has the knowledge and understanding to carryout work in eco-sensitive and conservation areas as per concerned guidelines. |
| P.3 | Addressing the Design and Bid Requirements for preserving the continuing landscape of the Hampi World Heritage Area: | Form and Design of the Turtha Anicut, 9.3 km length, located in the core zone of the Hampi WHA (in Anegundi, Turtha and Raya canals), 14.05 km length located in the buffer zone of Hampi WHA (in Anegundi, Turtha, Raya and Kalaghatta canals) and 24.33 km length located in the periphery zone of Hampi WHA (in Anegundi, Turtha, Raya, Basavanna and Kalaghatta canals) should be integrated with the heritage area landscape. | Regional | High | Long-Term | Planning and Design of the canal modernization project should be taken up in such a manner that the Form, Design and characteristics of the original sections of the Turtha Anicut and the canal sections located in the Core, Buffer and Periphery zones of the Hampi WHA are not adversely affected. The designs should be included in the bid document. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | Implementation of work in Heritage Areas | NA | NA | Construction Period | The bid documents will include guidelines for carrying out work in heritage areas. |
| P.4 | Developing designs for addressing direct entry of storm water runoff into the canal sections: | Flooding of command areas resulting from smaller sections of the canal in certain stretches of Hulugi, Upper Gangavathi, Lower Gangavathi and Anegundi. | Local | Medium | Medium-Term | The canal sections in Hulugi, Upper and Lower Gangavathi and Anegundi canals should accommodate the rainfall runoff from the rocky mountains located near the canal sections. The designs should be included in the bid document. |
| P.5 | Developing a Plan of Action to address untreated industrial effluent entry into Kalaghatta Canal | Impact on canal water quality due to disposal of industrial effluents into Kalaghatta canal sections | Site-Specific | Medium | Medium–Term | KNNL should work with the Karnataka State Pollution Control Board and ensure that concerned Industry stops discharge into the canal immediately. |
| P.6 | Developing a plan of action to address wastewater and solid waste disposal into certain canal sections | Impact on canal water quality due to disposal of liquid and solid waste into canal sections that passes through urban areas. | Local | Medium | Medium-Term | KNNL should work with ULBs along canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa to ensure that the ULB has a plan to prevent liquid and solid waste disposal into the canals. |
| P.7 | Incorporating Environmental Management Plan and Health & Safety Requirements into Contractor Bid Document | Implementation of the EMP | NA | NA | Construction Period | The EMP should be included in the bid documents so that the Contractor selected understands the issues and makes necessary plans to prepare and implement the EMP. |
| | | Implementation of the Health and Safety requirements | NA | NA | Construction Period | Health and Safety requirements should be incorporated as part of the contract bid documents so that the Contractor has the knowledge and understanding necessary to implement the health and safety requirements as part of the EMP during the period of the project. |

### 6.2.2 Impacts and Mitigation Measures during Construction

**Access to Sites:**

303. The key to starting the Construction activities is the access to the sites. The PSC visited each of the canals and the anicut structures to assess the possibilities of the access to the sites. During the visit, informal discussions were held with the local community and the structures that might hinder access to the sites for construction activities were identified. The strips maps provided as part of the Annexure in the SDDR study, provides the details of the structures and other assets along the canal right-of-way. The result of the assessment of the field data is provided in the ***Table 48***.

**Table 48: Access to the sites for construction activities**

| Name of Channel | Number of Structures | Objection from farmers for modernization work Yes/ No | Number of structures affecting access for construction | Comments |
|---|---|---|---|---|
| Raya | 20 Permanent structures and 1 compound wall | No. The concerned farmers appealed that they should be permitted to take the ensuing harvest. | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from Ch 0. |
| Basavanna | 39 (23 permanent, 16 semi-permanent houses and 1 school compound) | No. The concerned farmers appealed that they should be permitted to take the ensuing harvest. | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Full access from service road is available for modernization work, with the exception of Ch.16 to 16.5 km. |
| Bella | 22 (8 permanent, 10 semi- permanent and 4 temporary houses) | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | The Panchayat allotted the govt. land for construction of permanent houses.<br>Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |
| Kalaghatta | 2 (I permanent and 1 temporary houses) | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>3.58 km (51%) used for cultivation |
| Turtha | 11 (permanent building) | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |
| Ramasagara | 1 abandoned building and 1 religious structure | No | No structure is obstructing access to construction sites. Invariably, service | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |

| | | | | |
|---|---|---|---|---|
| | | | roads are available for movement of vehicles, equipment and materials. | |
| Kampli | 1 temporary building | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>1 temporary shed encroached at IP |
| Belagodahalla | Nil | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>Complete IP 11.22 (100%) is encroached for cultivation |
| Anegundi | 12 (6 toilets, 3 temporary houses,<br>2 shops and 1 temporary shelter | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | 3 temporary houses and 6 toilets at Ch. 15.0 15.50, including the compound walls of ANM quarters (health dept), School, Cooperative bank at IP<br>2 Shops and 1 temporary shelter at Ch. 6.62 to 6.8 km at SR<br>Heritage are at Ch. 0 to 8.5 km<br>Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |
| Shivapura | 2 religious structures | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>3.40 km encroached for cultivation<br>0.44 km encroached by religious structure |
| Hulugi | 1 religious structure, 1 temporary building (SR), and compound wall of religious structure at IP | No | | Ch.1.95 to 2.2 km temple compound encroaching the embankment at IP<br>3.44 km encroached for cultivation |

| | | | | |
|---|---|---|---|---|
| Upper Gangavathi | 9 (1 religious structure<br>8 temporary building in IP | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>Ch.8.6 to 8.8 – 8 temporary houses on the IP.<br>2.24 km of IP encroached for cultivation |
| Lower Gangavathi | 4 (2 abandoned building, 1 temporary cow shed and 1 religious structure) | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0.<br>1 temporary cow shed, 1 religious structure and two abandoned buildings (used earlier for making jaggery).<br>8.8 km of IP encroached for cultivation |
| Siruguppa | 21 permanent building 9 (houses) in IP | No | No structure is obstructing access to construction sites. Invariably, service roads are available for movement of vehicles, equipment and materials. | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |
| Deshnur | Nil | No | No | Access is available from SR throughout the length of the canal. Entry for construction work is from the Ch 0. |
| Bichal | 1 | No | Approach road needs to be constructed before starting the rehabilitation work. | Approach road needs to be constructed before starting rehabilitation work<br>13.06 km of IP encroached for cultivation, Besides the service road also encroached for cultivation |

304. As explained above, there is adequate access for the movement of vehicles, equipment and transferring construction materials to the proposed channels by existing service road or Panchayat road along the embankment of the canal. However, on the inspection path farmers are making use of the land for cultivation of seasonal crops. Some of the area is partially encroached by private structures and such areas are being denoted in the strip maps. The field assessment reveals that around 75% of the service road is available for modernization work and rest of the stretches are partially encroached (mostly by the adjacent farming people) with cultivation of seasonal crops. In some of the stretches, encroachment by people for residential purposes and for rearing of animals. In few places (especially in Bella Channel) the Gram panchayat has given permission to construct houses in the vacant government land. However, this will not affect the accessibility to the construction sites since alternate roads and space available for movement of vehicles, construction equipment and materials. Besides, the sub project implementation will neither require any permanent acquisition of land nor will involve physical displacement of any infrastructure or household. Before starting the construction, the KNNL needs to carry out rapid situation assessment of IP in each of the channels and come out with strategic plan in consultation with the occupants of the areas. This will enable the farmers to prepare a plan for their crops and harvesting.

**Construction Stage Activities**

305. The construction stage involves the following major components; Establishment of Construction Campsites; Rehabilitation of Anicuts; Rehabilitation of Canals and Closure Activities. Each of the major components are briefly described in the following paragraphs followed by providing an overview of the environmental impacts for each of the activities associated with the components.

### Establishment of Construction Campsites

306. Construction campsites are established to house the construction workers, provide parking space for vehicles and equipment, store materials and in certain cases construct and operate batching plants. Establishment of these facilities initially involved clearing the sites and later constructing temporary housing facilities with all necessary kitchen, water, sanitation and solid waste management infrastructure. Considering that over 16 canals and 12 anicuts need to be rehabilitated under the project, a number of construction campsites need to be established. In this regard, the Contractor should opt for an optimum number of campsites considering all aspects including land availability, resource availability, construction duration and proximity to the construction site location. However, in all cases, it is important for the Contractor to obtain the necessary permission from the local authorities to establish the construction campsite. In campsites where batching plant and/ or hazardous materials are stored the necessary consent from the Karnataka State Pollution Control Board should be obtained, as well. The site issues, likely impacts and guidelines to be followed to address the impacts while establishing the construction campsites is provided in ***Table 49.***

**Table 49: Construction Guideline to establish construction campsites**

| Site Issue | Impacts to be addressed | Guidelines to address impacts |
|---|---|---|
| Construction Worker Camps will be required for civil works materials<br>Construction camps sites should have adequate space for vehicle parking, storage of materials including construction of batching plants<br>Contractors need to obtain necessary permission from the local authorities and Karnataka State Pollution Control Board before setting up the construction camps<br>Following sites should be avoided:<br>• Lands close to habitations<br>• Lands close to or within the heritage area<br>• Lands belonging to small farmers<br>• Lands within 100m of community water bodies and other water sources such as tanks, rivers<br>• Irrigated agricultural lands<br>• Lands supporting dense vegetation and Forest with/ without conservation status<br>• Lands where there is no willingness of the landowner to permit its use<br>• Grazing lands and lands with or without tenure rights<br>• Low lying lands | The influx of migrant labour will have both positive and negative impacts on the nearby community and local environment.<br>The labour will be accommodated in temporary comfortable campsite within the project boundary which can have significant interface with the nearby community.<br>The increase in migrant labourers will affect the local resources such as fuel, wood, water etc.<br>Some local economic benefits are also envisaged due to the purchase of ration for these people from the local markets | Contractors need to obtain necessary permission from the local authorities and Karnataka State Pollution Control Board before setting up the construction camps.<br>On identification of the land the Contractor will submit to PIO the following:<br>• Copy of the land records duly signed by the local revenue official<br>• Written No-objection certificate of the owner<br>• Extent of land required and duration of the use<br>• Photograph of the site in original condition<br>• Activities to be carried out in the site;<br>• Environmental mitigation measures to be undertaken to prevent land, air, water and noise pollution;<br>• Facilities which would be provided in the camp should also be provided on the layout map;<br>• Detailed layout plan for development of the construction and labour camp that will indicate the various structures to be constructed in the camp including temporary, drainage and other facilities<br>• Proposal of site redevelopment after completion<br>• Opening and maintenance of registers indicating the details of workers<br>• Identity cards/labour cards to be issued to workers<br>• Health check-up cards |

307. Impacts from the construction camp and batching plant sites include increased levels of particulate matter and GHG emissions and noise levels arising from movement of vehicles and operation of batching plant, decreased groundwater levels resulting from increased drawing of groundwater to meet the demands of the construction workers, effect on hygiene and health of the local community and workers because of inadequate or ineffective sanitation and solid waste management infrastructure. Additionally, impacts from the leakage and spill over of stored material like fuel, lubricants and adhesives can

deteriorate the quality of nearby surface water and groundwater in addition to causing safety issues to the workers and the nearby community. Further, the temporary increase in population in the community can create conditions for competing use of resources.

308. Mitigation measures include provision of all infrastructure facilities at the construction campsites to ensure that the workers lead a healthy and productive life. These include provision of adequate drinking water, sanitation facilities including bathing, latrines and septic tanks, kitchen facilities supplying nutritious food, adequate beds and hygienic and adequate living spaces, solid waste management and composting facilities for kitchen waste management. Additionally, to ensure workers' safety adequate Personal Protection Equipment (PPE) should be provided along with the necessary instructions for using them at all working times. In addition, the periodic monitoring of health of the workers' and their family members should be carried out using professional doctors. Further, the Workers' Compensation Insurance should be applicable to all workers' and their family members at all times during the construction period and beyond.

### Rehabilitation of the Anicuts

309. Rehabilitation of Anicuts involve a number of activities including providing a dry-construction area by arresting the river flow into the anicut area, clearing the vegetation and silt and later performing the rehabilitation activities. In order to perform these activities, it is important to get adequate and safe access for vehicles, equipment and workers to all parts of the construction area. However, while doing so, it is important to consider the fact that the anicuts are located in areas that have rich aquatic biodiversity and it is important to safeguard the same for ensuring that the objective of sustainable water resource management is achieved under the project. Further, it should be noted that 9 of the 12 anicuts that are being rehabilitated are located within the notified Otter Conservation Reserve which calls for further stringent practices to protect the reserve.

310. The environmental Impacts from the rehabilitation of anicuts include increased levels of turbidity in the river water because of the possible movement of silt into the river, increased particulate matter and GHG emissions and noise levels arising from movement of vehicles. However, the most critical impact is in the aquatic biodiversity as any changes in the environmental conditions will impact the nesting, breeding, food availability and recreational activities of the aquatic animals located in the anicut area. Further, the changes in the environmental conditions will also impact the aquatic flora that sustain the aquatic biodiversity. Hence, in order to safeguard the aquatic biodiversity within the OCR and also the Tungabhadra River, it is important to adopt a construction methodology that considers these key impacts and implement mitigation measures as suggested in this report.

#### Construction Methodology for Anicuts

311. The broad framework of construction methodology and guidelines to be adopted for modernization (rehabilitation) works on anicuts deals with access for men, construction equipment and vehicles to move around with relative ease without causing disruption to not only the physical or economic assets but also to the aquatic biodiversity of the Tungabhadra River and the OCR located along the river stretch. The methodology suggests measures for accommodating those needs during rehabilitation.

312. As a standard practice, KNNL has a service road of 3.75 meters with a one-metre berm on either-side, and inspection path (IP) of 2.75 meters on either side of the canal. Access of the construction equipment and material to the anicuts is generally from the "0" chainage of the service road either directly or through construction of temporary ramps. Specified access points will be finalised by the contractors, KNNL and PSC before starting the construction work. Consultations with Panchayats and local famers will be conducted prior to execution of work specifically in case of inaccessible sites for which access from farmer fields/private land may be necessary. Any temporary ramps and / or structures should be removed by the contractor immediately after the work/contract is completed to prevent misuse.

313. As part of the mitigation measures, the following steps are being suggested to be adopted for rehabilitation of the anicuts:

***Step 1: Reconnaissance Survey***

314. A reconnaissance survey of the entire length of the anicut is taken up. During the survey, identify availability of access to the anicut area as well as access to construction of ring bunds to facilitate dry anicut construction area. In general, the access to the anicut construction area is from the edge of the Service Road at Ch. 0.00 km of the corresponding canal. For certain anicuts, approach roads are being constructed to facilitate access. In certain cases, the access ramp passes through private lands and / KNNL encroached land. In such cases, the relevant guidelines provided in the SDDR and Resettlement Framework should be utilized.

***Step 2: Conduct Location-Specific Pre-Construction Aquatic Biodiversity Survey***

315. The PSC should conduct a location-specific pre-construction aquatic biodiversity survey to specifically identify the zones for nesting birds and breeding of any other faunal species including otters. At the end of the survey, all the key areas that are important for maintaining the aquatic biodiversity should be identified and construction in those zones should be in accordance with the advice provided by the Biodiversity Expert. Appropriate biodiversity enhancement measures should also be incorporated in consultation with the Biodiversity Expert. Additionally, procedures as suggested in the Wild Life Clearance provided by the Karnataka Forest Department should be adhered to.

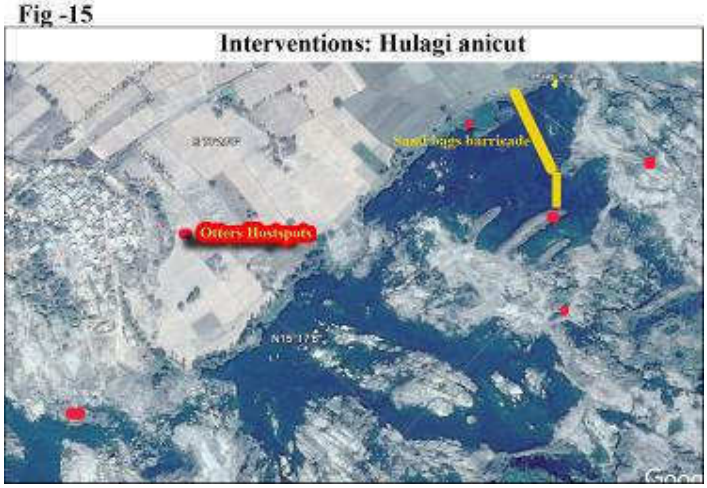
***Step 3: Construction of Diversion Structures***

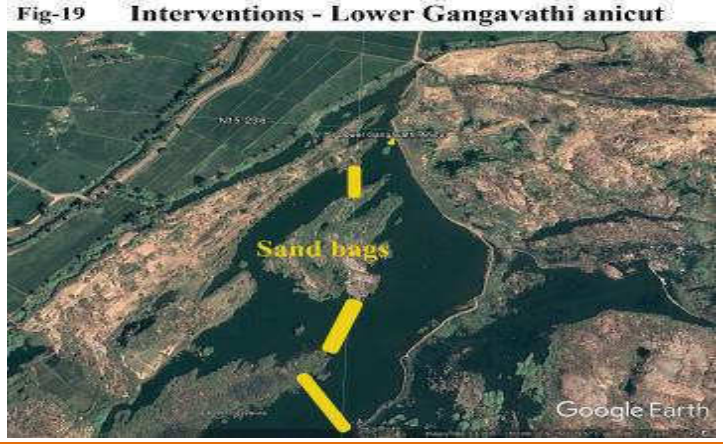
316. The rehabilitation of the anicuts involves working in the river bed and hence typically necessitates the construction of river diversion structures such as the primary and secondary ring bunds to facilitate a dry anicut construction area. The optimum scheme is to select an alternative that maximizes practicability while minimizing cost, negative impacts and risk involved. In this case, ring bunds are utilised for diverting the river during the rehabilitation of the anicut. The primary ring bunds are constructed to facilitate the dry construction area. However, the secondary ring bunds are located to provide an alternative habitation area for the Otter and other aquatic animals. The ring bunds across the river will enable the anicut site or portions thereof to be dewatered and rehabilitation works can proceed without interruption. The selection of both the primary and secondary ring bund sites should be done after a joint inspection involving KNNL, KFD and PSC

experts in Biodiversity and Technical areas so as to minimize impact on the aquatic biodiversity.

317. During the Rapid Biodiversity Assessment study, a preliminary assessment of the possible locations of the secondary ring bund locations for each of the anicuts located in the OCR was made and the same is shown in the following figures

| Sly No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 1 | Fig - 20 Interventions: Hosuru/Bella *Anicut*<br>  | **Bella anicut**<br>1. Otters and crocodiles are active in this anicut.<br>2. An appropriate secondary ring bund will be built across the river in the upstream of the anicut. |
| 2 | Fig-21 Interventions- Turtha anicut<br>  | **Turtha Anicut**<br>1. Complex of 5 and more anicuts.<br>2. Excessive weed grown and choked with excessive sedimentation.<br>3. Suitable secondary ring bund to be built based on condition of the anicut |
| 3 | Fig- 22 Interventions - Ramasagara Anicut<br>  | **Ramasagara Anicut**<br>1. It is a very long anicut.<br>2. Otters and crocodiles are in good numbers in this anicut area.<br>3. The existing islands will not be destroyed.<br>4. Secondary Ring bunds will be planned meticulously based on the condition and water level in the anicut area. |

| Sly No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 4 | Fig -23 Interventions - Kampli anicut   | **Kampli Anicut**<br>1. Otters are in good number in the anicut area.<br>2. A suitable secondary ring bund will be built based on the condition of the site and season. |
| 5 | Fig -15 Interventions: Hulagi anicut   | **Hulugi Anicut**<br>1. It is a very broad anicut.<br>2. Otters and crocodiles are in good number in this anicut.<br>3. The Otter use the long “finger shaped” islands for resting and mass defecation.<br>4. They also breed in side of the rocky island around anicut.<br>5. Construction of secondary ring bund will be planned meticulously based on the condition of the anicut and season. |
| 6 | Fig-16 Interventions - Shivapura anicut   | **Shivapura Anicut**<br>1. Otters and crocodiles are in good number in the upstream of the anicut.<br>2. Construction of Secondary ring bund will be planned based on the condition. |

| Sly No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 7 | Fig - 17 Interventions- Sanapura /Anegundi *anicut*<br>  | **Sanapura Anicut**<br>1. Otters use the anicut as corridor.<br>2. The Secondary ring bund will be built across the narrow part of the river. |
| 8 | Fig-18 Interventions - Upper Gangavathi<br>  | **Upper Gangavathi Anicut**<br>1. It is a very long anicut.<br>2. Most of the portion of the anicut area is over silted.<br>3. The secondary ring bund will be built based on the condition of the location. |
| 9 | Fig-19 Interventions - Lower Gangavathi anicut<br>  | **Lower Gangavathi Anicut**<br>1. It is a very long anicut.<br>2. Secondary Ring bunds will be constructed based on the condition of the anicut. |

***Step 4: Site Clearance***

318. Construction work in anicuts includes preparing the site around anicuts involves removing the weed, trees, snags, stumps, shrubs, brush, limbs, sticks, branches and other vegetative growth in and around the anicut right-of-way works. Rocks, lumps of concrete, fencing and all trash will also be removed. After the clearing of the vegetation, the accumulated silt will be removed from the anicut area.

319. The disposal of construction debris should be done at a pre-identified location and should meet the requirements of the Construction Waste and Debris Management Rules, 2016.

The rules will apply to all wastes from constructions, re-modellings, repairs and demolition activities of any civil structure of individual or organization. The rules require the generator to segregate the C&D Waste, develop a C&D Waste Management Plan and obtain approval from the ULB / GP prior to start of the construction activity.

***Step 5: Disposal Site Location***

320. The specification provided in the project allows a lead of 50m for construction debris management. This is wholly inadequate and hence should be relooked at. At the start of the project, the Contractor should discuss with KNNL and other Government agencies for selection of the right location for the disposal of construction waste and debris.

***Step 6: Weed Removal and Management***

321. Weed from the anicut that are removed can grow quickly and easily, and hence, care should be taken to see to that the seeds from the weeds are not scattered around and weed growth return to the anicut. Two proven ways can be used to ensure safe weed disposal. One, is to collect all the weeds removed at a pre-identified location, expose the weeds to the sun for over 30 days to ensure that the weeds dry out. And, later, the remains can be safely disposed on pre-identified disposal lands. The Contractor will be required to identify the weed disposal areas and seek approval for use of the land prior to the start of the construction activity. Another option to utilise is to compost the weeds and the compost used in agricultural lands. Under no circumstances burning of the weeds should be resorted to under the project.

***Step 7: Silt Removal and Management***

322. Silt from the anicut that are removed should be disposed in an environmental-friendly manner. The existing practice of disposing on canal embankments or a nearby open area should be avoided. This practise of indiscriminate silt disposal has led to affecting the local drainage patterns.

323. There are three options could be considered for safe silt disposal. The first option to reuse it as an embankment material after testing its characteristics and its suitability as an embankment material. The remaining quantity can be disposed in pre-identified disposal lands.The use of silt for the construction activity should be considered only upon testing the characteristics of the silt for as embankment material. More importantly, the silt should be tested for its non-polluting or contaminating nature prior to deciding on the disposal practise to be adopted for such silts. In the rehabilitation of the canals, there are intentions to use the dredged silt as an embankment material because most soils in the canal areas are suitable for earth-fill constructions. As long as they are insoluble and substantially inorganic, typical rock flours and clays with liquid limits above 80 are generally be avoided. Fine-grained soil within the range of water contents suitable for compaction and for operation of construction equipment can be used for embankment construction. Some slow-drying impervious soils may be unusable as embankment fill because of excessive moisture, and the reduction of moisture content would be impracticable in some climatic areas because of anticipated rainfall during construction. In other cases, soils may require additional water to approach optimum water content for compaction. The use of fine-grained soils having high water contents may cause high porewater pressures to develop in the embankment under its own weight. Moisture penetration into dry hard borrow

material can be aided by ripping or plowing prior to sprinkling or ponding operations.Hence, considering the soil characteristics that determine the suitability of the dredged silt as embankment material, it is suggested that the silt be tested in a laboratory for its suitability as an embankment material.

324. Second, because of the fertile characteristics of the silt, farmers prefer to spread it on their fields. However, in this case, the Contractor will obtain written permission from the concerned farmers prior to disposing the silt on farmers' lands and examine the quality of silt.

325. The third option is to dispose the silt at locations identified by the local authorities.The temporary sites and locations for construction waste and demolition debris disposal and silt disposal will be finalized at the start of the project and the information will be shared in the Contractor's EMP to be presented by the Contractor at the start of the project.

***Step 8: Rehabilitation of Anicuts***

326. Working on river bed typically necessitates diversion of the flowing water to create dry access to the concrete structure itself typically submerged. Strengthening of the anicuts are required as there is significant erosion around or under the anicut. Rehabilitation of the anicuts involves dewatering the dammed area necessary for construction (after the diversion structure is constructed), weed and vegetation removal, silt removal, removal of sediment and debris obscuring the structure, Grouting is one of the most common ways utilised to strengthen the anicut. Following this, placement of bank reinforcements such as riprap or concrete wing walls and aprons will be performed. Subsequently, following the activities on the anicut itself, repairing the river/stream flow through the structure is accomplished by removing the diversion mechanism in place.

***Step 9: Site Restoration***

327. Finally, any area that is utilised during the construction activities either for material storage and / or establishing construction camps should be restored to its baseline condition. The restored site should be handed over to the owners and a six-month groundwater monitoring of the area should be performed by the Contractor. Remediation of any contamination should be performed prior to hand over.

328. In addition, the following guidelines to address the key impacts should be followed:

**Table 50: Construction Guideline to preserve Aquatic Biodiversity**

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| Presence of Aquatic Biodiversity near the anicut being rehabilitated | To ensure that the aquatic biodiversity is preserved while carrying out the rehabilitation work | Construction workers will be given biodiversity training; |
| | | Update the baseline survey of the aquatic biodiversity within a 200m zone of influence of the anicut being rehabilitated; |
| | | Determine the movements and the regular activities of the aquatic animals around the anicut area; |
| | | Identify safe locations for construction of ring-bunds to create alternative habitation areas for the aquatic animals while facilitating the creation of dry construction area; |

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| | | Select the location of the ring-bund in consultation with the PSC/KNNL Biodiversity Expert and secure approval from the Karnataka Forest Department prior to the construction of the ring-bund; |
| | | Construct the secondary ring-bund at the start of rehabilitation of a particular anicut during the period December to June. |
| | | Rehabilitate the anicut during the period December to June. Any adverse impact on the aquatic biodiversity during the rehabilitation activity should be mitigated in consultation with the PSC / KNNL Biodiversity Expert and the Karnataka Forest Department; |
| | | After rehabilitation of the anicut is completed, dismantle the secondary ring-bund during June before the onset of monsoon. |
| | | Conduct a post-rehabilitation survey of the aquatic biodiversity within a 200 m zone of influence of the anicut that has been rehabilitated; |
| | | Provide an analysis of the baseline and post-rehabilitation aquatic biodiversity survey in the periodic reports submitted to KNNL and ADB. |

**Table 51: Construction Guideline to access Ring-Bund Location**

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| Ring-Bund construction is necessary to create a dry construction area for rehabilitating the anicuts. | The ring bunds are located along the river to prevent entry of water into the anicut area thereby creating a dry construction area. Considering that the temporary ring-bund construction can affect the aquatic biodiversity, adequate mitigation measures should be implemented while constructing the ring bunds. | Based on the aquatic biodiversity survey select the location for the construction of the ring bund in consultation with the PSC Biodiversity Expert and the Karnataka Forest Department. |
| | | For the selected ring bund location, determine the access points for vehicle, equipment and the construction materials. |
| | | If direct access is available through any of the existing roads, then the ring bund construction should be initiated as per designs. |
| | | If alternative approach roads are to be constructed (even temporarily), due procedures should be followed to ensure access to the ring-bund location. |
| | | Conduct a survey to determine the approach road alignment so that the vehicle and equipment can be brought in to the construction area through the approach road both for constructing the ring bund. |
| | | If the approach road passes through sections that indicates presence of trees, conduct a tree survey, seek the necessary approval from the Karnataka Forest Department and initiate the ramp construction as per the KFD approved conditions. Once the approach road is constructed, move |

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| | | the necessary equipment and carryout the ring bund construction. |
| | | If sections of the approach road passes through encroached land, follow the procedures provided in the Social Safeguard Due Diligence Study and the Resettlement Framework for carrying out the necessary works. |
| | | If the sections of the approach road passes through private land, follow the procedures provided in the Social Safeguard Due Diligence Study and the Resettlement Framework for carrying out the necessary works. |
| | | Retain the approach road (if temporary) until the ring-bund is removed at the end of the rehabilitation of the anicut. |

**Table 52: Construction Guideline to access the Anicut**

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| Vehicle and Equipment access to the Anicut is necessary to carry out the rehabilitation work | To ensure that the environmental impacts are avoided and if unavoidable, the impacts are mitigated while carrying out the rehabilitation work | Check the possible alignment for accessing the anicut either from the existing Service Road or Inspection Path or Approach Roads; |
| | | If accessible from the SR or IP without any additional improvements being necessary to make the SR or IP accessible, and after the construction of the ring bund, move the necessary equipment to carry out all rehabilitation works; |
| | | If not accessible form the SR or IP directly, check whether a ramp can be constructed along the SR or IR so that the vehicle and equipment can reach the anicut without trespassing any land either encroached, public or private or does not indicate presence of trees. If yes, construct the ramp and move the necessary equipment to carryout rehabilitation works. If not, determine whether a nearby approach road can be used / constructed to carry out the rehabilitation works. |
| | | If there is no access from the anicut either directly or indirectly, conduct a survey to determine the approach road alignment so that the vehicle and equipment can be brought in to the construction area through the approach road both for constructing the ring bund and for rehabilitating the anicut as per the designs. |
| | | If the ramp alignment section/ approach road passes through sections that indicates presence of trees, conduct a tree survey, seek the necessary approval from the Karnataka Forest Department and initiate the ramp construction as per the KFD approved conditions. Once the ramp / approach road is constructed, move the necessary equipment and carryout the rehabilitation works. |

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| | | If sections of the ramp alignment / approach road passes through encroached land, follow the procedures provided in the Social Safeguard Due Diligence Study Report. |
| | | If the sections of the ramp alignment/ approach road passes through private land, follow the procedures provided in the Social Safeguard Due Diligence Study Report. |

### Rehabilitation of the Canals

329. Rehabilitation of canals involve a number of activities including clearing the tree and vegetation along the canal right-of-way including service road, inspection path and canal embankments, removing the silt and later performing the civil works. In order to perform these activities, it is important to get adequate and safe access for vehicles, equipment and workers to all parts of the canal construction area. However, while doing so, it is important to consider the fact that there is considerable tree and vegetation cover along the canal length that makes important contribution to the local terrestrial biodiversity and reduces heat stress in the habitations located along the canal sections. And, it is important to safeguard both the terrestrial biodiversity and the interests of the local community while taking up civil works. Additionally, it should be noted that farmlands have encroached the Inspection Path along majority of the canal sections which calls for utilizing appropriate resettlement procedures prior to proceeding with the civil works in those areas.

330. The environmental Impacts from the rehabilitation of canals include increased levels particulate matter and GHG emissions and noise levels arising from movement of vehicles and the construction works. However, the most critical impact is in the protecting the tree cover to the maximum possible extent. Towards this, it is important to enumerate the tree cover and initiate an appropriate afforestation strategy to account for any trees that may need to be cleared to make for the canal rehabilitation works. Another, key impact is in the local drainage pattern resulting from silt disposal practices employed during the construction period. Hence, in order to minimize the impacts, it is important to adopt a construction methodology that considers these key impacts and implement mitigation measures as suggested in this report.

### Construction Methodology for Canals

331. As applicable for the anicuts, the broad framework of construction methodology and guidelines to be adopted for modernization (rehabilitation) works on canals deals with access for men, construction equipment and vehicles to move around with relative ease without causing disruption to physical or economic assets. Further, the construction methodology also examines environmental and social aspects, including for aquatic and animal life forms, and suggests measures for accommodating those needs during rehabilitation.

332. As a standard practice, KNNL has a service road of 3.75 meters with a one-metre berm on either-side, and inspection path (IP) of 2.75 meters on either side of the canal. Besides, there are bridges in many localities connecting service road and the inspection

path. Operation of construction equipment is possible from the service road in normal sections, or through temporary ramps in deep cut sections. Alternatively, the access to the canal can also be from "0" chainage. Materials will be provided from accessible points at different locations depending upon the requirement. Specified locations for transport of materials will be finalised by the contractors, KNNL and PSC before starting the construction work. Consultations with WUCS, Panchayats, municipality and local famers will be conducted prior to execution of work specifically in case of inaccessible sites for which access from farmer fields/private land may be necessary. Some stretches along four channels (Raya, Basavanna, Siruguppa and Belagodahalla) pass through urban areas. In all these four channels, KNNL land along the service road is encroached for dwelling and cow sheds. Further, the inspection paths are mostly used for cultivation by the farmers. Temporary ramps and such structures should be removed by the contractor immediately after the work/contract is completed to prevent misuse.

333. As part of the mitigation measures, the following steps are being suggested to be adopted for rehabilitation of the canals:

***Step 1: Reconnaissance Survey***

334. A reconnaissance survey of the entire length of the canal is taken up. During the survey, identify sections of the canals where SR needs minor repairs so as to ensure that access for the construction equipment and vehicles is available along the entire length of the canal.

***Step 2: Tree Enumeration***

335. Enumeration of the trees should be taken up with the assistance of the Karnataka Forest Department to identify the trees that need to be removed / preserved. Appropriate markings should be made and the Contractor should be made aware of the same. Appropriate compensatory afforestation (two trees in every one tree removed, 2:1) should be incorporated as suggested by the Karnataka Forest Department. In case of trees belonging to certain community organizations or religious institutions or adjacent private land owners (even on encroached land), prior information should be provided to them and site clearance should be initiated.

***Step 3: Site Clearance***

336. Construction work in canals covers three major areas viz., canals, cross-drainage structures and riprap. Preparing site around canals and canal structures for rehabilitation involves removing the trees, snags, stumps, shrubs, brush, limbs, sticks, branches and other vegetative growth in and around the canal right-of-way works. Rocks, lumps of concrete, fencing and all trash will also be removed. After the clearing of the vegetation, organic sod and top soil will be removed from the right-of-way. The top soil will be stockpiled on site to be sued for dressing the backfill after construction and before seeding the disturbed areas. Site clearance will be limited to the construction areas only to the extent of the outside toe of the canal bank. The disposal of construction debris should be done at a pre-identified location and should meet the requirements of the Construction Waste and Debris Management Rules, 2016.

***Step 4: Disposal Site Location***

337. The specifications provided in the project allows a lead of 50m for construction debris management. This is wholly inadequate and hence should be relooked at. At the start of the project, the Contractor should discuss with KNNL and other Government agencies for selection of the right location for the disposal of construction waste and debris.

***Step 5: Weed Removal and Management***

338. Weed from the canal and canal embankments that are removed can grow quickly and easily, and hence, care should be taken to see to that the seeds from the weeds are not scattered around and weed growth return to the canal and its embankment. Two proven ways can be used to ensure safe weed disposal. One, is to collect all the weeds removed at a pre-identified location, expose the weeds to the sun for over 30 days to ensure that the weeds dry out. And, later, the remains can be safely disposed on pre-identified disposal lands. Another option to utilise is to compost the weeds and the compost used in agricultural lands. Under no circumstances burning of the weeds or pesticides should be used for removal of weeds under the project.

***Step 6: Silt Removal and Management***

339. Silt from the canal that is removed should be disposed in an environmental-friendly manner. The existing practice of disposing on Service Road and Inspection Path should be avoided. This practise of disposing silt on Service Road and Inspection Path has led to increasing the height of these roads leading to affecting the local drainage patterns. There are three options that will be utilized. The first option to reuse it as an embankment material after testing its characteristics and its suitability as an embankment material. The remaining quantity can be disposed in pre-identified disposal lands. The use of silt for the construction activity should be considered only upon testing the characteristics of the silt for its intended use. More importantly, the silt should be tested for its non-polluting nature prior to deciding on the silt disposal practise to be adopted for such silts. Second, because of the fertile characteristics of the silt, farmers prefer to spread it on their fields. However, in this case, the Contractor will obtain written permission from the concerned farmers prior to disposing the silt on farmers' lands and analyse the sediment quality. The third option is to dispose the silt at locations identified by the local authorities. The temporary sites and locations for construction waste and demolition debris disposal and silt disposal will be finalized at the start of the project and the information will be shared in the Contractor's EMP to be presented by the Contractor at the start of the project.

***Step 7: Earth Work***

340. Preparing the canal section for rehabilitation incudes use of an excavator to enter the canal or reach from the Service Road to remove excess soil, vegetation, sediment, silt/sand bars or other debris so that the canal section can be prepared to conform to design grades. After excavation, earthwork includes preparation of the foundation sub-grade, preparation for placing fill or backfill, placing and compacting fill and structural fill, moisture control and site grading. Excavations will have sloping, sheeting, shoring and bracing to conform to safety standards. Where unacceptable subgrade exists, over-excavation will include the removal of all unacceptable material beneath the structure and replacement with structural backfill. Excavations will be to the depths and widths necessary to accomplish the construction, including concrete forms, working space,

structural backfill, and site grading. Site grading will be done to shape, trim, and finish slopes of channels to conform to design grades and minimize erosion.

***Step 8: Removal of Structures***

341. Removing a structure involves the use of an excavator to remove soil, gravel, riprap or any other debris from around the structure, hydraulic jack hammering using an excavator to break the concrete into pieces, and removing rubble including any reinforcing steel or debris from the site. The soil immediately surrounding the structure will be disturbed but no significant disturbance will be caused outside of the canal banks or maintenance road unless unusual circumstances exist.

***Step 9: Removal of cross-drainage structures***

342. Replacing a cross will involve disturbing an area under the road, stream or natural drainage where the canal path travels, in order to excavate the existing structure and prepare the subgrade for new construction.

***Step 10: Canal Lining***

343. The rehabilitation work involves lining of canals, rip rap replacement and rehabilitation of cross-drainage structures. Prior to constructing canal lining, the Contractor should ensure that the sub-grade layer of soil is adequately consolidated. For constructing concrete lining, slip forms are drawn down the length of the canal as the concrete is poured. At times, additives are utilised in concrete to improve water retention. If expansive clay is located on the site of the canal, a layer of this clay is removed and replaced with sand or gravel before the concrete lining is constructed. This removal minimizes the risk of ground swelling that can cause cracking in concrete. In order to prevent cracking during the curing process, water is sprinkled on the concrete or a damp cover is placed over the lining.

***Step 11: Riprap Replacement and Rehabilitation of Cross-Drainage Structures***

344. Riprap will be used to protect soils around structures and canal banks from erosion. Stones for riprap will be quarry stone, well-graded and angular and sourced from approved quarries. Concrete rubble may be used in places where the size of the pieces meets the minimum requirement. Concrete grout may be placed over the rubble to secure it in place and increase longevity. All cross-drainage structures are rehabilitated as per approved designs using specified materials.

345. The use of concrete is not banned in the Heritage Area but with restrictions according to the HWHAMA approval. The designs are being finalized to reflect the terms and conditions of HWHAMA for the works within the Heritage Area.

***Step 12: Restoration of Service Road and Inspection Path***

346. Service Road and Inspection Path are to be restored to ensure that the canal right-of-way is available for canal maintenance at all times. The levels of the SR and IP should not impact the local drainage patterns and cause floods in the command area of the canals.

***Step 13: Turfing***

347. Importantly, turfing of the area between the Canal Full Supply Level (FSL) and the edge of the Service Road and Inspection Path is done to ensure the stability of the embankments. Turfing is proposed only portions of the embankment that are above the high water level where concrete lining is generally not done. In fact, certain forms of vegetation offer excellent protection against erosion due to storm water runoff. The selection of the vegetation should be approved by KNNL.

***Step 14: Site Restoration***

348. Finally, any area that is utilised during the construction activities either for material storage and / or establishing construction camps should be restored to its baseline condition. The restored site should be handed over to the owners and a six-month groundwater monitoring of the area should be performed by the Contractor. Remediation of contamination should be performed prior to hand over.

**Table 53: Construction Guideline to access the Canal Construction Area**

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| Vehicle and Equipment access to the entire canal section in each of the canal is necessary to carry out the rehabilitation work | To ensure that the environmental impacts are avoided and if unavoidable, the impacts are mitigated while carrying out the rehabilitation work | Generally, the canal sections are accessible from the Service Road. In certain sections, the canal lengths are accessible from the IP, as well. In very few cases, the canal sections are not accessible for certain short distances. |
| | | If accessible from the SR or IP without any additional improvements being necessary to make the SR or IP accessible to the canals, move the necessary equipment to carry out all rehabilitation works; |
| | | If not accessible form the SR or IP directly, check whether a ramp can be constructed along the SR or IP so that the vehicle and equipment can reach the canal bed without trespassing any land either encroached, public or private or does not indicate presence of trees. If yes, construct the ramp and move the necessary equipment to carryout rehabilitation works. |
| | | If there is no access from the SR or IP either directly or indirectly, conduct a survey to determine the approach road alignment so that the vehicle and equipment can be brought in to the construction area through the approach road for rehabilitating the canal sections as per the designs. |
| | | If the ramp alignment section/ approach road passes through sections that indicates presence of trees, conduct a tree survey, seek the necessary approval from the Karnataka Forest Department and initiate the ramp/ approach road construction as per the KFD approved conditions. Once the ramp/ approach road is constructed, move the necessary equipment and carryout the rehabilitation works. |
| | | If sections of the ramp alignment/ approach road passes through encroached land, follow the procedures provided in the Social Safeguard Due Diligence Study Report. |

| Site Issue | Impacts to be addressed | Guideline to address impacts |
|---|---|---|
| | | If the sections of the ramp alignment/ approach road passes through private land, follow the procedures provided in the Social Safeguard Due Diligence Study Report. |

### Closure Activities

349. Closure activities are key tasks to be carried out by the Contractor during the construction period to ensure that all the construction sites and campsites to do not pose an environmental risk during the post-construction period. During this activity, the Contractor should restore all the construction campsites to their original condition as agreed upon with the land owner and ensure that all environmental media including land, surface and groundwater have not been contaminated at the time of its use during the construction period. Additionally, the borrow areas should be restored to a condition such that it does not affect the drainage pattern in the area or lead to heavy soil erosion and preferably should be good enough to put to productive use by the community, if required.

350. Mitigation measures include having an agreed upon Closure Plan with the land owners prior to utilizing it during the construction period and ensuring that the Closure Plan is adhered to at all times during the contract. Additionally, the Contractor should implement an environmental monitoring plan as suggested in this report so that appropriate and adequate evidence is available to ensure that the quality of the environmental media has not been compromised during the project period.

### Construction Period Activities

351. In summary, to carry out all the components effectively during the construction stage, the following construction related activities/ issues have to be dealt with during the period:

i. Site Clearance;
ii. Tree Removal and Afforestation;
iii. Weed Removal and Weed Management;
iv. Desilting and Silt Management;
v. Transport of machinery, equipment and material;
vi. Material Sourcing;
vii. Storage and handling of materials;
viii. Impact due to notified OCR;
ix. Impact due to Hampi World Heritage Area;
x. Rehabilitation of Anicuts, Canals and other Structures;
xi. Construction Campsite Facility Management;
xii. Worker Health and Safety;
xiii. Borrow Area Rehabilitation;
xiv. Closure Activities.

#### *i. Site Clearance*

352. Site Clearance is required to access the sites viz., anicuts, canals and campsites. The campsites are required to house the construction workers, store materials and to establish and operate batching plants. Preparing site around the anicuts, canals, canal structures and campsites involves removing trees, snags, stumps, shrubs, brush, limbs,

sticks, branches and other vegetative growth in and around the construction right-of-way. Rocks, lumps of concrete, fencing and all trash will also be removed.

353. Impacts from the site clearance activities are an increase in soil erosion arising from the removal of trees and vegetation and changing the drainage pattern in the area. If blasting is used for clearing rocks, localised noise levels will be impacted. And, blasting near the heritage area monuments can damage the structures, as well. Finally, the disposal of construction debris can cause land and water pollution.

354. Mitigation measures include limiting the tree and vegetation removal as detailed in the following sub-section i.e., after enumeration and as per the approval of the Karnataka Forest Department (KFD). Blasting of the rocks should be avoided at all times especially in areas closer to the monuments and habitations. Finally, the construction waste and debris should be disposed at an engineered landfill approved by the KSPCB.

### *ii. Tree Removal and Afforestation*

355. The tree count and identification of tree species along canal sections to be rehabilitated have been carried out by the PSC. A tree survey resulted in identification of 3,257 trees that belong to 55 species of 28 plant families along the 220 km length of the 16 canals that are being rehabilitation. A number of these trees need to be removed as they are located along the width of the canal alignment, service road and / or inspection path. Impacts from the tree removal includes increased land erosion leading to increased flooding areas, increased heat stress in the areas along the canals where there are human habitations and decreased shelter areas for birds and animals.

356. Mitigation measures include conducting an enumeration of the trees that need to be removed prior to start of work along each of the canals, with the assistance of the KFD and a Compensatory Afforestation Plan be drawn up to compensate for the trees that need to be removed. The Contractor should seek prior approval from the KFD for such removal and afforestation activities. Following any removal of trees, the contractor will arrange for trees of species as presented in the Compensatory Afforestation Plan to be planted elsewhere as directed by the KFD and the Project Implementation Agency.

### *iii. Weed Removal and Management*

357. Weed growth has been noticed along large stretches of the canal sections and in the anicut area. The weed growth has been a result of ingress of wastewater from habitations closer to the canal sections. The weed growth has to be removed prior to starting the rehabilitation activities. In order to avoid migration of toxic chemicals, pesticides will not be used for the removal of weeds or other vegetations in the canals or anicuts. Weed will be removed using appropriate equipment and disposed in an environmentally-friendly manner.

358. Impacts from the weed arise when the seeds from the weeds are scattered around and weed growth return to the canal and its embankment and the anicut area. As part of the mitigation measures, two proven ways can be used to ensure safe weed disposal. One, is to collect all the weeds removed at a pre-identified location, expose the weeds to the sun for over 30 days to ensure that the weeds dry out. And, later, the remains can be safely disposed on pre-identified disposal lands. Another option to utilise is to compost

the weeds and the compost used in agricultural lands. Under no circumstances burning of the weeds should be resorted to under the project. Another important aspect for preventing weed growth return is to work with local urban local bodies and village communities to ensure that the wastewater from the habitations are not discharged into the canals and / or the water bodies leading to the anicuts.

### *iv. Desilting and Silt Management*

359. Desilting of canals is one of the main activities under canal modernization project. Both desilting activity and desilting material itself should be managed such that there is minimal impact on the environment. The general practise of dispersing the desilted material in nearby field and adjoining areas would potentially inhibit growth pattern among the plants and trees. Additionally, spreading of silt material in to may surface water sources invariably affects its' potential utilisation by the local community. As such, the desilted material should not impact either the surface water bodies or land.

360. Avoidance and mitigation measures include have a comprehensive silt disposal plan to prevent the following impacts:

i. It may cause loss of vegetation from the banks of canals and adjoining areas.
ii. In case of high wind blows, the whole vicinity will be covered by a fine layer of silt.
iii. It may lead to disruption in movement of machines and trucks (carrying silt and other material).
iv. Transfer of polluted or contaminated silt to farmlands that can cause deterioration of environmental quality and human health.

361. ***Table 54*** describes key aspects to be considered during silt disposal.

**Table 54: Silt and Solid Wastes Management and Disposal-Environmental Impact**

| S. No. | Issue | Avoidance/Mitigation measures |
|---|---|---|
| 1. | **Lack of uniformity in silt deposition onto the banks of canals, leads to weakening of banks**<br>Improper disposal of silt may lead to weakening of banks as the quantum of silt deposited will not be consistent leading to lack of uniformity on the track/path of the canal and weakening of banks at some places. | • Close supervision should be kept to ensure proper disposal of desilted material at pre-decided place, as per plan.<br>• Deposition of silt on the banks (pre-decided) should be done in the presence of an experienced person (departmental official or as applicable), so that repercussions due to negligence can be checked.<br>• After completion of desilting work in an area, it should be ensured that the area gets restored to its original shape; in addition, no excess machinery should be left. |
| 2. | **Spillage of silt and solid wastes into the nearby farmland**<br>The spillage of desilted material also creates problem for the nearby farmlands, settlements (if any) and adjoining areas. | • To minimize of spillage or gusted of desilted material and solid watses, cover is provided while transportation.<br>• In any case, the desilted material should not be allowed to remain unattended. It should either be analyzed or transported to a pre-decided site for its disposal or should be properly dressed if will be used for agricultural activity or reinforcing the bunds and canal embankments. |

| S. No. | Issue | Avoidance/Mitigation measures |
|---|---|---|
| | | • Sometimes, moisture content in the desilted matter is significant enough to cause dripping while getting transported from site to the disposal site; it should be ensured that desilted materials are sun dried by at least 20 meters aways from the river or sensitive areas before transport.<br>• Solid wastes from the dreged materials should be sun dried by at least 20 meters aways from the river or sensitive areas before transport to landfill.<br>• While transportation, the desilted matter should be covered so that the spilling and flying of matter can be minimized.<br>• Overloading should be avoided, so that spillage can be reduced. |
| 3. | **Treatment at farmer's field**<br>In general, silt is fertile in nature and farmers love to transport the desilted material into their fields. However, there are many issues to be dealt with, for instance:<br>• Chemical, pathogenic and nutrient content of the silt<br>• it is bound to raise the ground level of that area<br>• silt is lighter in weight so it may cause dust problem during high surface winds. | • Sediment quality analysis (***Annexure 10***) should be performed from all anicuts and canals in order to determine if silt pollutants or heavy metals.<br>• The quantum of desilted material received by the farmer for their fields should not be too much such that it should not raise the ground level of the field too much. The desilted matter should be evenly spread onto the field to obtain symmetry.<br>• In order to avoid flying of silt, possible measure is its proper mixture with the native soil so that it gains weight and remains in the area.<br>• The PMU and PSC will recommend farmers to sun dry silt to disinfect and elimate pathogens to prevent diseases upon usage. |
| 4. | **Treatment at disposal site**<br>The disposed-off desilted material if left unattended may cause soil and water pollution; in addition, it may also cause severe SPM (Suspended Particulate Matter) problem as fine soil gets dispersed in the vicinity, especially during the period of high surface winds, thus forming a layer over existing resources. | • One of the key and preferred treatments methods is the development of a vegetative cover (bioremediation). In other words, some species of bushes and dense plants should be grown to reduce the impact of high surface winds and rainfall (which may cause soil erosion). Examples of plants are Indian Jujube (*Ziziphus* mauritiana) and Mulberry (*Broussonetia papyrifera*). These plants are useful for disposal site to avoid contamination and dispersion of desilted matter This treatment also does not involve much capital. Hence, can be easily promoted.<br>• Transport sontaminated silt and garbage by covered trucks to sanitary landfill for disposal; if unavailable, to engineered dump sites (compact clay-lined) for temporary disposal. |
| 5. | **Degradation/pollution to local water-bodies –** | It should be ensured that in any case the local water-body or the area near such a water-body is not identified as disposal site. Identification of |

| S. No. | Issue | Avoidance/Mitigation measures |
|---|---|---|
| | In the absence of a comprehensive disposal plan or if the compliance is poor, the local water-bodies may become prone to get severely affected by the desilted material. | such water bodies can be done by referring to current/old village maps. In addition to this, an appraisal exercise can also be undertaken in consultation with the villagers, as they have good knowledge of the area. |
| 6. | **Improper disposal of desilted material and other solid wastes**<br>Improper disposal may lead to local environmental hazards. In the absence of adequate measures/provisions for proper disposal, native villagers will also get affected. | • Disposal of silt and solid wastes (dredged materials and/or construction wastes) should be segregated. Uncomtaminated silt should be reused in farmlands or construction filling materials while the contaminated silt and construction wastes must be disposed in the landfill.<br>• Provisions should be clear in the contract document so that there is no possibility of back-track by the contractor on this aspect. In addition to this, penalty for non-compliance should also be ensured. |
| 7. | **Impact of odor from dredged sediments and temporarily dewatered anicuts and canals**<br>Unpleasant odour is a frequent cause for complaint by nearby community and may cause environmental nuisance. | Loading of organic materials is prominent in the agricultural setting of the project location. The odor coming from dewatering sediments will be important to mitigate during the rehabilitation period. The temporary disposal sites and management should be identified in order to mitigate the odour nuisance impact to local residents. |

*Stages for Sediment Assessment*

362. The polluted or contaminated sediments are comprised materials of organic and inorganic in nature. These sediments accumulate on the bottom of the canals and anicuts which might contain substances harmful to human health and the environment. The following paragraphs shows the level of assessment that will be done

363. *Preliminary site investigation*: The first stage is the identification of the risks of the project location on pollution and contamination of sediments. This EIA report served as preliminary investigation of the project locations and identified the potential types and sources of contamination, the locations of potential contamination, human and ecological receptors and potentially affected media (sediments). The thorough preliminary site investigation involves: (i) community consultation, (ii) development of sampling and analysis activities, (iii) land uses analysis and (iv) reporting of suspected polluted and contaminated sites.

364. *Detailed Site investigation (DSI)*: In the EIA report, the initial investigation of the project locations identified risk of pollution and contamination of sediments in the canals and anicuts. The available information of the EIA might be insufficient to develop site management strategies; hence, a more detailed sampling of the project site may need to be conducted. The site sampling sets (***Annexure 10***) out to delineate the possible contamination of the sediments in the anicuts and canals. Sediment analysis for contamination from heavy metals and pollution will be performed prior to rehabilitation of

the anicuts and canals. In this manner, succeeding activities for sediment management will depend on the results of the sediment analysis

365. *Sediment Management Plan*: Following an adequate and appropriate level of sampling analysis, sediments management is specified in the Environmental Management Plan of the report. There are recommendations that should be followed such as temporary storage, use of the sediments and final disposal. The type of use and disposal will depend on the type of contamination of the sediments.

### *v. Transportation of Material and Equipment*

366. Movement of trucks to carry material along access roads to the project areas will be via paved roads, temporarily laid access roads, canal service roads and inspection paths. However, precautions are recommended for transport of material/equipment to eliminate any potential adverse impacts. Impacts include an increase in localised GHG emissions, traffic congestions and possible accidents too.

367. Mitigation measures to be followed by the Contractor include an agreement with the local community on the schedule that could be followed for the use of local roads for transportation of material and equipment. Contractor will avoid peak hours on roads with moderate to high traffic. In certain cases, contractors will select alternative routes for their trucks based on the truck load, dividing the load if necessary, to prevent damages to local roads and bridges since the Contractor will be responsible for damages to local roads and bridges. For minimizing the GHG emissions, the trucks and the equipment should undergo regular maintenance and Pollution under Control (PUC) Certificate should be obtained for all trucks and equipment employed for the project and should remain current for the entire construction period. The maintenance of the vehicles should be carried out at authorized workshops. Vehicle cleaning and maintenance should be carried out on public land and / or private land with adequate oil and waste management practices at the site and consent to operate from the KSPCB. The vehicles maintenance is carried out on concrete platform with provision of drains and secondary tanks to collect waste oil. All vehicles will observe speed limits and be maintained in good operating condition. Material should be transported always under cover including use of doors to ensure safe transport of materials and equipment and prevent any incident arising from falling of objects / material on the road during transportation and impacting the safety of the people.

### *vi. Material Sourcing*

368. Material sourcing for the rehabilitation works includes soil, sand and stones. Sand and stones are available from licensed sand mining and quarry owners. Soil is obtained from borrow areas leased from private and / or public lands after due approval from the local authorities.

369. Sand mining has significant environmental impacts including on the river ecology from which it is mined. Operating quarries also has an ecological cost including altering the drainage pattern in the area and creation of wastelands. Hence, both sand mining and quarry operations are approved by the Government which requires the owners to operate under a consent issued by the KSPCB. As such, the Contractor is mandated to procure sand and stones from licensed sand mining and quarry owners. In order to minimize the ecological impact of sand mining, use of manufactured-sand, popularly known as m-sand

can be explored, as well. If the technical characteristics permits their use, m-sand may be used by the Contractor after securing the necessary approval from KNNL.

370. Impacts of soil removed from the borrow areas include altering the drainage pattern and cause soil erosion in the area and in some cases turns the borrow area into wasteland. Hence, all borrow areas should be leased from the respective land owners after finalising a Borrow Area Rehabilitation Plan that is agreed upon by all sides.

### *vii. Storage and Handling of Materials*

371. All materials should be stored prior to its use. If these materials are not stored safely, it can lead to deleterious environmental impacts including contamination of land and water.

372. To minimize the impact, the construction material and POL storage areas and equipment maintenance areas must be identified and developed. Fuel and oil will need to be stored in dedicated areas in sealed tanks with a concrete base at least 20 m away from a water course or other sensitive area. Vehicles and machinery are not to be re-fuelled near water courses. Trained personnel should be available at the site to prevent spills and for adopting appropriate procedures for cleaning up accidental spills, if any. All waste oil, oil and fuel filters are to be collected and disposed of in accordance with best industry practices. Upon closure of the site, all contaminated soil is to be excavated, removed and replaced with fresh topsoil and as approved by the KSPCB for such incidents.

### *viii. Impacts due to notified OCR*

373. The VNC System is located in the vicinity of two notified areas viz., Daroji Bear Sanctuary and Otter Conservation Reserve. The Daroji Bear Sanctuary is at a distance of over 25 km from canal portions and therefore the rehabilitation work does not negatively impact the sanctuary. Hence, mitigation measures are suggested only for work within the OCR.

374. On the other hand, a portion of the VNC system, primarily 9 of the 12 anicuts are located within the notified OCR. When work is carried out near protected areas, it is necessary to schedule the activities appropriately in terms of timing, both on daily and seasonal bases, to avoid disrupting animal or bird migrations, breeding or nesting. Daily construction activities should work from 9 a.m. to 5 p.m. because Otters are crespucular animals. The construction season should be during the months of January to June because this is the period when water level in the river go down and animals, i.e., the crocodiles, go towards the deeper part of the river. Workers should also be made aware of the precautions to be taken while working in these protected areas.

**Figure 19: Typical work area within the OCR: Need for Desilting and Deweeding**

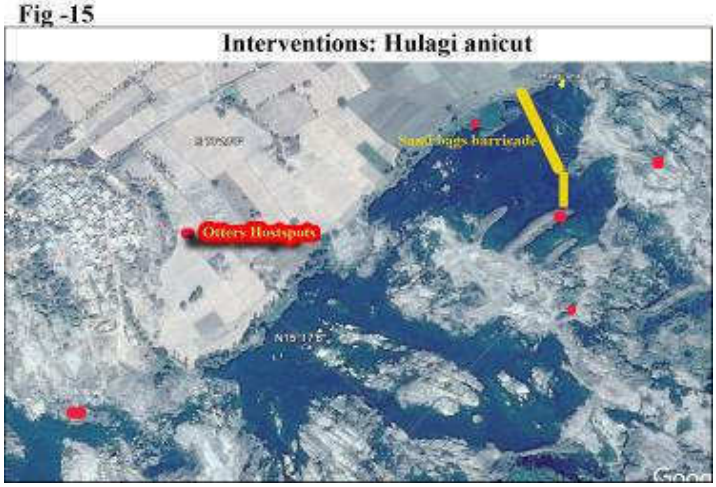
**Figure 20: Typical Work within the OCR Area: Need for Realigning and Strengthening of Anicuts to prevent seepage**

375. Based on the RBA mitigation measures were developed to ensure that the ADB Safeguard Principle No. 8 is adhered to. Hence, the suggested mitigation measures do not impair the ability of the OCR to function during the construction period and beyond and there will be no reduction in the population of any recognized endangered or critically endangered species. Listed below are certain measures that should be carried out while undertaking work in the OCR:

a. At the start of the rehabilitation work, awareness program on "Wild-life in the river and conservation" should be conducted for workers, supervisors and the staff at all levels so as to provide them an understanding of the changes that need to be incorporated in the work methodologies to protect the Otter Conservation Reserve. Awareness programs should be conducted by an Ecology/Biodiversity Expert familiar with both Otter Conservation and technical aspects of the rehabilitation project.

b. Before commencement of anicut rehabilitation activities, secondary ring bunds should be built using appropriate materials across the anicut about 100 m away to ensure availability of water for the wildlife till completion of the rehabilitation work. Additionally, primary ring bunds should be built near the Anicuts to ensure ample space available for workers to carryout rehabilitation work. However, a location-specific pre-construction aquatic biodiversity survey should be conducted to confirm the locations to be chosen for the primary and secondary ring bunds. An assessment has been done in regard to locating the secondary ring bunds and the results are provided in the following table along with the photographic view of the secondary ring bund location.

| S. No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 1 | Fig - 20 Interventions: Hosuru/Bella *Anicut*<br>  | **Bella anicut:**<br>1. Otters and crocodiles are active in this anicut.<br>2. An appropriate secondary ring bund will be built across the river in the upstream of the anicut. |
| 2 | Fig-21 Interventions- Turtha anicut<br>  | **Turtha Anicut:**<br>1. Complex of 5 and more anicuts.<br>2. Excessive weed grown and choked with excessive sedimentation.<br>3. Suitable secondary ring bund to be built based on condition of the anicut |
| 3 | Fig- 22 Interventions - Ramasagara Anicut<br>  | **Ramasagara Anicut**<br>1. It is a very long anicut.<br>2. Otters and crocodiles are in good numbers in this anicut area.<br>3. The existing islands will not be destroyed.<br>4. Secondary Ring bunds will be planned meticulously based on the condition and water level in the anicut area. |
| 4 | Fig -23 Interventions - Kampli anicut<br>  | **Kampli Anicut**<br>1. Otters are in good number in the anicut area.<br>2. A suitable secondary ring bund will be built based on the condition of the site and season. |

| S. No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 5 | Fig -15<br>  | **Hulugi Anicut**<br>1. It is a very broad anicut.<br>2. Otters and crocodiles are in good number in this anicut.<br>3. The Otter use the long "finger shaped" islands for resting and mass defecation.<br>4. They also breed in side of the rocky island around anicut.<br>5. Construction of secondary ring bund will be planned meticulously based on the condition of the anicut and season. |
| 6 | Fig-16<br>  | **Shivapura Anicut**<br>1. Otters and crocodiles are in good number in the upstream of the anicut.<br>2. Construction of Secondary ring bund will be planned based on the condition. |
| 7 | Fig - 17<br>  | **Sanapura Anicut**<br>1. Otters use the anicut as corridor.<br>2. The Secondary ring bund will be built across the narrow part of the river. |

| S. No. | Photo of the Anicut along with the secondary ring bunds | Details |
|---|---|---|
| 8 | Fig-18 Interventions - Upper Gangavathi   | **Upper Gangavathi Anicut**<br>1. It is a very long anicut.<br>2. Most of the portion of the anicut area is over silted.<br>3. The secondary ring bund will be built based on the condition of the location. |
| 9 | Fig-19 Interventions - Lower Gangavathi anicut   | **Lower Gangavathi Anicut**<br>1. It is a very long anicut.<br>2. Secondary Ring bunds will be constructed based on the condition of the anicut. |

c. At the start of the rehabilitation work, the route to be taken and the construction waste disposal location should be identified, and approval for its use should be obtained from concerned authority. Under no circumstances, construction waste and debris should be disposed near the OCR or any other unauthorized place;

d. No Construction campsite should be set up within a 100m zone of the OCR;

e. Rehabilitation work should be taken up from December to June only to avoid disturbance to the aquatic fauna. During this period, the flow of water in the river is greatly reduced and chances of floods are very less;

f. The rehabilitation work should start at 9 am and should be closed by 5 pm so as to make way for the feeding of the crepuscular and nocturnal animals;

g. De-silting and de-weeding activities should be taken up on the front-end of the anicuts only to make way for the construction equipment, vehicles and workers. And, the existing native species of bushes and shrubs in the shore line are to be retained. Such measures will help animals take shelter and hide under the cover of vegetation;

h. Retain the rocky islands, sand dunes and mud-banks within the anicuts which will help wild-life like Smooth-coated otters and crocodiles to rest;

i. During the rehabilitation of the VNCs, it is suggested that mud-bank and vegetation be retained on one side of the canal so as to help endemic forms like crabs, amphibians, snakes, turtles, birds etc. to feed, nest and live using available resources;

j. De-silting and removing the existing structure of the anicuts should be carried out with utmost care in the presence of a Biodiversity/ Ecology Expert. This is to avoid any kind of harm or disturbance to wildlife forms like turtles, snakes, monitor lizards, crocodiles, amphibians and fishes which are generally hidden under the crevices of the walls. All these wild-life forms are to be rescued and shifted to safer locations. Nests of crocodiles or turtles, if found, should be protected or shifted scientifically to a safer location under the guidance of an Ecology Expert;

k. Ecological enhancement measures such as harvest / collection of suitable aquatic flora from the river and implanting in the restored anicuts and release of Fingerlings such as Rohu, Catla etc. should be done to sustain the OCR;

l. Construction waste should not be, at any point of time, dumped or disposed of into rivers, islands, sand-dunes, mud-banks, river-banks, canals, canal-banks or any other structures within the OCR or within the canals or the command area. All construction waste should be removed to a previously identified and approved location, and

m. Finally, post-construction, weed by manual removal and disposal should be carried out for upto 4-years after the completion of the rehabilitation works.

### *ix. Impact due to Hampi World Heritage Area*

376. Hampi, the erstwhile capital of the Vijayanagara Kingdom, figures in the UNESCO's World Heritage List. Inscription of a property on the World Heritage List signifies that the World Heritage Committee has deemed that the site has cultural and natural values that can be considered of Outstanding Universal Value. While the VNC system is a 600-year old canal system, a portion of the canal system passes through the Hampi World Heritage Area.

377. A drive-through along the length of the canals revealed that over 12 protected monuments are located along the lengths of the three canals. These include 2 monuments along Anegundi, one along Raya and nine along Turtha Canal. Also, about 19.3km of the canal sections of Anegundi (8.95km), Raya(1.23km), Kalaghatta (0.55km) and Turtha (8.57km) are located in the core zone of the Hampi WHA. In addition, about 14.05km of the canal sections of Anegundi (3.43km), Raya (8.70km), Kalaghatta (0.44km) and Turtha (1.47km) are located in the buffer zone of the Hampi WHA. Further, about 24.33 km of the canal sections of Anegundi (0.63km), Raya (5.59km), Basava (8.44km), Kalaghatta (2.70km) and Turtha (6.97km) are located in the peripheral zone of the Hampi WHA. This imposes additional management demand on the Government and other entities to ensure high standards of protection and to comply with the requirements of the World Heritage processes.

**Figure 21: Part of Turtha Canal within Hampi WHA where canal rehabilitation designs should maintain integrity of the heritage landscape**

378. The UNESCO Operational Guidelines emphasize on the fact that the components of cultural heritage should, in addition, be restored wherever appropriate, to their former use and any work done on the heritage site should aim at preserving its traditional appearance and protecting it from any new construction or remodelling which might impair relations of mass or colour between it and its surroundings. Hence, construction materials selected for strengthening of canals should be such that they integrate with the surroundings and do not negatively impact the heritage status of the area. Accordingly, the canal designs for those portions of the canal sections falling with the Hampi WHA should be updated to meet the requirements of the Archaeological Survey and India and HWHAMA for such works. These designs and the corresponding Bill of Quantities should be part of the Bid Document.

379. Mitigation measures to avoid harmful effects within the Hampi WHA should be developed and implemented effectively. These include avoiding use of blasting techniques for the works conducted within the Hampi WHA comprising all the three zones viz., core, buffer and periphery. Additionally, construction materials that have possible harmful effects on the monuments should be avoided. Measures should be designed to counter the effects of shocks and vibrations caused by machines and vehicle movements. Measures should also be taken to prevent pollution of the heritage area during construction and thereafter during the operational period, as well. More importantly, construction campsite should be established not be near or in the Hampi WHA. Also, workers should be trained to understand the importance of maintaining the UNESCO heritage status and carryout construction as per directions of the Heritage Area Expert.

### *x. Impact during rehabilitation activities*

380. Once the construction campsites are established, workers are trained and all other preliminary activities are competed, appropriate construction methodologies as described earlier should be utilised to rehabilitate the anicuts, canal sections and the appurtenant structures. During these activities, which are conducted as per the designs and specifications provided in the contract, there are certain impact on the environmental media especially air, water, noise levels and land that would need to be minimised.

381. Impacts include increase in GHG emissions near the construction area caused by the movement of vehicles and operation of the equipment. The GHG emissions can be controlled by maintaining the vehicles and equipment and ensuring that it is in good operating condition during the entire duration of the construction period.

382. Additionally, excavation and construction work will generate dust and increase the suspended particulate matter near the construction sites. And, when canal sections are located near habitation area the increased SPM level and GHG emission levels will aggravate the problem and impact the health and wellbeing of the community. However, the overall impact of dust generation is minor on paved roads. When the contractor's work aggravates dusty working conditions, the contractor will need to control dust by spraying water on the susceptible areas. The contractor will also be required to maintain a record of dust control spraying.

383. In addition, project sites are at least 100 m away from the nearest settlement (except in urbanized stretches of the project) and therefore equipment that generates noise will not be an inconvenience to people. However, noise will be a particular issue for workers who may be operating the equipment. Workers and operators of noisy equipment will be provided with ear protection while noise suppressors on construction equipment are to be maintained to the manufacturer's specifications. In urbanized or where canal stretches are closer to habitations, extra care should be taken to carryout rehabilitation works such that the noise levels are controlled. Work schedules in these areas should be decided in consultation with the local community, as well. As an example, there will be no construction between 10 p.m. until 6 a.m.

384. Impacts on water quality, especially when works are carried out closer to surface waters, may be significant considering that weed, silt and other sediments need to be removed, prior to the start of the rehabilitation works. And, if the weed, silt and other sediment disposal are not managed effectively, it can lead to increase in turbidity and other contaminant levels resulting in impacting the aquatic biodiversity. Hence, mitigation measures that include transporting the weed, silt and other sediments to a pre-identified location where the disposal is done in an environmentally friendly manner. The disposal location should have an approval from the local authorities and "manifest" approach should be used to track the waste from the generation point to the disposal point. If private land is utilized for the purpose, a written approval from the land owner should be obtained for all such disposal. Records should be maintained at all times for review. During the construction stage, PIO and PMSC will agree on the diposal area prior to starting work on a particular canal section. Additional, monitoring measures should be employed to monitor the effect of the disposal on land and groundwater pollution around the disposal site.

385. Finally, such large-scale construction works leads to generation of large quantities of construction waste and debris. To the extent possible, all waste material is to be re-used or recycled. Anything that cannot be recycled will need to be taken to the existing landfill sites operated and/ or approved by the state agencies. If no state operated/ approved landfill sites are available, permission should be obtained from the district authorities to identify wastelands that could be utilized to dispose the construction debris. Upon disposal, appropriate cover and landscaping should be carried out to ensure that the area

drains properly. While no hazardous wastes are expected to be generated during the implementation of the project, in the event any hazardous wastes are generated, these wastes should be managed as per the Hazardous Waste (Management, Handling, Trans-boundary Movement) Rules, 2008.

### *xi. Impact from Construction Campsites*

386. Construction campsites is an inevitable infrastructure that need to be established by the Contractor in order to ensure smooth implementation of the project. These construction campsites are generally established closer to the worksites. In certain locations, storage space for equipment, vehicles and storage are provided in the same construction campsites where the workers inhabit. Also, there are locations where batching plants are established and operated, as well.

387. One of the key impacts include conflict of resource use with the local community be it roads, firewood, drinking water and other basic requirements to make a living. To ensure a smooth relationship between the migrant workforce and the local community, the Contractor should ensure that all the required facilities are provided to the workers including but not limited to providing kitchen facilities, drinking water, bathing, latrine and sanitation facilities and hygienic resting and recreating facilities for the workers.

388. Throughout construction period, the workforce will generate general refuse comprising food scraps, waste paper, empty containers etc. The storage, handling and disposal of general refuse have the potential to give rise to some environmental impacts if not properly managed. These include odour if waste is not collected frequently, windblown litter, water quality impacts if waste enters water bodies, and visual impact. Rapid and effective collection of site wastes will therefore be required. With the implementation of good site management including source separation and composting of kitchen wastes, adverse environmental impacts from solid waste disposal may be averted.

389. In addition, liquid wastewaters are generated from the sanitation facilities which if not treated properly can lead to contamination of both land and water. Mitigation measures include having septic tanks for treating the liquid wastes and maintain its effectiveness throughout the campsite operational period.

### *xii. Worker Health and Safety*

390. The contractor will be required to provide a safe working environment, personal protective equipment, a person trained in first-aid and a fully loaded first-aid kit at all construction activity sites. The contractor will be required to induct all workers into the construction area with a briefing session on workplace hazards and worker safety. A contingency plan must be developed by the contractor for handling major emergencies. The contractor is to keep a record of accidents and time lost from accidents. Additionally, because of the remoteness of the construction sites, mobile toilets should be provided by the Contractor for use by the workers and its effectiveness and usability should be maintained during the operational period.

391. Health monitoring is another important component of workers' health and safety. The Contractor should provide facilities for periodic heath monitoring by professional doctors

for the workers and their families. In addition, health and workers' compensation insurance should be provided to all the workers and should be current throughout the construction period.

### *xiii. Borrow Area Rehabilitation*

392. Borrowing an area during construction work for strengthening of structures/banks of the canals is a common occurrence. It is important to take effective measures to mitigate environmental impacts arising due to such borrow areas. It should also be ensured that approval from the village/gram panchayat is obtained for the borrow area. Listed in ***Table 55*** are certain measures which should be addressed.

**Table 55: Borrow Area Rehabilitation-Impacts and Mitigation Measures**

| S. No. | Issue | Mitigation measures |
|---|---|---|
| 1. | If a borrowed area is not compensated from environment point of view, it may cause soil degradation and removal of all floral and faunal species of that area, if any. The borrow areas may lead to<br>(i) soil erosion<br>(ii)stagnation of water leading to vector proliferation and thereby causing diseases related to mosquitoes or other biting flees etc. | Clearing and grubbing will expose large area to nature's wear and tear and will lead to soil erosion. Also, stagnation of water in the borrowed area is a very common occurrence when borrow area rehabilitation measures are not implemented. The stagnant water will lead to vector proliferation and thereby causes diseases in the nearby community. Hence, the borrowed area should be appropriately compensated from environment point of view.<br>at any time, to prevent soil erosion. In general Mitigation measures include providing for vegetative cover on all cut / fill slopes to prevent soil degradation and protecting native species. The vegetative cover allows native floral and faunal species to grow and propagate. It also checks loss of top productive soil either by wind or rainfall/run-off water. Also, use of turfing should be considered for preventing soil erosion. |
| 2. | Tree and vegetation removal to access the borrow material for use in rehabilitation activities | Removal of vegetation and cutting of trees should be done judiciously and limited to minimum possible extent. It is advised that cutting of any such tree (if highly essential) should be done in consultation with the Karnataka Forest Department and appropriate Compensatory Afforestation Plan should be implemented. |

### *xiv. Closing of Construction Sites*

393. The contractor will be responsible for cleaning up and disposing of all waste materials and rehabilitating (landscaping) all construction sites and work areas so that these can be returned as close as possible to their previous state. This includes the stabilization and landscaping of all of the construction sites. Any borrow pits that were operated by the contractor are to be reshaped and closed. Any contaminated soil must be removed from fuel and oil storage areas. A record including photographs / videos of all activities should be maintained for review at any point of time.

**Table 56: Anticipated Impacts and Proposed Mitigation Measures for Construction Phase**

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | **CONSTRUCTION PHASE** | | | | | |
| C.1 | Site Access and Clearance | Impacts from the site clearance activities is an increase in soil erosion and changing the drainage pattern in the area. If blasting is used for clearing rocks, localised noise levels will be impacted. And, blasting near the heritage area monuments can damage the structures, as well. Finally, the disposal of construction debris can cause land and water pollution. | Local | Medium | Short-Term | • Site Access should be obtained as per guidance provided in the ***Social Due Diligence Report and Resettlement Framework*** and documentation should be maintained throughout the project duration.<br>• Site clearance activities will be undertaken with due permission from the local authorities.<br>• Additionally, trees to be removed should be identified and necessary permission obtained from Karnataka Forest Department (KFD) prior to start of the activities.<br>• Blasting of the rocks should be avoided at all times especially in areas closer to the monuments and habitations.<br>• Finally, the construction waste and debris should be disposed at an engineered landfill approved by the KSPCB. All areas used for temporary construction operations will be subject to complete restoration to their former condition with appropriate rehabilitation procedures. Pre-construction and post-construction photographs will be recorded for all temporary sites. |
| C.2 | Tree Removal and Afforestation | Impacts from the tree removal includes increased land erosion leading to increased flooding areas, increased heat stress in the areas along the canals where there are human habitations and decreased nesting areas for birds and shelter areas for animals. | Local | Medium | Short-Term | Enumeration of the trees to be conducted prior to start of work to identify the trees that need to be removed and draw up and implement a ***Compensatory Afforestation Plan*** with the assistance of KFD. |
| C.3 | Weed Removal and Weed Management | Impacts from the weed arises when the seeds from the weeds are scattered around and weed growth return to the canal and its embankment and the anicut area. | Site-Specific | Medium | Short-term | • Mitigation measures include carrying out an environmental-friendly way of weed disposal including either expose the weeds to the sun for over 30 days to ensure that the weeds dry out with the remains being safely disposed on pre-identified disposal lands or compost the weeds and the compost used in agricultural lands.<br>• Also, it is important to work with local urban local bodies and village communities to ensure that the wastewater from the habitations are not discharged into the canals and / or the water bodies leading to the anicuts |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| C.4 | Desilting and Silt Management | Impact from desilting arising from temporary storage and disposal of desilted material. Improper disposal leads to (i) polluting nearby farmlands affecting environmental quality and human health (ii) altering the drainage pattern in the area and/or (iii) water quality of the surface water bodies in the region and (iv) odour impact to nearby households. | Site-Specific | Medium | Short-term | • Sediment quality analysis (***Annexure 10***) of the canals and anicuts should be performed to determine what should be done to the silt. The analysis should include testing for the presence of herbicides, pesticides and heavy metals, as well.<br>• There should be some temporary storage facilities for desilted material such that it does raise the ground level of the adjoining lands, service road and / or inspection path and affect the drainage pattern in the area.<br>• Silt should be disposed in pre-identified and approved locations with a vegetative cover over it to lessen the odour impact of desilted materials.<br>• Native species should be utilised for vegetative cover.<br>• If there is a high demand for silt from the local farming community, the silt may be disposed on their land after following the due sediment quality analysis results, approval process and documenting the procedures.<br>• If the silt analysis reveals the presence of pollutants beyond acceptable limits appropriate remedial actions should be proposed and implemented. These remedial actions should be presented in an ***Emergency Response Plan (ERP)*** that will be approved by the KNNL prior to its implementation. A format for the ERP is provided in ***Annexure 7***. |
| | | Spillage of silt and solid wastes into the nearby farmland. | Site-Specific | Medium | Short-term | • To minimize of spillage or gusted of desilted material and solid watses, cover is provided while transportation.<br>• In any case, the desilted material should not be allowed to remain unattended. It should either be analyzed and transported to a pre-decided site for its disposal or should be properly dressed if will be used for agricultural activity or reinforcing the bunds and canal embankments.<br>• Sometimes, moisture content in the desilted matter is significant enough to cause dripping while getting transported from site to the disposal site; it should be ensured that desilted materials are sun dried by at least 20 meters aways from the river or sensitive areas before transport.<br>• Solid wastes from the dreged materials should be sun dried by at least 20 meters aways from the river or sensitive areas before transport to landfill. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | • While transportation, the desilted matter should be covered so that the spilling and flying of matter can be minimized.<br>Overloading should be avoided, so that spillage can be reduced. |
| | | The disposed-off desilted material if left unattended may cause soil and water pollution by getting dispersed in the vicinity through high surface winds and produce unpleasant odour for the community | Site-Specific | Medium | Short-term | • One of the key and preferred treatments methods is the development of a vegetative cover (bioremediation). In other words, some species of bushes and dense plants should be grown to reduce the impact of high surface winds and rainfall (which may cause soil erosion). Examples of plants are Indian Jujube (*Ziziphus* mauritiana) and Mulberry (*Broussonetia papyrifera*).<br>• Transport contaminated silt and garbage by covered trucks to sanitary landfill for disposal; if unavailable, to engineered dump sites (compact clay-lined) for temporary disposal. |
| | | Degradation/pollution to local water-bodies. | Site-Specific | Medium | Short-term | It should be ensured that in any case the local water-body or the area near such a water-body is not identified as disposal site. Identification of such water bodies can be done by referring to current/old village maps. In addition to this, an appraisal exercise can also be undertaken in consultation with the villagers, as they have good knowledge of the area. |
| C.5 | Transport of Machinery, Equipment and Material | Impacts from transport of machinery, equipment and material include an increase in localised GHG emissions, noise levels, traffic congestions and possible accidents too. | Site-Specific | Low | Construction Period | • Vehicles, equipment and machinery used for construction will conform to relevant Standards.<br>• Regular maintenance should be carried out to ensure that air emission levels comply with the relevant requirements.<br>• Towards this, Pollution Under Control (PUC) Certificate should be obtained for all trucks and equipment employed for the project and should remain current for the entire construction period.<br>• Noise limits for construction equipment used in this project will not exceed 75 dB (A).<br>• Also, as part of safety measures, the Contractor should schedule transport of machinery, equipment and material in consultation with the local community to prevent any safety-related incidents.<br>• All vehicles will observe speed limits |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | • Materials should be transported always with cover to ensure safe transport of materials. |
| C.6 | Material Sourcing | Sand mining has significant environmental impacts including on the river ecology from which it is mined. Operating quarries also has an ecological cost including altering the drainage pattern in the area and creation of wastelands. | Site-Specific | Medium | Short-term | • Mitigation measures include obtaining sand and stones from licensed vendors who are subjected to environmental compliance from the KSPCB.<br>• Additionally, use of manufactured-sand (M-sand) should be explored in consultation with the implementing agency. |
| | | Impact from ready-mix-concrete (RMC) sourcing include increased levels of air emissions and noise levels in the area where the RMC plant is established and operated | Site-Specific | Medium | Construction Period | • The locations of Ready-Mix-Concrete Plants should be 200 meters or more away from community and not within the WHA and OCR.<br>• Appropriate approvals should be obtained from state agency such as KSPCB and local authorities to establish an RMC facility near the construction sites. |
| C.7 | Storage and Handling of Materials | Impact from improper material storage and handling include contamination of land and water. | Local | Medium | Medium-Term | • Mitigation measures include identifying and constructing dedicated storage areas and equipment maintenance areas at construction sites.<br>• Fuel, oil and other materials need to be stored in dedicated areas in sealed tanks with a concrete base at least 20 m away from a water course or other sensitive area.<br>• Vehicles and machinery are not to be re-fuelled near water courses.<br>• Trained personnel should be available at the site to prevent spills and for adopting appropriate procedures for cleaning up accidental spills, |
| C.8 | Impact due to notified OCR | The rehabilitation activities within the OCR impact the nesting, breeding, food availability, recreational habitats of the otters and other aquatic animals within the OCR. It also has a deleterious effect on the general aquatic biodiversity if the pollution levels of air, water and noise go beyond standard acceptable levels. | Local | High | Short-Term | • Mitigation measures include training the contractors and other agency staff on the importance of the OCR and procedures to be followed while working with the OCR such as no poaching or hunting activities.<br>• To avoid habitat damage and reduction of species, installation of signages about OCR will warn and guide people and construction workers.<br>• Also, apart from constructing secondary ring bund as provided in the bid documents<br>• The Contractor should refrain from use of blasting not only within the OCR region but also within 100 m of the OCR boundary. Pre-construction aquatic biodiversity survey |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | should be taken up to confirm the location of the secondary ring-bunds.<br>• Likewise, no construction camp or material storage sheds should be established within the OCR boundary or within 100 m of the OCR boundary.<br>• Additionally, all construction should be taken up during December to June period and between 9 am and 5 pm on the days of construction.<br>• Further, no construction technologies that causes noise and impacts the OCR should be utilised.<br>• Finally, the disposal of any silt, construction waste within the OCR should be avoided at all times during the construction period.<br>• More importantly, post-construction ecological enhancement measures suggested in the report should be implemented to safeguard the OCR. |
| C.9 | Impact due to Hampi World Heritage Area | Hampi is a UNESCO notified World Heritage Area. Rehabilitation works carried out within the Hampi World Heritage Area will impact the traditional appearance and impair relations of mass or colour between it and its surroundings. Moreover, the air emissions during the construction period can impact the colour and texture of the monuments. Further the noise levels and the construction techniques adopted can impact the stability and strength of the monuments. | Regional | High | Construction Period | • Mitigation measures include training the Contractors and other agency staff on the importance of the Hampi WHA and the measures to be taken to preserve the cultural integrity of the area.<br>• Also, in order to ensure that the heritage area is not impacted adversely, the rehabilitation works should be taken up as per the guidelines provided in the bid documents and conservation approach from HWHAMA.<br>• Also, blasting should be avoided with in the Hampi WHA so that the noise levels do not impact the 600-year old Hampi WHA.<br>• Likewise, no construction camp or material storage sheds should be established within the heritage area or within 100 m of the heritage area.<br>• Further, no construction technologies that cause excessive noise and affect the heritage area should be utilised.<br>• Finally, disposal of any silt, or construction waste within the heritage area should be avoided at all times. |
| | | Chance find of archaeological artefacts | Local | High | Construction Period | • Mitigation measures including sharing the construction schedule for the work carried out within the Hampi WHA with the ASI and HWHAMA at least two-weeks in advance for the start of the activity. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | • The schedule should also provide the list of project activities that are slated to be carried out so that the ASI and HWHAMA can make a decision on supervising the activity.<br>• Also, any chance find of archaeological artefacts should be reported to the ASI and HWHAMA and the artefacts secured until the ASI and HWHAMA staff arrive at the site.<br>• Further, no project activity should be carried in that area until clearance is obtained from the ASI and ad HWHAMA. |
| C.10 | Rehabilitation Activities at sites | Impact on Air Quality caused by increased GHG emissions and Suspended Particulate Matter (SPM) SPM levels induced from vehicle and equipment operations. | Local | Medium | Construction Period | • Contractor will take every precaution to reduce levels of dust at construction sites.<br>• Water sprinkling will be carried out on haul roads.<br>• All earthworks to be protected/ covered to minimize dust generation.<br>• Regular maintenance of vehicles and equipment should be carried out at Pollution Under Control (PUC) certificate should be obtained from the KSPCB and should remain current for the entire construction period. |
| | | Impact on Noise Levels caused by vehicle movement and equipment operations | Site-Specific | Medium | Construction Period | • Noise limits during the construction period should not exceed 75 dB (A)<br>• Work schedules should be decided in consultation with the local community so that the noise levels do not adversely impact the local community. |
| | | Impact on Water Quality and Land is caused by improper disposal weed, silt and other sediment encountered at construction sites. | Local | Medium | Short-term | • Mitigation measures include environmental-friendly weed disposal, silt disposal and sediment management practices.<br>• Records should be maintained for all practices. |
| | | Impact on Water Quality and Land is also caused by improper disposal of construction waste and debris, hazardous materials, oils and lubricants | Local | Medium | Medium-Term | • Construction waste will not be disposed of around the project site and cause adverse impact on either soil or water or any other environmental medium.<br>• Construction wastes and debris should be disposed at engineered-landfills approved by the KSPCB.<br>• Hazardous materials, oils and lubricants should be managed as per regulations and should be approved by the KSPCB.<br>• Waste records should be maintained for all waste disposals. |
| C.11 | Construction Campsite | Impacts from Construction Camps on air water and soil quality - Location, Selection, Design and Layout | Site-Specific | Medium | Medium-Term | • Construction camp with all amenities will be located away from settlements as far as possible to avoid conflict with the local community for resource use, be it roads, firewood, |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | Facility Management | | | | | drinking water and other basic requirements to make a living.<br>• Hampi WHA should not be used as location of construction camp facilities.<br>• Also, construction camp facilities should not be located at any place within 100 m of the OCR. |
| | | Construction campsites produce solid wastes, kitchen wastes, sewerage and septage, as well. Improper management of these wastes result in contamination of land and water. | Site-Specific | Medium | Short-Term | • Mitigation measures include separation of solid wastes at source and disposing the wastes in ongoing solid waste management system approved by the authorities<br>• Composting of the kitchen wastes, constructing and operating septic tanks for treating wastewaters.<br>• All these waste management systems should be operated in an effective manner throughout the construction period. |
| | | Impact on land and water due to leakage of fuel, oil and other materials stored in construction camp sites and due to operation of vehicle and equipment maintenance workshops without proper treatment facilities | Site-Specific | Medium | Short-Term | • The fuel storage and vehicle cleaning area will be stationed in such a way that water discharge does not drain into any water body.<br>• Soil and water pollution parameters will be monitored as per monitoring plan.<br>• At construction camp, vehicle washing ramps will be constructed and an oil water separator pit will be provided at ramp area.<br>• All the vehicles maintenance will be done at an authorized workshop. The discarded fuel and lubricants will be stored in drums and sold to recyclers authorised by KSPCB. |
| C.12 | Worker Health and Safety | Impact on Workers' Health | Site-Specific | Medium | Short-Term | • Sufficient supply of potable water should be provided at both the workers' campsites and construction sites for all the workers and their family members.<br>• Adequate, clean and hygienic sanitation (toilets and washing areas) and waste management facilities should be provided at both the workers' campsites and construction sites to protect the health of the workers' and their family members.<br>• provision of clean eating areas where workers are not exposed to the hazardous or noxious substances.<br>• Nutritious food should be provided for the workers at all times during the construction period and if workers' families prefer to cook their own food, adequate infrastructure should be provided for the same. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | • To ensure good health for all workers and their family members during the construction period, periodic health monitoring from professional doctors should be carried out.<br>• Records should be maintained for all the facilities such as (i) or lost time cases, (ii) dangerous occurrences and incidents and (iii) work related fatalities<br>• Ensure that qualified first-aid can be provided at all times and easily accessible throughout the place of work<br>• Occupational Health and Safety orientation/training to all workers to ensure they are apprised of the basic site rules of work at/on the site and of personal protection and preventing injury to fellow employees. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate.<br>• All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard |
| | | Impact on Workers' Safety During Construction | Site-Specific | Medium | Construction Period | • Surface water quality analysis is necessary for possible contamination and pollution of canals and anicuts.<br>• Adequate safety measures for workers while handling of materials at site will be ensured.<br>• Contractor has to comply with all regulations for the safety of workers, including complete use of PPEs.<br>• Precaution will be taken to prevent danger to workers from fire, etc.<br>• First aid treatment will be made available for all injuries likely to be sustained during the course of work.<br>• First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids<br>• Contractor will conform to all instructions on maintaining health and safety of the workers and their family members. |
| | | Impact from material handling at site on workers' safety and air, land and water media. | Site-Specific | Medium | Short-Term | • Workers employed on mixing cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles.<br>• Workers, who are engaged in welding works, will be provided with welder's protective eye-shields. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | | | | | • Workers engaged in stone breaking activities will be provided with protective goggles and clothing.<br>• Use of any toxic chemical will be strictly in accordance with manufacturer's instructions.<br>• The Implementing Agency will be given at least 6 working days' notice of the proposed use of any chemical.<br>• A register of all toxic chemicals used at the site will be kept and maintained up to date by the Contractor. |
| C.13 | Borrow Area Rehabilitation | Improper management of borrow areas will cause soil degradation and removal of all floral and faunal species of that area, if any. The borrow areas may also lead to stagnation of water leading to vector proliferation and thereby causing diseases related to mosquitoes or other biting flees etc. | Site-Specific | Medium | Short-Term | • Mitigation measures include establishing borrow areas at pre-identified locations where the Borrow Area Rehabilitation is approved by the local agencies.<br>• The ***Rehabilitation Plan*** that will be implemented effectively should include providing for vegetative cover on all cut / fill slopes to prevent soil degradation and protecting native species.<br>• The vegetative cover allows native floral and faunal species to grow and propagate. It also checks loss of top productive soil either by wind or rainfall/run-off water. Also, use of turfing should be considered for preventing soil erosion. |
| C.14 | Closure Activities | Improper closure of construction sites and campsites will result in contamination of land, thereby affecting the groundwater quality, as well. If the surface water sources are closer to these sites, the quality of surface water is also affected. | Site-Specific | Medium | Short-Term | • Contractor to prepare ***site restoration plans*** for approval by the implementing agency.<br>• The plan to be implemented by the contractor prior to demobilization should contain at a minimum, clearing of all temporary structures, disposal of wastes at pre-identified approved locations (by the KSPCB and local authority), and septic tanks effectively sealed off.<br>• The site should be left clean and tidy by the Contractor to the entire satisfaction of the implementing agency. |

### 6.2.3 Impact due to Operation,

394. During operation, the main issues will be: (i) monitoring water abstractions; (ii) monitoring water quality; (iii) desilting of canals periodically; (iv) de-weeding and other solid wastes, (v) ensuring environmental-friendly agricultural practices in the command area and (vi) ecological enhancement to safeguard the OCR. Items iii and iv are suggested during the Operation Phase for the Hampi WHA area.

395. ***Monitor Water Abstractions:*** Operational procedures following canal modernization are likely to be improved. Additionally, improvements in operation efficiencies are expected from installation of telemetry devices and flow meters which allow better monitoring and control of water delivery. Also, once the main canals are cleaned and lined, infiltration losses during operation will be reduced substantially. Canal deformation and erosion, now occurring in various places, will be absent once the rehabilitated system is in operation. A monitoring program for water flows should be implemented during the operation. In addition to the main canal sections, water conservation is expected to occur because of the techniques that the farmers adopt including but not limited to (i) land levelling so that water is better spread over the land and less water is needed; (ii) better application rates, which are adjusted to the growing periods of the crops, and (iii) mulching of soils to reduce evaporation from the soil and enhance water holding capacity of soils. Hence, both the implementing agency and WUCS should monitor the water abstractions so that the objective of the project is achieved in the long-term.

396. ***Monitor Water Quality:*** Water quality gives an excellent indication of the suitability of the canal water for agricultural purposes. Considering the various potential point and non-point sources of pollution, it is important to monitor the quality of water on a regular basis. The canal water samples should be collected at regular intervals and analysis performed through the use of recognized analytical laboratories. The KNNL and WUCS could carry out this activity at periodic intervals. The results should be shared with the CADA so that appropriate action can be initiated by the implementing agency in case of deterioration in water quality.

397. ***Desilting of Drains:*** The canal gets silted up and the silt has to be removed at regular intervals in order to maintain the hydraulic capacity of the canals. The WUCS should carry out the desilting work and the desilted material should be either disposed-off on farmers land (with prior permission) or at an approved site. Under no circumstances should the silt material be left on the banks of the canal or disposed-off on banks of lakes or rivers thereby impacting the surface water bodies.

398. *Deweeding:* De-weeding by manual removal of *water hyacinth, Ipomoea cornea* and other plants is to be taken up in the anicuts on regular basis to prevent siltation and to maintain the hydraulic capacity of the canals;

399. ***Ensuring environment-friendly agricultural practices:*** Agricultural practices these days rely on the use of fertilizers and pesticides to increase productivity. To grow properly, plants need nutrients (nitrogen, potassium, calcium, zinc, magnesium, iron, manganese, etc.) which normally can be found in the soil. However, fertilizers are needed to overcome any of the shortfall in the soil nutrients and achieve the desired plant growth. Hence, the farmers in the command area should have tests carried out to determine the soil health.

Accordingly, appropriate amount of fertilizers should be utilized to create balanced medium for sustained plant health. Utilizing excess fertilizers to promote rapid plant growth should be avoided. In fact, rapidly growing plants are weak and without an adequate root system. The excess quantity of fertilizers also increases run-off and contaminate water bodies.

400. Similarly, the use of pesticides has become the most common approach to pest control. Majority of the pesticides do kill their target pests but they also kill beneficial organisms living in the soil, such as pollinators and pest-predators and pose health risks to wildlife. Using pesticides also reduces insect populations that are important food source for birds and other wildlife. The best way to minimize the migration of toxic chemicals into the natural environment is to reduce or eliminate pesticide use. Farmers in the region should be trained in the use of fertilizers and pesticides, and the WUCS and CADA should have a program to monitor application of environment-friendly agricultural practices by the farmers, such as organic farming.

401. ***Ecological enhancement to safeguard OCR:*** Sedimentation or silt formation over time had decreased the carrying capacity of *anicuts* and the channels which has necessitated the need to take up rehabilitation activities. In addition, the over growth of invasive alien weeds such as Water Hyacinth and Ipomoea during monsoon and winter and subsequent decaying of the weed leads to silt accumulation. However, Sediment (or silt) also plays a vital role in elemental cycling in the aquatic environment. Hence, as part of the ecological enhancement, sedimentation or silt removed and stored separately will be broadcast over the restored anicut to restore the ecosystem. Along with this, submerged aquatic flora will also be introduced at different levels of the anicut so as to bring back the aquatic ecosystem. After completion of restoration of the anicuts, fingerlings of fishes like *Ruhu* and *Catla* will be released in the anicut during monsoon so as to provide secured food source for Otters and Crocodiles. The release of fingerlings will be continued for 3-4 years in each anicut in OCR to safeguard the food source of Otters and Crocodiles. Further, alien invasive weeds such as Water Hyacinth and Ipomoea will be removed from the anicuts from time to time to maintain the health of each anicut for 3-4 years.

## 6.3 Description of Planned Mitigation Measures

402. Screening of environmental impacts is based on the magnitude and duration of the impact. ***Table 57*** lists anticipated environmental impacts and mitigation measures to be adopted during the construction and operation phases of the project. The environmental impacts will be in the entire project life cycle.

**Table 57: Anticipated Impacts and Proposed Mitigation Measures for Operation Phase**

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | **OPERATION PHASE** | | | | | |
| O.1 | Controlling Water Abstractions to make the agricultural sector climate-resilient | Climate Change impacts on the water sector will have serious implications on water availability for all sectors including the agricultural sector. | Regional | High | Long-Term | The project has water conservation objective in line with the need to enable the agriculture sector to be climate resilient. As such, it is necessary to monitor water abstractions from the canal so that the impact of the project can be monitored on a regular basis. |
| O.2 | Controlling quality of canal water and surface-water bodies to which the canal water is discharging into. | Maintaining water quality for its various uses is the prime objective of the integrated water resources management. | Regional | High | Long-Term | • Periodic water quality monitoring is suggested to ensure that the point and non-point pollutant discharges do not impact the water quality either in the canal or in water bodies to which the canal ultimately would discharge into.<br>• KNNL should work with ULBs covering canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa for the implementation of action plans to prevent or minimize liquid and solid wastes disposal into the canals. |
| O.3 | Maintain carrying capacity of the canals | Carrying capacity of the canals plays a very important role in ensuring equity in water | Local | High | Long-Term | • Desilting of drains should be done periodically to maintain the hydraulic capacity of the canals. |

| S. No. | Project Activity | Environmental Impacts | Extent | Magnitude | Duration | Proposed Mitigation Measures |
|---|---|---|---|---|---|---|
| | | distribution to the farmers, one of the major objectives of the integrated water resource management | | | | • Silt should be disposed of in an environment-friendly manner. |
| O.4 | Controlling non-point pollutant discharges | Sustainable agricultural management has been impacted by the unscientific use the chemical fertilizers and pesticides. | Regional | High | Long-Term | • Non-point pollution discharges primarily nutrients and pesticides from the agricultural fields can be prevented through skilled application of these materials on farm lands.<br>• Appropriate training and capacity building activities should be carried out in the command areas so that farmers are trained to utilize fertilizers and pesticides in an optimum eco-friendly manner. |
| O.5 | Ecological enhancement to safeguard Otter Conservation Reserve | Ensuring ecological sustainability is an important objective of sustainable integrated water resources management | Local | High | Long-Term | Measures for ecological enhancement to safeguard the OCR include deweeding periodically for enhancing growth of the aquatic flora and introducing native fingerlings for ensuring food security for the aquatic animals. |

# 7. ENVIRONMENTAL MANAGEMENT PLAN

403. The Environmental Management Plan (EMP) outlines the environmental management actions that will be implemented during the construction works of the project to manage minimization of deleterious effects and implementation of rehabilitation measures. The EMP also embraces environmental management issues following the implementation of the project works to maximize the beneficial effects of the project and detect and ameliorate adverse long-term effects.

404. The EMP is based on the anticipated environmental impacts and mitigation measures identified and described in an earlier chapter but it would be developed and updated regularly as the project implementation progresses.

405. The objective of the EMP is to provide a framework for the monitoring and management of environmental issues in a comprehensive manner. The EMP outlines the environmental management system that will be implemented during the construction and operation phases. The EMP also defines environmental management issues maximize the beneficial effects of the project and detect and ameliorate adverse long-term effects.

406. Specifically, the EMP monitors and manages environmental aspects and issues of the Project during its technical lifetime by:

- Identifying potential environmental impacts;
- Recommending mitigation measures to minimize impacts;
- Identifying opportunities for improvement;
- Providing an organisational framework for operating IWRM and other functions of the Project by assigning roles and responsibilities for environmental monitoring and management;
- Formulating relevant Action Plans that detail the specific mitigation, enhancement, and monitoring activities and indicators, to be prepared and attached to (i) annual and periodic activity plans for project implementation.

407. Responsibilities of various stakeholders for carrying out specific activities during construction and operational stages to safeguard the environment are as follows:

**Table 58: Environmental Management Plan: Roles and Responsibilities of Stakeholders**

| Project Stage | Responsible Organization | Responsibilities |
|---|---|---|
| Overall | Water Resources Department (WRD), Government of Karnataka | Ensure that the project planning and designs are as per applicable policy and legal framework; |
| | Karnataka Neeravari Nigam Limited (KNNL) - Project Management Unit | Approve all designs and bid document for the project; seek necessary approvals from all relevant state and national agencies; financial accounting, disbursement of funds; review Project EIA and monitor and supervise project legal compliance during the project implementation. |
| | KNNL – Project Implementation Unit | Overall review, monitoring, and reporting to PMU including quarterly reports Monitoring, guidance, and supervise the environmental management activities arranged or implemented by selected agencies. |
| | Command Area Development Authority | Monitor the implementation of the CAD Works by the WUCS; ensure sustainable O&M of the project; |
| | Project Support Consultants | Support development of the capacity for environmental management in KNNL, line departments, and WUCS, Monitor, guide, and supervise the environmental management activities by the contractors. |
| Construction | Contractor | Develop a site-specific Environmental Management Plan (based on the EIA/EMP report attached to the bid document) soon upon award of contract and seek approval from KNNL; Implement the site-specific EMP throughout the project construction period; |
| | KNNL – PIO | Supervise contractors' and service providers' implementation of EMP, and enforce contractual and program requirements; Monitor and report environmental indicators |
| | PSC | Assist PMU and PIU on supervising the EMP Implementation and submit quarterly reports; |
| Operation | KNNL – PMU | Provide budget for environmental monitoring; |
| | KNNL–PIO and CADA | Strengthen hydrological monitoring; monitor soil quality data; monitor use of fertilizers and pesticides and ensure sustainable cropping patterns; periodic reporting; |
| | WUCS | Carryout environmental monitoring and reporting; implement site-specific sustainable agricultural management system (including cropping pattern, pesticide and fertilizer use) |

| Project Stage | Responsible Organization | Responsibilities |
|---|---|---|
| | Karnataka State Pollution Control Board | Legal entity delegated for control of pollution (air, water and environmental) in the Indian State of Karnataka. |

408. Primary responsibility for environmental management lies with the PIO in KNNL, Munirabad. However, all stakeholders involved such as the KNNL, contractor, and state and local agencies (WRD, KFD, KSPCB, CADA, WUCS, HWHAMA etc.) have specific roles and responsibilities for effective implementation of the EMP for minimizing adverse environmental impacts and maximizing benefits. Specific environmental impacts and mitigation measures at pre-construction, construction and operational phases are summarized in the previous chapter. For each mitigation measure, indicator for compliance, agencies responsible for implementation and supervision and Monitoring Frequency for enforcement of remedial actions, monitoring and training are provided in the EMP. Each of the information required to complete the EMP requirements are provided in the following tables:

- ***Table 59***: Summarizing the Mitigation Measures for Pre-Construction Phase;
- ***Table 60***: Summarizing the Mitigation Measures for Construction Phase;
- ***Table 61***: Summarizing the Mitigation Measures during Operation Phase;
- ***Table 62***: Environmental Monitoring Plan for each of the Environmental Attributes;
- ***Table 63***: Summarizing the Monitoring Requirements for the Mitigation Measures for Pre-Construction Phase;
- ***Table 64***: Summarizing the Monitoring Requirements for the Mitigation Measures for Construction Phase;
- ***Table 65***: Summarizing the Monitoring Requirements for the Mitigation Measures for Operation Phase;
- ***Table 66***: Summary of Costs for implementing Construction Phase EMP;
- ***Table 67***: VNC Modernization–Summary of Costs for Implementing Construction Phase EMP
- ***Table 68***: Summarizing Training on Environment.

409. All the tables mentioned above together with the construction guidelines provided in this chapter will constitute the EMP.

**Table 59: Summarizing the Mitigation Measures for Pre-Construction Phase**

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementing Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | **PRECONSTRUCTION PHASE** | | | | |
| P.1 | Long-Term Sustainability | Ensure long-term sustainability of improvements and protection of assets created. | The design will include provisions for ensuring effective maintenance and protection of assets created so as to ensure long-term sustainability, especially with regard to defining and preparing WUCS for carrying out its role in O&M of the assets. | All designs of the project | KNNL, CADA, WUCS | WRD, Government of Karnataka (GoK) |
| P.2 | Addressing the Design and Bid Requirements for work in the OCR | Impact on the aquatic eco-system; especially in terms of food availability, habitation, nesting areas, breeding areas and areas used for regular activities of the aquatic animals, arising from the rehabilitation of the anicuts located in the stretch within the OCR should be addressed adequately and effectively. | • Planning and Design of rehabilitation of anicuts located in the OCR should be taken up in such a manner that there are no negative impacts.<br>• Towards this, the design of the necessary structures to be constructed prior to the rehabilitation of the anicuts within the OCR, the implementation schedule and other key issues as suggested by the Biodiversity Expert and the KFD will be included in the bid document. | Planning and design of the rehabilitation for the nine anicuts in the OCR | KNNL | WRD, GoK |
| | | Implementation of work in the Conservation Areas | The bid documents should incorporate the necessary conditions to select a contractor who has the knowledge and understanding to carryout work in eco-sensitive and conservation areas as per concerned guidelines. | All bidding documents will require bidders with competence to work in conservation areas. | KNNL | WRD, GoK |
| P.3 | Addressing the Design and Bid Requirements for preserving the | Form and Design of the Turtha Anicut, 9.3 km length located in the core zone of the Hampi WHA in Anegundi, Turtha and Raya canals, 14.05 km length located in | Planning and Design of the canal modernization project should be taken up in such a manner that the Form, Design and characteristics of | Planning and design of the rehabilitation for all the canals in the Hampi WHA | KNNL | WRD, GoK |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementing Responsibility | Supervision Responsibility |
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| | continuing landscape of the Hampi World Heritage Area: | the buffer zone of Hampi WHA in Anegundi, Turtha, Raya and Kalaghatta canals and 24.33 km length located in the periphery zone of Hampi WHA in Anegundi, Turtha, Raya, Basavanna and Kalaghatta canals should be integrated with the heritage area landscape. | the original sections of the Turtha Anicut and the canal sections located in the Core, Buffer and Periphery zones of the Hampi WHA are not adversely affected. The designs should be included in the bid document. | | | |
| | | Implementation of work in Heritage Areas | The bid documents will include guidelines for carrying out work in heritage areas. | All bidding documents will require bidders with competence to work in heritage areas. | KNNL | WRD, GoK |
| P.4 | Developing designs for addressing direct entry of storm water runoff into the canal sections: | Flooding of command areas resulting from smaller sections of the canal in certain stretches in Hulugi, Upper Gangavathi, Lower Gangavathi and Anegundi. | The canal sections in Hulugi, Upper and Lower Gangavathi and Anegundi canals should accommodate the rainfall runoff from the Rocky Mountains located near the canal sections. The designs should be included in the bid document. | Designs for Hulugi, Upper and Lower Gangavathi and Anegundi canals should be included in the bid document. | KNNL | WRD, GoK |
| P.5 | Developing a Plan of Action to address raw industrial effluent entry into Kalaghatta Canal | Impact on canal water quality due to disposal of industrial effluents into Kalaghatta canal sections. | KNNL should work with the Karnataka State Pollution Control Board and ensure that concerned Industry stops discharge into the canal immediately. | One official agreement between KNNL and Karnataka State Pollution Control Board | KNNL, KSPCB | WRD, GoK |
| P.6 | Developing a plan of action to address wastewater and solid waste disposal into | Impact on canal water quality due to disposal of liquid and solid waste into canal sections that passes through the urban areas. | KNNL should work with ULBs along canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa to ensure that the ULB has a plan to prevent liquid and solid waste disposal into the canals. | One official agreement for each ULBs of Hospet, Kampli, Gangavathi and Siriguppa with KNNL | KNNL, ULBs | WRD, GoK and Department of Municipal Administration, GoK |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementing Responsibility | Supervision Responsibility |
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| | certain canal sections | | | | | |
| P.7 | Incorporating Environmental Management Plan and Health & Safety Requirements into Contractor Bid Document | Implementation of the EMP | The EMP should be included in the bid documents so that the Contractor selected understands the issues and makes necessary plans to prepare and implement the EMP. | EMP and environmental monitoring plan are part of the bid documents | Contractor | KNNL |
| | | Implementation of the Health and Safety requirements | Health and Safety requirements should be incorporated as part of the contract bid documents so that the Contractor has the knowledge and understanding necessary to implement the health and safety requirements as part of the EMP during the period of the project. | All relevant Health and safety requirements are part of the bid documents | Contractor | KNNL |

**Table 60: Summarizing the Mitigation Measures for all Construction Phase**

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| C.1 | Site Access and Clearance | Impacts from the site clearance activities is an increase in soil erosion and changing the drainage pattern in the area. If blasting is used for clearing rocks, localised noise levels will be impacted. And, blasting near the heritage area monuments can damage the structures, as well. Finally, the disposal of construction debris can cause land and water pollution. | • Site Access should be obtained as per guidance provided in the *Social Due Diligence Report and Resettlement Framework* and documentation should be maintained throughout the project duration.<br>• Site clearance activities will be undertaken with due permission from the local authorities.<br>• Additionally, trees to be removed should be identified and necessary permission obtained from Karnataka Forest Department (KFD) prior to start of the activities.<br>• Blasting of the rocks should be avoided at all times especially in areas closer to the monuments and habitations.<br>• Finally, the construction waste and debris should be disposed at an engineered landfill approved by the KSPCB. All areas used for temporary construction operations will be subject to complete restoration to their former condition with appropriate rehabilitation procedures. Pre-construction and post-construction photographs will be recorded for all temporary sites. | permits for site clearance<br>100% markings of all trees for removal and acquisition of permits from KFD<br>No blasting in OCR and Heritage areas<br>100% disposal of construction debris every 10 days in the approved landfill<br>100% rehabilitation of temporary construction operations areas within a month after use. | Contractor, | KNNL in coordination with KSPCB, KFD and local agencies |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| C.2 | Tree Removal and Afforestation | Impacts from the tree removal includes increased land erosion leading to increased flooding areas, increased heat stress in the areas along the canals where there are human habitations and decreased nesting areas for birds and shelter areas for animals. | Enumeration of the trees to be conducted prior to start of work to identify the trees that needs to be removed and draw up and implement a Compensatory Afforestation Plan with the assistance of KFD. | One Compensatory Afforestation Plan after marking of trees. | Contractor | KNNL in coordination with KFD |
| C.3 | Weed Removal and Weed Management | Impacts from the weed arise when the seeds from the weeds are scattered around and weed growth return to the canal and its embankment and the anicut area. | • Mitigation measures include carrying out an environmental-friendly way of weed disposal including either expose the weeds to the sun for over 30 days to ensure that the weeds dry out with the remains being safely disposed on pre-identified disposal lands or compost the weeds and the compost used in agricultural lands.<br>• Also, it is important to work with local urban local bodies and village communities to ensure that the wastewater from the habitations are not discharged into the canals and / or the water bodies leading to the anicuts | 100% weed disposal every 30 days or composting. | Contractor | KNNL in coordination with KSPCB and local agencies |
| C.4 | Desilting and Silt Management | Impact from Desilting arising from temporary storage and disposal of desilted material. Improper disposal leads to (i) polluting nearby farmlands affecting environmental quality and human health (ii) altering the drainage pattern in the area and/or (iii) water quality of the surface water bodies in the region and (iv) odour impact to nearby households. | • Sediment quality analysis (***Annexure 10***) of the canals and anicuts should be performed to determine what should be done to the silt. The analysis should include testing for the presence of herbicides, pesticides and heavy metals, as well.<br>• There should be some temporary storage facilities for desilted material such that it does raise the ground level of the adjoining lands, service road and / or inspection path and affect the drainage pattern in the area. | All anicuts and canals should undergo sediment quality analysis before desilting<br>100% temporary storage of desilted materials in approved areas.<br>100% re-use of non-contaminated or polluted silt for | Contractor | KNNL in coordination with KSPCB and local agencies |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | | • Silt should be disposed in pre-identified and approved locations with a vegetative cover over it to lessen the odour impact of desilted materials.<br>• Native species should be utilised for vegetative cover.<br>• If there is a high demand for silt from the local farming community, the silt may be disposed on their land after following the due sediment quality analysis results, approval process and documenting the procedures.<br>• If the silt analysis reveals the presence of pollutants beyond acceptable limits appropriate remedial actions should be proposed and implemented. These remedial actions should be presented in an Emergency Response Plan (ERP) that will be approved by the KNNL prior to its implementation. A format for the ERP is provided in ***Annexure 7***. | interested farmers every month.<br>100% disposal of unusable silt to prescribed landfill sites every month | | |
| | | Spillage of silt and solid wastes into the nearby farmland. | • To minimize of spillage or gusted of desilted material and solid watses, cover is provided while transportation.<br>• In any case, the desilted material should not be allowed to remain unattended. It should either be analyzed and transported to a pre-decided site for its disposal or should be properly dressed if will be used for agricultural activity or reinforcing the bunds and canal embankments.<br>• Sometimes, moisture content in the desilted matter is significant enough to cause dripping while getting | No oocurence of leakage or disposal of unsable silt and solid waste in farmlands or during transport of construction wastes and silt. | Contractor | KNNL in coordination with KSPCB and local agencies |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | | transported from site to the disposal site; it should be ensured that desilted materials are sun dried by at least 20 meters aways from the river or sensitive areas before transport.<br>• Solid wastes from the dreged materials should be sun dried by at least 20 meters aways from the river or sensitive areas before transport to landfill.<br>• While transportation, the desilted matter should be covered so that the spilling and flying of matter can be minimized.<br>• Overloading should be avoided, so that spillage can be reduced. | | | |
| | | The disposed-off desilted material if left unattended may cause soil and water pollution by getting dispersed in the vicinity through high surface winds and produce unpleasant odour for the community | • One of the key and preferred treatments methods is the development of a vegetative cover (bioremediation). In other words, some species of bushes and dense plants should be grown to reduce the impact of high surface winds and rainfall (which may cause soil erosion). Examples of plants are Indian Jujube (Ziziphus mauritiana) and Mulberry (Broussonetia papyrifera).<br>• Transport contaminated silt and garbage by covered trucks to sanitary landfill for disposal; if unavailable, to engineered dump sites (compact clay-lined) for temporary disposal. | 100% plant/tree cover on disposed desilted materials | Contractor | KNNL in coordination with KSPCB and local agencies |
| | | Degradation/pollution to local water-bodies. | It should be ensured that in any case the local water-body or the area near such a water-body is not identified as disposal site. Identification of such water bodies can be done by referring to current/old village | No water-body nor river embankments will serves as diposal area | Contractor | KNNL in coordination with KSPCB |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | | maps. In addition to this, an appraisal exercise can also be undertaken in consultation with the villagers, as they have good knowledge of the area. | | | and local agencies |
| C.5 | Transport of Machinery, Equipment and Material | Impacts from transport of machinery, equipment and material include an increase in localised GHG emissions, noise levels, traffic congestions and possible accidents too. | • Vehicles, equipment and machinery used for construction will conform to relevant Standards.<br>• Regular maintenance should be carried out to ensure that air emission levels comply with the relevant requirements.<br>• Towards this, Pollution Under Control (PUC) Certificate should be obtained for all trucks and equipment employed for the project and should remain current for the entire construction period.<br>• Noise limits for construction equipment used in this project will not exceed 75 dB (A).<br>• Also, as part of safety measures, the Contractor should schedule transport of machinery, equipment and material in consultation with the local community to prevent any safety-related incidents.<br>• All vehicles will observe speed limits<br>• Materials should be transported always with cover to ensure safe transport of materials | All equipment and machinery will conform to relevant standards and acquire PUC certificate.<br>Noise limits for construction equipment will not exceed 75 dB.<br>Local community consultation in every transport machinery, equipment and material.<br>Speed limits will be observed by all vehicles<br>All materials should be transported with cover. | Contractor | KNNL in coordination with KSPCB |
| C.6 | Material Sourcing | Sand mining has significant environmental impacts including on the river ecology from which it is mined. Operating quarries also has an | • Mitigation measures include obtaining sand and stones from licensed vendors who are subjected to environmental compliance from the KSPCB. | All sources of sand and stone materials are from licensed vendors. | Contractor | KNNL in coordination with Department of |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | ecological cost including altering the drainage pattern in the area and creation of wastelands. | • Additionally, use of manufactured-sand (M-sand) should be explored in consultation with the implementing agency. | | | Mines and Geology, GoK and KSPCB |
| | | Impact from RMC Sourcing include increased levels of air emissions and noise levels in the area where the RMC plant is established and operated | • The locations of Ready-Mix-Concrete Plants should be 200 meters or more away from community and not within the WHA and OCR.<br>• Appropriate approvals should be obtained from state agency such as KSPCB and local authorities to establish an RMC facility near the construction sites. | All permits should be obtained from as KSPCB and local authorities to establish an Ready-Mix-Concrete facility prior to operation | Contractor | KNNL in coordination with KSPCB |
| C.7 | Storage and Handling of Materials | Impact from improper material storage and handling include contamination of land and water. | • Mitigation measures include identifying and constructing dedicated storage areas and equipment maintenance areas at construction sites.<br>• Fuel, oil and other materials need to be stored in dedicated areas in sealed tanks with a concrete base at least 20 m away from a water course or other sensitive area.<br>• Vehicles and machinery are not to be re-fuelled near water courses.<br>• Trained personnel should be available at the site to prevent spills and for adopting appropriate procedures for cleaning up accidental spills, | Establishments of storage areas and equipment maintenance areas at construction sites prior to constructions. | Contractor | KNNL in coordination with KSPCB |
| C.8 | Impact due to notified OCR | The rehabilitation activities within the OCR impact the nesting, breeding, food availability, recreational habitats of the otters and other aquatic animals within the OCR. It also has a deleterious effect on the general aquatic biodiversity if the | • Mitigation measures include training the contractors and other agency staff on the importance of the OCR and procedures to be followed while working with the OCR such as no poaching or hunting activities. | Training of entire workforce of the contractor prior to constructions.<br>No poaching or hunting incidents | Contractor | KNNL in coordination with KFD and KSPCB |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | pollution levels of air, water and noise go beyond standard acceptable levels. | • To avoid habitat damage and reduction of species, installation of signages about OCR will warn and guide people and construction workers.<br>• Also, apart from constructing secondary ring bund as provided in the bid documents<br>• The Contractor should refrain from use of blasting not only within the OCR region but also within 100 m of the OCR boundary. Pre-construction aquatic biodiversity survey should be taken up to confirm the location of the secondary ring-bunds.<br>• Likewise, no construction camp or material storage sheds should be established within the OCR boundary or within 100 m of the OCR boundary.<br>• Additionally, all construction should be taken up during December to June period and between 9 am and 5 pm on the days of construction.<br>• Further, no construction technologies that causes noise and impacts the OCR should be utilised.<br>• Finally, the disposal of any silt, construction waste within the OCR should be avoided at all times during the construction period.<br>• More importantly, post-construction ecological enhancement measures suggested in the report should be implemented to safeguard the OCR. | Pre-construction aquatic biodiversity surveys prior to constructions.<br>No blasting in OCR<br>No construction camp or material storage sheds within 100 m OCR boundary.<br>No disposal of silt and construction wastes within the OCR.<br>100% compliance to post-construction ecological enhancement measures. | | |
| C.9 | | Hampi is a UNESCO notified World Heritage Area. Rehabilitation works | • Mitigation measures include training the Contractors and other agency staff | Training of entire workforce of the | Contractor | KNNL in coordination |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | Impact due to Hampi World Heritage Area | carried out within the Hampi World Heritage Area will impact the traditional appearance and impair relations of mass or colour between it and its surroundings. Moreover, the air emissions during the construction period can impact the colour and texture of the monuments. Further the noise levels and the construction techniques adopted can impact the stability and strength of the monuments. | on the importance of the Hampi WHA and the measures to be taken to preserve the cultural integrity of the area.<br>• Also, in order to ensure that the heritage area is not impacted adversely, the rehabilitation works should be taken up as per the guidelines provided in the bid documents and conservation approach from HWHAMA.<br>• Also, blasting should be avoided with in the Hampi WHA so that the noise levels do not impact the 600-year old Hampi WHA.<br>• Likewise, no construction camp or material storage sheds should be established within the heritage area or within 100 m of the heritage area.<br>• Further, no construction technologies that cause excessive noise and affect the heritage area should be utilised.<br>• Finally, disposal of any silt, or construction waste within the heritage area should be avoided at all times. | contractor prior to constructions.<br>No blasting in Hampi WHA<br>No construction camp or material storage sheds within 100 m Hampi WHA boundary.<br>No disposal of silt and construction wastes within the Hampi WHA | | with HWHAMA, ASI |
| | | Chance find of archaeological artefacts | • Mitigation measures including sharing the construction schedule for the work carried out within the Hampi WHA with the ASI and HWHAMA at least two-weeks in advance for the start of the activity.<br>• The schedule should also provide the list of project activities that are slated to be carried out so that the ASI and | | Contractor | KNNL in coordination with HWHAMA, ASI |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | | HWHAMA can make a decision on supervising the activity.<br>• Also, any chance find of archaeological artefacts should be reported to the ASI and HWHAMA and the artefacts secured until the ASI and HWHAMA staff arrive at the site.<br>• Further, no project activity should be carried in that area until clearance is obtained from the ASI and ad HWHAMA. | | | |
| C.10 | Rehabilitation Activities at sites | Impact on Air Quality caused by increased GHG emissions and Suspended Particulate Matter (SPM) SPM levels induced from vehicle and equipment operations. | • Contractor will take every precaution to reduce levels of dust at construction sites.<br>• Water sprinkling will be carried out on haul roads.<br>• All earthworks to be protected/ covered to minimize dust generation.<br>• Regular maintenance of vehicles and equipment should be carried out at Pollution Under Control (PUC) certificate should be obtained from the KSPCB and should remain current for the entire construction period. | Target concentrations for PM2.5 is 25 µg/m3 (24-hour mean) and PM1o 50 µg/m3 24-hour mean<br>All vehicles must acquire PUC certificate. | Contractor | KNNL in coordination with KSPCB |
| | | Impact on Noise Levels caused by vehicle movement and equipment operations | • Noise limits during the construction period should not exceed 75 dB (A)<br>• Work schedules should be decided in consultation with the local community so that the noise levels do not adversely impact the local community. | Noise limits during should not exceed 75 dB(A) (7am to 10 pm) and 45 dB(A) (10pm to 7am) | Contractor | KNNL in coordination with KSPCB |
| | | Impact on Water Quality and Land is caused by improper disposal weed, silt and other sediment encountered at construction sites. | • Mitigation measures include environmental-friendly weed disposal, silt disposal and sediment management practices. | 100% disposal of wastes to prescribed disposal facility | Contractor | KNNL in coordination with KSPCB |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | | • Records should be maintained for all practices. | | | |
| | | Impact on Water Quality and Land is also caused by improper disposal of construction waste and debris, hazardous materials, oils and lubricants | • Construction waste will not be disposed of around the project site and cause adverse impact on either soil or water or any other environmental medium.<br>• Construction wastes and debris should be disposed at engineered-landfills approved by the KSPCB.<br>• Hazardous materials, oils and lubricants should be managed as per regulations and should be approved by the KSPCB.<br>• Waste records should be maintained for all waste disposals. | 100% disposal of wastes into engineered-landfills approved by the KSPCB. | Contractor | KNNL in coordination with KSPCB |
| C.11 | Construction Campsite Facility Management | Impacts from Construction Camps on air water and soil quality - Location, Selection, Design and Layout | • Construction camp with all amenities will be located away from settlements as far as possible to avoid conflict with the local community for resource use, be it roads, firewood, drinking water and other basic requirements to make a living.<br>• Hampi WHA should not be used as location of construction camp facilities.<br>• Also, construction camp facilities should not be located at any place within 100 m of the OCR. | Construction camps should be located away from the settlements as far as possible<br>No construction camp within 100 m of the Hampi WHA boundary and OCR | Contractor, | KNNL in coordination with KFD, HWHAMA |
| | | Construction campsites produce solid wastes, kitchen wastes, sewerage and septage, as well. Improper management of these wastes result in contamination of land and water. | • Mitigation measures include separation of solid wastes at source and disposing the wastes in ongoing solid waste management system approved by the authorities<br>• Composting of the kitchen wastes, constructing and operating septic tanks for treating wastewaters. | 100% segregation of solid wastes and disposal to engineered-landfills approved by the KSPCB. | Contractor | KNNL in coordination with KSPCB |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | | • All these waste management systems should be operated in an effective manner throughout the construction period. | At one least septic tank for each campsites | | |
| | | Impact on land and water due to leakage of fuel, oil and other materials stored in construction camp sites and due to operation of vehicle and equipment maintenance workshops without proper treatment facilities | • The fuel storage and vehicle cleaning area will be stationed in such a way that water discharge does not drain into any water body.<br>• Soil and water pollution parameters will be monitored as per monitoring plan.<br>• At construction camp, vehicle washing ramps will be constructed and an oil water separator pit will be provided at ramp area.<br>• All the vehicles maintenance will be done at an authorized workshop. The discarded fuel and lubricants will be stored in drums and sold to recyclers authorised by KSPCB. | No leakage fuel, oil and other materials stored in construction camp sites<br><br>Installation of oil water separator pit will be provided at washing ramp area | Contractor | KNNL in coordination with KSPCB |
| C.12 | Worker Health and Safety | Impact on Workers' Health | • Sufficient supply of potable water should be provided at both the workers' campsites and construction sites for all the workers and their family members.<br>• Adequate, clean and hygienic sanitation (toilets and washing areas) and waste management facilities should be provided at both the workers' campsites and construction sites to protect the health of the workers' and their family members.<br>• provision of clean eating areas where workers are not exposed to the hazardous or noxious substances.<br>• Nutritious food should be provided for the workers at all times during the | No incidence of workers' ailments due to unhealthy campsite condition | Contractor | KNNL in coordination with Department of Labour, GoK |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
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| | | | construction period and if workers' families prefer to cook their own food, adequate infrastructure should be provided for the same.<br>• To ensure good health for all workers and their family members during the construction period, periodic health monitoring from professional doctors should be carried out.<br>• Records should be maintained for all the facilities such as (i) or lost time cases, (ii) dangerous occurrences and incidents and (iii) work related fatalities<br>• Ensure that qualified first-aid can be provided at all times and easily accessible throughout the place of work<br>• Occupational Health and Safety orientation/training to all workers to ensure they are apprised of the basic site rules of work at/on the site and of personal protection and preventing injury to fellow employees. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate.<br>• All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard | | | |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | Impact on Workers' Safety During Construction | • Surface water quality analysis is necessary for possible contamination and pollution of canals and anicuts.<br>• Adequate safety measures for workers while handling of materials at site will be ensured.<br>• Contractor has to comply with all regulations for the safety of workers, including complete use of PPEs.<br>• Precaution will be taken to prevent danger to workers from fire, etc.<br>• First aid treatment will be made available for all injuries likely to be sustained during the course of work.<br>• First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids<br>• Contractor will conform to all instructions on maintaining health and safety of the workers and their family members. | No incidence of accidents and injuries related to unsafe working conditions. | Contractor | KNNL in coordination with Department of Labour, GoK |
| | | Impact from material handling at site on workers' safety and air, land and water media. | • Workers employed on mixing cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles.<br>• Workers, who are engaged in welding works, will be provided with welder's protective eye-shields.<br>• Workers engaged in stone breaking activities will be provided with protective goggles and clothing.<br>• Use of any toxic chemical will be strictly in accordance with manufacturer's instructions. | No incidence of accidents and injuries related to unsafe working conditions. | Contractor | KNNL in coordination with Department of Labour, GoK |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | | • The Implementing Agency will be given at least 6 working days' notice of the proposed use of any chemical.<br>• A register of all toxic chemicals used at the site will be kept and maintained up to date by the Contractor. | | | |
| C.13 | Borrow Area Rehabilitation | Improper management of burrow areas will cause soil degradation and removal of all floral and faunal species of that area, if any. The borrow areas may also lead to stagnation of water leading to vector proliferation and thereby causing diseases related to mosquitoes or other biting flees etc. | • Mitigation measures include establishing borrow areas at pre-identified locations where the Borrow Area Rehabilitation is approved by the local agencies.<br>• The Rehabilitation Plan that will be implemented effectively should include providing for vegetative cover on all cut / fill slopes to prevent soil degradation and protecting native species.<br>• The vegetative cover allows native floral and faunal species to grow and propagate. It also checks loss of top productive soil either by wind or rainfall/run-off water. Also, use of turfing should be considered for preventing soil erosion. | Rehabilitation Plan for each borrow areas | Contractor | KNNL in coordination with Local Authorities |
| C.14 | Closure Activities | Improper closure of construction sites and campsites will result in contamination of land, thereby affecting the groundwater quality, as well. If the surface water sources are closer to these sites, the quality of surface water is also affected. | • Contractor to prepare site restoration plans for approval by the implementing agency.<br>• The plan to be implemented by the contractor prior to demobilization should contain at a minimum, clearing of all temporary structures, disposal of wastes at pre-identified approved locations (by the KSPCB and local authority), and septic tanks effectively sealed off. | Restoration plans for each construction sites and campsites. | Contractor | KNNL in coordination with Local Authorities |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| | | | • The site should be left clean and tidy by the Contractor to the entire satisfaction of the implementing agency. | | | |

**Table 61: Summarizing the Mitigation Measures during Operation Phase**

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| O.1 | Controlling Water Abstractions to make the agricultural sector climate-resilient | Climate Change impacts on the water sector will have serious implications on water availability for all sectors including the agricultural sector. | The project has water conservation objective in line with the need to enable the agriculture sector to be climate resilient. As such, it is necessary to monitor water abstractions from the canal so that the impact of the project can be monitored on a regular basis. | | KNNL | WRD, GoK |
| O.2 | Controlling quality of canal water and surface-water bodies to which the canal water is discharging into. | Maintaining water quality for its various uses is the prime objective of the integrated water resources management. | • Periodic water quality monitoring is suggested to ensure that the point and non-point pollutant discharges do not impact the water quality either in the canal or in water bodies to which the canal ultimately would discharge into.<br>• KNNL should work with ULBs covering canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa for the implementation of action plans to prevent or minimize liquid and solid wastes disposal into the canals. | One water quality monitoring activity for each canal and anicut in every season. | KSPCB | WRD, GoK in coordination with KNNL |
| O.3 | Maintain carrying capacity of the canals | Carrying capacity of the canals plays a very important role in ensuring equity in water distribution to the farmers, one of the major objectives of the integrated water resource management | • Desilting of drains should be done periodically to maintain the hydraulic capacity of the canals.<br>• Silt should be disposed of in an environment-friendly manner. | Desilting of canals at least twice a year | CADA | WRD, GoK |
| O.4 | Controlling non-point pollutant discharges | Sustainable agricultural management has been impacted by the unscientific use the chemical fertilizers and pesticides. | • Non-point pollution discharges primarily nutrients and pesticides from the agricultural fields can be prevented through skilled application of these materials on farm lands.<br>• Appropriate training and capacity building activities should be carried out in the command areas so that farmers are trained to utilize fertilizers and pesticides in an optimum eco-friendly manner. | Yearly training for farmers on fertilizer applications | CADA | KNNL in coordination with KSPCB |

| No. | Project Activity | Environmental Impacts | Proposed Mitigation Measures | Performance Indicators | Implementation Responsibility | Supervision Responsibility |
|---|---|---|---|---|---|---|
| O.5 | Ecological enhancement to safeguard Otter Conservation Reserve | Ensuring ecological sustainability is an important objective of sustainable integrated water resources management | Measures for ecological enhancement to safeguard the OCR include deweeding periodically for enhancing growth of the aquatic flora and introducing native fingerlings for ensuring food security for the aquatic animals. | Increase of otter population. | KNNL | WRD, GoK in coordination with KFD, GoK |

## 7.1 General Environmental Guidelines during Construction

410. Based on the findings of the EIA and consideration of the necessity to limit environmental impact during construction and operation, the following general guidance would be devised and incorporated into the Bid Documents for the Contractor.

## 7.2 Contractor's Responsibilities with Respect to the Environment

411. The contractor's environmental responsibilities would be prescribed in the Bid Documents and later on in the Contract agreement. In the detailed designs, the contractor will bestow due consideration to the following:

***General***

412. The Contractor will take all reasonable steps to protect the environment and to prevent environmental damage and public nuisance resulting from construction activities.

413. The Contractor will take all reasonable steps to protect the aquatic ecosystem including that within the OCR and to prevent ecological damage resulting from construction activities.

414. The Contractor will take all reasonable steps to protect the Hampi Heritage Area and to prevent any damage to the area resulting from construction activities. The same has been put together in the following paragraphs as the Physical Cultural Resources Management Plan:

**Physical Cultural Resources Management Plan**

415. Hampi is a UNESCO notified World Heritage Area. Rehabilitation works carried out within the Hampi World Heritage Area will impact the traditional appearance and impair relations of mass or colour between it and its surroundings. Moreover, the air emissions during the construction period can impact the colour and texture of the monuments. Further the noise levels and the construction techniques adopted can impact the stability and strength of the monuments.

416. Mitigation measures include training the Contractors and other agency staff on the importance of the Hampi WHA and the measures to be taken to preserve the cultural integrity of the area. Also, in order to ensure that the heritage area is not impacted adversely, the rehabilitation works should be taken up as per the guidelines provided in the bid documents. Also, blasting should be avoided with in the Hampi WHA so that the noise levels do not impact the 600-year old Hampi WHA. Likewise, no construction camp or material storage sheds should be established within the heritage area or within 100 m of the heritage area. Further, no construction technologies that cause excessive noise and affect the heritage area should be utilised. Finally, disposal of any silt, or construction waste within the heritage area should be avoided at all times.

417. In matters on chance find of archaeological artefacts, mitigation measures including sharing the construction schedule for the work carried out within the Hampi WHA with the ASI and HWHAMA at least two-weeks in advance for the start of the activity. The schedule should also provide the list of project activities that are slated to be carried out so that the ASI and HWHAMA can make a decision on supervising the activity. Also, any chance fiend of archaeological artefacts should be reported to the ASI and HWHAMA and the

artefacts secured until the ASI and HWHAMA staff arrive at the site. Further, no project activity should be carried in that area until clearance is obtained from the ASI and ad HWHAMA.

418. Towards addressing the Design and Bid Requirements for preserving the continuing landscape of the Hampi World Heritage Area, Planning and Design of the canal modernization project should be taken up in such a manner that the Form, Design and characteristics of the original sections of the Turtha Anicut and the canal sections located in the Core, Buffer and Periphery zones of the Hampi WHA are not adversely affected. The designs should be included in the bid document. Towards this, Form and Design of the Turtha Anicut, 9.3 km length located in the core zone of the Hampi WHA in Anegundi, Turtha and Raya canals, 14.05 km length located in the buffer zone of Hampi WHA in Anegundi, Turtha, Raya and Kalaghatta canals and 24.33 km length located in the periphery zone of Hampi WHA in Anegundi, Turtha, Raya, Basavanna and Kalghatta canals should be aligned with the theme or design of the heritage area landscape. Also, for effective implementation of work in Heritage Areas, the bid documents will include HWHAMA's guidelines for carrying out work in heritage areas.

419. Periodic monitoring of the PCR Management Plan will be carried out by the PSC. The indicators of compliance that will be verified include Training Plan, Pre-Construction and Post-Construction Photographs of the canal sections and monuments near the canal sections; Construction Schedules, Waste Disposal; Field Notes; Quarterly Progress Report, Safeguard Monitoring Reports etc.

420. The Contractor will comply with all statutory requirements, environmental regulations and environmental quality standards, as per the Indian environmental guidelines relevant to the project.

421. The Contractor will bear all costs associated with environmental pollution avoidance and environmental mitigation, including any clean-up operations if necessary.

***Solid Waste Management***

422. Maintain all construction sites in a clean and safe condition and provide and maintain appropriate facilities for temporary storage of all wastes before transportation and disposal.

423. Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal sites, so as to cause least environmental impact.

424. Take all precautionary measures when handling and storing fuels and lubricants, to avoid causing environmental pollution. This is to include establishment of contingency plans for clean up in the event of spillage.

***Occupational Health and Safety***

425. Provision of adequate sanitation facilities on all construction sites, contractor's office(s) etc., if and when established.

426. Disposal from all sanitary systems should be undertaken to avoid causing environmental pollution. Wastewater should be routed through suitable designed septic tanks and soak well, without contaminating either ground or surface water or causing a health risk.

427. Provision of an adequate supply of water for drinking (to meet national potable standards) and washing purposes for all site personnel, including all workers, as appropriate.

***Noise***

428. Avoid any unnecessary noise for disturbance during construction.

429. Maintenance of all vehicles and mechanics to a high standard, in accordance with manufacturers' maintenance procedures.

430. Careful sitting of noise generating activities to avoid unnecessary noise disturbance to local residents, in accordance with environmental guidelines.

***Air Quality and Dust***

431. Minimization of dust nuisance by regular watering of material stockpiles, access roads, bare soil, sand and other areas, as appropriate and as determined by weather conditions.

432. Covering temporary piles and transport of loose (ex. sand) and dredged materials.

***Disruption to Road Transport***

- Minimization of disruption to road traffic, in consultation with local authorities and representatives.
- A summary of the specific mitigation and enhancement measures during the design and construction phase related to the construction phase will be prepared by the Contractor and submitted to the KNNL for approval at start of project implementation.

## 7.3 General Environmental Guidelines during Operation Phase

- During the Operation Phase, a range of monitoring and mitigation measures will be undertaken to safeguard the environment and secure no unanticipated negative impacts would occur. If any negative impacts are identified during the Operation Phase, the relevant mitigation measures should be implemented.
- The Agricultural Extension services including the soil and fertilizer management issues will be continued as part of regular services provided by Agricultural Department, GoK.
- Provision of effective O&M for safeguarding against negative impacts of erosion and siltation would be continued as part of the maintenance of the rehabilitated canals under the responsibility of KNNL / CADA sub-divisional office and carried out in close cooperation with the WUCS.
- Planning for and coordination and management of water abstractions would be an ongoing activity during the O&M phase under the responsibility of KNNL / CADA and carried out in close cooperation with the WUCS.

## 7.4 Environmental Monitoring Plan

433. This section describes environmental monitoring and auditing procedures to be adopted during pre-construction, construction and post construction-operation phases of the

Project. Environmental monitoring will be carried out under the overall responsibility of the PIO, with necessary technical backstopping from PMU and PSC.

434. The PIO and PSC will monitor the progress and compliance of EMP implementation through site inspection, examination of certificates, clearances, registers and other related documents. The Contractor will submit Monthly Reports to the PIO and PSC. PSC will submit quarterly progress report including safeguard monitoring observations to PIO, who in turn would review and submit to PMU. The half yearly safeguard monitoring reports will be prepared by PSC and submitted to PMU for review and submission to ADB. After due approvals by KNNL and ADB, the reports will be uploaded on respective websites after due approvals.

435. ADB will review project performance against the EA's commitments as per loan agreements. Further, Monitoring and supervision of social and environmental safeguards will be integrated into the project performance management system.

## 7.5 Monitoring Considerations

436. Environmental monitoring will be carried out for development of project performance indicators, monitoring of implementation of mitigation measures, and overall regulatory monitoring of environmental aspects identified in the EIA. To ensure effective implementation of the Environmental Monitoring Plan and mitigation measures, it is essential that all key environmental attributes are monitored. The monitoring plan for each of the environmental attributes is provided in ***Table 62.***

437. The Contractor will also be responsible for conducting regular monitoring of the site and environmental parameters (e.g. air and water quality) during the construction period. This will be carried out as per the approved site-specific Environmental Management Plan.

438. At the same time, KNNL, through PSC will also undertake supervision to assess the performance of the Project with respect to environmental impacts, EMP implementation, and improvement measures. The assessment will also identify specific operational and capacity constraints and advise on specific recommended actions to improve the performance, along with any unforeseen effects and mitigation measures.

439. Following the *Table 62* on Environmental Monitoring Plan for each of the environmental attributes, the *Tables 63, 64 and 65* provides the monitoring plan for each of the mitigation measures for the pre-construction, construction and operational phases of the project, respectively.

**Table 62: Environmental Monitoring Plan for each of the Environmental Attributes**

| S. No. | Environmental Attribute | Phase | Monitoring Parameters | Locations | Frequency | Responsibility |
|---|---|---|---|---|---|---|
| 1 | Air | Baseline | PM10, $NO_2$ | One sampling station along construction locations | Once prior to construction starts at a location | Contractor |
| | | Construction | | Three sampling stations along active construction fronts. | Once every Month | Contractor |
| 2 | Surface/ Canal Water | Baseline | TDS, pH, BOD, COD, Oil | One sampling station along construction locations | Once prior to construction starts at a location | Contractor |
| | | Construction | | Three sampling stations along active construction fronts. | Once every Month | Contractor |
| | | Operation | | One sampling station at the tail end of canals | Once every season | WUCS and CADA |
| 3 | Groundwater | Baseline | pH, Turbidity, $NO_3$ | One sampling station along construction locations | Once prior to construction starts at a location | Contractor |
| | | Construction | | Three sampling stations along active construction fronts. | Once every Month | Contractor |
| | | Operation | | Three (source, mid and tail end) along entire canal | Once every season | WUCS and CADA |
| 4 | River/ Anicut | Baseline | TDS, pH, BOD, COD, Oil | One every anicut including the anicuts outside the OCR | Once prior to construction starts at a location | Contractor |
| | | Construction | | | Once every Month | Contractor |
| 5 | Noise | Baseline | Noise Levels | One sampling station along construction locations | Once prior to construction starts at a location | Contractor |
| | | Construction | | Three sampling stations along active construction fronts. | Once every Month | Contractor |
| 6 | Sediments | Baseline | pH, texture, available NPK, S, Ca, Mg, Na, B, permeability, organic Carbon, EC, cyanide, cyanide, MC, heavy metals | One sample every five km of canal length in the agricultural command; two samples in every anicut and one sample every km in the contaminated stretch of the canal | Before desilting starts | Contractor |

| S. No. | Environmental Attribute | Phase | Monitoring Parameters | Locations | Frequency | Responsibility |
|---|---|---|---|---|---|---|
| 7 | Aquatic Biodiversity | Baseline | Aquatic species and quantity sighted | Every Anicut within the OCR | Once before the construction start | Contractor |
| | | Construction | | | Once just after the construction | Contractor |
| 8 | Hampi World Heritage Area | Baseline | Videos and Photographs | Every Monument within 50m near the Project Area | Once before the Construction start | Contractor |
| | | Operation | | | Once just after the construction | Contractor |

**Table 63: Summary-Monitoring Requirements for Mitigation Measures for Pre-Construction Phase**

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Responsibility | Costs |
|---|---|---|---|---|---|---|---|---|
| P.1 | The design will include provisions for ensuring effective maintenance and protection of assets created so as to ensure long-term sustainability, especially with regard to defining and preparing WUCS for carrying out its role in O&M of the assets. | Feasibility Report | Project Objectives and Activities that have been defined | NA | NA | Once prior to the Bid | KNNL | NA |
| P.2 | • Planning and Design of rehabilitation of anicuts located in the OCR should be taken up in such a manner that there are no negative impacts.<br>• Towards this, the design of the necessary structures to be constructed prior to the rehabilitation of the anicuts within the OCR, the implementation schedule and other key issues as suggested by the Biodiversity Expert and the KFD will be included in the bid document. | Detailed Project Report; Bid Document | Designs of Secondary Ring bunds | NA | NA | Once prior to the Bid | KNNL | NA |
| | The bid documents should incorporate the necessary conditions to select a contractor who has the knowledge and understanding to carryout work in eco-sensitive and conservation areas as per concerned guidelines. | Bid Document | Selection Criteria for Contractor | NA | NA | Once prior to the Bid | KNNL | NA |
| P.3 | Planning and Design of the canal modernization project should be taken up in such a manner that the Form, Design and characteristics of the original sections of the Turtha Anicut and the canal sections located in the Core, Buffer and Periphery zones of the Hampi WHA are not adversely affected. The designs should be included in the bid document. | Detailed Project Report; Bid Document | Designs of Turtha Anicut and Canal Sections within the Hampi WHA | NA | NA | Once prior to the Bid | KNNL | NA |
| | The bid documents will include guidelines for carrying out work in heritage areas. | Bid Document | Selection Criteria for Contractor | NA | NA | Once prior to the Bid | KNNL | NA |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Responsibility | Costs |
|---|---|---|---|---|---|---|---|---|
| P.4 | The canal sections in Hulugi, Upper and Lower Gangavathi and Anegundi canals should accommodate the rainfall runoff from the Rocky Mountains located near the canal sections. The designs should be included in the bid document. | Detailed Project Report | Designs of the canal sections | NA | NA | Once prior to the Bid | KNNL | NA |
| P.5 | KNNL should work with the Karnataka State Pollution Control Board and ensure that concerned Industry stops discharge into the canal immediately. | Action Plan to be developed in consultation with KSPCB and the Industry | Activities taken up under the Action Plan | NA | NA | Once prior to the Construction Closure | KNNL | NA |
| P.6 | KNNL should work with ULBs along canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa to ensure that the ULB has a plan to prevent liquid and solid waste disposal into the canals. | Action Plan to be developed in consultation with ULBs | Activities taken up under the Action Plan | NA | NA | Once prior to the Construction Closure | KNNL | NA |
| P.7 | The EMP should be included in the bid documents so that the Contractor selected understands the issues and makes necessary plans to prepare and implement the EMP. | Bid Document | EMP | NA | NA | Once prior to the Bid | KNNL | Package 1 ₹ 6.09.Crores (US$ 937,785) Package 2 ₹ 5.66 Crores (US$ 871,692) |
| | Health and Safety requirements should be incorporated as part of the contract bid documents so that the Contractor has the knowledge and understanding necessary to implement the health and safety requirements as part of the EMP during the period of the project. | Bid Document | EMP | NA | NA | Once prior to the Bid | KNNL | Package 1 ₹ 70 Lakhs (US$ 107,692) Package 2 ₹ 38 Lakhs (US$ 58,462) |

**Table 64: Summarizing the Monitoring Requirements for the Mitigation Measures for Construction Phase**

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| C.1 | • Site Access should be obtained as per guidance provided in the *Social Due Diligence Report and Resettlement Framework* and documentation should be maintained throughout the project duration.<br>• Site clearance activities will be undertaken with due permission from the local authorities.<br>• Additionally, trees to be removed should be identified and necessary permission obtained from Karnataka Forest Department (KFD) prior to start of the activities.<br>• Blasting of the rocks should be avoided at all times especially in areas closer to the monuments and habitations.<br>• Finally, the construction waste and debris should be disposed at an engineered landfill approved by the KSPCB. All areas used for temporary construction operations will be subject to complete restoration to their former condition with appropriate rehabilitation procedures. Pre-construction and post-construction photographs will be recorded for all temporary sites. | Records on adherence to SDDR and Resettlement Framework on Site Access; Approvals from Local Authorities, Field Notes; Quarterly Progress Reports (QPR); Safeguard Monitoring Report (SMR) | Pre and Post-Construction Photographs; Manifest for Waste Disposal; Approvals from KSPCB, KFD and Local Authorities | All Construction Campsites and Construction Sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with KSPCB, KFD and local agencies | Package 1<br>₹ 33.60 Lakhs (US$ 51,692)<br>Package 2<br>₹ 20.16 Lakhs (US$ 31,015) |
| C.2 | Enumeration of the trees to be conducted prior to start of work to identify the trees that need to be removed and draw up and implement a Compensatory Afforestation Plan with the assistance of KFD. | Tree Enumeration Report, KFD Approval for tree removal, Compensatory | Pre and Post-Construction Photographs; Approvals from KFD and | All Construction Campsites and Construction Sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with KFD | Package 1<br>₹ 87.50 Lakhs (US$ 134,615)<br>Package 2<br>₹ 5.00 Lakhs (US$ 7,692) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | | Afforestation Plan; Field Notes; QPR; SMR | Local Authorities | | | | | |
| C.3 | • Mitigation measures include carrying out an environmental-friendly way of weed disposal including either expose the weeds to the sun for over 30 days to ensure that the weeds dry out with the remains being safely disposed on pre-identified disposal lands or compost the weeds and the compost used in agricultural lands.<br>• Also, it is important to work with local urban local bodies and village communities to ensure that the wastewater from the habitations are not discharged into the canals and / or the water bodies leading to the anicuts | Weed Disposal Plan, Field Notes; QPR, SMR | Manifest for Weed Disposal; Pre and Post-Disposal Photographs | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with KSPCB and local agencies | Package 1<br>₹ 4.50 Lakhs (US$ 6,923)<br>Package 2<br>₹ 3.00 Lakhs (US$ 4,615) |
| C.4 | • Sediment quality analysis (***Annexure 10***) of the canals and anicuts should be performed to determine what should be done to the silt. The analysis should include testing for the presence of herbicides, pesticides and heavy metals, as well.<br>• There should be some temporary storage facilities for desilted material such that it does raise the ground level of the adjoining lands, service road and / or inspection path and affect the drainage pattern in the area.<br>• Silt should be disposed in pre-identified and approved locations with a vegetative cover over it to lessen the odour impact of desilted materials.<br>• Native species should be utilised for vegetative cover. | Sediment quality analysis laboratory results, silt disposal plan; field notes; QPR, SMR | Manifest for Silt Disposal; Pre and Post-Disposal Photographs | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with KSPCB and local agencies | Package 1<br>₹ 15,00 Lakhs (US$ 23,077)<br>Package 2<br>₹ 7.00 Lakhs (US$ 10,769) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • If there is a high demand for silt from the local farming community, the silt may be disposed on their land after following the due sediment quality analysis results, approval process and documenting the procedures.<br>• If the silt analysis reveals the presence of pollutants beyond acceptable limits appropriate remedial actions should be proposed and implemented. These remedial actions should be presented in an ***Emergency Response Plan (ERP)*** that will be approved by the KNNL prior to its implementation. A format for the ERP is provided in ***Annexure 7***. | | | | | | | |
| | • To minimize of spillage or gusted of desilted material and solid watses, cover is provided while transportation.<br>• In any case, the desilted material should not be allowed to remain unattended. It should either be analyzed and transported to a pre-decided site for its disposal or should be properly dressed if will be used for agricultural activity or reinforcing the bunds and canal embankments.<br>• Sometimes, moisture content in the desilted matter is significant enough to cause dripping while getting transported from site to the disposal site; it should be ensured that desilted materials are sun dried by at least 20 meters aways from the river or sensitive areas before transport.<br>• Solid wastes from the dreged materials should be sun dried by at least 20 meters aways from the river or sensitive areas before transport to landfill. | Silt disposal plan; field notes; QPR, SMR | Manifest for Silt Disposal; Pre and Post-Disposal Photographs | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL | NA |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • While transportation, the desilted matter should be covered so that the spilling and flying of matter can be minimized.<br>• Overloading should be avoided, so that spillage can be reduced. | | | | | | | |
| | • One of the key and preferred treatments methods is the development of a vegetative cover (bioremediation). In other words, some species of bushes and dense plants should be grown to reduce the impact of high surface winds and rainfall (which may cause soil erosion). Examples of plants are Indian Jujube (*Ziziphus* mauritiana) and Mulberry (*Broussonetia papyrifera*).<br>• Transport contaminated silt and garbage by covered trucks to sanitary landfill for disposal; if unavailable, to engineered dump sites (compact clay-lined) for temporary disposal. | Silt disposal plan; field notes; QPR, SMR | Manifest for Silt Disposal; Pre and Post-Disposal Photographs | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL | NA |
| | It should be ensured that in any case the local water-body or the area near such a water-body is not identified as disposal site. Identification of such water bodies can be done by referring to current/old village maps. In addition to this, an appraisal exercise can also be undertaken in consultation with the villagers, as they have good knowledge of the area. | Silt disposal plan; field notes; QPR, SMR | Manifest for Silt Disposal; Pre and Post-Disposal Photographs | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL | NA |
| C.5 | • Vehicles, equipment and machinery used for construction will conform to relevant Standards.<br>• Regular maintenance should be carried out to ensure that air emission levels comply with the relevant requirements. | Vehicle and Equipment Operation and Maintenance Plan | PUC Certificates from KSPCB, Vehicle and Equipment Maintenance | All applicable sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out; | Contractor with Supervision of KNNL in coordination with KSPCB | Package 1<br>₹ 1.56 Lakhs (US$ 2,400)<br>Package 2<br>₹ 1.04 Lakhs (US$ 1,600) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • Towards this, Pollution Under Control (PUC) Certificate should be obtained for all trucks and equipment employed for the project and should remain current for the entire construction period.<br>• Noise limits for construction equipment used in this project will not exceed 75 dB (A).<br>• Also, as part of safety measures, the Contractor should schedule transport of machinery, equipment and material in consultation with the local community to prevent any safety-related incidents.<br>• All vehicles will observe speed limits<br>• Materials should be transported always with cover to ensure safe transport of materials | including Safety Plan and Schedule Arrangements for its use; Field Notes, QPR, SMR | Record, Safety Sign Boards where Vehicles and Equipment are used, Schedule agreements with local community for vehicle and equipment to be used, Air and Noise Quality | | | Monthly monitoring and Air and Noise Quality at all construction sites | | |
| C.6 | • Mitigation measures include obtaining sand and stones from licensed vendors who are subjected to environmental compliance from the KSPCB.<br>• Additionally, use of manufactured-sand (M-sand) should be explored in consultation with the implementing agency. | License of Material Suppliers; Field Notes, QPR, SMR | List of Material Suppliers, License of Material Suppliers, Record of Supplies; EMP of Material Suppliers | All Construction Sites | Contractor's Documents for all the indicators of Compliance | Periodically to verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with Department of Mines and Geology, GoK and KSPCB | Package 1<br>₹ 19.50 Lakhs (US$ 30,000)<br>Package 2<br>₹ 4.60 Lakhs (US$ 7,077) |
| | • The locations of Ready-Mix-Concrete Plants should be 200 meters or more away from community and not within the WHA and OCR.<br>• Appropriate approvals should be obtained from state agency such as KSPCB and local authorities to establish an RMC facility near the construction sites. | RMC Sourcing Plan; Approvals from local authorities; Field Notes, QPR, SMR | EMP of RMC Suppliers, Air Quality (if self-sourced), Consent to Operate from KSPCB | All RMC Sites | Contractor's Documents for all the indicators of Compliance, Air Quality Sampling and Analysis at all RMC sites | Monthly monitoring of air quality at all RMC sites and Periodically verify the validity of all approvals | Contractor with Supervision of KNNL in coordination with KSPCB | |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | | | | | | and activities carried out | | |
| C.7 | • Mitigation measures include identifying and constructing dedicated storage areas and equipment maintenance areas at construction sites.<br>• Fuel, oil and other materials need to be stored in dedicated areas in sealed tanks with a concrete base at least 20 m away from a water course or other sensitive area.<br>• Vehicles and machinery are not to be re-fuelled near water courses.<br>• Trained personnel should be available at the site to prevent spills and for adopting appropriate procedures for cleaning up accidental spills, | Material Storage Plan; Approvals from local authorities; Field Notes; QPR; SMR | Consent from KSPCB for Material Storage, Air and Water Quality | All material storage sites | Contractor's Documents for all the indicators of Compliance, Air and Water Quality Sampling and Analysis at all Material Storage sites | Monthly monitoring of air and water quality at all Material Storage sites and Periodically verify the validity of all approvals and activities carried out | Contractor with Supervision of KNNL in coordination with KSPCB | Package 1<br>₹ 37.50 Lakhs (US$ 57,692)<br>Package 2<br>₹ 22.00 Lakhs (US$ 33,846) |
| C.8 | • Mitigation measures include training the contractors and other agency staff on the importance of the OCR and procedures to be followed while working with the OCR such as no poaching or hunting activities.<br>• To avoid habitat damage and reduction of species, installation of signages about OCR will warn and guide people and construction workers.<br>• Also, apart from constructing secondary ring bund as provided in the bid documents<br>• The Contractor should refrain from use of blasting not only within the OCR region but also within 100 m of the OCR boundary. Pre-construction aquatic biodiversity survey should be taken up to confirm the location of the secondary ring-bunds.<br>• Likewise, no construction camp or material storage sheds should be | Training Plan, Pre-Construction and Post-Construction Aquatic Biodiversity Survey, Construction Schedules, Waste Disposal, Ecological Enhancement Plan; Field Notes; QPR, SMR | Aquatic Biodiversity Survey Report, Pre and Post-Construction Photographs and Videos, Waste Manifest, Approvals from KFD for all OCR related activities; Air, Water and Noise Quality Sampling and Analysis | All 9 anicuts located within the OCR | Analysis of the Project's Effect on Aquatic Biodiversity from Report, Photographs and Videos; Air, Water and Noise Water Quality; | Monthly monitoring of air, water and noise quality during the construction period at all sites; and Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KFD and KSPCB | Package 1<br>₹ 5.94 Lakhs (US$ 9,138)<br>Package 2<br>₹ 278.04 Lakhs (US$ 427,754) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | established within the OCR boundary or within 100 m of the OCR boundary.<br>• Additionally, all construction should be taken up during December to June period and between 9 am and 5 pm on the days of construction.<br>• Further, no construction technologies that causes noise and impacts the OCR should be utilised.<br>• Finally, the disposal of any silt, construction waste within the OCR should be avoided at all times during the construction period.<br>• More importantly, post-construction ecological enhancement measures suggested in the report should be implemented to safeguard the OCR. | | | | | | | |
| C.9 | • Mitigation measures include training the Contractors and other agency staff on the importance of the Hampi WHA and the measures to be taken to preserve the cultural integrity of the area.<br>• Also, in order to ensure that the heritage area is not impacted adversely, the rehabilitation works should be taken up as per the guidelines provided in the bid documents and conservation approach from HWHAMA.<br>• Also, blasting should be avoided with in the Hampi WHA so that the noise levels do not impact the 600-year old Hampi WHA.<br>• Likewise, no construction camp or material storage sheds should be established within the heritage area or within 100 m of the heritage area. | Training Plan, Pre-Construction and Post-Construction Photographs of the canal sections and monuments near the canal sections; Construction Schedules, Waste Disposal; Field Notes; QPR; SMR | Pre and Post-Construction Photographs and Videos, Waste Manifest, Approvals from HWHAMA and ASI for all Hampi WHA related activities; Air, Water and Noise Quality Sampling and Analysis | All canal sections in the Core, Buffer and Periphery zones of the Hampi WHA | Analysis of the Project's Effect on Hampi WHA from Report, Photographs and Videos; Air, Water and Noise Quality and Vibration measurements; | Monthly monitoring of air, water and noise quality and vibrations during the construction period at all sites; and Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with HWHAMA, ASI | Package 1<br>₹ 10.60 Lakhs (US$ 16,308)<br>Package 2<br>₹ 21.40 Lakhs (US$ 32,923) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • Further, no construction technologies that cause excessive noise and affect the heritage area should be utilised.<br>• Finally, disposal of any silt, or construction waste within the heritage area should be avoided at all times. | | | | | | | |
| | • Mitigation measures including sharing the construction schedule for the work carried out within the Hampi WHA with the ASI and HWHAMA at least two-weeks in advance for the start of the activity.<br>• The schedule should also provide the list of project activities that are slated to be carried out so that the ASI and HWHAMA can make a decision on supervising the activity.<br>• Also, any chance find of archaeological artefacts should be reported to the ASI and HWHAMA and the artefacts secured until the ASI and HWHAMA staff arrive at the site.<br>• Further, no project activity should be carried in that area until clearance is obtained from the ASI and ad HWHAMA. | Field Notes; QPR; SMR | Field Note recordings of information sharing and action taken | All canal sections in the Core, Buffer and Periphery zones of the Hampi WHA | Verifying field notes recordings on chance finding of archaeological artefacts | Periodically verify the activities | Contractor with Supervision of KNNL in coordination with ASI / HWHAMA | |
| C.10 | • Contractor will take every precaution to reduce levels of dust at construction sites.<br>• Water sprinkling will be carried out on haul roads.<br>• All earthworks to be protected/ covered to minimize dust generation.<br>• Regular maintenance of vehicles and equipment should be carried out at Pollution under Control (PUC) certificate should be obtained from the | Dust Reduction Plan; Vehicle and Equipment Maintenance Plan; Field Notes, QPR, SMR | Contractor's Record on adhering to the provisions of Dust Reduction Plan and Vehicle and Equipment Maintenance Plan; PUC | All Construction and Campsites; | PUC Certificates of Vehicles and Equipment Maintenance Schedule Followed; Air, Noise and Water Quality, Water Use Record | Monthly monitoring of air, water and noise quality during the construction period at all sites; and Periodically verify the validity of all | Contractor with Supervision of KNNL in coordination with KSPCB | Package 1<br>₹ 58.92 Lakhs (US$ 90,646)<br>Package 2<br>₹ 28.68 Lakhs (US$ 44,123) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | KSPCB and should remain current for the entire construction period. | | Certificates; Vehicles and Equipment Maintenance Record; Air, Water and Noise Quality Sampling and Analysis, Water Use for Dust Prevention | | | approvals and activities | | |
| | Noise limits during the construction period should not exceed 75 dB (A)<br>Work schedules should be decided in consultation with the local community so that the noise levels do not adversely impact the local community. | Noise Prevention Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Noise Prevention Plan; Noise Quality | All Construction and Campsites; | Noise Quality | Monthly monitoring of noise quality during the construction period at all sites; and Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KSPCB | |
| | Mitigation measures include environmental-friendly weed disposal, silt disposal and sediment management practices.<br>Records should be maintained for all practices. | Weed Management and Silt Disposal Plan and Sediment Management Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Weed, Silt and Sediment Management Plan; Manifest for Weed, Silt and Sediment Disposal; Air and Water | At all Construction Sites and Air and Water Quality Analysis and Sampling at all disposal sites; | Analysis of Weed, Silt and Sediment Disposal Activity; Air and Water Quality; | Monthly monitoring of Air and Water Quality during the construction period at disposal sites; Periodically verify the validity of all | Contractor with Supervision of KNNL in coordination with KSPCB | |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | | | Quality Analysis; | | | approvals and activities | | |
| | • Construction waste will not be disposed of around the project site and cause adverse impact on either soil or water or any other environmental medium.<br>• Construction wastes and debris should be disposed at engineered-landfills approved by the KSPCB.<br>• Hazardous materials, oils and lubricants should be managed as per regulations and should be approved by the KSPCB.<br>• Waste records should be maintained for all waste disposals. | Construction Waste and Debris and Hazardous Waste and Materials Management Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Waste Management Plan; Manifest Record of all wastes; KSPCB Approvals and Consents; Air and Water Quality Sampling | Air and Water Quality Analysis and Sampling at all disposal sites; | Analysis of Construction Waste, Debris and Hazardous Material and Waste Disposal Activity; Air and Water Quality; | Monthly monitoring of Air and Water Quality during the construction period at disposal sites; Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KSPCB | |
| C.11 | • Construction camp with all amenities will be located away from settlements as far as possible to avoid conflict with the local community for resource use, be it roads, firewood, drinking water and other basic requirements to make a living.<br>• Hampi WHA should not be used as location of construction camp facilities.<br>• Also, construction camp facilities should not be located at any place within 100 m of the OCR. | Construction Campsite Facility Management Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Facility Management Plan; Air, Water and Noise Quality | At all Construction Campsites | Air, Water and Noise Quality Monitoring | Monthly monitoring of Air and Water Quality during the construction period at construction and construction campsites; Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KFD, HWHAMA | Package 1<br>₹ 33.64 Lakhs (US$ 51,754)<br>Package 2<br>₹ 23.96 Lakhs (US$ 36,862) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • Mitigation measures include separation of solid wastes at source and disposing the wastes in ongoing solid waste management system approved by the authorities<br>• Composting of the kitchen wastes, constructing and operating septic tanks for treating wastewaters.<br>• All these waste management systems should be operated in an effective manner throughout the construction period. | Sanitation Plan; Waste Management Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Sanitation Plan and Waste Management Plan; Sanitation Maintenance Record; Waste Manifest Record; | All Construction and Construction Campsites | Air, Water and Noise Quality Monitoring; | Monthly monitoring of Air and Water Quality during the construction period at construction and construction campsites; Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KSPCB | |
| | • The fuel storage and vehicle cleaning area will be stationed in such a way that water discharge does not drain into any water body.<br>• Soil and water pollution parameters will be monitored as per monitoring plan.<br>• At construction camp, vehicle washing ramps will be constructed and an oil water separator pit will be provided at ramp area.<br>• All the vehicles maintenance will be done at an authorized workshop. The discarded fuel and lubricants will be stored in drums and sold to recyclers authorised by KSPCB. | Vehicle Operation and Maintenance Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of Vehicle Operation and Maintenance Plan; Approvals from KSPCB and any other local authorities' Air and Water Quality Monitoring | Fuel and Lubricant Storage Area; Vehicle and Equipment Cleaning and Maintenance Area; cleaning and Air, Water and Noise Quality Monitoring | Air, Water and Noise Quality Monitoring | Monthly monitoring of Air and Water Quality during the construction period at construction and construction campsites; Periodically verify the validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with KSPCB | |
| C.12 | • Sufficient supply of potable water should be provided at both the workers' campsites and construction sites for all the workers and their family members. | Construction Campsite Facility Management | Contractor's Record on adhering to the provisions of | At all Construction Campsites | Air, Water and Noise Quality Monitoring | Monthly monitoring of Air and Water Quality | Contractor with Supervision of KNNL in coordination with | Package 1<br>₹ 70 Lakhs<br>(US$ 107,692) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • Adequate, clean and hygienic sanitation (toilets and washing areas) and waste management facilities should be provided at both the workers' campsites and construction sites to protect the health of the workers' and their family members.<br>• provision of clean eating areas where workers are not exposed to the hazardous or noxious substances.<br>• Nutritious food should be provided for the workers at all times during the construction period and if workers' families prefer to cook their own food, adequate infrastructure should be provided for the same.<br>• To ensure good health for all workers and their family members during the construction period, periodic health monitoring from professional doctors should be carried out.<br>• Records should be maintained for all the facilities such as (i) or lost time cases, (ii) dangerous occurrences and incidents and (iii) work related fatalities<br>• Ensure that qualified first-aid can be provided at all times and easily accessible throughout the place of work<br>• Occupational Health and Safety orientation/training to all workers to ensure they are apprised of the basic site rules of work at/on the site and of personal protection and preventing injury to fellow employees. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. | Plan; Field Notes; QPR; SMR | Campsite Management Plan; Air, Water and Noise Quality | | | during the construction period at construction and construction campsites; Periodically verify the validity of all approvals and activities | Department of Labour, GoK | Package 2<br>₹ 38 Lakhs<br>(US$ 58,462) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • All vessels that may contain substances that are hazardous as a result of chemical or toxicological properties, or temperature or pressure, should be labeled as to the contents and hazard | | | | | | | |
| | • Surface water quality analysis is necessary for possible contamination and pollution of canals and anicuts.<br>• Adequate safety measures for workers while handling of materials at site will be ensured.<br>• Contractor has to comply with all regulations for the safety of workers, including complete use of PPEs.<br>• Precaution will be taken to prevent danger to workers from fire, etc.<br>• First aid treatment will be made available for all injuries likely to be sustained during the course of work.<br>• First aid stations and rooms should be equipped with gloves, gowns, and masks for protection against direct contact with blood and other body fluids<br>• Contractor will conform to all instructions on maintaining health and safety of the workers and their family members. | Workers' Safety Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of the Workers' Safety Plan; Insurance Details; Safety Equipment Details including its use; | At all construction sites and construction camps | Contractor' Record Book; Training Record; Insurance Details including claims, if any; | Monthly verification and validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with Department of Labour, GoK | |
| | • Workers employed on mixing cement, lime mortars, concrete etc., will be provided with protective footwear and protective goggles.<br>• Workers, who are engaged in welding works, will be provided with welder's protective eye-shields. | Workers' Safety Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of the Workers' Safety Plan; Insurance | At all construction sites and construction camps | Contractor' Record Book; Training Record; Insurance Details | Monthly verification and validity of all approvals and activities | Contractor with Supervision of KNNL in coordination with Department of Labour, GoK | |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | • Workers engaged in stone breaking activities will be provided with protective goggles and clothing.<br>• Use of any toxic chemical will be strictly in accordance with manufacturer's instructions.<br>• The Implementing Agency will be given at least 6 working days' notice of the proposed use of any chemical.<br>• A register of all toxic chemicals used at the site will be kept and maintained up to date by the Contractor. | | Details; Safety Equipment Details including its use; | | including claims, if any; | | | |
| C.13 | • Mitigation measures include establishing borrow areas at pre-identified locations where the Borrow Area Rehabilitation is approved by the local agencies.<br>• The *Rehabilitation Plan* that will be implemented effectively should include providing for vegetative cover on all cut / fill slopes to prevent soil degradation and protecting native species.<br>• The vegetative cover allows native floral and faunal species to grow and propagate. It also checks loss of top productive soil either by wind or rainfall/run-off water. Also, use of turfing should be considered for preventing soil erosion. | Borrow Area Rehabilitation Plan; Field Notes; QPR; SMR | Contractor's Record of adhering to the provisions of the Borrow Area Rehabilitation Plan; Approvals; Water Quality Monitoring | At all Borrow Area locations; | Baseline, During Construction Period and Post-Construction Period Monitoring | Recording Baseline, Construction Period and Post-Construction Period changes; Monthly Water Quality Monitoring | Contractor with Supervision from KNNL in coordination with Local Authorities | Package 1<br>₹ 54.30 Lakhs (US$ 83,538)<br>Package 2<br>₹ 21.72 Lakhs (US$ 33,415) |
| C.14 | • Contractor to prepare *site restoration plans* for approval by the implementing agency.<br>• The plan to be implemented by the contractor prior to demobilization should contain at a minimum, clearing of all temporary structures, disposal of wastes at pre-identified approved locations (by the KSPCB and local | Site Restoration Plan; Field Notes; QPR; SMR | Contractor's Record on adhering to the provisions of the Site Restoration Plan; | All construction campsites used by the Contractor | Pre and Post-Construction Topographic Survey, Photographs and Videos; Water Quality | Recording Baseline, Construction Period and Post-Construction Period changes; | Contractor with Supervision from KNNL in coordination with Local Authorities | Package 1<br>₹ 45 Lakhs (US$ 69,231)<br>Package 2<br>₹ 24 Lakhs (US$ 36,923) |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | authority), and septic tanks effectively sealed off.<br>• The site should be left clean and tidy by the Contractor to the entire satisfaction of the implementing agency. | | Approvals; Water Quality | | Sampling and Analysis | Monthly Water Quality Monitoring | | |

**Table 65: Summarizing the Monitoring Requirements for the Mitigation Measures for Operation Phase**

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| O.1 | The project has water conservation objective in line with the need to enable the agriculture sector to be climate resilient. As such, it is necessary to monitor water abstractions from the canal so that the impact of the project can be monitored on a regular basis. | Water Abstractions Measurement Plan; Field Notes; QPR; SMR | KNNL adherence to the Water Abstractions Measurement Plan | As indicated in the Water Abstractions Management Plan | Water Abstractions | As indicated in the Water Abstractions Management Plan | KNNL with Supervision from WRD, GoK | Through budgetary provisions after construction period |
| O.2 | • Periodic water quality monitoring is suggested to ensure that the point and non-point pollutant discharges do not impact the water quality either in the canal or in water bodies to which the canal ultimately would discharge into.<br>• KNNL should work with ULBs covering canal sections namely, Hospet, Kampli, Gangavathi and Siriguppa for the implementation of action plans to prevent or minimize liquid and solid wastes disposal into the canals. | Water Quality Monitoring Plan; Field Notes; QPR; SMR | KNNL adherence to the Water Quality Monitoring Plan | As indicated in the Water Quality Monitoring Plan | Water Quality | As indicated in the Water Quality Monitoring Plan | KNNL with Supervision from WRD, GoK in coordination with KSPCB | Through budgetary provisions after construction period |
| O.3 | • Desilting of drains should be done periodically to maintain the hydraulic capacity of the canals.<br>• Silt should be disposed of in an environment-friendly manner. | Canal Desilting Plan; Field Notes; QPR; SMR | KNNL adherence to the Canal Desilting Plan | As indicated in the Canal Desilting Plan | Budgetary Spends on Desilting Works | Annually | KNNL and CADA with Supervision from WRD, GoK | Through budgetary provisions after construction period |
| O.4 | • Non-point pollution discharges primarily nutrients and pesticides from the agricultural fields can be prevented through skilled application of these materials on farm lands.<br>• Appropriate training and capacity building activities should be carried out in the command areas so that farmers are trained to utilize | Water Quality Monitoring Plan; Field Notes; QPR; SMR | KNNL adherence to the Water Quality Monitoring Plan | As indicated in the Water Quality Monitoring Plan | Water Quality | As indicated in the Water Quality Monitoring Plan | CADA with Supervision from WRD, GoK in coordination with KSPCB | Through budgetary provisions after construction period |

| S. No. | Proposed Mitigation Measures | Indicators of Compliance | Parameters to be Monitored | Location | Measurement | Frequency | Implementation Responsibility | Cost Estimates |
|---|---|---|---|---|---|---|---|---|
| | fertilizers and pesticides in an optimum eco-friendly manner. | | | | | | | |
| O.5 | Measures for ecological enhancement to safeguard the OCR include deweeding periodically for enhancing growth of the aquatic flora and introducing native fingerlings for ensuring food security for the aquatic animals. | Ecological Enhancement Plan; Field Notes; QPR; SMR | KNNL adherence to the Ecological Enhancement Plan | As indicated in the Ecological Enhancement Plan | Status of Aquatic Biodiversity | Annually | KNNL with Supervision from WRD, GoK in coordination with KFD, GoK | Package 2 ₹ 48 Lakhs (US$73,846) |

## 7.6 Costs for Implementing Environmental Management Plan

440. Implementing the Modernization of the VNC Project is being taken up in two packages. The Package 1 consists of rehabilitating 15 canals (except Turtha) and 3 anicuts (i.e., Deshnur, Siriguppa and Bichal) referred to as the Non-OCR / Non-HHA project area. The Package 2 consists of rehabilitating Turtha canal and 8 anicuts (i.e., Bella, Turtha, Ramasagara, Kampli, Anegundi, Hulugi, Upper Gangavathi and Lower Gangavathi). In this regard, it should be noted that though Shivapura Anicut is located within the OCR, rehabilitation of the anicut will not be taken up under the project because of certain technical reasons.

441. Since the Project is implemented in two packages, the costs for implementing the Environmental Management Plan (EMP) is estimated for both the packages and summed up together to provide the total cost for implementing the EMP for both the packages under the Project. The implementation schedule is provided in ***Annexure 5***.

442. The total cost of implementing the EMP for the Modernization of VNC Project is estimated to be **Rupees 14.13 Crores (Approximately (USD 2.17 Million)**. The costs mainly cover costs of monitoring environmental impact arising from project implementation on various environmental attributes such as air, noise, groundwater, surface water, river water and aquatic ecosystem. It may be noted that these costs do not include capital costs required to establish camp sites and sanitation facilities for workers and staff, vehicles used for implementing EMP including O&M of the vehicles and equipment, and implementation of mitigation measures for safeguarding the OCR and the HHA and all the other costs generally considered part of the main project costs. It may be noted that monitoring of all environmental media, viz., air, noise, groundwater, surface water and aquatic ecosystem should be done as per standard international practices. This would include conducting both baseline monitoring and actual monthly monitoring the various parameters as per standard international practice. However, cost towards burrow area closure and construction camp closure has been provided on a lump-sum basis so that the closure of these areas is done in an environmental-friendly manner. Additionally, a cost towards afforestation and ecological enhancement has also been estimated. The breakup of EMP costs implementation for each of the packages is provided in ***Table 66***:

**Table 66: Breakup of EMP Costs**

| Package | Costs in INR | Cost in USD (@ 1USD=INR65) |
|---|---|---|
| **Package 1** | **7,47,51,600** | **1,150,025** |
| **Package 2** | **6,65,06,000** | **1,023,169** |
| **TOTAL** | **14,12,57,600** | **2,173,194** |

443. The detailed calculation of the EMP costs for each of the activities during the Construction Phase is provided in ***Annexure 6***. ***Table 67*** provides a summary of all the costs.

**Table 67: Modernization of VNC Project–Summary of Costs for Implementing Construction Phase EMP**

**1 USD = INR 65**

| No. | Project Activity | EMP Costs (PACKAGE 1) | | EMP Costs (PACKAGE 2) | |
|---|---|---|---|---|---|
| | | In INR | In USD | In INR | In USD |
| 1 | Site Clearance Costs | 33,60,000 | | 20,16,000 | |
| 2 | Tree Removal and Afforestation | 87,50,000 | | 5,00,000 | |
| 3 | Weed Removal and Management | 4,50,000 | | 3,00,000 | |
| 4 | Silt Removal and Silt Disposal | 15,00,000 | | 7,00,000 | |
| 5 | Transportation of Machinery, Equipment and Material | 1,56,000 | | 1,04,000 | |
| 6 | Material Sourcing | 19,50,000 | | 4,60,000 | |
| 7 | Storage and Handling of Materials | 37,50,000 | | 22,00,000 | |
| 8 | Impact due to construction within the River (for Package 1) and OCR (for Package 2) | 5,94,000 | | 278,04,000 | |
| 9 | Impact due to construction within the Hampi WHA | 10,60,000 | | 21,40,000 | |
| 10 | Rehabilitation of Anicuts, Canals and Canal Structures | 58,92,000 | | 28,68,000 | |
| 11 | Construction Campsite Facility Management | 33,64,000 | | 23,96,000 | |
| 12 | Workers' Health and Safety | 70,00,000 | | 38,00,000 | |
| 13 | Borrow Area Rehabilitation | 54,30,000 | | 21,72,000 | |
| 14 | Closure Activities | 45,00,000 | | 24,00,000 | |
| 15 | Staff and Book-keeping Costs | 192,00,000 | | 96,00,000 | |
| 16 | Purchase of Environmental Monitoring and other Equipment | 10,00,000 | | 10,00,000 | |
| | **Total** | **679,56,000** | | **604,60,000** | |
| | **Miscellaneous (10% of Total)** | **67,95,600** | | **60,46,000** | |
| | **Grand Total** | **747,51,600** | **11,50,025** | **665,06,000** | **10,23,169** |

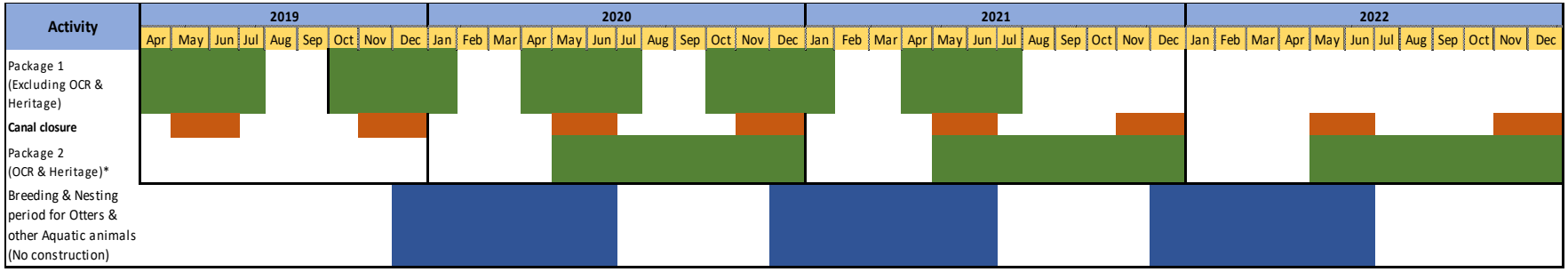
444. In order to avoid construction impacts to the sensitive areas, the canals and anicuts are grouped into two implementation schedule packages. In this manner, construction methodologies are aligned with the level of sensitivity of the area. As an example, based from the Biodiversity expert and the KFD, December to June are the months when aquatic animals (otters, crocodiles, etc) breeding and nesting period in their habitats. Hence, there will be no construction during this period in package 2. However, construction activities continue in package 1 because there are no sensitive habitats in the project location.

445. The first package involves non-sensitive areas of the project. These are canal lining of the Raya, Basavanna, Kalaghata, Ramasagara, Kampli, Belagodahal, Deshur, Hulugi, Shivapura, Anegundi, Upper and Lower Gangavathi and Bichal. Also, the rehabilitation of anicuts of Siruguppa, Deshnur and Bichal are included in package 1. It is suggested that there will be no construction activities during wet season or the months of June until October.

446. Package 2 includes the anicuts of Bella, Turtha, Ramasagara, Kampli, Hulugi, Anegundi, Upper and Lower Gangavathi and Turtha canal. These are the sensitive areas of the project because of the otter conservation reserve and heritage zone. There will be no construction activity during the breeding and nesting period of aquatic animals for over half of a year.

447. The following figure shows the possible implementation schedule. It is the result of the findings of the environmental study of the project. Moreover, this will be recommended for the site-specific EMP of the contractor.

Program chart for Canal lining, Structures and Building works




***Anicut works to be done during July-Nov period ONLY due to Breeding/Nesting period of Otter and other aquatic animals. However, channel works are possible during May-Dec period.**

## 7.7 Environmental Institutional Strengthening and Training Program

448. The effectiveness of the EMP implementation will be dependent on the effectiveness of the institutions executing the project. Towards this, the key institutions such as KNNL who are involved in overseeing the Contractor's works should have sufficient manpower either in-house or hired through Consultants for carrying out periodic review of the EMP implementation. In addition, considering that the project is implemented in ecologically and culturally sensitive areas, the Contractor carrying out the civil works should utilize staff who have the necessary skills to appreciate the issues involved and implement the EMP in an effective manner. In order maintain the environmental integrity during the construction and operation phases of the project; the following institutional strengthening should be carried out, as well.

**Table 68: Summarizing Institutional Strengthening on Environment**

| S. No. | Strengthening Activity | Position (Responsibilities) | Strengthening Program | Schedule | Cost Estimate |
|---|---|---|---|---|---|
| 1 | Mitigation of Environmental Impacts | Executive Engineer (Environment) with a responsibility to oversee the processes adopted to assess the environmental impact and finalise the mitigation measures that would need to be implemented for mitigating the environmental impacts for each of the projects | PSC to provide technical assistance to strengthen the capacity within the organization to address environmental issues in each of the project carried out by the organization. | Strengthening activities to be carried out by the PSC during the project | NA |
| 2 | Monitoring of Environmental Quality | Environmental Scientist with a responsibility to monitor the effectiveness of the mitigation measures and the environmental management plan developed for each of the projects. | PSC to provide technical assistance to strengthen the capacity within the organization to monitor the environmental impacts and the effectiveness of the mitigation measures on the environmental media for each of the project carried out by the organization. | Strengthening activities to be carried out by the PSC during the project | NA |

449. Additionally, the following training program should be undertaken. While the cost for the training program has been indicated, these are not part of the EMP costs but will be provided under provisional sums in the main project.

**Table 69: Summarizing Training Program on Environment**

| S. No. | Training Activity | Participants | Training Content | Schedule | Cost Estimate |
|---|---|---|---|---|---|
| 1 | Environmental Policies and Programs | Management and Senior Engineers at KNNL and CADA | Program to include environmental linkages to the water, biodiversity, physical cultural resources, irrigation and agricultural sector including policy, and legal issues so that the sectors can be managed in a sustainable manner | PSC to conduct one Program at the start of the Project | Total for both Packages ₹ 10 Lakhs (US$ 15,384) |
| 2 | Environmental Processes Methods and Equipment | All Senior Engineers at KNNL and CADA | Program to include environmental assessment process employed including identification of alternatives and finalisation of designs so as to address the environmental impacts prevalent in the sector. | PSC to conduct one Program at the start of the Project | Total for both Packages ₹ 10 Lakhs (US$ 15,384) |
| 3 | EMP Implementation (borrow pit management plan, silt disposal plan, compensatory afforestation plan and physical cultural resources management plan) and GRM | All Engineering staff at KNNL and CADA; Senior and Environmental related Staff of the Contractor | Program to provide details of EMP designs provided for the project and the related implementation issues including fostering stakeholder engagement practices for effective implementation of the EMP. Moreover, there are many sub-plans in the EMP that will guide KNNL, CADA and contractors to mitigate impacts of construction. Also, the trainings will provide information on the policies and requirements of the government towards subjects of the trainings. | PSC to conduct one Program at the start of the Project | Total for both Packages ₹ 10 Lakhs (US$ 15,384) |
| 4 | Emergency Prepared-ness and Response | All Engineering staff at KNNL and CADA; all of the contractor's staff and nearby communities | In order to be prepared and respond to accidental and emergency events, there is a capacity building for emergency responses that will include procedures on how to respond effectively to emergencies associated with project hazards. The appropriate information about emergency preparedness and response activities, resources, and responsibilities should be disclosed to nearby communities during the training. | PSC to conduct one Program at the start of the Project | Total for both Packages ₹ 15 Lakhs (US$ 23,076) |

## 7.8 Addressing Capacity Building Needs

450. The environmental impact assessment has identified the need for effective operation of environmental management activities during the pre-construction, construction and operation phases to ensure optimal management of water resources, and due local resource mobilization for sustainable O&M while minimizing the negative environmental impacts. These have to be operated with necessary hardware and software to establish and monitor appropriate indicators. The key to effective environmental management would be the presence of well-trained and motivated human resources within KNNL, and

within collaborating agencies such as CADA and WUCS. As to KNNL, sensitivity to non-engineering issues, ability to work with beneficiary population and affected people, skills to resolve conflicts need to be developed/strengthened on top of engineering skills that they already have. To meet these requirements, KNNL in Project 1 has diversified the concerned engineers' skill mix to include an understanding of the environmental and social issues. However, these need to be further expanded in project 2 KNNL staff with establishment of skills in working in conservation and heritage areas.

451. The PSC will assist KNNL in implementing Environmental Management Plan (EMP) and provide necessary awareness and training to KNNL staff and other collaborating organizations including CADA and WUCS. In the absence sufficient staff with environment related subject matter specialisation, PSC will organize capacity building activities for engineers. Tie-ups with training and research institutions as part of the project for all capacity building requirements on thematic aspects will also be explored.

## 7.9 Reporting

452. Soon upon selection, the Contractor should prepare and submit the Construction Environmental Management Plan (CEMP) to the PMU in accordance to the EMP provided in the EIA Report (vol. 2a of the VNC Feasibility Study Report). Upon approval of the CEMP by the PMU, the Contractor will begin CEMP implementation, monitoring, recording the results, collecting data and submitting monthly reports to the PIO. The PIO should supervise the Contractor on its tasks and resposibilities under the CEMP. On the basis of the reports received and audits, PSC and PIO will prepare the Safeguard Monitoring Report on a quarterly basis and submit to KNNL/PMU on half yearly basis. Upon review and approval, PMU submits the bi-annual Safeguard Monitoring Report to the ADB.

# 8. GRIEVANCE REDRESSAL MECHANISM

453. The Contractor will outline a detailed procedure for community complaint and grievance redressal mechanism (GRM). Every affected person will have three options to get the grievance redressed. Option 1 is established under the Project, Option 2 is accessing through the country's legal system and Option 3 is for the affected person to access through the ADB Accountability System.

454. **Option 1:** Option 1, which is the Project-level GRM will consist of the following stages:

***First Stage:***

455. At the first stage, the person with any form of grievance would approach the Contractor (proposed as the agency responsible for implementation of the EMP). A copy of the grievance may also be provided by the affected person to the local WUCS office. The Contractor will make efforts to resolve the grievance within 1-5 working days at that level in a consultative manner. A Grievance Redressal Register must be maintained by the Contractor and WUCS for all such complaints.

***Second Stage:***

456. If the affected person is not satisfied or the grievance is not redressed within 5 working days, the Contractor will be responsible for assisting the concerned person for getting the grievance registered with the Canal-Level Grievance Redressal Committee (CL-GRC) who will comprise representatives from the Contractor, WUCS, KNNL and GP. The CL-GRC will make efforts to resolve the grievance of the complainant within 5-7 working days after the matter is brought to the Committee notice. A Grievance Redressal Register will be maintained by the Contractor for all complaints. The Contractor will share the information on such complaints with the Executing Agency on a Monthly basis. Additionally, the local WUCS office will be instructed to maintain a Complaint Register.

***Third Stage:***

457. If the affected person is not satisfied or the grievance is not redressed within 7 working days, the Contractor will assist the affected person to register the complaint with the Project Manager at the KNNL Project Implementation Office (PIO). At the third stage, the Project Manager will ensure that the aggrieved person is heard and the grievance redressed in the best possible manner in a consultative manner within 10 working days from the date of registering the grievance.

***Fourth Stage:***

458. If the affected person is not satisfied or the grievance is not redressed within 10 working days, the Project Manager will be responsible for getting the grievance registered for the hearing by the Project-Level Grievance Redressal Committee (PL-GRC). The PL-GRC comprises PIO Chief Engineer as Chairman, one member from the Revenue and Agriculture Departments, a representative of KNNL, Contractor, Panchayat, a representative from the WUCS Federation, members and representatives of affected persons, including women and vulnerable people. The PL-GRC will conduct a hearing on the grievance within 3 weeks from the date of registration of grievance. Other than disputes relating to ownership rights under the court of law, the PL-GRC will review

grievances involving all environmental and social impacts arising from the project implementation. All costs incurred in resolving the complaints will be borne by the Project. A comprehensive record will be maintained by EA for all grievance proceedings organized at different stages and reported within the Safeguard Monitoring report, submitted to ADB on a bi-annual basis.

459. The flow chart of the Option 1 GRM process is provided in ***Figure 22***, below:

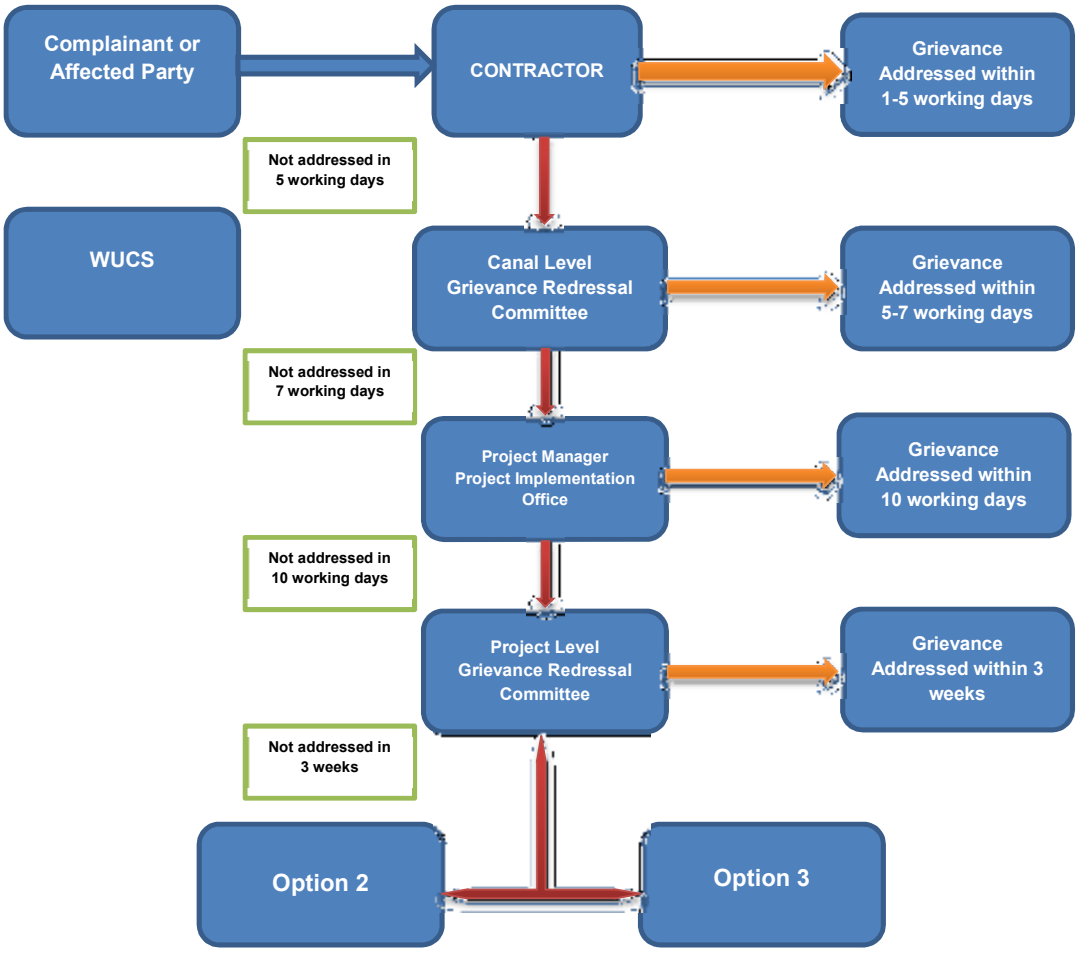



**Figure 22: Flowchart for Grievance Redressal Mechanism**

**Option 2:**

460. An aggrieved person is free to access the country's legal system and that this is not conditional upon the perceived unsatisfactory outcome of the CL- or PL-GRM.

**Option 3:**

461. In the event that the established GRM is not in a position to resolve the issue the affected person can also use the ADB Accountability Mechanism by directly contacting (in writing) the Complaint Receiving Officer (CRO) at ADB headquarters or ADB India Resident Mission (INRM). The complaint can be submitted in any of the official languages of ADB's developing member countries. Before submitting a complaint to the Accountability

Mechanism, it is recommended that affected people make a good faith effort to resolve their problems by working with the concerned ADB operations department (in this case, the resident mission). Only after doing that, and if they are still dissatisfied, they could approach the Accountability Mechanism. The ADB Accountability Mechanism information will be included in the project-relevant information to be distributed to the affected communities, as part of the project GRM.

**Record Keeping**

462. Records of all grievances received, including contact details of complainant, date the complaint was received, nature of grievance, status and agreed corrective actions will be kept by the Contractor, PIO (with the support of PSC) will collect the data from the Contractor and submit to PMU (state level). This information will be reported to ADB by the PMU in bi-annual safeguard monitoring reports.

**Information Dissemination Methods of the Grievance Redress Mechanism**

463. The PIO, assisted by PSC will be responsible for information dissemination to affected persons and general public in the project area on the options for filing a grievance; including easy to understand detail of the first option. A public awareness campaign will be conducted at the individual canal-level, at the start of the project to ensure awareness on the project and its grievance redress procedures. The campaign will ensure that the poor, vulnerable (women) and others are made aware of grievance redress procedures. The information campaign will also provide details on whom to contact and when, where/ how to register grievance, various stages of grievance redress process, time likely to be taken for redress of minor and major grievances, etc. Grievances received and responses provided will be documented and reported back to the affected persons. The number of grievances recorded and resolved and the outcomes will be displayed/disclosed in the PIO offices, WUCS, GP offices, as well as reported in the semi-annual safeguard monitoring reports to be submitted to ADB. Contractors must display details of the CL-GRM on their notice board at every site.

**Periodic Review and Documentation of Lessons Learned**

464. The PMU will periodically review the functioning of the GRM and record information on the effectiveness of the mechanism, especially on the PIU's ability to prevent and address grievances.

**Costs**

465. All costs involved in resolving the complaints (meetings, consultations, communication and reporting/information dissemination) will be borne by the respective PIO. Cost estimates for grievance redress are included in resettlement cost estimates.

# 9. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

## 9.1 Stakeholder Consultations

466. Several stakeholder consultations were carried out in the VNC project area in the past two years. These consultations were both informal and formal in nature.

467. Informal consultations are those consultations that have been held with various stakeholders while carrying out the field visits. During informal consultations, the PSC reached out to the stakeholders through senior officials of KNNL, farmers' organizations in the region and through personal contacts with the Non-Governmental Organizations (NGOs).

468. In addition, formal consultations were held during April and May 2018 with government departments and farmers separately. Formal consultations were held by sending out invitation letters to the various stakeholders 7-10 days in advance. In case of formal public consultations, newspaper advertisements were issued to inform the public about the venue, time and purpose of the consultations.

The following are the key stakeholder groups:

- Farming communities from the VNC project area represented by the farmers associations, WUCS, NGOs and others;
- Institutional stakeholders such as Karnataka Neeravari Nigam Limited (KNNL), Karnataka Forest Department (KFD), Hampi World Heritage Area Management Authority (HWHAMA), KSPCB, Hospet City Municipal Corporation, Gangavathi Town Municipal Corporation in the command area and the Tungabhadra Board which is a Government of India administered Board to monitor the implementation of the Krishna Tribunal Award amongst the basin states including Karnataka.

## 9.2 Objectives of Stakeholder Consultations

469. The main objective of consultations is to mobilize public opinion towards the project, and take on board their views, opinions and concerns so that they can be accommodated within the project design. The objectives of stakeholder consultations can be stated as:

- To promote public awareness among various stakeholder groups about the proposed project, especially amongst communities who could be potentially impacted;
- To educate such communities about the proposed course of action and project alternatives;
- To solicit views of stakeholders on environmental and social issues;
- To gather inputs from affected communities on crucial decisions regarding mitigation of the identified environmental and social issues;
- To stimulate community self-evaluation and analysis. and
- To minimize public resistance to change by providing them a platform in the decision-making process.

## 9.3 Stages of Consultation and Information Dissemination

470. As per the Section 7(i) III (3) (a) of EIA Notification, 2006, conducting public consultations for modernization of irrigation projects are exempted. Nevertheless, PSC team and KNNL led by the Environmental Specialist and the Social and Gender Specialist held

consultations with relevant stakeholders to arrive at logical conclusions presented in the EIA. The team as a whole has conducted consultations with farmer's representatives from the command areas of each of the canals, HWHAMA, NGOs and WUCS and local communities in both Hospet and Gangavathi Urban Local Body.

## 9.4 Informal Consultations

471. Eight informal consultations were held during the study. The issues raised during these informal stakeholder consultations is presented below in ***Table 70***.

**Table 70: Issues Raised and Addressed during Stakeholder Consultations**

| S. No. | Event Location | Stakeholder Consultation Date | No. of women attended | Issues Raised | Response |
|---|---|---|---|---|---|
| 1 | HWHAMA, Hospet | 16 April 2016 | None | Construction materials utilised to implement rehabilitation works should be in line with the Heritage status of the area. | Towards this, KNNL has agreed to provide modified designs to be included in the bid document also taking care to use materials suggested in HWHAMA guidelines. |
| 2 | Farmers Representatives in Anegundi | 25 May 2016 | 2 out of 20 people | Issues raised include conditions of canals causing leakages; non-availability of adequate quantity of water to farmers.<br><br>Farmers also expressed their keenness to form/strengthen Water Users Cooperative Societies and to take up implementation of CAD works through WUCS.<br><br>Shivapura Canal farmers wanted Shivpura Anicut to be included in the project. | Project design explained along with its objective of ensuring sustainable water resources management through canal rehabilitation and irrigation system modernization with formation/strengthening of WUCS and giving responsibility to WUCS to implement CAD works.<br>It was explained to Shivpura Canal Command Area farmers that rehabilitation of Shivpura Anicut was not included in the project due to technical reasons. Technical options may be further explored by KNNL. |
| 3 | Farmers Representatives served from Hulugi and Shivapura Canals | 26 May 2016 | 2 out of 30 people | | |
| 4 | Farmers and Town Representatives from Gangavathi Town | 26 May 2016 | 4 out of 20 people | | |
| 5 | Farmers representatives served from Deshnur and Siruguppa Canals | 27 May 2016 | None | | |
| 6 | Public Consultation at Shivapura Panchayat | 27 May 2016 | 20 out 50 people | Community expressed the need for the project to provide funds for the development of | To explore further about the type of infrastructure needs demanded and examine if this is possible within the |

| S. No. | Event Location | Stakeholder Consultation Date | No. of women attended | Issues Raised | Response |
|---|---|---|---|---|---|
| | | | | local infrastructure in the villages | project components. If necessary, project will try to dovetail with other government schemes. |
| 7 | Tungabhadra Board | 01 June 2016 | None | Need to educate farmers on environmental and water conservation aspects. | Explained the project design and incorporation of WUCS training and capacity building aspects on various issues including environmental, social, CAD works implementation, O&M etc. |
| 8 | Farmers representatives served from Upper Gangavathi and Lower Gangavathi Canals | 23 February 2018 | None | Issues raised include canal condition leading to leakages; non-availability of adequate quantity of water for farming.<br>Also, farmers expressed their readiness to form/strengthen Water Users Cooperative Societies and to take up implementation of CAD works under WUCS. | Explained the project design and its objective of ensuring sustainable water resources management through canal rehabilitation and irrigation system modernization with a focus on formation of WUCS and giving the WUCS the responsibility to implement CAD works. |

## 9.5 Formal Consultations

472. In addition to informal consultations described in Table 70, PSC conducted two formal public consultations during the months of April and May 2018. For these consultations, an agenda had been prepared and invitations to the concerned departments and farmers/WUCS sent out in advance. The agenda comprised explaining details about the project, social safeguards, environmental aspects, rapid biodiversity assessment and tree survey findings. The role of WUCS in the execution of the main works in terms of participation through monitoring was stressed. Explaining the need for preservation of Otters and other aquatic animals, PSC team stressed about being sensitive towards them and their habitats. In response to the newspaper ad and invitations, there was an overwhelming response to the farmers consultation held on 29 May 2018. During the course of the event, PSC has also showed videos about the ongoing Gondi Modernization and the encouraging response and active participation of WUCS in CAD packages. It was announced that farmers from VNC will be taken to Gondi project shortly.

473. The public showed strong acceptance from various sectors including women and disadvantage people. The rehabilitation of canals and anicuts will improve water availability in the project areas. For them, the tail end regions will also benefit as much as the head areas of the project. Also, they believed the improvement of the capacity of WUCS and a project level federation will address local water management problems and issues on water access.

474. To motivate farmer groups and WUCS, PSC has already planned to have canal wise consultations/meetings before execution of modernization works to inform about the proposed works in detail, and to ensure their participation.

### 9.5.1 Formal Stakeholder Consultation on April 24, 2018

475. A formal stakeholder consultation was held with various state and central agencies on April 24, 2018. The central agencies invited included the Tungabhadra Board and the Archaeological Survey of India. State agencies invited for the consultations include Karnataka Forest Department, State Archaeological Department, Hampi World Heritage Area Management Authority, Karnataka State Pollution Control Board, Municipal Corporation at Hospet, Kampli, Gangavathi and Siruguppa. Details of formal stakeholder consultation are provided in ***Table 71***.

**Table 71: Issues raised during Formal Stakeholder Consultations on April 24, 2018**

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Stakeholders |
|---|---|---|---|---|
| 1 | Chief Engineer's Office, Munirabad | 24 April 2018 | • To begin with, KNNL delivered a brief presentation providing an overview of the technical and the implementation aspects of the Modernization of the VNC Project.<br>• Following this, PSC made a presentation on the Feasibility Study on the Project;<br>• Subsequently, PSC delivered a presentation on the Social safeguards and Environmental aspects of the project primarily focusing on Otter Conservation Reserve and the Hampi World Heritage Area. | • Representatives of HWHAMA mentioned that in response to the KNNL letter dated December 11, 2017, a Joint Inspection of the ASI, HWHAMA and the State Archaeology Department members was conducted in December 19, 2017 to all the project areas coming within the Hampi WHA.<br>• Representatives of ASI informed that a report on the Joint Inspection was submitted by the ASI to HWHAMA.<br>• Representatives from HWHAMA mentioned that upon receiving the report from the ASI, HWHAMA has issued approval on April 6, 2018 to implement the project within the Hampi WHA reiterating the terms and conditions mentioned in their earlier approval dated January 23, 2013. |

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Stakeholders |
|---|---|---|---|---|
| | | | | • Representatives from ASI mentioned that because of certain institutional changes within ASI, the Director General of Hampi Circle will be responsible for providing approvals to all projects coming within the purview of the ASI and located within the Hampi WHA.<br>• ASI also mentioned that a separate DPR for the portions of the project falling within the Hampi WHA should be submitted by KNNL to both ASI and HWHAMA for a review on how the project will be addressing the terms and conditions set out in the HWHAMA approval letter. Upon submission of the DPR, the agencies agreed to review the report and suggest necessary changes so that the project can be implemented in line with the requirement of the agencies.<br>• Representatives from KFD, who reviewed the measures included in the project for the portions of the project falling within the OCR had a word of appreciation for the initiative taken to carry out the Biodiversity Assessment and understand the impacts of the project on the OCR.<br>• Also, representatives from KFD mentioned that the staffs from KFD have visited 4 (now 6) of the 9 Anicuts located within the OCR and field visits for the other 5 Anicut sites will be completed soon. KFD also requested for submission of drawings of all the relevant anicuts. Upon completion of the field visits and the review of the additional documents sought for, representatives from KFD said that a report |

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Stakeholders |
|---|---|---|---|---|
| | | | | will be submitted to the Head Office who will take a decision on issuing the necessary *'recommendation'* for the project.<br>• All stakeholders who attended the consultations were highly appreciative of the project and lauded the initiative of KNNL to carry out the consultations, thus ensuring that all relevant issues are addressed during the initial stages of the project. |

### 9.5.2 Formal Public Consultation with farmers on May 29, 2018

476. Subsequent to the stakeholder consultations involving central and state agencies, a formal public consultation was held on May 29, 2018. All farmers' organizations and their members were invited officially through a letter issued by KNNL. An advertisement was also placed in the local paper. The details of the formal public consultation are provided in ***Table 72***.

**Table 72: Issues raised during Formal Public Consultation with farmers on May 29, 2018**

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Public Stakeholders |
|---|---|---|---|---|
| 1 | Vedapathashala, Chikkarampura Village, (Near Anjanadri betta); | 29 May 2018 | • Initially, KNNL delivered a brief presentation providing an overview of the technical and the implementation aspects of the Modernization of the VNC Project.<br>• Later, PSC delivered a presentation on the Participatory Irrigation Management System focus of the Project;<br>• Subsequently, the PSC delivered a presentation on the Environmental and Social | • Farmers from almost all the canals requested to share with them the DPR of each of the canals separately. PSC has revealed that this activity is already planned and all details will be shared along with KNNL before execution of the project begins.<br>• Farmers from Basavanna Canal area wanted that wastewater from Hospet should not enter Basavanna Canal as this was causing health problems.<br>• Farmers from Shivpura Canal command area demanded rehabilitation of Shivpura Anicut to ensure water availability to the command area farmers.<br>• Farmers from the Hulugi Canal command area |

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Public Stakeholders |
|---|---|---|---|---|
| | | | aspects and how these have been integrated into the project.<br>• Finally, both PSC and KNNL stressed the need for the farmers to raise their issues of concern openly at the meeting.<br>• A video of the entire public consultation was filmed and will be digitized for future reference. | stressed on the need to ensure that discharges from Hulugi Village and Hulugi Temple are prevented so that contamination of canal water arising from these discharges could be avoided.<br>• Farmers from Anegundi Canal command areas requested to ensure that canal sections are able to accommodate the storm water runoff from the rocky terrain adjacent to the canal. This may require some modifications in the canal designs of those locations.<br>• Also, farmers mentioned that the elevation of the service road has increased following disposal of silt on the service road over the years. Farmers of the command area have requested KNNL to maintain the elevation of the service road as per KNNL design standards and ensure that excess silt disposed on the existing service road is removed.<br>• Farmers from the Upper and Lower Gangavathi Canal command areas, while welcoming the project, appreciated the establishment of the Water Users Cooperative Societies (WUCS) in each of the command areas and assured all help in sustaining the initiative.<br>• There was initially some restlessness expressed by some farmers due to the inordinate delay in project implementation. They were however explained the reasons, and the need for systematic study of social, environmental and other |

| S. No. | Location | Consultation Date | Agenda | Issues Raised by Public Stakeholders |
|---|---|---|---|---|
| | | | | aspects especially when external funding is involved.<br>• Finally, all stakeholders who attended the consultations were highly appreciative of the project and the consultations. They felt that all relevant issues have been addressed. |

477. As part of environmental safeguards requirement, inputs from the women stakeholders were sought through two formal public consultations. In April 24, 2018, the first formal consultation was attended by various state and central stakeholders. Out of twenty people, there were three women involved in this public consultation. The second formal public consultation on May 29th 2018, majority of the people was attended by farmers from different Water User Cooperative Societies (WUCS), farmer associations and non-government organizations. Out of the 265 attendees, twenty women joined the public consultation.

478. List of participants who attended the public consultations along with photographs is provided in ***Annexure 4.***

# 10. CONCLUSIONS

479. The study has concluded that the proposed "Modernization of the Vijayanagara Channels Project" can be executed without any major environmental impacts and is considered beneficial to both farmers and flora and fauna. The project is likely to achieve its goals of equitable distribution of water, improved water use efficiency and creation of congenial environment including abundant availability of water for Otters and aquatic animals to thrive. Strengthening of Water Users Cooperatives and their active participation are expected to contribute to sustainability of project gains.

480. Though the project is called a modernization project, in fact, all the civil components of the project constitute only rehabilitation of irrigation infrastructure, improved drainage and on-farm development. There is no new construction envisaged. Put differently, rehabilitation includes improvements to anicuts, lining of canals, rehabilitation of various structures along the main and distributaries, and field irrigation channels. Due to implementation of the project, it is expected that there would be improved availability and distribution of water, with water reaching the tail end portions too, at design rates. Timely and adequate availability of irrigation water combined with sustainable agricultural practices is expected to increase crop yields significantly as projected in the economic and financial analysis chapter of the VNC Feasibility Study Report. All these are likely to increase agricultural productivity and farmers income, which will further have a spin-off effect on other sectors. Simultaneously, the Project will alleviate the negative impacts of the existing and inadequate infrastructure, such as water leakages, inadequate and inequitable access to water within the command area and water pollution. The project implementation will also enhance economic growth and livelihood opportunities for local communities through direct and indirect employment.

481. Based on the findings of the EIA, classification of the project as Category "A" as per ADB SPS (2009), because 9 of the 12 anicuts to be rehabilitated are located in the notified Otter Conservation Reserve (OCR) along the Tungabhadra River. Hence, in order to comply with the ADB SPS (2009), a Rapid Biodiversity Assessment (RBA) was also carried out and key findings incorporated into this report.

482. However, as per the Environmental Impact Assessment (EIA) Notification (2006) and its amendments issued under the Environmental Protection Act (1986) by the Government of India (GoI), the project does not attract provisions requiring prior Environmental Clearance. This is despite the fact that 9 of the 12 anicuts to be rehabilitated are located in the notified OCR. Hence, as per Indian environmental regulations, preparation of the EIA for obtaining Prior Environmental Clearance will not be required. However, because portions of the project are located in the OCR, the project requires *recommendation* of the National Board for Wildlife (NBWL), Ministry of Environment, Forests and Climate Change, Government of India through State Board for Wildlife (SBWL), Karnataka Forest Department, GoI for carrying out works within the OCR. Towards this, KNNL has already submitted an online application for obtaining the necessary recommendation from SBWL and NBWL of MoEFCC. Presently, KFD has completed the field visit to 6 of the 9 anicuts located with the OCR. After completion of visit to all the anicut sites, a report from the KFD Zonal Office will be submitted to the KFD Head Office, who would in turn take a decision on recommending the project for implementation.

483. The RBA covering portions of the project within the OCR revealed that the entire OCR area once an ideal habitat for RET species like Smooth-coated Otter, mugger crocodile, four species of Turtles, hundreds of species of fish fauna and also supporting a repertoire of avifauna has now deteriorated significantly. Data collected and analysed as part of the RBA study revealed that at present all the nine anicuts within the OCR have deteriorated resulting in reduced storage capacity as against abundant water availability during early decades. This deterioration has shown an adverse effect on the breeding practices and population of the Otters and other animals as described in detail in the RBA report (***Annexure 9***).

484. The rehabilitation project is considered a good opportunity to arrest the declining population of the inhabiting species within the OCR by restoration of the anicuts and the canals, resulting in availability of abundant water throughout the year. The micro environment would thus become more favourable for breeding and thriving of the Otters and the aquatic life forms. The rehabilitation activities may temporarily hamper routine movement of Otters. But, once completed, the modernization project would prove to be haven for Otters and other aquatic life forms to flourish as they will be assured of plenty of water in the anicuts throughout the year. A case study of a bridge constructed between June 2014 and February 2017 connecting Bukkasagara in Hospet taluk and Kadebagilu in Gangavathi taluk on river Tungabhadra provides clear evidence of: (a) coming back of the Otters, (b) more breeding of fish and consequently increased Otter movement around fishing nets cast by fishermen, also indicating that Otters do not bother about human presence, and (c) thriving of Otters.

485. Additionally, a portion of the Project is located within the UNESCO Hampi WHA. A drive-through along the canals revealed that over 12 protected monuments are located along three of the 16 canals where the project is proposed. These include two along Anegundi, one along Raya and nine along Turtha Canal. Also, about 19.3 km of the canal sections of Anegundi (8.95 km), Raya (1.23 km), Kalaghatta (0.55 km) and Turtha (8.57 km) are located in the core zone of the Hampi WHA. In addition, about 14.04 km of the canal sections of Anegundi (3.43 km), Raya (8.70 km), Kalaghatta (0.44 km) and Turtha (1.47 km) are located in the buffer zone of the Hampi WHA. Further, about 24.33 km of the canal sections of Anegundi (0.63 km), Raya (5.59 km), Basava (8.44 km), Kalaghatta (2.70 km) and Turtha (6.97 km) are located in the peripheral zone of the Hampi WHA. This portion of canal rehabilitation has to be carried out in accordance with the internationally-accepted processes adopted for such areas especially in regard to maintaining existing canal designs, materials utilized and construction and operational procedures adopted. Towards this, approval from the HWHAMA has been obtained from carrying out the works within the Hampi WHA, albeit under certain conditions that KNNL needs to comply with during implementation.

486. The proposed project components do not involve significant environmental impacts on air, land and water media other than those associated with construction of canal rehabilitation works. However, a portion of the project, i.e., 9 of the 12 anicuts located in the notified OCR is being rehabilitated, and hence mitigation measures to safeguard aquatic ecosystem will be implemented as described in this report. Also, for portions of the project located within the Hampi World Heritage Area, the Form and Design of the

rehabilitation components should ensure that the integrity of the heritage area is not impacted in any manner.

487. Further, portions of some canals pass through urbanized areas; hydraulic capacity of the canals and canal water quality are compromised because of the disposal of liquid and solid waste directly into the canal. KNNL has to work out mechanisms with the respective urban local bodies' viz., Hospet, Kampli, Siruguppa and Gangavathi to mitigate these adverse environmental impacts.

488. Major mitigation measures involve safeguarding the aquatic ecosystem within the OCR while rehabilitating 9 of the 12 anicuts located within the OCR and ensuring the integrity of the Hampi Heritage Area while carrying out the rehabilitation of the portions of the project within the Hampi WHA.

489. Other than temporary environmental impacts associated with the location of portions of the Project within the OCR and Hampi Heritage Area, the rest of the environmental impacts are minor in nature. Nevertheless, implementing identified environmental management activities including monitoring of environmental impact, mitigation and enhancement indicators are critical to minimize negative environmental impacts and maximize positive impacts. The identified EMP should be integrated with project-specific information management systems such that all project-related activities are effectively managed through appropriately identified processes and output indicators encompassing institutional, social, financial, and economic aspects. This also calls for effective operation of basic mechanisms for recording, reporting, monitoring and auditing by the Contractor, KNNL, CADA, WUCS and Project Support Consultant and should be embedded within the KNNL field office structures. EMP will be operated within this context, with appropriate capacity building for environmental management within the KNNL supplemented with technical expertise. Further, the environmental monitoring plans provide adequate opportunity towards course correction to address any residual impacts during construction or operation stages.

490. While public consultations are exempted for canal rehabilitation projects as per Section 7(i) III (3) (a) of the EIA Notification 2006, the PSC team including Environmental Specialist and Social and Gender Specialist carried out various consultations during the course of the EIA. These consultations demonstrated that rehabilitating the VNC system and on-farm structures while taking care of local water management problems through WUCS is an alternative that has been welcomed wholeheartedly by the VNC farmers (along the lines of Gondi Modernization Project 1). This approach combining farmers requirements in terms of irrigation water availability, scheduling and timing with the operational aspects of the department is expected to maximize returns through enhancement of water-use efficiency, increased agricultural productivity and enhanced agrarian returns.

491. The total cost of implementing the construction-phase EMP component in the Modernization of the VNC System Project for both the packages is about **INR14.13 Crores (US$ 2.17 Million).** This is in addition to the costs estimated for additional civil works related to taking care of environmental considerations as described in EIA and RBA.

492. In sum, the Project will have overall positive benefits achieved through increased water-use efficiency, improved sustainable agricultural practices and enhancing the positive impacts through participatory irrigation management approaches involving WUCS. Its successful implementation will also serve as a model to demonstrate the process of improving agricultural productivity while mitigating the environmental impact, safeguarding the aquatic eco-system in the OCR and protecting the integrity of the Hampi WHA. Further, these measures would enable the region to effectively adapt to the projected climate change impacts in the region during the period 2021-2050, viz., increasing temperature, changing rainfall patterns and increased incidence of droughts leading to increased climate resilience of the region.

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