Appraisal note

For

'Water Quality Monitoring System for River Ganga'

Under

The Institutional Development Component of the World Bank Assisted National Ganga River Basin Project

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National Mission for Clean Ganga

Contents

1. Introduction

The proposal is aimed to assess nature and extent of pollution control needed at various locations in the water bodies; to evaluate effectiveness of pollution control measures already in place; to plan rational pollution control strategies and their prioritization; to evaluate water quality trend over a period of time; to assess and use assimilative capacity of a water body and thereby reducing cost on pollution control; to understand the environmental fate of different pollutants; to assess the fitness of water for different uses and to achieve an overall improvement of the water quality of River Ganga and its tributaries and the proposal would enable a solution for achieving the very purpose of NGRBA.

The Cabinet Committee on Economic Affairs (CCEA) has approved the NGRB project (World Bank assisted EAP component of the NGRBA Programme) for Rs. 7000 crores, of which Rs. 900 crore was allocated for Institutional development and project implementation support component including the CPCB proposal of "Water Quality Monitoring System for River Ganga" under NGRBA. As per the mandate of the NGRBA it has to be ensured that by 2020 no untreated municipal sewage and industrial effluents flow into Ganga.

The expected output and the outcome of the proposal shall be as follows:

- ✓ Real time (Automatic) monitoring stations at 113 locations
- ✓ Quality Assurance service for the Real time water quality monitoring system
- ✓ Biomonitoring at all the real time monitoring locations
- ✓ Community supported Monitoring at remote locations

2. Background of Executing Agency

The Central Pollution Control Board (CPCB), a statutory organization, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986.

Principal Functions of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) to improve the quality of air and to prevent, control or abate air pollution in the country.

Functions of the CPCB at the National Level are given below:

- Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.
- Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution;
- Co-ordinate the activities of the State Board and resolve disputes among them;
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement;
- Plan and organize training of persons engaged in program on the prevention, control or abatement of water and air pollution;
- Organize through mass media, a comprehensive mass awareness program on the prevention, control or abatement of water and air pollution;
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement;
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;
- Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
- Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air; and
- Perform such other function as may be prescribed by the Government of India

As per the policy decision of the Government of India, the CPCB has delegated its powers and functions under the Water (Prevention and Control of Pollution) Act, 1974, the Water (Prevention and Control of Pollution) Cess Act, 1977 and the Air (Prevention and Control of Pollution) Act, 1981 with respect to Union Territories to respective local administrations. CPCB along with its counterparts State Pollution Control Boards

(SPCBs)/Pollution Control Committees (PCC) are responsible for implementation of legislations relating to prevention and control of environmental pollution.

Experiences of CPCB on automatic monitoring stations

During the year 1989-90 CPCB had introduced automatic water quality monitoring stations for analyzing water quality of River Ganga. As an introductory program only two stations were developed and it was analyzer based system where samples were sucked by a diaphragm pump and analyzed in analyzer to provide automatic data for 5 parameters i.e DO, temperature, Conductivity, Nitrate and Phosphate. However, due to unavailability of components and O & M problem it could not be run for long time. Later on during the year 1991-96 CPCB had installed 5 real time water quality stations which run on solar power system in floating boats. The parameters were Turbidity, Conductivity, pH, DO and temperature. The results for DO reported not reliable and far from the actual value noticed from manual monitoring. Operation & Maintenance problem was the major drawbacks for both phases.

Considering the above experience CPCB is now in advance stage of implementing 10 real time monitoring stations under hydrology project covering 10 parameters.. O & M issue has been incorporated in the procedure of procurement itself incorporating all the safeguards.

3. Project Details

3.1 Objectives

Water quality implies physical, chemical characteristic that ensure, support and sustain the biological system in order to attain the wholesomeness of the water body under study. Water quality monitoring therefore consists of periodic and systematic observations to enable its assessment covering physical, chemical and biological parameters.

Water Quality Monitoring Network (WQMN) is therefore, a programme consisting of three key components

- Where to observe (Sampling stations)

- How frequent to observe (Frequency of samplings)
- What to observe (Parameters)

The WQMN therefore designed to fulfill the objective. The Central Pollution Control Board (CPCB) performs the water quality monitoring with the objectives mentioned below.

- To assess nature and extent of pollution control needed at various locations in the water bodies;
- To evaluate effectiveness of pollution control measures already in place;
- To plan rational pollution control strategies and their prioritization;
- To evaluate water quality trend over a period of time;
- To assess and use assimilative capacity of a water body and thereby reducing cost on pollution control;
- To understand the environmental fate of different pollutants;
- To assess the fitness of water for different uses

3.2 Scope of Work

In the Ganges system, there are a number of types of water quality monitoring that would need to be addressed over time. These include:

- Ambient Water Quality (automatic and manual methods; quality assurance)
  - Upstream and downstream of major urban areas and investments
  - Along Main stem and in Major tributaries
  - At Sensitive locations
- Major Wastewater inflows (major *Nallah* mapping and monitoring for polluted stretches)
- Industrial effluents (strengthening Env. Regulators)
- Solid Waste (studies of polluted stretches)

- Non-point sources (studies e.g. agro-chemicals)
- Bio-monitoring & Ecological monitoring (special studies)
- Sediment/Benthic monitoring (special studies)
- Groundwater quality monitoring (data integration)
- Community Monitoring

This proposal will focus on a subset of the activities, i.e. the Water Quality Monitoring System, to be financed by the project under Component 1(iii) Technical Assistance for Environmental Regulators. As conceived under this project, water quality monitoring activities consist of: real time water quality monitoring, bio-monitoring and community monitoring. Some water quality monitoring activities, particularly ***manual monitoring activities, are detailed under a separate proposal for the capacity building of regulators***. This proposal will focus on three elements:

- **Real time water quality monitoring**, at key locations, for example, upstream and downstream of cities, at water supply intake points, at bathing ghats, downstream of wastewater treatment plants, to provide a state-of-the-art, real-time picture of the water quality of the Ganga. Given that the modernization needs are so great, only a part of the hundreds of sites will be automated and there will be a need also to modernize the manual systems being used.

  In order to put the proposed activities in context, a background is provided below to the types of recent improvements in water quality monitoring technology that are expected to be deployed on the project. In order to allow flexibility and accountability, a data contract would be set up (building on recent experience in many Pollution Control Boards on air quality monitoring) to provide data services for provision of required water quality information at desired locations on desired parameters at a desired frequency. The data collected from the manual monitoring will be synchronized with the data of National River Conservation Directorate (NRCD) already collected with the help of the software developed by NRCD.

- **Biomonitoring will be** conducted at select stretches for the purpose of ‘calibration’ with physico-chemical based WQM so as to come up with a protocol for Ganga as well as at the national level. So far, the water quality monitoring networks depict the physico-

chemical, bacteriological characteristics of the water. However, impact of this pollution to aquatic ecosystem is not well addressed. Biomonitoring of water quality at select stretches will address this limitation. Biomonitoring will also help to compare with conventional physico-chemical-bacteriological measurements as well as help in development of a monitoring protocol.

- **Community supported water quality monitoring** to support awareness-raising on water quality issues with various groups (e.g. schools/universities/NGOs) in the Basin. These initiatives would need to be supported with appropriate testing kits and training.

In addition, there are a number of research activities proposed that will enhance CPCB's understanding of the water quality issues, developing solutions to water quality problems and improving the effectiveness of CPCB and SPCB operations. ***There are a number of other related activities that are addressed as part of the Capacity Building of Pollution Control Board's proposal***

3.3 Locations of WQM stations

Selection of sites of real time monitoring locations is dependent on variation of observations and agglomeration of industries and urban city waste water discharge. Therefore, the stations are proposed at key locations, for example, upstream and downstream of cities, at water supply intake points, at bathing ghats, downstream of wastewater treatment plants on the main stem of River Ganga across the 5 basin states to provide a state-of-the-art for a real-time picture of the water quality of the river. The Bio-monitoring will also be conducted at the same locations.

State-wise Stations of the proposed Real time network:

State	Station Type			Total
	Class I	**Class** II	**Class** III	
Bihar	4	1	8	13
Uttar Pradesh	21	17	19	57
Uttarakhand	3	4	1	8
West Bengal	12	14	9	35
Total	40	36	37	113

However, locations for community monitoring across the basin will be finalised in consultation with the community particularly for inaccessible stretches of the river.

3.4 Works Proposed

For Real time monitoring network:

Considering the complexity of establishing real-time monitoring stations and the lack of experience in India, the data service contract is proposed to be implemented in two packages (split based on geographical spread) and the stations will be established by the service provider in two phases. This provides the CPCB, the flexibility of changing the monitoring stations and parameters based on the experience of first phase implementation.

Real time data will be collected with the interval of fifteen minutes, hourly or daily basis depending on the parameters from the various stations over the Ganga basin. The real time data collected will be transferred to the Central Repository / Data Server / RDBMS though the GSM/GPRS telemetry link. The Data Server will be supported with the mechanism to feed raw data and processed data. The dataset will be able to monitor manually also through a properly designed calibrated system. The filtered and calibrated data will be analyzed and process in the desired form to feed in the NGRBA Ganga Knowledge Center Portal and also other Websites/ Portals/ Mobile Applications.

It is worth to mention that there will be 30 locations, which would be common between real time and manual monitoring network. This will help to maintain (CPCB) historical data base of the parameters not covered under real time monitoring and ensure about the acquired data quality of the real time monitoring.

The payment will be made according to the quality and quantity of the data as per the terms of reference.

Bio-monitoring will be conducted at all the 113 real time monitoring locations on monthly basis during 1st year and on quarterly basis during the remaining years.

3.5 Real time monitoring parameters

Real time data will be collected with the interval of fifteen minutes, hourly or daily basis depending on the parameters from the various stations over the Ganga basin. Sensors are available to monitored 21 parameters through real time system from which the following 18 parameters have been selected for the proposed real time network.

Sl.no.	Parameter	Class 1	Class 2	Class 3
1.	BOD	✓	✓	✓
2.	BTX	✓		✓
3.	Chloride	✓		✓
4.	COD	✓	✓	✓
5.	DO	✓	✓	✓
6.	DOC	✓		
7.	EC	✓	✓	✓
8.	Fluoride	✓		
9.	Ammonia	✓	✓	✓
10.	Nitrate	✓	✓	✓
11.	pH	✓	✓	✓
12.	Potassium	✓		✓
13.	Temperature	✓	✓	✓
14.	TOC	✓		
15.	TSS	✓	✓	✓
16.	Turbidity	✓		
17.	Water level	✓		✓
18.	Colour			✓

3.6 Implementation schedule

Considering the complexity of establishing real-time monitoring stations and the lack of experience in India, the data service contract is proposed to be implemented in two packages (split based on geographical spread) and the stations will be established by the service provider in two phases.

Projects/Activity	Financial Year	Time Frame											
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Real Time stations and quality assurance consultancy													
1. Real time water Quality Monitoring													
a) Survey & Identification of locations	1st year												
b) Approval of TOR	1st year												
c) Evaluation EOI (Expression of interest)	1st year												
d) RFP (Request for Proposal)	1st year												
e) Evaluation of RFP and signing the contract	1st year												
f) Installation, testing, and commissioning of monitoring stations to provide data	1st year												
g) Ongoing operation of monitoring system	1st year												
	2nd year												
	3rd year												
	4th year												
	5th year												
	6th year												
	7th year												
2. **Real time - Quality assurance consultancy -** Appointment of QA consultant													
a)Approval of TOR	2012-13												
b)Evaluation EOI (Expression of interest)	2012-13												
c)RFP (Request for Proposal)	2012-13												
d)Evaluation of RFP and signing the contract													

e)Ongoing operation of quality assurance consultancy	2012-13												
	2013-14												
	2014-15												
	2015-16												
	2016-17												
	2017-18												
	2018-19												

Proposed Implementation Schedule for development of Biomonitoring network of River Ganga

Sl. no.	Projects/Activity	Financial Year	Time Frame											
			Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1.	**Biomonitoring**													
	a) Development of Protocol	2012-13												
	b) Application and evaluation of the protocol	2012-13												
	c) Training of the taxonomist	2012-13												
	d) Initiation of bio-monitoring in the selective stretch of Ganga	2012-13												
		2013-14												

3.6.1 Procurement plan

Procurement of Goods, Works, consulting and non-consulting services for the project shall be aligned with the implementation schedule. Accordingly, NGRBA Cell of CPCB need to prepare a procurement plan for every financial year in accordance to the respective procurement guidelines / manual laid down in the NGRBA programme frame work.

3.7 Project Operating Cost

The operating cost of the project includes basically the office expenses towards transportation and communication, cost of the utilization of the existing manpower in CPCB, AMC of the existing laboratory infrastructures that are being used and maintenance of office and its hardware.

3.8 CPCB's organizational preparedness

CPCB has developed the expertise of water quality monitoring imparting training in the various aspect related to quality assurance in monitoring since the inception of the organization and capacity being enhanced time to time.

The Central Pollution Control Board is already executing a project entitled “Pollution Inventorization Assessment & Surveillance (PIAS) on Ganga River Basin” under NGRBA wherein detailed water quality monitoring (surface & ground water) are considered as inbuilt component of the project.

The proposed projects are the extension of the activities with enhanced parameters and frequency employing state of art in order to minimize the cost and time over run with increased reliability of data. CPCB being the implementing agency has made the assessment of manpower required to fulfill the objective of the project, and such requirement is purely project driven and could not be pre-assessed.

With the limited manpower availability, the CPCB is well prepared to initiate the projects (including the ongoing, PIAS and proposed SER & WQM projects), which need to be supported with additional manpower in due course of time. NGRBA Cell of CPCB

shall however, carry out periodical assessment of the proposed manpower requirement based on the actual progress of the project works and report on a regular basis for decisions, if any.

4. Project Cost

The project cost has been distributed in 5 main budget heads as per the World Bank guidance. The details of the same are given in the table below;

Main budget head	Cost in Lakhs (Rs.)
A. Consultancy	**1437**
Quality assurance system for real time water quality monitoring system	980
Information system integration for online display	0
Program monitoring system optimization	0
Biomonitoring	457
Community monitoring program	0
B. Goods	**210**
Field water quality monitoring kits	210
Monitoring IT Systems (e.g. server) for water quality monitoring	
C. Services	**6300**
Real time monitoring system	6300
D. Operating Cost	**1372**
Project operating cost	1372
E. Training	**126**
Community Monitoring	126
Total	**9445**

4.1 Project cost comparison

Development of Real time monitoring system, through which 113 stations are proposed to be installed through the service provider, requires the substantial funds of Rs.6300 lakhs for 7 years. The cost has been calculated based on the past experience of CPCB in Hydrology Project (HP) wherein the cost was Rs.2.35 crores for 10 stations for 5 years which amounting Rs. 4.7 lakhs per station per year. The communications

received from Ministry of Water Resources has also been considered. In HP only 10 parameters were included as against the 18 parameters in the present scope of work (Ref. table 9, p.31 of Volume 1). Considering the additional 8 parameters and for 2 more years, the equipment maintenance and security cost increases substantially. Accordingly, the present cost has been increased to Rs.7.965 lakhs per stations per year i.e. Rs. 55.75 lakhs per stations for 7 years

5. Risk analysis and mechanism

CPCB introduced automatic water quality monitoring stations in the year 1989-90 for analyzing water quality of River Ganga. Only two stations were developed and it was analyser based for 5 parameters i.e DO, temperature, Conductivity, Nitrate and Phosphate. However, due to unavailability of components and O & M problem it could not be run for long time. Later on during the year 1991-96 CPCB had installed 5 real time water quality stations which run on solar power system in floating boats. The parameters were Turbidity, Conductivity, pH, DO and temperature. The results for DO reported not reliable and far from the actual value noticed from manual monitoring. Operation & Maintenance problem was the major drawbacks for both phases. Considering the above experience CPCB is now in advance stage of implementing 10 real time monitoring stations under hydrology project covering 10 parameters.. O & M issue has been incorporated in the procedure of procurement itself incorporating all the safeguards.

To avoid further complication for instrumentation or implementation problems CPCB has proposed data purchase concept. In this mechanism data will provided by farm and only validated and third party audited data will be accepted and allowed for payment based on agreed terms of reference of both the party.

6. Conclusions

Real time data networks for water management are becoming standard practice around the world. There is a growing acceptance that traditional grab sampling is

unlikely to provide a reasonable estimate of the spatial and temporal variability in water quality at a particular site. Traditional sampling and analysis techniques result in delays of days to weeks for analytical results to be available, and results in a real loss of high frequency information content that can greatly enhance understanding the water quality behavior of the river. Fluctuations can only be detected through high frequency real time 'continuous' measurements, with a sampling frequency of typically 15 minutes, that have the capability to capture most natural variability and measure sporadic concentration peaks. It is therefore, necessary to support the automatic WQ monitoring by manual WQMN. The manual WQMN will also help as a quality assurance of the performance of the automatic monitoring stations and vice-versa.

The benefits of real time systems have been realized over time to include an overall reduction in monitoring system costs, provision of better spatial coverage and long-term trends in fluctuations of pollutant concentrations, and a vastly improved understanding of the natural river processes and conditions. Improved data quality and quantity results in an improved ability to conduct more accurate mathematical modeling of water quality trends at local, watershed and regional scales. In addition, the greatly enhanced rapid detection of hydrologic variability is critical for early warning and rapid response to harmful events.

The real-time, automated, collection of water quality data will greatly assist the advancement of obtaining a secure, safe and sustainable quality of water to those who rely on it. The automated collection of water quality data collection is just a first step in developing an efficient repository of information that can be used by stakeholders, such as regulatory agencies, industry, education, research, communities, as well as the public in general.

7. Recommendations

CPCB itself is a regulatory authority under the constitution of India. Hence, the appraisal has been done by the NMCG in-house and recommended for consideration of approval under NGRBA program.