Terms of Reference

For conducting reservoir survey including hydrographic survey,

Preparation of DEM & AEC curve, Sedimentation study and development of inflow forecast model for Kharagpur Lake

Contents

1.0. Background

Bihar is one of the fastest growing states in India, both economically and technologically. However, the recurrent nature of floods is retarding its growth process on a regular basis. Floods are an especially major problem along the Ganges and its Himalayan tributaries. Floods not only affect lives, livelihoods, and security of existing investments, but are also proving to be disincentive for additional investments in Bihar.

Bihar accounts for about 17% of the flood-prone area and 22% of the flood-prone population in India. As much as three-fourths of Bihar's area is flood-prone having recurrent thread of floods. Bihar's vulnerability to floods is due to its very flat topography in the foothill just downstream of the Himalayas, intense monsoon rains (more than 2,500 mm/yr in the upstream areas and about 1,200 mm/yr in the State, 80% during the months of June-September), high sediment loads, high population density (1102 per km^2), resulting low-socio-economic development and inadequate water infrastructure to regulate flows (e.g. storage upstream or designated detention areas).

Dams are barriers typically constructed across a stream channel to impound water whereas reservoirs are artificial lake, usually formed by constructing a dam across a river or by diverting a part of the river flow and storing the water in a reservoir. The water stored in the reservoir can be used for irrigation, hydro-power or as a water source for domestic or industry use. Reservoirs are also very effective in moderating unexpected floods.

Dams are manmade structures requiring routine inspection and maintenance for preventing dam failures. The loss or significant lowering of a pond or lake impounded by a dam may cause hardship for those dependent on it for their livelihood or water supply. The likelihood of future residential and commercial development occurring both downstream of dams and adjacent to impoundments means that the potential for such losses will continue to grow over time.

One of the important aspects of planning a storage reservoir for continued benefits is provision in the storage space for accumulation of sediment brought down by the rivers and their tributaries. This is particularly important to ensure that storage capacities provided are not lost or reduced prematurely due to inadequate provision and the reservoirs should continue to serve the expected functions for the planned life span. Sedimentation of reservoir is, therefore, considered as a matter of vital concern to all water resources development projects. Sedimentation not only occurs in the dead storage but also encroaches into the live storage, which impairs the intended benefits from the reservoirs. Therefore, the problem of sedimentation needs clear understanding and careful consideration. Uncontrolled

deforestation, forest fires, overgrazing, improper method of tillage, unwise agricultural practices and anthropogenic activities in the catchment areas may cause increase in silt load in rivers and aggravates the consequent sedimentation of reservoirs.

It has, therefore, been decided to assess the accumulated sedimentation with sounding method in reservoir so that sedimentation of reservoirs will not reduce the targeted benefits. An in-depth study of this problem with possible remedial measures such as engineering structures, forestation and soil conservation etc. in the catchment areas for each reservoir is of immense value. Consequently, the Government has been paying particular attention to the problem of sedimentation of reservoirs. In February 1978, Reservoir Sedimentation Committee set up to make in depth studies of sedimentation process, review actual reservoir sedimentation status and lay down recommendation for future policies on various aspects of sedimentation of reservoirs.

Moreover, development of Water Resources through dams, canals, power houses, flood protection works etc. has been the thrust of national policies since independence. As such, the task of conducting Sedimentation Survey of Reservoir has been proposed and included in approved PIP under Purpose Driven studies in National Hydrology Project III, Surface Water Component.

In this back ground, an accurate information base has to be developed containing river cross sections, longitudinal gradients in the river and periodically *update them to study* the migration as well as the sedimentation patterns of the river. *This is to ensure that all these data and outcome of studies* are recorded and used in the various water resources management models

1.1. Kharagpur Reservoir Characteristics

Origin of Kharagpur reservoir (lake)

Kharagpur Lake was originally constructed in 1876 by Darbhanga Raj. Later it was taken over by Irrigation Department, Government of Bihar in 1954 for its maintenance and operation. The Dam is located 3 km from Haweli Kharagpur on the river Mani over a gorge at latitude 25°07′00"N & Longitude 86°34′00"E. Haweli Kharagpur is a sub-division of Munger district in state of Bihar. The Kharagpur hill range is littered with tiny hills. These hills have a number of mineral water springs coming out. Close to a village in the Kharagpur sub-division, there are a number of hot springs exist and called Tatapani. The collective water from these streams forms a pond under an over-hanging rock in that river. That is called Bhimkund. The river Mani is fed by the water from these streams. A dam has been built on the river Mani. The spring water from the different hills feed the river and forms a large reservoir called Kharagpur Lake. Water fall from the Panchkumari hill and a few hot springs known as Laxmikund, converge into the lake.

The catchment area of the river Mani u/s of reservoir is 64 sq. Miles (164 sq.km). Maximum recorded rainfall at the time of project planning was 59.42 inches (1500 mm) and the corresponding discharge observed during the same period was 11,067 cusecs (314 cumec). The hydrological studies then carried out indicated that the largest discharge may be of the order of 19,278 cusecs (546 cumec).

During the flood of 1961, North Dyke was overtopped and breached. After this incident, spillway capacity was reassessed as 30,000 cusecs (850.16 cumec). As a result, the height of the main dam had to be modified for adequate flood cushion and free board. Also, an additional spillway had to be provided with 8,500 cusecs (240.88 cumec) capacity. The old spillway was checked to pass a discharge of 21,500 cusecs (609.28 cumec) with revised M.W.L.

Kharagpur reservoir scheme is an irrigation scheme. C.C.A of the scheme is 5310 Ha. 5620 Ha area irrigated in kharif and 2000 Ha area irrigated in Rabi. 226.30 Ha m water received per year for water supply to a Fluoride affected village Khaira in Kharagpur Block.

A map showing the Basin is given at Fig 1. **Salient features of the Kharagpur Lake Reservoir project is enclosed at Annexure-A**

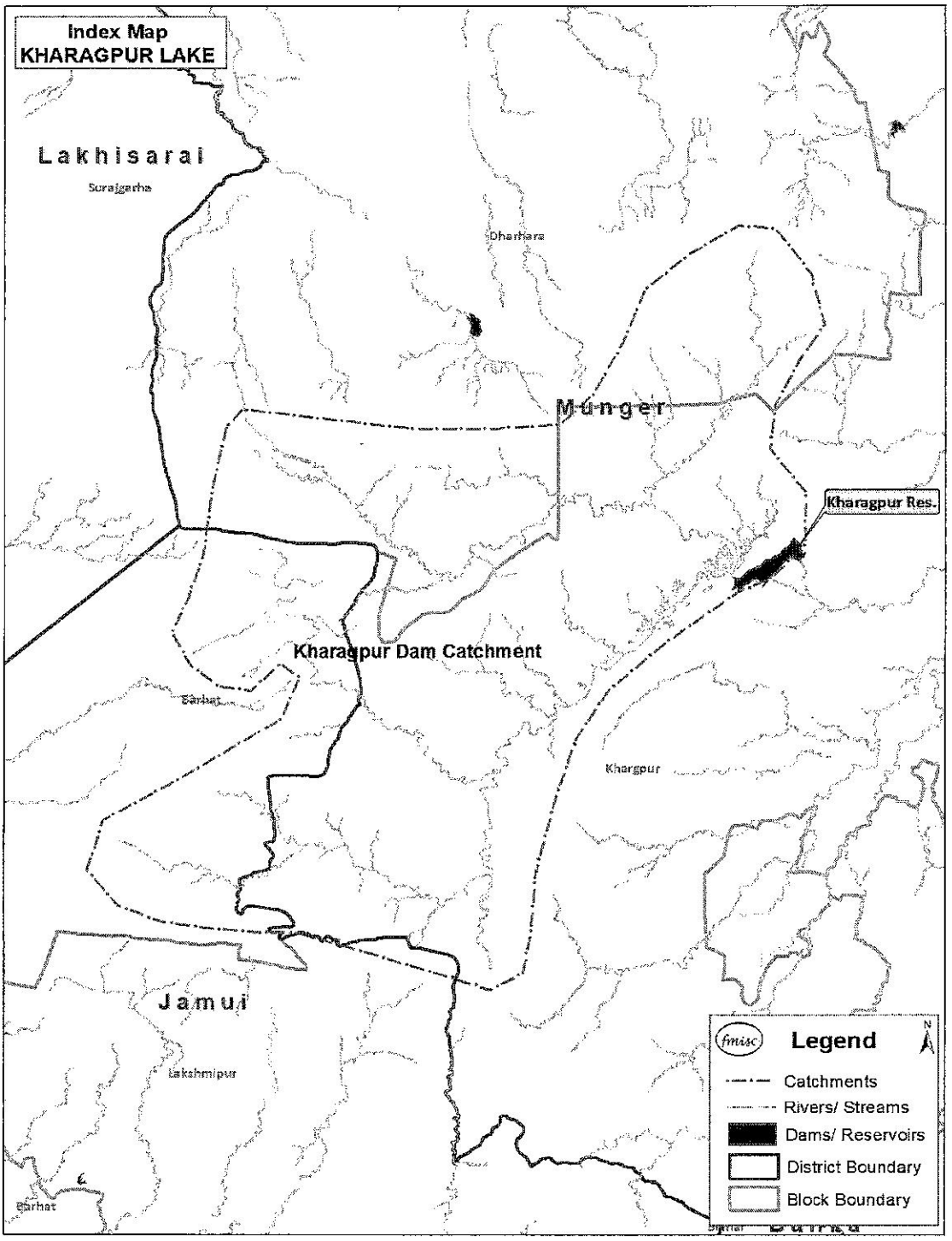

Fig 1- Index Map of Kharagpur Lake

2.0. Objectives

The overall objectives of the consultancy are: -

(i) Conducting Reservoir Survey including Hydrographic Survey, preparation of DEM of resolution 0.3 m, preparation of Elevation-Area-Capacity (EAC) curve of Kharagpur Lake on river Mani,
(ii) Sedimentation Study of Kharagpur Lake to assess Quality, Quantity, rate of annual sedimentation and present condition of the Lake with remedy and
(iii) Development of Inflow forecast model for Kharagpur Lake.

The study will support the decision makers to assess the quantity of sediment deposited in the lake during the previous years which will be helpful in assessment of lake storage capacity for planning and management of water in consideration of existing as well as futuristic water resource development. It will determine the extent to which challenges (upstream development and climate) hinder water availability, sediment deposition, changes in the area elevation as well as area capacity curve of the lake. The study also provides the quantity and quality assessment of the sediment, rate of annual sedimentation, and its remedial measures which will explore prospects for sustainable socio-economic and environmental uses. This study will also develop inflow forecast model which will helpful for the decision maker to assess the quantity of runoff to manage the floods.

3.0. Scope of Consultancy

The scope of this consultancy will cover to carry out Reservoir capacity Survey including Hydrographic Survey with preparation of DEM of resolution 0.3 m for more realistic estimate of rate of siltation for updating the area elevation curve relationship to provide reliable criteria for studying the implication of annual loss of storage area over a definite period of time with particular reference to reduction of intended benefit in the form of irrigation potential and flood absorption. The consultant specific services towards this consultancy should comprise of following tasks and deliverables, but not limited to:

Task-1: Conducting Reservoir Survey including Hydrographic Survey, preparation of DEM of resolution 0.3 m, preparation of A.E.C curve. The task will include: -

A. Mobilization of personnel, equipment, instruments, establishment of site camp etc. The work includes arrangement of all hydrographic/topographic survey equipment like boat, consumables, all instruments and other T & P articles etc., R & M of

equipment, providing required man power for handling the equipment, establishment of site camps, providing backup system/equipment or arranging immediate repair of equipment to ensure uninterrupted survey.

B. Lay out of Ground Control Stations including reconnaissance/preliminary surveys, if any. The consultant has to carry out the reconnaissance survey of the area of interest by visual observation supported with the high-resolution satellite imageries to collect information and prepare a survey plan to finalize the complete sequence of working, establishment of control pillars and has to submit an Inception Report on appropriately scaled index maps. The consultants are required to select appropriate SoI (if available) GTS/GCP (Great Trigonometrical Survey/ Ground Control Point) bench mark from the existing one and prepare a table of both the GTS/GCP benchmark and additional established bench marks for the whole survey area, validate for accuracy and reliability. A work plan in map form shall be prepared before conducting actual benchmark survey so that Field officers under WRD could check that the objective of such a detailed survey is fully met.The survey plan would also reflect the detailed scheduling to ensure survey for timely job completion with desirable accuracy as per design norms using the most suitable latest modern technology. The drawing of layout plan would be prepared in ArcGIS showing Reservoir Plan, Gauge location, all structures, reference points and other salient features along with the Reservoir. The consultant would also prepare a report that will consist of the project appreciation, detailed scheduling of micro level activities at weekly/fortnightly interval with Gantt Chart, work output and critical manpower deployment schedule, Proforma for data collection, identification of social and environmental sensitive areas. A general overview of conducting hydrographic and topographic survey with their technology, methodology and accuracy level is to be provided

C. Conduct hydrographic and topographic survey to cover the entire area of the reservoir up to maximum water level in the grid of **50 m x 50 m:** -The activities under this is to collect precise level data at close intervals in the grid of 50mx50m and may be smaller grid to generate contour and DEM of resolution of 0.3m, in consultation with Engineer In charge. The tolerance for vertical accuracy at measured points should be well within± 05 cm, with a provision for later verification by the Engineer-in-charge at 10% of the points chosen randomly. The contour map shall be prepared in appropriate size preferably in **A0 size** with contour at suitable interval from the lowest bed level to MWL.The consultant shall assess the quantum of work in advance and if need be; shall engage partner firms to complete the hydrographic and topographic survey work within stipulated time frame. Computer based Hydrographic survey shall be carried out within the water spread area so that reservoir area under water is covered at 50mx50m grid and may be smaller grid sufficient enough for obtaining a fully representative bed profile.

D. Analysis of data to upgrade the elevation-area-capacity table/curves, contour plots, balance life of reservoir, cross sections, L-sections. Elevation-Area-Capacity curve along with table will be prepared from the lowest elevation up to MWL **at 0.5m or less interval**.

E. The equipment preferably used by the consultant would be High-technology equipment like Integrated Hydrographic Survey System which should include recording type echo sounder and computer software for interfacing and recording the position and depth data in real time. GPS survey technology is essential. The consultants are free to select another method of survey but the primary objective of the client should be fulfilled.

F. All topographic and Hydrographic data should be acquired, stored and processed in a Geo-referenced manner in user friendly standard format that can be accessed both by CAD programs such as Auto CAD and GIS programs such as Arc View/ Arc Map, Geo Media or Map Info.

Output:

An **Inception/Survey Report** reflecting Task 1 assignment containing all the above scope should be submitted both in hard copy (20 number of copies) as well as soft copy to the client and the consultant has to make a presentation of the work done for consideration of the Standing Review Committee constituted by the Client. (End of Month 4 from the Start)

Task-2: Sedimentation Study of Kharagpur Lake to assess Quality, Quantity, rate of annual sedimentation and present condition of the Lake with remedy. The task will include: -

A. Collection and analysis of sediment samples from the reservoir bed with not less than 10 samples of the bed material shall be collected as per standard methods prescribed in APHA 1989 (American Public Health Association)covering the entire area of the reservoir to obtain sediment sizes, density, specific gravity, moisture content etc. Depth and Location of the collection points should be clearly indicated duly geo tagged on a map.

B. Daily Sediment Suspended samples and analysis in the river upstream of the Kharagpur Lake during the Monsoon period and development of sediment rating curve.

C. Assessment of sediment and its distribution in the reservoir shall be made and likely effects of such sedimentation on the performance of the reservoir shall be assessed. While analyzing the reservoir data, the validity of Empirical Area Reduction method using data of silt deposition collected during survey may also be checked out. The Elevation-Area-Capacity curve may be produced for another 100 years at 10 years interval by conducting mathematical modeling studies. The Consultant may refer to various standards/references including **I.S. 12182-1987** *"Guidelines for Determination*

of Effects of Sedimentation in Planning and Performance of Reservoirs", C.B.I. & P Publication on the subject and **I.S. 5477 Part-II** "Fixing Capacities of Reservoirs – Dead Storage". Loss of storage capacity and rate of sedimentation shall be worked out in each vertical zone separately viz. dead storage, live storage and flood storage, if any. An assessment of the sedimentation behaviors in different horizontal zones throughout the reservoirs may also be made.

Plot between Percent Reservoir Depth and Percent Sediment Deposited is to be plotted as per IS 5477 PART-II 1994. "Fixing Capacities of Reservoirs– Dead Storage".

D. To assess and review life expectancy of the reservoir, particularly in view of some apprehensions from certain quarters about the higher rate of sedimentation in reservoirs.

E. Collection of information from project authorities/any other agency including data on sediment yield from the upstream free catchment of the reservoir as well as accounting for the effect of upstream reservoirs, if any and incorporating of the same while writing the report.

F. To recommend suitable measures for desiltation of the Kharagpur Lake. Should include plan for disposal of removed silt at a few suitable alternative disposal sites, along with its associated environmental and social implications.

G. To recommend suitable measures for increased benefits and enhanced life of reservoir, specific measures for Soil conservation, Catchment area treatment, Watershed details etc. should also be included in the report. It should include sub-watershed prioritization to be taken up for catchment area treatment, based on their erosion potential.

H. Laboratory analysis of the bed material samples collected from the reservoir bed is carried out to obtain sediment sizes, density, specific gravity, moisture content etc. Analysis of samples should also be aimed to evaluate geometric standard deviation to know whether the sediment is uniform or non-uniform (Melville et al.). Kramer's coefficient shall also be evaluated. Method of calculation of bulk density (Lane's method or Miller's method or some other method) is to be mentioned.

I. To assess the quality of the sediment and suggest the uses.

J. To create database for developing regional sediment indices and facilitate Rational Sedimentation Planning of future reservoirs.

K. The trap efficiency of reservoir is to be calculated according to Brune's or Churchill trap efficiency curve as per I.S. 12182-1987"Guidelines for Determination of Effects of Sedimentation in Planning and Performance of Reservoirs".

L. Preparation of report containing general information about the reservoir, catchment characteristics, details of capacity survey performed including methodology of data collected, analysis of data with standard guidelines/ procedures, finding of results, conclusion and recommendations keeping in view the objective of the study to the satisfaction of the Client

M. Any difficulties/special problem encountered during the course of the study and how they were overcome may be included in the report.

Output:

An Interim report -1 containing all the above scope under task-2 should be submitted both in hard copy (20 number of copies) as well as soft copy to the client and the consultant has to make a presentation of the work done for consideration of the Standing Review Committee constituted by the Client. (End of Month 8 from the Start)

Task 3: Development of Inflow Forecast Model for Kharagpur Lake: -

Inflow forecasting play a vital role in the reservoir operation for flood control as well as the water release depending upon the purpose of the project. The Task will include: -

A.

(i) Collection, compilation and quality check of the historical hydro meteorological and Hydrological data on Arc GIS platform; geo-spatial data like DEM(Survey data), Soil and land use, delineation of catchment boundary and drainage system, and demarcation of free catchment etc.;

(ii) Compilation of Meteorological forecast data from IMD/NCMRWF and other sources and its quality check;

(iii) Review of Inflow Forecast model and selection of appropriate tool comprising of necessary hydrological components;

(iv) Report on data availability along with its temporal resolution;

(v) Report on suitability of hydro-meteorological network and need assessment for future development;

(vi) Review of RR model suitable for inflow forecasting;

(vi) Review of Inflow Forecast Model being used for the reservoir or reservoir operation; etc.

B. Development of the Rainfall – Runoff (RR) model: Calibration and validation of appropriated rainfall – runoff model based on historical event data; the development of the model should include the use of appropriate statistical measures to test the model performance on runoff simulation.

C. Development of a tool/adopter for meteorological forecast, which should comprise of (i) automatic fetching/downloading of forecast data from appropriate website especially the precipitation (QPF) and temperature (QTF); (ii) Bias-correction of meteorological forecast using appropriate method, if found to be present; (iii) preparation of input time series for the RR model.

D. Development of Inflow forecast Simulation Model: - Consultant should develop GUI based suite/software integrating Meteorological Forecast Adopter and RR model.

E. Report on the development of Inflow forecast model for the Kharagpur Lake should also include a detailed chapter on the Reservoir Operation with different inflow pattern. The chapter should also include the Operation Policy of the Lake under different Monsoon yield.

F. Development of catchment Model for Sediment Yield study.

G. Capacity building on (i) Developing RR model, and (ii) Reservoir operation and developing an Operation Policy. (iii) Model developed for Sediment Yield in catchment.

Output:

An Interim report- 2 containing all the above points under task-3 should be submitted both in hard copy (20 number of copies) as well as soft copy to the client and the consultant has to make a presentation of the work done for consideration of the Standing Review Committee constituted by the Client. (End of Month 12 from the Start)

4.0. Responsibility of Client

A. Provide letter of introduction for visit to WRD and other GOB offices.

B. Facilitate access to the consultant for procuring data and for needful works.

C. Provide access to available office data on Reservoir and hydrologic/hydraulic data, and satellite imagery and thematic GIS data.

D. Facilitate access to FMC (Flood Monitoring Cell) and field offices for data Collection and field visits.

E. The cooperation of existing FMISC professional will be available as and when required.

F. Facilitate access to other consultancies on topographic, river and embankment survey, inflow forecast modeling, hydrological information system etc. and connected databases.

G. Reimbursement of actual cost of data and actual cost of data collection as per approved norms. However, prior approval in writing by the appropriate authority of the client side will be mandatory for each case.

5.0. Responsibilities of the consultant

A. The Consultant shall conduct and complete the consultancy in a professional manner as per the agreed ToR and scope of the consultancy. He will have his own hardware (Laptop) and required software.

B. Collecting all source data from different agencies, facilitated by WRD as needed for this consultancy.

C. The Consultant shall deploy necessary resources to collect all the relevant data proposed in this work.

D. Conduct field visits for data collection and ground verification.

E. The consultant shall use the restricted data available in WRD such as topographic data, satellite imagery provided by WRD in secure environment required for classified category data.

F. The Consultant shall carry out the services as detailed in "Scope of Consulting Services" in the best interest of the Client for successful realization of the project with reasonable care, skill and diligence with sound technical, administrative and financial practices and shall be responsible to WRD for the discharge of responsibilities. The Team Leader will be responsible to the Director, Dam Safety Cell,WRD for proper and timely execution of all the activities and submission of outputs/reports.

G. In performing their duties, the Consultant will work in a coordinated manner with all other consultants working under NHP.

H. The Consultant shall preferably use appropriate open source modelling software for obtaining satisfactory results. The requirement of all input data for the model, the consistency of data, including primary or secondary validation should be analyzed in the initial phase. In case use of any proprietary software is planned by the consultant, there will be no additional payment for the software or its upgrade during the entire project period, and the cost will be deemed to be included in the contract value itself.

I. After the completion of the consultancy the Consultant has to provide software, hardware, data, and source code of all applications to the Client.

6.0. Handling Restricted Data

The Consultants, their sub-consultants, and the personnel of either of them shall not, either during the term or even after the expiration of this Contract, disclose any proprietary or confidential information relating to the Project, the Services, this Contract, or the Client's business or operations without prior written consent of the Client. Certain data (such as topographic maps in 1:50,000 scale with heights and contour information, river discharge data for Ganga river system and DEM with 50 cm contour interval) which may be used in project may be considered 'restricted' as per Ministry of Defense and Ministry of Water Resource guidelines. Keeping in view security guidelines for data secrecy and to provide optimum functionality and to enable sharing data with the consultants, a secure data handling environment has been proposed. FMISC will maintain all classified/ secret data in this Secure Data Centre (SDC). Confidentiality and non-disclosure agreements are to be signed by the Consultant firm, as well as the individual Consultants/employees deputed for working in Secure Data Centre (SDC). Technical data brought by the Consultant may be allowed to be loaded on the server after approval of the officer not below the rank of Deputy Director. A detailed record of all the data transferred from confidential unit will be maintained in register and data will be transferred only after approval. No original data kept on server will be modified or changed. Change/ modification required if any will be done only after having a backup of the existing data and with prior permission of the client.

7.0. Reporting and Review

The activities described earlier and the outputs described below shall be completed within a period **eighteen months**. Key reporting requirements follow:

Submission of Reports	Covering	Time /Month due
Inception Report	Report will cover Task-1 incorporating all assignments underthese tasks.	4 months from the date of commencement
Interim Report-1	Report will cover Task-2 incorporating all assignments underthese tasks.	8 months from the date of commencement
Interim Report-2	Report will cover Task-3 incorporating all assignments under these tasks.	12 months from the date of commencement
Draft Final report	The Report will incorporate the deliverables mentioned under all the tasks.	16 months from the date of commencement
Final Report after acceptance of Draft Final Report by WRD, Bihar	Report will incorporate the suggestions on Draft Final Report to achieve the objective under this consultancy.	18 months from the date of commencement

The Reports shall be submitted in 5 copies (Hard copy) and in Soft Copy.

The reports will be reviewed by NHP Standing Review Committee (NHP-SRC) set up by WRD and consisting of members from Flood Management Improvement Support System (FMISC), officers from WRD and external experts well acquainted in this field. The committee will provide review report within 15 days after report submission by the Consultant. The consultant will be liable to comply all the observations and comments provided by the committee.

8.0. Professional Key Staff Requirements

The indicative list of Key Staff and man months are listed below. The Consultant may propose alternative team composition and skill mix in order to carry out its roles and responsibilities efficiently for successful completion of the assignment.

#	Position	Qualification & Experience	Tasks and responsibility	Man Months
1	2	3	4	5
A	Key Staff			
1	Team Leader- Water Resources expert	Master degree in Civil Engineering/ Water Resources Engineering/Hydrology/Hydraulic with minimum 15years of experience in design, planning and management of water resource project. He /She should have extensive knowledge ofhydrological and hydrodynamic modeling tools used in water surface assessment. He/ She should have working experience in multi-disciplinary teams and reservoir sedimentation studies	• Will be responsible for overall output delivery as required in Terms of Reference. • He / She shall ensure that all the works are done as per the scope and objective mentioned in the ToR. • He shall liaise between the various stakeholders of the project. • He shall also be responsible for mobilization/ Demobilization and scheduling of the consultant's team.	17

#	Position	Qualification & Experience	Tasks and responsibility	Man Months
1	2	3	4	5
2	Co-Team Leader- Bathymetric survey Expert	Bachelor's Degree in Civil Engineering, Computer proficiency having knowledge of Auto CAD. Shall have 10 years' experience in Reservoir survey and data collection and analysis using modern surveying techniques and tools with experience in the use of GIS technology.	• Shall assist in Team Leader in finalizing the specification for carrying out the survey work. • Shall coordinate and supervise all the survey work. • Shall assist the Team Leader in planning and coordination for the timely and qualitative delivery as desired in this consultancy assignment.	6
3	GIS Specialist	Master degree in geography/ geo-informatics specialization in Remote Sensing and GIS with 5 years of experience in water resource engineering sectors including Geo-data base management. or Bachelor in Engineering/ MCA / Master degree in geography/ geo-informatics with 10 years of experience of GIS application in Water resources	• Shall assist Team Leader in review of all the survey and other GIS data. • Shall assist Team leader in finding the gaps of available data and support in collection of missing data. • Shall assist Team Leader in technical studies of the expected outputs of this consultancy assignment.	8
4	Environmental / Social expert	Master's degree in Environmental Sciences/ Engineering or closely related field. At least 05 years of experience of working in the field of environment management/ Environmental/ social Impact Assessment	• The Environmental/ Social expert will be responsible for preparing the environmental and social checklist, EIA appraisal of the activities under the project; • Shall assist the team leader in Environmental/	4

#	Position	Qualification & Experience	Tasks and responsibility	Man Months
1	2	3	4	5
		Good Knowledge of Government procedures/ policies for environment/ social safeguards is a prerequisite.	social issues.	
5	Hydrologist	Master degree in Hydrology; Hydraulics or Water Resource Engineering At least 5 years working experience in designing/ managing water resources project including working experience in Basin and water Resources Planning Knowledge of hydrological modeling tools used in Basin Planning Desirable: Experience in application Software Development/design/scripting in Water resources sector.	• Shall assist Team Leader in review of all the hydrological, Meteorological & other data. • Shall assist Team leader in finding the gaps of available data and support in collection of missing data. • Shall assist Team Leader in technical studies of the expected outputs of this consultancy assignment.	12
6	Database Specialist	Graduate in Engineering in Computer Science/IT /Civil Engineer 05 years' experience in development IT software with at least 03. years in Water Resource field etc. Extensive experience in scripting.	• Experience in management of data and its depiction as useful information on which policy decision could be taken. • Write scripts for exchange of data between various formats and models. • Development of dashboard to support Decision Support System.	6

#	Position	Qualification & Experience	Tasks and responsibility	Man Months
1	**2**	**3**	**4**	**5**
7	Surveyor	Certificate course in field surveying from recognized ITI. At least 5 years' experience in precision survey in flat terrain using Modern Electronic survey equipment like DGPS and Total station/Auto Level and control of preparation of output tables/ maps with validated data.	• Shall supervise the survey work at ground	12
B	Support Staff			
8	Technical Support Staff	Bachelor's Degree in Civil Engineering He/ She should have at least 3 years' experience in terrain survey/ Hydrological and Meteorological data collection/ analysis using modern techniques with experience in the use of GIS technology	Collection and inventory of primary hydrological and meteorological data, maps, information, and relevant available study report with geo-tagging. Check for data accuracy and completeness before entry.	2×17
9	Other support staff			2×17

9.0. Duration

The duration of the Consultancy shall be **18 (Eighteen) months.**

10.0. Payment schedule under the consultancy-

Payment Schedule:

A. 30% after submission and approval of the Inception Report by NHP-SRC.

B. 20% after submission and approval of Interim Report- 1 by NHP-SRC.

C. 20 % after submission and approval of Interim Report-2 by NHP-SRC.

D. 20% after submission and approval of the Draft Final Report by NHP-SRC.

E. 10% after submission and approval of the Final Report by NHP-SRC.

11.0. Mode of Procurement

Quality and Cost Base Selection (QCBS).

12.0. Annexure-A: Salient features of Kharagpur Lake

#	Particulars	Descriptions
1	Name of project	Kharagpur lake scheme
2	Purpose of project	Irrigation
3	Name of dam	Kharagpur lake dam
4	Year of completion	1876- original scheme 1966-Additional spillway
5	Benefits	Irrigation
		Kharif-5620 Ha
		Rabbi-2000 Ha
6	CCA	5310 Ha
7	Catchment Area	64 sq. Miles
8	Area of foreshore at FRL	3.84 sq.km
9	Dead storage capacity	22.20 Ha-m

#	Particulars	Descriptions
10	Gross storage at FRL.	1651 Ha m
11	Height of Dam above lowest river bed	26.53 m
12	Length of Dam (at crest)	221.04 m
13	Spillway (old) 4 Nos. gate	609.28 m^3/s
	Gate size -5.8 x3.05 m	
14	Spillway (New) 2 Nos. gate	240.88 m^3/s
	Gate size -7.62 x 6.09 m	
15	North dyke –E. L 57.93 m	335.365 m
16	South Dyke- E.L 57.93 m	807.93 m
17	Top of Dam	72.80 m
18	Maximum water level	70.66 m

#	Particulars	Descriptions
19	Full reservoir level	67.93 m
20	Sill level of irrigation sluice	57.93 m
21	Spillway crest level	64.87 m (old)
22	Spillway crest level	61.89 m (New)
23	Minimum draw down level	57.93 m
24	Lowest river bed level	46.27 m