NATIONAL HYDROLOGY PROJECT

TERMS OF REFERENCE

FOR

SEDIMENTATION MODELLING & RIVER MORPHOLOGICAL STUDY

APRIL, 2016

Contents

Project Summary:

Hydrology Project-I, an Integrated Hydrological Information System for Central and participating State agencies comprising the infrastructure and human resources to collect, process, store and disseminate hydro-meteorological quantity and quality variables was implemented in the five regions of CWC in peninsular India. The project started in September, 1995 and closed on December, 2003.

The Hydrology Project-II was a follow up on Hydrology Project-I. The overall project development objective was to extend and promote the sustained and effective use of Hydrological Information System by all potential users concerned with Water Resources Planning and Management thereby contributing to improved productivity and cost effectiveness of water related investments. The project was cleared by the CCEA in October, 2005. The agreement for the project between the Govt. of India and the World Bank was signed on 19th January, 2006 and approved by the GOI in the month of May, 2006. The original completion period of HP-II was June, 2012. The project completion period was extended upto May, 2014 by the World Bank. The major components undertaken during HP-II comprise institutional strengthening and vertical extensions.

Based on the successful outcome of Hydrology Project, Government of India, requested World Bank assistance for a follow on project – Hydrology Project III- Approach towards Integrated Water Resources Management'. There are a total of 47 implementing agencies (IAs) including eight central agencies, 37 state-level agencies and two river basin organizations (RBO).

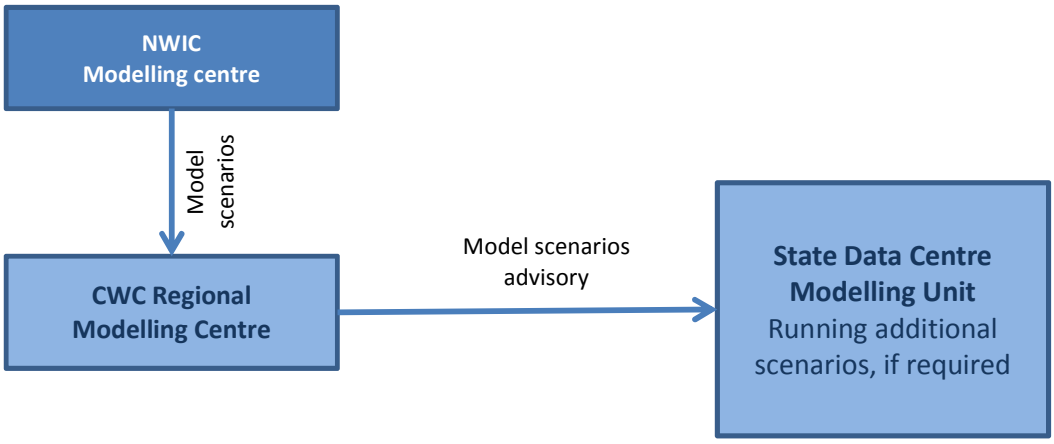
During the HP-III, the Central Water Commission will like to focus on core area activities which will improve the overall efficiency. In future, it is expected that inter-state disputes will crop up more and more and pose a challenge in the field of water management aspect. CWC future plan would be ideally focused on development of good forecasting and real-time management facilities to allow the organization to develop its ability to manage against catastrophes and to support optimum use of water resources.

The project seeks to enable improved decisions in water resources planning and operations. It posits that this requires not just improved water information products but also enhanced institutional capacity – both technical capacity and policy & planning capacity. Improved water information products (including water resources assessments, water accounts and audits, scenario analyses and option assessments, forecasts and early warnings) require improved water data and improved tools (analytical and decisions support systems) to transform data into information. The project thus spans the value chain from water resources data through to decision making capacity in water resources planning and operations. Beyond the project, this is expected to lead to improved water resources decisions (operations and planning) generating greater economic, social and environmental benefits from the management of a limited water resource. The PDO of the project is proposed "to strengthen the institutions and water information required for integrated water resources management in India". The key outcome envisaged during the project is as below:

- To establish National Water Information System with multi-disciplinary data from states and central agencies and data exchange amongst agencies in real time basis
- To create National information systems with generic models for improved water resources assessment
- States are able to manage flood and water resources using a river basin approach.
- Reservoirs and irrigation systems are operated more efficiently leading to water savings and improved productivity.

CWC has been envisaged to play a critical role in the implementation of National Hydrology Project (NHP), specially in Water Resources Planning and Operation, which focuses on developing tools/ models for water resources planning as well as for operation purposes. River basin approach is at the heart of all the activities proposed to be taken up by CWC under NHP. It is also envisaged that when modeling at the basin level is carried out, the water as a resources will be accounted in its totality incorporating the surface, ground and quality aspects. The macro level basin models will be developed in participatory approach along with various stakeholder agencies including CGWB, CPCB and the state government implementing agencies. CWC along with CGWB will develop framework/ model for assessing

surface hydrology, water allocation, groundwater assessment and water infrastructures. CWC will also develop platform for scenario analysis and data visualization (user interface for hydrological model and data management)
CWC and CGWB will coordinate this component with assistance from international/national consultants. Consultancies will support an integrated river basin approach including flood forecasting, stream flow prediction and water resources assessment integrating surface water, ground water and water quality.



1. Background:

One of the most important issues in the planning of storage reservoirs is the loss in the storage capacity due to silting. The sediment entering into a storage reservoir gets deposited progressively with the passage of time and thereby reducing the dead as well as live storage capacity of the reservoir. Further, it also affects the braiding characteristics & course of alluvial rivers impacting the ecology & biology of the nearby settlements. Hence, it is necessary to assess the rate of sedimentation at the planning stage and accordingly a portion of the capacity of the reservoir can be reserved for silt deposition. The assessment of sediment generation from various parts of the catchment would also help in identifying/prioriting the vulnerable areas to soil erosion and take appropriate mitigation measures like catchment area treatment, sediment retention structures etc. Phenomenon of generation of sediment from the catchment and river banks is complex in itself. Current understanding of the factors affecting soil erosion & hence sedimentation include soil characteristics, meteorological characteristics such as intensity & duration of precipitation, wind velocity etc. and exposure conditions & topography of the soil cover, land use conditions etc. The morphological characteristics such as soil texture, channel geometry, longitudinal slope, flood intensity, flood retention structures etc. play an important role in transport of the sediment generated from the catchments. Integration of sediment generation, transportation & deposition would give a picture of sediment flow in rivers and would be useful in sediment management. This study proposes to establish a methodology/modeling of sediment generation from catchment, its transport mechanism through channels/rivers and its retention/deposition by flood water retention structures like reservoirs. The following basins are proposed for the study

Package - I

- Ramganga Basin
- Barak Basin

Package - II

- Narmada Basin
- Cauvery Basin
- Three West Flowing rivers in western Ghats
    - Kuttiadipuzha Basin
    - Peechi Basin
    - Mangalam Basin

For the sake of clarity, the study may be divided into following components:

(A) Sedimentation
   i. Study and modeling of sediment generation from catchment
   ii. Study and modeling of the sediment transport mechanism through rivers
   iii. Study and modeling of sediment deposition in flood retention structures

(B) The study and modeling of morphological characteristics of the rivers

2. Objectives of consultancy:

The broad objective of consultancy is

(a) To compile the all related information/data in respect of sediment generation, sediment transports, river morphology, sedimentation deposition in flood retention structures, catchment area treatment, sediment retention structures in a proper database in GIS compatible format.
(b) To understand the sediment generation phenomenon, sediment transport mechanism, morphological characteristics of the rivers, sediment deposition mechanism in respect of identified river basins
(c) Assess the present condition of critical areas/ reaches in the catchment by conducting ground reconnaissance.
(d) Establish mathematical models for each river basin covering sediment generation, sediment transport, silting/de-silting of rivers, erosion/deposition in river banks etc.
(e) Study the likely impact of LULC changes in the catchment, climate changes, river fluviological characteristics, landforms, flood retention structures etc on the sediment generation, sediment transport, river morphology and sediment deposition.
(f) Assess the likely sediment rate from various part of catchment, rate of sediment flows in the rivers, morphological parameters of the rivers, sediment deposition profile in flood retention structure for each river basin with confidence level.
(g) Evaluate braiding pattern of river by using Plan -Form Index (PFI) criteria along with its threshold classifications.
(h) Identify critical and other vulnerable locations in the catchment/ reaches in rivers.

(i) Suggest suitable catchment treatment/ river training works for restoration of critical locations/ reaches depending on site conditions.

3. Scope of the Consultancy:

The Scope of the Consultancy is divided in two phases as follows:

Phase-I: Development of the comprehensive sedimentation model/ suite of models for establishing the sediment generation phenomenon and identification of critical areas within the basin, creation of watershed/ sub-basin wise zones based on potential of sediment generation, development of a GUI based on the finalized/ accepted mathematical model for estimation of sedimentation rate in the sub-basin, morphological characteristics of the river along with critical reaches prone to silting/ de-silting, possible engineering or biological interventions/ works that are technically & economically feasible in reducing the rate of sedimentation, model simulated quantitative reduction in rate due to interventions, creation of dissemination web based GIS portal and dissemination of model output in defined platform.

Phase-II: Maintenance & updation of the model for geographical transposability during warranty period of 1 year after completion of the project.

Note: The activities of training and capacity building are to be conducted at all stages.

3.1. The key tasks in Phase-I

3.1.1 Task 1: Review of Data availability, Data Collection and its Compilation

i) To collect and compile the all the requisite information/ data for the study as suggested under:
   a. The Survey of India (SOI) topo-sheets in respect of the reference time datum on a scale of 1:50,000.
   b. The satellite imageries having spatial resolution of 23.5 m , IRS LIS-I, LIS-II, LIS-III comprising scenes on regular interval say for the years 1980, 1990, 2000,2010 and the latest
   c. Highest resolution Digital Elevation Models/ Digital Terrain Models available in the public domain.
   d. LULC maps on 1: 250 000 scale
   e. Soil classifications maps of the basin on 1: 250 000 scale
   f. Meteorological and climate data
   g. River gauge and discharge data at available locations
   h. Observed sediment rate data at available locations
   i. Locations of major hydraulic structures on the rivers along with their features
   j. Sediment deposition profiles of reservoirs (all available bathometric survey of reservoirs need to be compiled)
   k. River geometry and river cross sections
   l. Geology of the area
   m. Sediment characteristics
   n. Review of available data and information with respect to minimum and optimum requirement for sedimentation and morphological modeling. Requirement of additional data, if any, may also be recommended by the consultant for better performance of the model.
   o. Correction and gap filling of data based on consistency checks.
   p. Identification of required license free modeling software/ suites of models, compatible hardware, system for sedimentation modeling & morphological analysis. The models available in public domain (preferably freeware with open source) shall be used.

In case the data is required to be procured from an agency, prior permission of same shall be obtained by the consultant from the client. The actual cost of the procurement shall be reimbursed to the consultant.

(ii) Delineation , Layer Generation and Data Compilation
   a. Delineation of River Bank Line, River Centre Line along-with generation of important GIS layers of river banks, major hydraulic structures, embankments/ levees, railway bridge line, island, airport, cities/ towns/ villages, and important monuments etc. located in the catchment for the selected years of the studies are to be integrated with the river basin maps.
   b. Generation of various GIS layers/maps for soil type, terrain slope, land use and land cover, and other parameters affecting sediment generation & its transportation at a common resolution for distributed analysis. All the maps shall be GIS compatible.
   c. Creation of web enabled data base in RDBMS.

3.1.2 Task 2: Study of sedimentation and its modeling

a) Understanding the sediment generation phenomenon, sediment transport mechanism, sediment deposition mechanism in respect of identified river basins through literature survey and review of the basin, identify the various factors influencing generation and deposition of sediments. Criteria for identifying the susceptibility of soil to erosion may be identified along with sensitivity analysis.

   i. Assess the present condition of critical areas/ reaches in the catchment by conducting ground reconnaissance. Field recon trips may be taken, if required.
   ii. Establish physics based distributed/ conceptual/ empirical models for sediment generation for the various time periods and validating using the sedimentation rate as observed at the observation sites. The model giving the highest correlation under geographically & varied land use transformation may then be finalized for each of the basin.

iii. Assess the sediment rate generation from various parts of the catchments. The spatial variability/pattern of sediment generation from catchment needs to established and critical areas be identified for soil erodablity and sediment generation. The confidence level/confidence band of the assessment need to be given
iv. Assess the likely impact of LULC changes in catchment, climate changes, landform changes on sediment generation from the catchment
v. Assess the present condition of critical areas/ reaches in the catchment by conducting ground reconnaissance. Field recon trips may be taken, if required.
vi. Establish sediment transport physics based conceptual/ empirical models model in the rivers and assess the suspended and bed sediment rates/load at various river reaches. The models should be calibrated/ validated based on observed sediment data at GDS site or reservoirs.
vii. Compare the sediment rates arrived based on sediment rates observations at GDS sites and reservoirs. Analyze the causes for differences in the sediment rates, if any.
viii. Analyse the sediment characteristics (size, physical, chemical etc) in various rivers reaches
ix. Establish physics based conceptual/ empirical models for sediment trapping by a flood water retention structures like reservoirs.
x. Estimate the sediment trapped by flood water retention structures over the years.
xi. Indentify the key factors/parameters affecting the sediment trapping the flood water retention structures.

b) Establish conceptual/ empirical models for assessing the profile of the sediment deposited over the years. Models may calibrated/ validated by the observed sediment profiles available at various reservoirs.

c) Identify the measures for reducing the sediment trapping by the hydraulic structures

3.1.3 Task 3: River Morphological Studies

a. Estimation of left & right bank shifting amount(s) w.r.t. base year & appropriate graphical plotting of these shifting.
b. Evaluation of braiding of different river course reaches by using Plan Form Index (PFI) criteria along with its threshold classification, wherever required.
c. Estimation and comparison of bank erosion for different reaches in term of erosion area, LULC, soil type, erosion length etc. of the river w.r.t. base year by using appropriate GIS tool, accordingly vulnerability index for different reaches may be evolved & prioritised along with causative factors detail for this erosion may be worked out.
d. The most critical reaches may be shown separately with appropriate suitable catchment area treatment/ stream reach(s) restoration/ stabilisation technique(s) depending upon the catchment/ channel condition.
e. The cross section data available may be used for identifying riffle locations, and measure topography changes. The cross sectional data provided may be used to extract necessary information to analyze the channel, which ultimately led to identifying the channel stage or condition.
f. The plan view of various stream patterns may be used to define the geometric relationship that may be quantitatively defined through measurement of meander wavelength, radius of curvature, amplitude, and belt width. It may be done by separating river reaches based on change in valley slopes into different RDs, estimation of sinuosity, no.s of bends for different RDs, average radius of curvature for each segment of the rivers defined. Based on this channel pattern analysis, proper interpretation may be given.
g. River Channel Dimension; river channel width and the representative cross section are a function of the channel hydrograph, suspended sediments, bed load, and bank materials, etc. The future river channel dimensions may be evaluated based on the available cross-section detail for vulnerable/critical reaches of the rivers.
h. Maximum Flow Probability curves at CWC H.O. sites located on concern river, may be developed to predict the channel discharge corresponding to 1.5 year to 25 year Return Interval (RI). These values i.e. 2 year Return Interval is widely accepted as the “Channel Forming Discharge” or “Bankfull”. These are the flows that contribute most to the channel dimension. These parameters may be used to determine the Channel Evolution Stage based on the Channel Evolution Analysis. Comparison of channel forming discharge and the maximum channel capacity may be done, accordingly interpretation about the channel carrying capacity is to be presented.

i. Channel profile is commonly referred to channel slope or gradient. The channel profile may be developed for river reach under consideration. The proper interpretation w.r.t. bed formations, aggradation, degradation etc. may be made part of the study.
j. Impaired stream analysis; as part of the scope of work, part of impaired streams to be identified along with the causes and sources by the consultant. Based on the causes of stream impairment, stream restoration mechanism/methods to be recommended. While stream restoration and bank stabilization techniques do improve water quality, land use practices may also be discussed, which is typically the main culprit of chemical pollution.
k. Analysis of shifting of left and right banks of the rivers at about 50 kilometer interval as well as covering critical reaches of the river irrespective of river RDs interval.

3.1.4 Task 4: Development of Integrated Modeling Tools

i. Develop Integrated Modeling Tools for sediment and morphological studies with Graphical User Interface (GUI) for dissemination of Model output in form of dash board
ii. Development of Dashboard for query based generation of various scenarios.
iii. Apart from website, the input data used and outputs generated should also be made available in the form of web service / web query; enabling stakeholders to develop own mobile apps regarding flood forecast.

3.1.5 Task 5: Capacity Building and Training

A key objective of this consultancy is to ensure that the experience gained through this consultancy can be used to develop the capacity of central & state engineers to further extend the work to all major river basins of India. This will require substantive training from the Consultants.

The capacity building will be achieved through various modes including formal, on the job and e-learning. The e-learning will be designed to approach all the interested stakeholders including state departments and will be possible opened to the public.

This will require substantive training from the Consultants. This may include:

Formal Training

i. Conduct Training program after each milestone as detailed below:

Training Programme	Area of Training	Duration
T1	Data processing and compilation and GIS processing (on completing task 1)	One week
T2	Sedimentation modelling (on completing task 2)	One week
T3	Morphological studies and Modelling (on completing Task 2)	One week
T4	Sedimentation modelling (on submission of Final report)	One week
T5	Morphological studies and Modelling (on submission of Final Report)	One week
T6	Sedimentation & Morphological Modelling	One week

ii. Conduct workshops on current technologies and future developments and operational management of full system.
iii. Training of Trainer (TOT) shall be organized on modeling software, model development, data processing, Sedimentation modelling, Morphological studies and GIS processing. A minimum of 15 officials shall be trained during the development of model.
iv. Four workshops of 2-3 day durations may also be conducted for officials from Central/ State Govt. officials on complete system including modeling and dissemination
v. Develop E-learning module for end to end flood forecasting system

Informal Training

Provide on the job training, where client may appoint officers from CWC / States to work with consultant during development phase of models / interfaces for better transfer of technology.

3.2 Key Deliverables and Reporting

The consultant shall also provide following deliverables for this work:

- **Inception report**: consultant shall provide an "inception report" clearly indicating how consultant plans to achieve the assigned objectives of this consultancy. The inception report shall include detailed work plan along with time schedule, selection of database, and finalization of models, data requirement, review of available data and data gaps, if any. The inception report shall indicate the time schedule represented by weekly Gantt chart showing major milestones, task deliverables, completion dates and any interdependencies. 20 copies of the report may be submitted.

- **Monthly progress report**: Consultant shall provide monthly progress report of the work carried out by them in the month positively by 5th of the next month clearly indicating achievements, works proposed to be taken up, and bottlenecks in carrying out the work.

- **Data Compilation Report**: Consultant shall consolidate all data used in development of the mathematical model in accordance with the data formats as decided in consultation with Engineer-in-Charge and shall deliver a consolidated report of the same free of errors in both content and format. The consultant shall deliver all data and data products, metadata records with detail datum, re-projections, re-sampling algorithms, processing steps, field records, and any other pertinent information etc. The consultant is also required to submit the shape-files, raster files, features, layers and all other files related to the geo-databases as needed in soft format. The data shall be compiled in proper RDBMS.

- **Draft Final Reports**: The draft final reports (15 copies each) shall be submitted by the consultant on completion of the study:
  (i) Draft Final report of Sedimentation modeling and study for each basin
  (ii) Draft Final report of Morphological study of each river basin

  The draft final reports shall cover complete details such as data analysis, modeling, analysis, outcome and results, recommendations, software user manual etc.

- Final report, User manual and prepare peer-reviewed papers for a joint publication. Consultant shall submit the final report to the client in hard (30 copies) and soft copy.

  The final report shall include User Manual which shall act as a technical operational and training/ workbook material for use of the developed models. The User manual shall also include the description of model design, parameters involved, operation of the model, use of the results along with the troubleshooting tips.

  Consultant will prepare a paper based on results of the modeling in consultation with CWC for joint publication in a national/ international journal.

3.3 The key tasks in Phase-II

3.3.1. Maintenance and updation of the models during warranty period of 1 year:

- Maintenance of the model including attending any bugs found in the model
- Maintenance of the auxiliary systems for coupling sedimentation, HO and Met data with the model and data dissemination portal.
- Review of model and updating/ fine tuning of parameters based on the model performance and improving model results.
- Conducting workshops/ conferences addressing the changes made during updation/ fine tuning of the models & resultant changes in the outcomes.

3.3.2 Key Deliverables

- **Monthly progress report**: Consultant shall provide monthly progress report of the work carried out by them in the month positively by 5th of the next month clearly indicating achievements, works proposed to be taken up, and bottlenecks in carrying out the work.

- **Updation/ Modification report**: Consultant shall provide a consolidated report indicating the changes made in the model during fine-tuning of the model and the changes observed in the results due to the modifications.

4 Schedule for completion of tasks:

Total schedule time for completion of the work of sediment modeling, establishing sedimentation rate and river morphological studies for the above mentioned packages shall 36 months. Studies & hence preparation of comprehensive report of all the basins within the package may be taken up simultaneously. The time schedule for the proposed work and deliverables are given below:

Deliverables	Description	Timing
1. Inception Report	Review of data availability and data quality, Review of International experience, Identification of possible models suitable to each river basin, Conceptual design of flood Monitoring system, Methodology for the development of model, Identification of data inputs for the model, Outputs expected, Methodology for the calibration and validation of model, and fortnightly schedule of implementation work plan.	T + 4 months
2. Data collection, processing and compilation Report	Collection, Validation & Compilation of the Required data (hydro-meteorological, topographical, GIS layers including DEM and other data required for modeling)-parallel activity along with inception report.	T + 6 month
3. Draft Final report of Sedimentation modeling and study for each basin	The draft final reports shall cover complete details such as data analysis, modeling, analysis, outcome and results, recommendations, software user manual etc.	T+12 months
4. Draft Final report of Morphological study of each river basin	The draft final reports shall cover complete details such as data analysis, modeling, analysis, outcome and results, recommendations, software user manual etc.	T + 18 months
5. Final Report	Covering all Task described in the ToR and addressing all the observations of the client on draft final reports including user manual	T + 22 month
6. Capacity building and Training		T+4-24 month
7. Updation/ Modification report	A consolidated report covering the improvements/fine-tuning in the model during warranty period and the changes observed in the results due to the modifications made.	Completion date + 12 months
* T is the time in month from signing if the contract		

5 Data Services & Facilities to be Provided by the client:

The following amenities will be provided by the Client:

- Consultant has to collect available historic and current data on hydrometeorology, hydrology, hydraulics bathometry and sedimentation; available thematic data; rainfall and sedimentation as per prevailing policy/guidelines. The data collection shall be facilitated by the client. In case, data is required to be purchased, the same shall be purchased by consultant after approval from client and thereafter the actual cost of data shall be reimbursed to the consultant.

6 Handling Restricted Data

The Consultants shall not, either during the term or even after the expiration of this contract, disclose any proprietary or confidential information related to the Project, the services, this contact, or the Client's business or operations without the prior written consent of the Client.

7 Technical Advisory & Review Committee:

A Technical Advisory & Review Committee (TARC) may be formed comprising of officers from CWC and other prominent organizations to guide and review the works/reports.

8 Desirable Experience of Consulting Firm and their key team Members

The lead organization for the project shall meet the following criteria

- Minimum ten years of experience in providing international consultancy services in the water sector, with particular emphasis and a track record of successfully delivering major analytical projects that directly interface with water resources policy or management.
- Demonstrated experience in Extended Hydrological/ sedimentation modeling at basin/ watershed scale,
- Track record of managing major multi-organizations technical partnerships on complex water problems including in the last five years.
- Experienced in technical assignments in developing countries; preferably India.
- Ability to quickly deploy a team (professionals with relevant experience and qualifications) either from the lead organization or through sub-contracting arrangements.

Consultant Team (For Each package)

Discipline of the Consultant	Qualifications and Experience	Suggested Man-Months
Team Leader	1. Doctorate/master in Hydrology, Hydraulic and / or Water Resources engineering. 2. At least 15 years working experience in water resources. 3. Preferably having sound knowledge of hydrological, hydrodynamic & Sediment modeling tools used in Sedimentation & Morphological studies.	12 month
Deputy Team Leader	1. Master degree in Hydrology, Hydraulic and / or Water Resources engineering. 2. At least 10 years working experience in water resources/ hydrological and hydrodynamic modeling. 3. Preferably having knowledge of hydrological, hydrodynamic & Sediment modeling tools used in Sedimentation & Morphological studies.	12 month

Modeler	1. Degree in Hydrology, Hydraulic and / or Water Resources engineering. 2. At least 10 years working experience in sediment transport/ sedimentation/ Hydrological modeling with efficient working knowledge of GIS. 3. Extensive knowledge of hydrological and hydrodynamic modeling tools used in sedimentation analysis; should have a very good experience with sedimentation and morphological modeling. 4. Proven experience in setting up models for sedimentation in large river basin. 5. Experience in the study of morphological conditions of rivers, Engineering/ non-engineering Catchment Area Treatment Methods.	1 modeler for 36 month (24 during Development & 12 during Warranty period)
Hydrologist	1. Degree in Hydrology, Hydraulic and / or Water Resources engineering. 2. At least 10 years working experience in sediment transport/ sedimentation/ Hydrological modeling with efficient working knowledge of GIS. 3. Extensive knowledge of hydrological and hydrodynamic modeling tools used in sedimentation analysis; should have a very good experience with sedimentation and morphological modeling. 4. Desirable: experience in application Software Development / design in Water resources sector; experience in setting up models for sedimentation in large river basin; experience in the study of morphological conditions of rivers, Engineering/ non-engineering Catchment Area Treatment Methods.	1 Hydrologist for 12 month during development.
GIS/ RS specialist	1. M.Sc. Geography/ Geo Science with specialization in GIS/ RS. 2. 5 year experience in RS/ GIS applications for river mapping, preparation and integration of GIS datasets, experience in integrating global satellite derived data; experience in hydrologic application, 3D analysis and customization and experience in morphological mapping for GIS/RS specialist.	1 for 12 month
Database specialist	1. Graduate in Engineering in Computer Science/IT Database 2. 2 year experience in data base applications for Database specialist ;	1 for 6 month
Technical Support Staff	Engineers/ Database operators/ other	2 for 24 months
Other Support Staff	Matriculate and above	1 for the whole period

9 Administration

For the purposes of this assignment, the Consultant will report to Hydrology(S) Directorate and River Data Directorate of CWC. The Consultant will work closely with the CWC offices as a Client throughout this assignment – especially to discuss interim results and on methodology.

10 Payment Schedule

Phase-I

- 10 percent on signing of contract as advance against a bank guarantee
- 10 percent after acceptance of Inception Report.
- 10 percent after acceptance of Data Compilation Report.
- 15 percent after submission and approval of draft final report of Sedimentation modeling
- 15 percent after submission and approval of draft final report on Morphology study
- 20 percent after submission and approval final report.
- 10 percent on completion of trainings/ workshops and completion of project in all respect
- 10 (5 percent in each half year) percent after completion of satisfactory services during warranty period

Phase II

- Payment will be made on half yearly basis after providing the satisfactory services during that period.

11 Duration of Consultancy

- 2 years + 1 year warranty