TECHNO-ECONOMIC ASSESSMENT STUDY (TEAS) for the Rogun Hydroelectric Power Plant Construction Project

TERMS OF REFERENCE

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# Section 5. Terms of Reference

## TEAS for Rogun Hydroelectric Power Plant Construction Project

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1. INTRODUCTION

1.1 Background

The Government of Tajikistan (GORT) plans to re-start of the construction of the 3600 MW Rogun hydroelectric project (HEP) (which was partially constructed during the Soviet rule and has made no further progress since the early 1990s for want of funds to complete the construction); and intends to mobilize the needed financing for completing the construction of this project through an international consortium.

For the completion of the construction of the Rogun Hydroelectric Project (HEP) GORT intends to secure consulting services for the assessment of this project from technical, economic, financial, environmental and social perspective. GoRT has received funding from the World Bank for an Energy Loss Reduction Project, and GoRT intends to apply part of the proceeds of this funding towards the preparation of the Assessment Study consisting of: (a) Techno-Economic Assessment Study (TEAS); and (b) separately, but in parallel, an Environmental and Social Assessment (ESIA).

GoRT and Barki Tajik (the national electricity utility and the contracting party) are now inviting detailed proposals from shortlisted consulting firms to undertake the consulting assignments for TEAS for Rogun HEP.

The work on TEAS would include an assessment of all the previous work done to date on the Rogun HEP; and an assessment of the entire Vaksh River development master plan. In respect of Rogun HEP the TEAS would evaluate (bearing in mind that this is a case of completing a partially constructed project and not a case of green field project) different options for dam type, dam height, construction phasing, reservoir operations, as well as issues of dam safety. Importantly, TEAS would analyze and recommend the possible trade-offs between techno-economic issues and the safeguards issues of dam safety, environmental, social, resettlement and impacts on other riparian states.

The ESIA which would be conducted in parallel by another Consultant would comply with World Bank and other IFI requirements, and would be guided by the policies of the World Bank, in addition to those of Tajikistan. Under the guidance of the World Bank, clarifications may be provided as necessary to address minor differences between the policies of the World Bank and those of other participating IFIs. Assessments would include compliance requirements of the applicable World Bank Safeguard Policies including, but not limited to, environmental assessment, involuntary resettlement, physical cultural property and dam safety.

In addition, TEAS and ESIA would receive information upon coordination with the Government subject to confidentiality of proprietary financial data, and provide information to, an independent assessment of the potential regional impacts\(^1\) of Construction of Rogun HEP on the other riparian states of Amu Darya basin that the World Bank plans to undertake in parallel.

1.2 Overall Guidelines for Project Development

Key Principles for Project Development

\(^1\) Such as, for example, the impacts (during the construction and operating phases of Rogun HEP) on irrigation, agriculture, drinking and industrial water supplies, sanitary flows, sedimentation, flooding etc in the downstream countries, as well as impact on the agreed flow of water to Aral Sea and impacts on the downstream countries relating to the safety of the dam.
The construction of Rogun HPP was begun in 1980 during the Soviet Union era as per the original designs prepared by Tashkent HydroProject. According to this design, Rogun HPP would have a reservoir with multi-year regulation mode with a dam height of 335 m, located on the Vaksh River upstream of the existing Nurek HPP cascade, to be realized in two stages. The reservoir would have a total storage volume of 13 km$^3$, a live storage of 8.6 km$^3$, and would likely extend upstream over a distance of about 70 km. The installed capacity is proposed to be 6x600 MW (totaling 3,600 MW) and the annual power generation would be 13,300 GWh. Despite significant storage, Rogun HPP was expected to produce electricity in Tajikistan and develop irrigation in the region. Construction works were started during 1980-ies of the past century, but stalled about 15 years ago for lack of funds. Currently most of the site preparation works about 70% of the underground works (access tunnels, penstocks, diversion and outlet tunnels, chambers for turbines/generators and transformers) have been completed.

The majority of the electricity to be produced by Rogun HPP is expected to be exported. Currently, the main export market identified is that of Pakistan, and the intention of Pakistan to import electricity from Rogun HPP has been explored in bilateral (Pakistan Tajikistan Joint Economic Commission) and multilateral (Central Asia South Asia Regional Electricity Market or CASAREM) forums. Other possible markets would also be considered as part of the Assessment.

In view of the size of investments needed, Rogun HPP would need significant private/foreign investment and but also requires the Government to play a key role, in view of the existing assets and the necessity to take responsibility for environmental, social, resettlement and riparian issues, and also for establishing the export markets (which are to be underpinned by inter-governmental agreements). The Government intends to establish an International Consortium of investors and financiers for the development of Rogun HPP.

**Process**

The development of Rogun HPP is a high priority task for the Government, which has established a high level inter-ministerial committee to oversee this task. This high level steering committee is chaired by the First Deputy Prime Minister and comprises the Presidential Administration, State Investment Committee and the Ministers of Energy and Industry; Justice; Economy and Trade; Finance;; Agriculture and Water Resources; and Ecology; with Barki Tajik performing the role of Secretariat of the Steering Committee.

The Assessment Study would comprise two distinct parts – (1) Technical-Economic and (2) Environmental and Social. There will be two separate consulting services contracts for these two parts, with the work to be carried out in parallel and in an interactive manner. Barki Tajik would be responsible for the process of bidding and selection of the Consultant (following the World Bank Guidelines for Consultant selection), but the tender committee would [either] be the Inter-Ministerial Steering Committee mentioned above [or] a committee appointed by the Inter-Ministerial Committee.

The Assessment Study would be reviewed in parallel by International Independent Panels of Experts (PoE), one each for (a) techno-economic/dam safety and (b) environmental/social aspects. The costs of these PoE would also be met from the funding provided by the World Bank under the on-going Energy Loss Reduction Project.

The Assessment Study work would include assessment of all the previous work done to date. The most relevant studies that need to be reviewed are: Rogun HPP Technical Project, 1978, by Hydroproject Tashkent, and the 1993 supplementary studies done by the same organization, as well as technical projects/studies (documents) done in 2008-2009 by design institutes “Hydroproject” and “Moshydrostal” . These studies would be given to the consulting firm(s) that would carry out the Study, in English and in Russian.

1.3 The Rogun Hydro Power Project
According to the original design Rogun HPP would have a reservoir with a rockfill/earthfill dam with a height of 335 m. MW (totaling 3.6 GW). The estimated average annual energy would be 13,300 GWh.

The selected dam location is a narrow gorge with steep flanks. The geology is characterized by highly heterogeneous sedimentary layers (in terms of strength and permeability) including haline, soluble strata, which necessitate careful investigation and analysis. The facility’s design life is estimated to be 150-200 years.

Construction works were started around 1980 and were stopped in 1992. Since then, GoRT has allocated a minimum budget to continue works on a low key and maintenance basis. Currently most of the site preparation works as well as an estimated 70% of the underground works (access tunnels, penstocks, diversion and outlet tunnels, chambers for turbines / generators and transformers) have been completed.

The location of Rogun HPP is presented in Appendix 1 and its salient characteristics as of 1992 are presented in Appendix 2.

2. OBJECTIVE OF THE CONSULTANT’S SERVICES

The overall objective is to prepare and submit to the Government of Tajikistan and Barki Tajik a Techno Economic Assessment Study of the proposed Rogun Hydropower Power Plant.

3. OVERSIGHT OF THE CONSULTANT’S SERVICES AND RELATED STUDIES

The Government of Tajikistan/Barki Tajik will appoint its own Project Manager/Coordinator and support staff to administer the Contract.

The Consultant’s work shall be undertaken in accordance with the World Bank’s Safeguards Policies, including Operational Policy OP 4.37, Dam Safety. An Engineering Panel of Experts will oversee the engineering and dam safety aspects during the execution of the services. Another Panel of Experts will oversee the environmental and social impact assessments which will be carried out by another consultant under separate contract with the Government of Tajikistan and Barki Tajik.

4. SCOPE OF WORK OF THE CONSULTANT

These ToRs describe the services/tasks to be performed by the Consultant for the Government of Tajikistan and Barki Tajik in respect of the TEAS

All services of the Consultants described herein shall be performed in close cooperation with the Government of Tajikistan and Barki Tajik and agencies and authorities designated by the Government/Barki Tajik. The Consultant shall keep in mind that the services and tasks described herein can not be considered as the complete and comprehensive description of the Consultant’s services and duties. It is rather the Consultant’s responsibility to critically verify the scope of the services indicated herein, and to propose modifications in his proposal wherever he deems it necessary according to his own professional judgment and the knowledge that he will acquire during the preparation of his proposal. It is understood that the Consultant shall perform all the services/work as necessary to fulfill the objectives of the Consultancy Contract.

During the Consultant’s assignment, other consultants and advisers may provide services to the Government of Tajikistan and Barki Tajik. The Consultant shall have to coordinate his activities with those of the said parties.
The Consultant is expected to execute as much work as possible in Tajikistan, and shall have staff with knowledge of Tajik and Russian, in addition to English, which is the main working language.

The Consultant shall carry out the work in four inter-related Phases:

- **Phase 0 (Zero)**: Geological and Geotechnical Investigation of the Salt Dome in the Dam Foundation and Reservoir
- **Phase I**: Assessment of the Existing Rogun HPP Works
- **Phase II**: Rogun HPP Project Definition Options
- **Phase III**: Assessment Report of the Selected Option

The Consultant shall be responsible for carrying out all the necessary field work and investigations to compile information and data required for the work. This includes the preparation of tender documents for field investigations (for instance: topography and mapping; geological, geotechnical and geophysical field investigations; hydraulic model testing; etc.), the tendering process, where necessary, for such investigations, and the award and management of said contracts in agreement with the Government of Tajikistan and Barki Tajik. The contracts shall stipulate that the Consultant shall be responsible for their correct performance. These investigations shall be defined and completed as soon as possible to have the information available when required at the time of the services. The consultant should include in their financial proposal the cost of such investigation, as a separate item clearly defined and based on best possible estimates, with a specific breakdown of Consultant costs for preparing bid documents and supervision. These sub-contracting costs shall not be used in the evaluation of financial proposals; the cost of preparing bid documents and engineering services to supervise will be considered in the evaluation. The scope of the investigations and the related costs will be agreed during negotiations and any subsequent changes must be determined in consultation with the Government of Tajikistan and the World Bank, and authorized in writing as such.

All the reports shall be prepared in English and Russian.

### 4.1 PHASE 0 (ZERO): GEOLOGICAL AND GEOTECHNICAL INVESTIGATIONS OF THE SALT DOME IN THE DAM FOUNDATION AND RESERVOIR

The Consultant shall pay special attention and investigate thoroughly the heterogeneous bedrock at the dam site composed of sedimentary systems including a wedge of salt fed by the Gaudark salt formation along the Ionaksh fault, including the crossing in the reservoir, and area which will therefore be submerged.

The Consultant shall perform under this Phase 0 a risk assessment pertaining to the salt dome's influence on dam safety. The assessment shall be based on existing documentation and visual surveys. The Consultant may recommend additional investigations as appropriate.

The assessment shall recommend possible treatment options, residual risks during Rogun's operation and how to manage them, and based on it, the Consultant shall recommend the most appropriate course of action to the Client.

The Consultant shall present a complete report on said assessment as soon as it is completed.
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The Consultant shall not proceed to commence the Phase I work unless the Client authorizes him to do so in writing, after a careful review and acceptance of the above report in consultation with the Engineering Panel of Experts.

5. PHASE I. ASSESSMENT OF THE EXISTING ROGUN HPP WORKS

The Consultant shall carry out an assessment of the existing works at Rogun HPP to establish the adequacy of the selected site for the development of the Project. Phase I and Phase II shall be carried out in parallel. The Consultant shall carry out the following tasks, but is not limited to them:

5.1 Document/Data Collection on Rogun HPP

The Consultant shall collect, review and analyze available documents/records on the existing Rogun HPP documents and works, such as:

- Topographic surveys and mapping
- Meteorology
- Hydrology
- Sediments
- Hydraulics
- Reservoir simulation studies (power, energy, irrigation, flood mitigation)
- Envisaged Reservoir operating regime
- Geological reports
- Geotechnical investigations and reports, foundation investigations
- Seismic reports
- Electrical and mechanical equipment
- Engineering design criteria used (civil, electrical, mechanical, etc.)
- Engineering design of the Project components
- Bidding documents and construction and equipment supply contracts
- Construction drawings of the executed works
- Construction records and reports
- Structural and hydraulic model tests reports
- Infrastructure
- Transmission
- Estimated investment made at current price level in the existing works
- Existing documents on water sharing within Nukus Declaration (September 5, 1995)

5.2 Rogun HPP Site Inspection

The Consultant shall conduct a project area and site inspection to assess the condition of the existing works, which shall include, but not be limited to the following:

- Access road to the Project Site
- Permanent and temporary roads, tunnels and bridges
- Accommodation for construction workers
- Upstream and downstream cofferdams
- River diversion works during construction
- Reservoir area conditions including slope stability
- Pertinent geological features
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- Dam foundation and abutments, spillway, intake, diversion works, powerhouse, substation sites, etc.
- Dam integrity and dimensions and elevations
- Intake and lower outlets dimensions
- Head race pressure tunnel
- Concrete integrity, extent of deterioration (detailed structural inspection of structures, confirm concrete strength and integrity, confirm concrete contact with other materials [foundation, abutments, reinforcement steel], and collect other information related to the structural soundness of all works
- Access tunnels to underground power house
- Underground power house and partial concreting
- SF6 insulated switchgear – 500 kV

5.3 Assessment of Current Conditions of the Rogun HPP Site and Works

Assessment of the value of the infrastructure already constructed at the Rogun HEP would be part of the Feasibility Study from the points of view of its usefulness and value. Assessment and especially valuation of this infrastructure is to be done in a clear and professional manner and the methodology for such assessment would be agreed with the Government and the World Bank at the time of the Inception Report review of the Consultants' work.

The Consultant shall prepare a report that shall cover the results of the assessment of the Project, inter alia:

- An executive summary in Russian and in English
- Analysis and results of the documentation reviewed as stated under paragraph 5.1
- Analysis and results of the site inspection including conditions of the structures and other project components as indicated under paragraph 5.2.
- Identification of potential problems and weaknesses, evidence of defects, indications of deterioration
- Recommendation of appropriate measures to correct unsafe conditions and bringing the existing works to specifications
- Adequacy of the works and Site for the development of the Project including for the proposed dam.
- Detailed estimate of the investment made (sunk cost at current price level) in the Project on the basis of the agreed methodology.
- Location map and layout and drawings of the existing works

6. PHASE II. ROGUN HPP PROJECT DEFINITION OPTIONS

The objective of Phase I is to review the Rogun HPP as proposed originally, compare it with alternative options, and as a result of the substantiated technical economic comparison, select and recommend the option for which a detailed Assessment shall be carried out in Phase II

Work on Phase I and Phase II shall start simultaneously and run in parallel until one option is selected.

For Phase II, the depth of the investigations, designs and estimates shall be limited to the degree of accuracy required for a clear delineation among the project alternatives considered, enabling the Consultant to make a substantiated recommendation as to the selected scheme.

The Consultant shall carry out the following work, but is not limited to:

6.1 Review and Analysis of the Vaksh River Masterplan
The TEAS should look at the entire Vaksh River development master plan, including the Sangtuda 1, Sangtuda 2, and Shurob HPPs.

The TEAS shall provide a description of the Vaksh river valley, its hydroelectric potential; the Vaksh river development master plan; rationale and justification for the master plan; and progress achieved to date in the development of the master plan;

The TEAS shall assess whether it would be optimal to build the first stage Rogun HPP; then in parallel construct the Shurob run-of-river project, and then pursue the construction of Rogun Stage 2.

6.2 Selection of Dam Site and Dam Type and Height

Considering that this is a case of completing the construction of a partially constructed project, change in the dam site/type and the power house site shall be considered only when the existing criteria site/type, height etc) is proved clearly unsafe or otherwise technically unsuitable.

The original design of Rogun HPP adopted a rockfill/earthfill dam. The Consultant shall evaluate the existing design of the dam and its site, and compare it with other dam types feasible for the site, and select the appropriate dam type and height and its characteristics on the basis of a technical and economic evaluation. The construction of Rogun dam and of the installed capacity in two or more stages shall be analyzed. The spillway capacity must be available at all times to discharge the design/probable maximum flood during the construction stages.

6.3 Assessment of selected Powerhouse Site and Other Components

Since the Rogun HPP power house cavern has been completed earlier, the Consultant shall evaluate the site, on the basis of a technical and economic evaluation, taking into consideration uncompleted construction of site objects. Related project waterways shall also be evaluated.

Considering that this is a case of completing the construction of a partially constructed project, consultant will further confirm that the existing construction is safe and technically suitable.

6.4 Topographical Surveys and Preparation of Maps

Review of existing documentation to be provided by the Government/Barki Tajik.

Prepare topographical maps on GIS platform at the appropriate scales and contour curves for the project area as follows:

- Entire reservoir area (reservoir and capacity data/curves versus elevation; e.g. horizontal scale 1:10,000 with 5 m contour levels)
- Selected dam site and power house site (river cross sections, etc.; e.g. horizontal scale 1:1,000 and 1 m contour levels)

As far as possible, satellite remote sensing (SRS) shall be linked to the GIS models. The remote sensing based information shall be integrated appropriately in the on-site topographic surveys and investigations.

The Consultant shall submit all maps prepared and procured by him in hard and soft copies (5 copies of each).

All the scope of work, including calculations, shall be presented in the report on topography and maps.
6.5 Geological, Geophysical and Geotechnical Investigations

Review of existing documentation to be provided by the Government/Barki Tajik, among other things, to assess the completeness, adequacy, and usability and quality of investigations carried out in the past against good international practice.

Establish the engineering geological conditions of the project area and component (reservoir, dam, waterways, powerhouse, etc.) sites.

Compilation of geological maps and reports of the project area and sites

A regional geological assessment shall be carried out based on the available data, maps, and aerial surveys. Regional geological maps, regional geological cross sections and seismic-tectonic maps shall be prepared.

Geological, geophysical, and geotechnical investigations shall be integrated to the topographic maps.

A regional geological assessment shall be carried out based on the available data, maps, and aerial surveys. Regional geological maps, regional geological cross sections and seismic-tectonic maps shall be prepared.

The geophysical investigations shall be performed for selected lines/profiles.

The geotechnical investigations shall include boring in soil, drilling/coring in rock, trenches, sampling, in-situ tests, galleries on the dam abutments, site tests, laboratory test and reports, and shall establish the soil and rock strata along with their properties.

The assessment shall be performed for the project components such as:

- Reservoir (including reservoir tightness, losses if any, and slope stability etc.)
- Dam
- Spillway and energy dissipation area
- Intake area
- River diversion works during construction
- Headrace tunnel
- Surge chamber
- Penstocks
- Power house site (caverns)
- Substation
- Sources of construction materials
- Infrastructure to the site

Identify and comment on potential or possible specials problems or risks such as: (a) halite and gypsum bearing strata in the dam foundation area dissolving and causing preferential seepage flow; (b) cracks at the clay core-foundation rock contact, which could initiate erosion of core material (Teton Dam Effect); and (c) flow through zones of high permeability such as fractured sandstone or faults.

Sampling and field-testing shall take place during the investigation program. Selected samples of soil and cores recovered through drilling of boreholes shall be sent to the laboratory for tests to find out/confirm the quality and suitability of the rock for foundation of the civil works structures and soil as construction material.
Assemble the classified drill cores and other samples in a safe place/warehouse.

All the scope of work, including analysis, findings and calculations, carried out shall be presented in the geological, geophysical, and geotechnical report.

### 6.6 Seismic Studies

Review of existing documentation to be provided by the Government/Barki Tajik.

The Consultant shall undertake, inter alia: detailed seismological investigations, evaluation of available studies for Sangtuda, Nurek and other HPPs in the region; description of seismicity of the region; evaluation of the seismic hazard [methodologies, zone of influence, seismic sources (faults, etc.), estimation of the maximum credible earthquake (MCE), operating basis design earthquake (OBE), and acceleration of the design earthquake, reservoir triggered seismicity, etc.], and present results and conclusions. The project shall be designed on the basis of the results of seismic studies.

Review the existing seismic network in the region/zone/project area and propose means to improve it to closely monitor the seismic activity in the region/zone/project area.

All the scope of work, including analysis, findings and calculations, carried out shall be presented in the seismic studies report.

### 6.7 Construction Materials Survey

Review of existing documentation to be provided by the Government/Barki Tajik

Survey shall be carried out of the proposed site area for identification of suitable location for construction materials. This shall cover investigations of locations of potential quarries for sand, soils, dam core materials, rock and aggregates, etc. and preparation of maps identifying the borrow areas; estimation of quantities; collection of samples from borrow areas; testing of samples of the materials at the various locations, preparation of location maps, road maps, etc. showing transport routes up to the borrowing areas and their relation to the construction site(s).

In addition, the source (national and international) of supply of other materials such as cement, steel, lumber, etc. shall be identified.

All the scope of work, including findings, analysis and calculations, carried out shall be presented in the report on construction materials.

### 6.8 Meteorological and Hydrological Studies

Review of existing documentation to be provided by the Government/Barki Tajik.

Carry out the necessary meteorological and hydrological studies and investigations necessary to define the project.

The following parameters shall be collected from the respective agencies:

- Temperature
- Rainfall /Snow fall / Glacier melt
• Discharge
• Water quality
• Humidity
• Sedimentation
• Evaporation, etc.

The following shall be performed, inter alia:

• Preparation of maps showing the location of the stations along with the available and collected data.
• Evaluation of existing meteorological and hydrologic measuring stations/network in the river basin and, if necessary, actions to improve them, including new installations.
• Evaluation of the condition of the existing gauging station at the Project site, and determine if it needs recalibration or if a new station should be installed and calibrated for daily measurement of the river flow at the Project site.
• Collection and organization of available meteorological and hydrological data in the catchment area upstream of the Project site
• Assessment of data quality.
• Analysis of precipitation, snow melt, evaporation, river flows, sediment discharges and volumes, etc.
• Compilation of historical updated data of river flows at sites: daily, weekly, monthly and annual. Representative period of dry, medium and high flow conditions shall be selected for analysis of hydraulic conditions.
• Studies for validation of hydrological data, compilation and processing including extension and generation of data, and preparation of hydrological inputs for reservoir simulation studies shall be performed. Consider stochastic methods.
• Assessment of historic flows at identified locations.
• Studies of construction diversion flow, flows for various return periods, accompanied by the respective hydrographs.
• Estimate of floods with different return periods and of the probable maximum flood (PMF) accompanied by their respective hydrographs, data and methodology used.
• Studies of sediment discharge and volume.
• Overview of water use along the Amu Darya, including in riparian countries.

All the items covered by the above scope of work, including findings, analysis and calculations, shall be presented in the report on meteorology and hydrology.

6.9 Climate Change Impact Assessment
The Consultant shall review the trends in annual and seasonal water flow in the Vaksh River during the past several decades, forecast changes in water flows as a result of climate change and global warming and take these into account while finalizing the design of Rogun HPP and its operating regime.

The Consultant should assess the possible positive aspects of Rogun HPP in the context of climate change - flood control in the event of higher flows due to climate change, avoided carbon emission of Rogun HPP relative to similar-sized fossil fuel generation; the beneficial impact it would have on the glaciers and other sources of water into Vaksh etc.

The Consultant should review the available global and regional climate models and studies carried out with relevance for the Central Asian countries (Tajikistan, Kyrgyz Republic, Uzbekistan and Turkmenistan), assess the likelihood of variability in the flow regime, optimize the equipment design and flow regime for the most likely flow ranges and carry out sensitivity studies in relation to the variations on either side.

The lines on which this aspect of the work may be handled are given in Box 1 below.

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2 For further details see Addressing Climate Change Driven Increased Hydrological variability in Environmental Assessments of Hydropower projects- A Scoping Study, Vattenfall Power Consultants AB, Sweden, July 2007
Box 1: Approach to encompass Climate Change aspects in Hydro Projects Design

The Vattenfall report provides the following guidelines:

- Do baseline planning assessments based on available solid information. Conduct standard trend analysis for exiting hydrological records. This is empirical evidence and does not have a dependency on modeling.

- Obtain detailed scenario projections for the particular region from global climate models or regional models if available.

- Generate runoff scenarios with deterministic hydrological models, which can account for non-linear dynamic responses. Focus on quantity (annual volumes), seasonal distribution and variability as the main outputs. Also assess potential changes in environmental flow requirements.

- If the outputs of climate models are insufficient (or even as a control measure), revert to the use of statistical models. The scaling of the key variables such as total precipitation should be proportionate to the changes predicted by the GCMs.

- **Either** calibrate a statistical model to observed rainfall sequences and then change the key parameters such as the mean and coefficient of variability, to generate optional scenarios of possible rainfall sequences, as input to deterministic models Or calibrate a statistical model directly on the observed runoff records and change key variables to generate possible resulting runoff scenarios.

- Use the outputs from the above in simulation models and apply probabilistic techniques for assessing the impacts of the various flow scenarios on water resource systems and hydropower schemes. It is important to include the other and competing water uses in such simulations. This will then allow an assessment of the impacts on the hydropower plant and reservoir operating rules and hence on the potential for water yield and hydropower generation.

- Carry out the economic and financial analyses.

- Adopt an adaptive management approach with regular monitoring, evaluation and reviews, with possible redesign of the management program as necessary. This needs to be based on a solid set of indicators.

- Design changes may be needed for spillway capacities, outlet structures etc.

- Sediment transport, domestic and agricultural water withdrawals, and environmental flow needs may all be affected by major changes in hydrological regime and need to be kept in view.


6.10 Hydraulic Studies

The following shall be performed, inter alia:

Review of existing documentation to be provided by the Government/Barki Tajik.

Flood routing of the probable maximum flood through the reservoir to establish the discharge capacity of the spillway, operating rule of the reservoir, and water levels downstream of the dam/spillway.
The Consultant shall provide the model, methodology, criteria and calibration used in the flood routing. The spillway capacity must be available at all time to discharge the design/probable maximum flood during lower and final stage of the dam.

Backwater studies to determine maximum water level at full reservoir level and its location, and maximum distance from the axis of the dam.

Reservoir sedimentation studies including methodologies, sediment characteristics, sediment volume, sediment accumulation profile in the reservoir, profile/elevation of sediment at the upstream face of the dam, determination of reduction of the dead and useful reservoir/live storage/volume as a function of time (years, e.g. 50 years) after commencing the operation of the reservoir, reservoir area and volume curves versus water reservoir elevation. The Consultant shall assess possible sediment reduction by various methods of reservoir flushing.

The reservoir area/elevation and volume/elevation should be presented on the basis of these studies.

All the scope of work, including findings, analysis and calculations, carried out shall be presented in the report on hydraulics of the Project.

6.11 Reservoir Operation Simulation Studies

For each project alternative including stages of Project implementation, the Consultant shall, inter alia:

Carry out reservoir operation simulation using the latest reliable hydrological data available for the longest period of months.

Estimate the operating reservoir levels (minimum, normal and maximum). Use latest tail water rating curve available, and if not, develop the rating curve.

Run Rogun reservoir simulation and multi reservoir simulation of Rogun with other HPPs combined. The Rogun Project development may improve operations of downstream HPPs. The Consultant shall assess and describe the impacts of Rogun on said HPPs. The simulation should consider the dam construction and installed capacity in stages.

The reservoir operation and simulation studies for the power and energy analysis shall be presented in a report along with the model/methodology, criteria and data used and the analysis of the results.

The reservoir operation studies shall be based on Nukus Declaration (September 5, 1995). The Consultant will provide simulation of analysis of possible operating regimes of Roghn Reservoir over 50-60 years. These scenarios will be described in terms of economic, financial, environmental and social impacts.

The Consultant shall prepare a phased reservoir filling schedule in accordance with the construction stages. These scenarios should be assessed in terms of economic, financial, environmental and social impacts.

The Consultant shall review, in the light of international experience, possible institutional arrangements (e.g., a reservoir management commission with multi-country representation) for monitoring reservoir operation and regimes for ensuring compliance with the prescribed operating regime. The options should be described in terms of strengths and weaknesses. The Consultants shall identify preferred institutional arrangements both in respect of initial filling schedule and in respect of the regular operation of Rogun HEP.
6.12 Power and Energy Analysis

Since all power in excess of the power demand in Tajikistan is destined for exports (mainly to South Asia) the objective function of the energy analysis is to optimize energy output consistent with the reservoir operation regime discussed earlier in section 6.11.

As part of the reservoir simulation study and based on the long term load forecast (power and energy) as well as detailed information of other generation sources in Tajikistan (with costs, capacities, capabilities and restrictions) and sources of power imports and power exports (costs and availabilities) as provided by the Government/Barki Tajik, the Consultant shall identify the place and role of Rogun HPP (base load, peak load, etc) within the electric power system of Tajikistan and between Tajikistan and present and foreseen electric power interconnections to export markets. The power and energy analysis should consider the dam construction and installed capacity in stages.

The Consultant shall discuss several export scenarios with the Government/Barki Tajik, and provide technical, economic, financial, and operational analysis of the scenarios involving exports to such markets as with Afghanistan and Pakistan.

The Consultant shall simulate the energy generation for all Project options, and shall determine firm and secondary energy for the full potential of a given site.

The Consultant shall optimize the power/capacity and number and size of generating units to be installed in Rogun whether it is in one stage or by stages.

The power and energy studies shall be presented in a report along with the model/methodology, criteria and data used, and the analysis of the results.

6.13 Engineering Design

Review of existing documentation to be provided by the Government/Barki Tajik.

The Consultant shall carry out design at the project definition level. It shall prepare design criteria and memoranda and lay out drawings.

The determination of alternative layout and design shall go hand in hand, and shall include various dam types and height/reservoir capacity and mode of operation of the power plant with respect to base load and peaking, reservoir and flow management, environmental mitigation and volume in the reservoir to absorb floods, and the construction of Rogun dam and installed capacity in stages.

Based on the results of the technical designs and the various cost elements derived, an optimization of the layout and of its various components shall be carried out.

Project definition design shall be carried out and drawings prepared based on field investigations and optimization performed. The optimization shall include, among others, the reservoir size, the dam height, development stages, the spillway design capacity and size, the waterways (intake type and size, headrace pressure tunnel length and cross-sectional area, surge chamber, pressure shaft, penstocks, valves, major mechanical (turbine capacity and number of turbines), electrical equipment (generators, transformers), gross and net operating heads, power house cavern, tailrace, etc.
The design and drawings shall cover all major components of the dam, spillway, intake, bottom outlets, tunnels, penstocks, river diversion during construction, power station, installed capacity and number and size of generating units, hydraulic, electrical and mechanical equipment, etc.

The layouts and design shall include, but will not be limited to the following:

River diversion works (cofferdams, diversion tunnel, etc.)

Dam, spillway (cranes, gates, etc.), including optimization of the spillway (number of bays, type and size of gate, etc.)

Waterways:
- Intake with trash racks, stop logs, gates, hoists, sediment traps,
- Facilities for ecological discharge from the reservoir
- Head race pressure tunnel, rock and sand traps
- Penstocks
- Surge chamber and pressure shaft
- Valves, etc.
- Tailrace: draft tubes, gates surge arrangements, tailrace tunnel, gates, cranes, etc.

Power House
- Civil works
- Mechanical equipment such as turbines, governors, cooling system ventilation, drainage, cranes, etc.
- Electrical equipment such as generators, transformers, switch gear, auxiliary power supply, power cables, control cables, communication, protection and control equipment, switchyard, control room, etc.

Stability Analysis

The structural analysis is intended to determine the integrity of the dam and structures under standard loadings and other loadings. These include dead load, maximum reservoir water level, downstream water levels, internal pressures, foundation uplift, backfill/sedimentation, earthquakes, etc.

For type of dam considered/selected, the corresponding stability analysis shall be performed.

The engineering design shall be presented in a report, including findings, design memoranda, calculations, analysis, and optimization of the Project components

6.14 Infrastructure

Review of existing documentation to be provided by the Government/Barki Tajik

Analyze access to project site by roads, offices, workshop, housing facilities, electric power, recreation areas and provisional installations such as construction camps, contractor’s plants, borrow areas, etc., and establish the infrastructure that will have to be implemented for the Project.

6.15 Transmission System Associated with Rogun HPP and Export of Electricity

Review of existing documentation to be provided by the Government/Barki Tajik.
The Consultant shall evaluate the alternatives for linking Rogun HPP to the national grid and to neighboring countries such as Kyrgyzstan, Afghanistan, and Pakistan. To make his own assessment of the Tajikistan transmission system’s capacity and ability to transport Rogun power to major Tajik consumption centers and neighboring countries, the Consultants shall utilize system expansion plans and feasibility studies for system expansion and rehabilitation, as provided by the Government/Barki Tajik. Similarly, the Consultant shall make his own assessment of the transmission system’s capacity and ability to export Rogun power to said countries on the basis of system expansion plans and feasibility studies provided by the Government/Barki Tajik. These alternatives should be considered in conjunction with the CASA 1000 HVDC transmission line project to access the power markets of Afghanistan and Pakistan and its expansion plans.

The Consultant shall prepare the corresponding transmission plans on a least cost basis to evacuate electricity produced from Rogun HEP into the domestic market as well as to the export markets. The transmission system findings and studies should be submitted in a report.

6.16 Cost Estimate of each Rogun HPP Alternative

The Consultant shall prepare a project definition stage cost estimate separate for each alternative option for the Rogun HPP with break down in local and foreign currency. The cost estimate should be prepared on the basis of prevailing market prices. The reference price level and exchange rate(s) should be provided. The civil works prices should be derived specifically for the project taking into account construction methodology and cost for construction equipment, local labor, materials, etc. For all equipment, the prices should be based on collected information from potential suppliers. An estimate for engineering, supervision, administration, legal costs, land acquisition, resettlement, environmental, etc. shall be included along with the basis for their estimate. The criteria for estimating physical contingencies for the various project components and the price escalation during construction shall be provided. It shall cover also, among others, hydraulic and structural model tests; topography and mapping; geological, geotechnical and geophysical field investigations, etc. Financing charges during construction shall be included along with the criteria used in their calculation.

The sunk cost estimate of existing works should be shown separately.

If the dam and installed capacity are to be built in stages, the estimate for each stage should be presented.

The Consultant shall estimate the annual operation and maintenance costs of each alternative.

The cost estimate of the various alternatives and of the selected one shall be presented in a separate report.

6.17 Implementation Schedule

The Consultant shall prepare an implementation schedule for each alternative of Rogun HPP so that a cash flow can be developed for consideration in the economic and financial analysis. This schedule shall define, among others, the preconstruction activities, including access and transportation route and method, contract packaging, location of borrow areas for construction materials, construction methodologies, construction equipment, construction labor force requirements, construction camp and site infrastructure, and office facilities, environmental requirements and population resettlement activities. The critical activities and the critical path of activities in the schedule shall be illustrated in the schedule.

The implementation schedule for each dam stage and installed capacity phase should be presented.

The implementation schedules shall be presented in a separate report accompanied by the necessary explanation, analysis, recommendation, etc.
6.18 Economic Analysis

The Consultant shall prepare: (a) a national electricity demand and supply analyses using an appropriate, internationally recognized methodology acceptable to GoRT and the World Bank, and this methodology should be agreed at the Inception Report stage; (b) a least cost generation expansion program to meet the domestic demand and (c) the Average Incremental Costs of the electricity produced at Rogun HPP in comparison with other generation alternatives, including small hydro. Please see Attachment 3 for details of parts (a) and (b) of this subtask.

The Consultant shall carry out the economic analysis for each Rogun alternative taking into account the national demand and planned exports and the costs and benefits identified. Indicators such as Net Present Value (NPV), Benefit Cost (B/C) Ratio, and Economic Internal Rate of Return (EIRR) shall be calculated. Sensitivity analysis shall be applied on important parameters in order to check their impact on the viability.

The analysis shall be based on domestic and export energy prices (plus sensitivities) to be agreed with the Government/Barki Tajik.

The economic impact on downstream HPPs such as Nurek from having an upstream Rogun reservoir should be included in the economic analysis. The impact should also be analyzed and presented separately, considering the option that the ownership of Rogun and other Vaksh River HPPs may be different.

The Consultant shall provide the model applied in the analysis including description of the methodology and criteria used. The cash flow estimate based on the relevant alternative implementation schedule shall be used in this analysis.

The complete economic analysis shall be presented in a separate report.

6.19 Financial Analysis

The Consultant shall carry out the financial analysis of Rogun taking into account the national demand and planned exports and the costs and benefits identified. In general, the financial analysis should evaluate the commercial merits of the alternative under alternative power market conditions such as only the national market, a combination of the national market and export, ownership models, financial packages, fiscal regime.

The complete financial analysis shall be presented in a separate report including the model applied in the analysis including description of the methodology and criteria used. The cash flow estimate based on the relevant alternative implementation schedule shall be used in this analysis.

6.20 Risks Evaluation/Assessment and their Mitigation

The Consultant shall identify risks associated with the construction and operation and maintenance of each Rogun alternative and of the combined operation and maintenance of Rogun with other HPPs in the Vaksh River. The identification of risks shall include, among others: topography, hydrology, geology/geotechnical, seismic, material investigations, power and energy/plant performance, construction costs, construction schedule, dam construction and installed capacity in stages, economic and financial aspects.
The Consultant shall prepare the outlines of an Instrumentation Plan to monitor the behavior of the Dam through its life time and an Emergency Preparedness Plan for the contingency of dam failure.

The risk simulations methods shall be presented.

The means/actions/measures to minimize the impact of each risk shall be presented.

6.21 Project Definition Report

(A) The consultant shall prepare and submit the report which shall present the substantiated recommendation of the project configuration for which the feasibility study should be carried out based on the alternatives assessed with regard to dam height, dam type, reservoir operations regime and reservoir filling.

(B) The report shall comprise as a minimum:

An executive summary in Russian and in English

Separate reports for:

Methodology adopted

Infrastructure (roads, office building, accommodation, electricity, water, etc.) of the Project

Confirmation of Dam Site

Selection of Dam Type and Height and Construction by Stages

Confirmation of Powerhouse Site (caverns)

Confirmation of installed power capacity

Description of each Rogun HPP Alternative

Topography and mapping

Geological, Geophysical, Geotechnical

Seismicity and Seismic Studies

Construction Materials

Meteorological and Hydrological Studies

Climate change aspects

Hydraulic Studies

Reservoir Simulation and Power and Energy Studies

Reservoir operating regime
Legal Framework analysis underpinning the operation of this multi-year regulatory reservoir in the Amu Darya Basin (taking into consideration such treaties and regulatory documents as have been approved by the Government of Tajikistan).

Engineering Design and Optimization

Cost Estimate and Financial Requirements

Implementation Schedule

Initial reservoir filling schedule

Transmission studies

Economic Analysis

Financial Analysis

Risks Evaluation/Assessment and their Mitigation


Actions to be taken

Comments to the Terms of Reference for the Feasibility Study

Required maps, drawings, figures, tables, etc. to illustrate the technical solutions

7. PHASE III. ASSESSMENT OF THE SELECTED ROGUN SCHEME

After the approval by Government/Barki Tajik of the Project Definition report (prepared in Phase II), the Consultant shall, during Phase III, prepare a complete bankable Assessment Report for the option selected in Phase II that can be presented to potential investors, developers, donors and lenders for the financing and implementation of Rogun HPP. The scope of work for Phase III will be confirmed after the results of Phase 0, I and II and by agreement with the Government of Tajikistan and the World Bank. The bidder is advised to provide the costs for phase 3 separately in the relevant sections of the financial proposal.

The Consultant shall:

- include in the report all data and information compiled under Phase II, Project Definition for the selected alternative

- complement as necessary the scope of work of the tasks listed under Phase II, to gather all required information and data for the Phase III report

- carry out all studies, field investigations, and other activities as required at detailed assessment level.
Section 5. Terms of Reference

- perform the design, layout and optimization of each Project component

7.1 Infrastructure

The Consultant shall establish the plan to implement the required infrastructure necessary to support transport and construction activities of the Project such as: access roads to the Project site, accommodation, offices, warehouse, work shops, security, medical and educational facilities, and laboratories at the Project site.

7.2 Topographical Surveys and Preparation of Maps

The Consultant shall update all topographic surveys and maps prepared and procured by him in hard and soft copies.

The final topographic surveys and maps and studies shall be presented in a topographic report.

7.3 Geological, Geophysical and Geotechnical Investigations

The Consultant shall update all information and perform the necessary additional studies and investigations for the feasibility of the selected Project, in accordance with the scope of work for the Phase II, and other as required.

The assessment shall be carried out for the project components such as:

- Reservoir (including reservoir tightness, losses if any, slope stability etc.)
- Dam
- Spillway and energy dissipation area
- Intake area
- River diversion works during construction
- Headrace tunnel
- Surge chamber
- Power house (caverns)
- Substation
- Sources of construction materials
- Infrastructure to the site

Major faults and features of the faults crossing the Rogun Site as well as of other geological features should be identified and analyzed.

Consultant shall prepare a Geotechnical Baseline Report (GBR) based on international guidelines\(^3\) that presents the complete findings, analysis, investigations of the geological, geophysical and geotechnical aspects of the selected project.

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\(^3\) The GBR aims to establish a contractual understanding of the subsurface site conditions, referred to as a baseline. Risks associated with conditions consistent with or less adverse than the baseline are allocated to the contractor and those significantly more adverse than the baseline are accepted by the owner. The more clearly defined the anticipated conditions, the more easily the encountered conditions can be evaluated. Therefore, the baseline statements shall be described using quantitative terms that can be measured and verified during construction. Where the baseline has been set determines risk allocation and has a great influence on
7.4 **Seismic Studies and Design**

The seismic studies resulting from Phase II, Project Definition/Prefeasibility shall be revised and updated as required. The design of the works shall be performed on the basis of these results. Please refer to paragraph 6.4.

An updated report shall be presented with the complete information/data, analysis, findings, and conclusions.

7.5 **Construction Materials Survey**

Conduct additional surveys as required, and present an updated report on construction materials survey following the scope of work for the Phase II, Project Definition/Prefeasibility.

7.6 **Meteorological and Hydrological Studies**

Carry out complementary meteorological and hydrological studies and investigations necessary for the feasibility study following the corresponding scope of work under Phase II, and revise and update them, and present the report.

7.7 **Hydraulic Studies**

Carry out complementary studies and investigations necessary for the feasibility study following the corresponding scope of work under Phase II, and revise and update them, and present the report. The updated calculations shall be used to dimension and optimize the hydraulic structures such as cofferdams, dam, spillway, bottom outlets, river diversion during construction, waterways, etc.

7.8 **Hydraulic Model Tests**

The Consultant will propose to carry out hydraulic model tests for the performance of the spillway and the energy dissipation arrangements downstream of the dam. The model studies shall be carried out in a well recognized and reputed laboratory. The efficiency and features of the spillway and spillway channel over the entire range of discharges/flood flows shall be established.

Other model studies may be carried out; for example: operation and efficiency and features of the bottom outlet, intake, etc.

The activities connected with the model studies and the presentation of the corresponding reports shall take into account the period of preparation and presentation date of the bidding documents that include said components.

7.9 **Structural Model Tests**

The Consultant may propose to carry out these tests for the dam. The activities connected with the tests, and the presentation of the corresponding reports shall take into account the period of preparation and presentation date of the bidding documents that include the dam.

7.10 **Reservoir Operation Simulation Studies**

risk acceptance, bid prices, quantity of change orders and the final cost of the project. For example “ASCE 2007, Geotechnical Baseline Report for Construction – Suggested Guidelines”
The Consultant shall prepare these studies specifically for the project subject of the feasibility study. It shall follow the scope of work applied in Phase II and improvements thereof. The studies shall be done for Rogun alone and Rogun combined with other HPPs in the Vaksh River such as Nurek. A Rogun project development may improve operations of Nurek and other downstream HPPs. The Consultant shall assess and describe the impacts (positive and negative, if any) from Rogun on other HPPs. The simulation should consider the dam construction and installed capacity in stages.

The Rogun reservoir operation and simulation studies for the power and energy analysis shall be presented in a report along with the model/methodology, criteria and data used, analysis of the results, conclusions and recommendations.

The Consultant shall prepare an initial reservoir filling schedule spread over several years in such a manner that the downstream riparian states are not adversely affected.

7.11 Power and Energy Analysis

The Consultant shall develop the Long-Term demand and supply forecasts on the basis of agreed methodology with and without the project (refinement of work done in 6.18 Economic Analysis Phase III, Project Definition).

The Consultant shall revise and update the studies carried out in the Project Definition phase including optimization of installed capacity, unit type, size and number; confirmation of the mode of operation of the power plant (base load/peak load) within the electric power system; and calculation of the annual firm and secondary energies.

The Consultant shall optimize the power/capacity and number and size of generating units to be installed in Rogun whether it is in one stage or by stages.

The power and energy studies shall be presented in a report along with the model/methodology, criteria and data used, and the analysis of the results.

7.12 Engineering Design

The Consultant shall carry our design at the level of feasibility level. It shall prepare design criteria and memoranda and layout drawings.

The design shall be carried out and drawings prepared based on field investigations and optimization of the various components of the Project. The staged construction should be considered in the design.

The optimization shall include, inter alia, the reservoir size and operating water elevations, the dam height and type, the spillway design capacity and size, the waterways (intake type and size, headrace pressure tunnel length and cross-sectional area, surge chamber, pressure shaft, penstocks, valves, major mechanical (turbine capacity and number), electrical equipment (generators, transformers), operating head, power house, tailrace, etc.

The design and drawings shall cover all major components of the dam including instrumentation, spillway, intake, bottom outlets, river diversion during construction, power station, installed capacity and number and size of generating units, electrical and mechanical equipment, and transmission.

The layouts, design and drawings shall include, but will not be limited to the following:
- **Infrastructure**
  Finalize the design for works needed for access to project site by roads, offices, workshop, housing facilities, electric power, recreation areas and provisional installations such as construction camps, contractor’s plants, borrow areas, etc.

- **River diversion works (cofferdams, diversion tunnel, etc.)**
  Dam, spillway (cranes, gates, etc) The spillway capacity must be available at all time to discharge the design/probable maximum flood during lower and final stages of the dam.

- **Waterways:**
  - Intake with trash racks, stop logs, gates, hoists, sediment traps
  - Facilities for ecological discharge from the reservoir
  - Head race pressure tunnel, rock and sand traps
  - Surge chamber and pressure shaft
  - Penstocks
  - Valves, etc.
  - Tailrace: draft tubes, gates, surge arrangements, tailrace tunnel, gates, cranes, etc.

- **Power House (cavern)**
  - Civil works
  - Mechanical equipment such as turbines, governors, cooling system ventilation, drainage, cranes, etc
  - Electrical equipment such as generators, transformers, switch gear, auxiliary power supply, power cables, control cables, communication, protection and control equipment, switchyard, control room, etc.

- **Stability Analysis**

  The Consultant shall carry out a dam stability analysis of the selected dam type, location and height in accordance with a Method to be proposed by him and agreed with the Client at the Inception Stage.

  The structural analysis is intended to determine the integrity of the dam and structures under standard loadings and other loadings. These include dead load, maximum reservoir water level, downstream water levels, internal pressures, foundation uplift, backfill/sedimentation, earthquakes, etc.

  The engineering design shall be presented in a report, including findings, design memoranda, calculations, analysis, optimization, and drawings of the Project components.

7.13 **Transmission System Associated with Rogun and Export of Electricity**

The Consultant shall perform all the necessary studies and investigations related to the feasibility of the Rogun transmission system to the national grid and proposed interconnections with other countries. Please refer to paragraph 6.13. The corresponding report shall be presented.

7.14 **Drawings**

Drawings shall be elaborated so that they can be readily converted into bidding documents drawings at the time of design for bidding documents. A volume containing the drawings shall be presented.
7.15 Quantity Estimate

The Consultant shall prepare a detailed quantity estimate of the civil works and equipment of the various components of the Project, taking into account that they may be used in bidding documents. If the Project is to be built by stages, the quantity estimate should be presented for each stage.

The corresponding report shall be presented accompanied by explanations and sources of the estimate and drawings used.

7.16 Cost Estimate

The Consultant shall prepare a feasibility cost estimate for the Rogun HEP with a break down in local and foreign currency. The cost estimate should be prepared on the basis of prevailing market prices. The reference price level and exchange rate(s) should be provided. The civil works prices should be derived specifically for the project taking into account construction methodology and cost of construction equipment, local labor, materials, insurance, etc. For equipment, the prices should be based on collected information from potential suppliers. An estimate for engineering, supervision, administration, legal costs, land acquisition, resettlement including compensation for loss property and loss income, construction of social infrastructure, environmental, etc. shall be included along with the basis for their estimate. The criteria for estimating physical contingencies for the various project components and the price escalation during construction shall be provided. It shall cover also, among others, hydraulic and other model tests. Financing charges during construction shall be included along with the criteria used in their calculation.

If the dam and installed capacity are to be built in stages, the estimate for each stage should be presented.

The cost estimate for civil works and equipment shall be prepared following the format to be used for the bidding documents.

The Consultant shall estimate the annual operation and maintenance costs of Rogun HPP.

The cost estimate shall be presented in a separate report, providing methodology, criteria, analysis, etc. accompanied by tables and graphs.

7.17 Procurement Planning

Prepare a procurement strategy for Rogun HPP to define the contract lots/packages for the civil works and for the electrical and mechanical equipment accompanied by the justification thereof. Pre-qualification shall be taken into account for major contracts for civil works and electrical and mechanical equipment. Procurement planning should be done for each stage as required.

A separate report shall be presented for procurement planning, furnishing criteria, analysis of options, justification of the selected option, etc.

7.18 Implementation Schedule

Prepare an implementation schedule for Rogun HPP based on the lots/packages resulting from the procurement strategy so that a cash flow can be developed for consideration in the economic and financial analysis. This schedule shall define the preconstruction activities, including access and transportation route and method, location of borrow areas for construction materials, construction methodologies, construction equipment, construction labor force requirements, construction camp and site infrastructure, and office facilities, environmental requirements and population resettlement activities. The critical activities and the critical path of activities in the schedule shall be illustrated in the schedule.
If the dam and installed capacity are to be built in stages, the schedule for each stage should be presented. The construction process for each stage should be described.

Prepare an implementation schedule for the associated transmission system to the national grid. On the basis of information from system expansion plans and feasibility studies for system expansion and rehabilitation agreed with the Government/Barki Tajik, (see paragraph 7.13.)

The schedules shall be presented in a CPM – Gantt charts accompanied by the corresponding explanations and criteria used in their preparation.

7.19 Economic Analysis

The economic analysis for the selected Project should be carried out in detail from three perspectives: macro economic impact; sectoral analysis; and project analysis.

**Macro Economic Impact.** This should analyze the:

(a) revenues that would accrue to the Government through: (i) value added taxes; (ii) other taxes and levies as contributions to specific funds (e.g. Social Fund); (iii) corporate taxes; (iv) municipal taxes; (v) custom duties and excise levies on equipment and services imported/purchased; (iv) guarantee/on-lending margins charged by the Government;

(b) impact on Government overall debt and debt service position; and

(c) employment generation, regional development, betterment of people directly affected, etc. both in Tajikistan and riparian countries, taking into consideration impacts on ecosystem services where possible (drawing from the ESIA).

**Sectoral/Market Analysis.** Economic aspects of the targeted markets: demand projections for the target country for the length of the project period (minimum 30 years); supply options the target country has in terms of its own or alternative options to meet the projected electricity demand; the competitiveness of the Project vis-à-vis the target country’s marginal cost of generation; the share of the Project in meeting the power capacity demand and share of the Project in meeting electricity demand; and

**Project Level Analysis.** The economic analysis of Rogun taking into account the national demand and planned exports and the costs and benefits identified. Indicators such as Net Present Value (NPV), Benefit Cost (B/C) Ratio, and Economic Internal Rate of Return (EIRR) shall be calculated. Sensitivity analysis shall be applied on important parameters in order to check their impact on the viability of the Project. The analysis shall be based on an energy price and sensitivities to be agreed with the Government/Barki Tajik.

The Consultant shall provide the model applied in the analysis including description of the methodology and criteria used. The cash flow estimate based on implementation schedule shall be used in this analysis.

7.20 Financial Analysis

The Consultant shall carry out the financial analysis of Rogun based on national demand and planned exports and the costs and benefits identified. In general, the financial analysis should evaluate the commercial merits of the Project under several power market scenarios such as only the national market, a combination of the national market and export, ownership models, financial packages, fiscal regime. Scenarios with varying financial schemes should include financing by the Government/Barki Tajik, by
private investors, international financing institutions, commercial lending, carbon credit financing, and others.

Financial projections of Rogun shall be prepared including the period of implementation of the project and up to five years after its commissioning. The projection shall include sources and applications of funds.

The Consultant shall provide the model applied in the analysis including description of the methodology and criteria used. The cash flow estimate based on the implementation schedule shall be used in this analysis.

7.21 Export Market Analysis

Rogun power and energy is planned to be exported to other countries for reasons related to the Rogun HEP production characteristics.

The Consultant shall study the electricity balances of neighboring countries or countries in other regions. The Consultant shall also assess the electricity markets of these countries to verify the practicality of the export objective of the project.

The Consultant shall also carefully review the impact on, and implications to, the operation of the Central Asian Power System of such export orientation of the project.

7.22 Rogun Project Financing

The Legal and Financial Advisors to the Government would be considering several financing models for the Rogun HPP investment. Funding sources may include Government of Tajikistan, international financial institutions, commercial banks, private sector investors, and others. Various mechanisms may be employed to mitigate risks and reduce financing costs. They will be providing an overview of the various financial options available to Tajikistan and provide guidance as to their attractiveness, advantages and drawbacks.

The Legal and Financial Advisors to the Government would develop and present a road map for the steps the Government (or its agent) needs to take to mobilize financing for Rogun. This would include the specific steps to engage the potential financiers and developers of the Project as well as the approach to negotiate and obtain reliable power purchasing arrangements/agreements that would satisfy the needs of the Government, the investors/developers and the lenders to secure a cash flow from Rogun.

The Consultant shall furnish a detailed cost estimate and all the relevant technical data to enable the Legal and Financial Advisors to carry out the above mentioned tasks properly. The Consultant shall work interactively with such Advisors and provide his professional judgment on the proposed options from the technical point of view.

7.23 Risks Evaluation/Assessment and Mitigation

The Consultant shall identify risks associated with the developing of the Project, construction and operation and maintenance of Rogun HPP and of the combined operation and maintenance of Rogun with other HPPs in the Vaksh River. The identification of risks shall include, among others: topography, hydrology, geology/geotechnical (including potential for induced landslides), seismic (including induced seismicity), material investigations, power and energy/plant performance, construction costs, construction schedule, construction and installeed capacity in stages, economic and financial aspects. Particular attention should be paid to the risks associated with dam safety and dam operation and maintenance procedures to avoid major disasters leading to the flooding of downstream areas. For this purpose the Consultant shall, among other things, prepare:
- Instrumentation Plan to monitor the behavior of the dam through its life time and a plan for such monitoring as envisaged in Annex A to BP 4.37 of the World Bank entitled “Dam Safety Reports: contents and timing”

- An Emergency Preparedness Plan to cover the contingency of dam failure as envisaged in the above mentioned Annex A to protect the people, property, animals, heritage sites, national treasures etc in the downstream areas in the Amu Darya basin. This should also include an early warning system and communication plans.

Consultant shall prepare a Risk Register differentiating among:
- Risks associated with design assumptions and approach;
- Risks associated with proposed construction methodology/ sequencing;
- Risks associated with construction activities;

For each set of risks, the Register shall assess and quantity:
- Events associated with the specific hazard;
- Assessment of probability of occurrence;
- Potential consequences;
- Preventive and/ or mitigation measures;
- Contractual entity who, in the Consultant’s opinion, is best placed to take responsibility for costs and delays associated with the specific risk.

The risk simulations methods shall be presented.

7.24 Assessment Report

The report shall be prepared to comprise as a minimum the following on the basis of the Terms of Reference and the work carried out:

Executive Summary

Introduction

Interrelation of the proposed project with existing and future projects

Methodology adopted

*Individual reports as follows:*

Infrastructure

Confirmation of selected Dam Site,

Selection of Dam Type and Height and Construction Stages

Confirmation of Powerhouse Site

Topography and mapping

Geological, Geophysical, Geotechnical
Seismicity and Seismic Studies
Construction Materials
Meteorological and Hydrological Studies
Climate Change Impact and Mitigation
Hydraulic Studies
Hydraulic Model Studies
Structural Model Studies
Reservoir Simulation and Power and Energy Studies
A legal framework analysis for the operation of this multi-year regulatory storage in the Amu Darya basin
Engineering Design and Optimization
Cost Estimate and Financial Requirements
Implementation Schedule
Initial reservoir filling schedule
Reservoir operating regime and institutional arrangements for ensuring adherence to the prescribed regime
Procurement Planning
Economic Analysis
Financial Analysis
Export Market Analysis
Project Financing
Risks Evaluation/Assessment and their Mitigation
An Instrumentation Plan to monitor the behavior of the dam through its life time and a plan for such monitoring as envisaged in Annex A to BP 4.37 of the World Bank entitled “Dam Safety Reports: contents and timing”
An Emergency Preparedness Plan to cover the contingency of dam failure as envisaged in the above mentioned Annex A.
Actions to be taken
Required maps, drawings, figures, tables, etc., to illustrate the technical solutions

8. PHASE IV: PREPARATION OF DOCUMENTS

A fourth phase of the project may be exercised subject to the findings of the assessments, the opinions of the Panels of Experts, and funding. The specific tasks for this phase will be determined after completion of Phase III and the ESIA. Phase IV is also subject to World Bank funding and no objections on contract extension. The Consultant is not required to provide methodology nor cost estimate for Phase IV in their proposal.

9. OUTPUTS AND DELIVERABLES

a) Stage 1 Assessment
The present terms of reference have been prepared for assisting GoT in developing the hydropower potential of the Rogun site in an optimal manner. In order to achieve that goal, the Consultant will have to take into account the following stage 1 option:

Before raising the dam to the final design height, a Stage 1 project is planned by the GoT coincident with the completion of technical, environmental and social studies, riparian consultation and financial arrangements for the final project design. This Stage 1 would comprise raising the embankment dam to level 1,060 m above sea level (70 m dam height), with operating water level at 1,055 m above sea level; it would entail the completion of intake structure and hydro-tunnels, as well as the installation of the first two 600 MW units with replaceable runners. The operation of this stage would be quasi run of the river with a reservoir capacity of well below 250 Mill m³. The units would yield a maximum capacity of 120 MW each due to the low water head.

The Consultants will assess the feasibility of the proposed use of the 600 MW units with temporary runners during Stage I of the project, operating to a maximum capacity of 120 MW a much lower head (about 70 m), and then replacing the temporary runners with the permanent runners for operation with a much greater head (325 m) during Stage II of the project. Implications on civil works modification, equipment efficiency, and increased erosion effects should be examined up-front before proceeding to further detailed analysis, if warranted. Should the priority analysis reveal that the idea is worth more detailed studies, the Consultants will cover technical and cost implications of proposal, including the changes to be made in the units and the associated civil works for Stage II.

The Stage 1 option should be designed in such a way to allow future rising of the dam, and adaptation of associated works (river diversion, foundation construction, vertical waterways layout, extraction of the ground, etc.), to develop the site further.

The Consultant will have to undertake tasks described under phases 0, I, and II as related to the above described option. In particular:
1. Review and Analysis of Vakhsh River Master Plan
2. Topographic Surveys and Preparation of Maps
3. Geological, Geophysical and Geotechnical Investigations
4. Seismic Studies
5. Construction Materials Survey
6. Meteorological and Hydrological Studies
The Stage 1 assessment shall be developed in parallel to Phases 0, I, and II of the overall assignment. Deliverables shall be as follows:

- Preliminary Report: 6 months after Effective Dated of the Contract;
- Final report: 8 months after Effective Dated of the Contract.

The Consultant will propose a methodology for developing the studies with the inclusion of the Stage 1 option and reflect the associated costs in its financial proposal.

b) Complete Assessment

Best efforts should be made by the Consultants to complete all the work and provide all the reports envisaged for Phase 0 to the Client within 20 (twenty) weeks from the Effective Date of Contract.

Phase I work should be completed and all the reports envisaged for this Phase submitted to the Client within 12 (Twelve) weeks from the date on which the Client authorizes the Consultant to proceed to Phase I.

Phase II work should be completed and all the reports envisaged for this phase including the final Project Definition Report shall be submitted to the Client within 24 (twenty four) weeks from the date on which Phase I commenced.

Phase III work should be completed and all relevant reports including the final Assessment Report should be submitted to the Client within 40 weeks from the date on which phase I commenced.

The Consultant shall prepare and present the draft reports mentioned in Deliverables (c) and other documentation to the Government/Barki Tajik for comments and approvals. In general the Government/Barki Tajik will review them and convey its comments to the Consultant within thirty (30) days from the date it receives the reports/documents.

The Consultant shall present the final versions to the Government/Barki Tajik within thirty (30) days from the date it receives the comments.

Reports not commented by the Government/Barki Tajik within thirty (30) days after its receipt by them shall be deemed to have been approved by the Government/Barki Tajik.
(a) Ten (10) copies of the Inception Report that shall be presented within five (5) weeks from the Effective date of Contract. The Inception Report shall provide the work plan and schedule and the annotated content of the reports for Phase I, Phase II, and Phase III.

(b) Five (5) copies of the monthly progress reports. These reports shall be provided within seven (7) days after the end of the month covered in the report. These reports shall summarize, inter alia, the Consultant’s activities, highlight important aspects and actions, address specific difficulties encountered or to be expected and their solutions, progress achieved and comparison with the contractual schedule, and expenditures on various activities as per the Contract.

(c) All draft reports and final reports for Phases 0, I, II and III shall be provided to the Client in 10 copies each in the time frame indicated above.

All the reports and documents for Phase 0, Phase I, Phase II, and Phase III shall annex the engineering design memoranda, engineering calculations, economic and financial calculations, drawings, etc. In addition to the hard copies, the complete reports and annexes shall be furnished in CD in MSWord, MSExcel, and the drawings in AutoCAD, or similar versions.

c) Summary of Deliverables:

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<th>Deliverable</th>
<th>Schedule</th>
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<tr>
<td>Inception Report</td>
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<td>Phase 0 Reports</td>
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<tr>
<td>Stage I preliminary report</td>
<td>24 weeks (6 months) from effective date of contract</td>
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<tr>
<td>Stage I final report</td>
<td>32 weeks (8 months) from effective date of contract</td>
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<td>Phase I reports</td>
<td>12 weeks after authorization to proceed with Phase I</td>
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<tr>
<td>Phase II reports including Project Definition Report</td>
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<tr>
<td>Phase III reports</td>
<td>40 weeks after authorization to proceed with Phase I</td>
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<tr>
<td>Monthly progress reports</td>
<td>7 days after end of reporting month</td>
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</table>

d) All reports and deliverables should be provided in English and Russian with, (approximately) equal number of each within the required numbers noted above.

10. **CONDUCT OF THE WORK**

The Consultant shall provide overall management on all aspects of the work/services. The Consultant shall nominate a Project Manager and a Deputy Manager (during all times of unavailability of the former) to liaise with the designated representative of the Government/Barki Tajik. All contractual matters shall be channeled through these persons.

The Consultant shall also provide the necessary level of independent quality assurance and control of the work.
The Consultant staff shall work closely with the Government/Barki Tajik staff assigned to the work, and shall coordinate as needed with other consultants working in other aspects of the Project and with the Engineering/Dams Safety Panel of Experts.

The Consultant shall be fluent in English and have staff with knowledge of Tajik or Russian, or both.

The standards for design and construction and for materials and equipment shall be those of recognized agencies in Tajikistan and of those of recognized international agencies.

The Consultant shall implement his internal quality control and assurance procedures during the execution of the Contract, and shall demonstrate that they are being applied to his work.

The Consultant shall provide all facilities, including office equipment (computers and software, etc.) and vehicles required for the work.

Additional investigations works and above those included in the Contract for essential project investigations such as but not limited to topographic surveys and mapping; geological, geotechnical and geophysical; hydraulic and structural model testing and studies; shall be undertaken through the Contract with prior consent of the Client.

The Consultant shall fully cooperate with the consultants contracted to carry out the Environmental and Social Impact Assessments (ESIA) and work with them in an interactive manner.

The Consultant shall coordinate with the ESIA consultant during all relevant phases of the services to ensure that both consultant teams have all necessary information from each other to facilitate the high quality execution of both assignments. The Consultant shall assist and supplement the Government/Barki Tajik and the ESIA consultant as necessary for their consultation with stakeholders.

The Consultant shall provide information to and meet as necessary with the consultant for the Environmental and Social Impact Assessment.

11. PARTICIPATION OF THE GOVERNMENT/BARKI TAJIK

The Government of Tajikistan will appoint a Project Manager/Coordinator during the preparation of proposals by the Consultants, and during the performance of the Consultant’s services.

The Government of Tajikistan/Barki Tajik will provide for examination of the firms during the preparation of their proposals available documentation related to the Rogun HPP such as:

(a) Rogun HPP Technical, 1980, by Hydroproject Tashkent, Uzbekistan, Technical projects/documents designed in 2008-2009 by design institutes Hydroproject Moscow, Moshydrostal
(b) Existing documentation on, inter alia: topography and maps, hydrology, hydraulics, geological, geotechnical, seismic, engineering design and drawings, etc.
(c) Existing transmission system information and long-term transmission expansion plan.

In addition Government of Tajikistan will:

(a) Ensure access to the Rogun HPP Site, to the Nurek HPP and to other HPP sites in the Vaksh River as necessary;
(b) Arrangements for meetings between the Consultant and other agencies in Tajikistan and in relevant countries (such as for energy export and interconnection);
(c) Arrangements for topographic surveys; geological, geophysical and geotechnical investigations; structural and hydraulic model studies

The Government/Barki Tajik will provide above documents to the contracted Consultant for the performance of his services. For whatever services the Government/Barki Tajik cannot provide, the Consultant shall make his own arrangements in coordination with the Government/Barki Tajik.
Appendix 1

LOCATION MAP OF ROGUN HPP
SALIENT FEATURES OF THE ROGUN HPP AS CONSIDERED IN 1992

Access to Project Area
Various roads

Vaksh River Flows
- Average annual flow: 635 m³/sec
- Maximum measured flow: 3730 m³/sec
- Maximum estimated discharge: 5710 m³/sec

Construction Diversion Tunnel
- Length: 1483+1479 (2962) m
- Cross section: 203 (107) m²
- Rated discharge: ________ m³/sec

Rockfill/eartfill Dam
- Construction height: 335 m
- Elevation of dam crest: 1291.5 m (amsl)
- Crest length: 612 m
- Thickness of dam:
  - (at dam base): 1500 m
  - (at dam crest): 20 m

Spillway
- ___ bays with ___ gates)
  - __ m x __ m each
- total rated discharge capacity: 3760 m³/sec

Bottom outlets
- at ___ m elevation-
  - 14 x 17 m diameter each

Reservoir (at normal water elevation)
- Total volume: 13500 million m³
- Useful volume: 10300 million m³
- Area: 16750 hectares
Waterways

- Water intakes \( \_\_ \_ m \times \_\_ \_ m \) each
  Total rated discharge \( 1644 \text{ m}^3/\text{sec} \)

- Headrace pressure tunnel
  - length 180 m
  - diameter 7.5 m
  - rated discharge 274 m\(^3/\text{sec}\)

- Penstocks
  - length \( \_\_ \_ m \)
  - diameter 7.5 m

Underground Power House

- Building (length x width x height in meters) B x H x 27 x 67.75 x 205.5
- Installed power capacity (MW) 3,600 MW (six units each 600 MW; Francis turbines)
- Estimated average annual generation 13,41 GWh
- Head (gross)
  - Maximum 320 m
  - Minimum 200 m
  - Nominal rated 245 m
- Nominal rated flow per turbine 274 m\(^3/\text{sec}\)
- Discharge conduit into tailrace – three \( \_\_ \_ m \)
- Cavern for tailrace gates (L x W x Height) \( \_\_ \_ m \times \_\_ \_ m \times \_\_ \_ m \)
- Tailrace tunnel 512 m
- Access tunnel to power house \( \_\_ \_ m \long\)

500 kV Switchyard

On the \( \_\_ \_ \) bank of the river
Appendix 3

Details of Tasks 6.18 for Preparation of Load Forecasts and Least Cost Generation Plan

Electricity Market Survey and Load Forecasts

The purpose of this sub-task of the Study is to arrive at the economic justification of the Rogun HPP. The Consultant shall:

- conduct a power market survey for the whole country and prepare demand projections from 2010-2040 with sufficient detail as required by the following stages of the Study.

- propose the methodology he intends to use for this part of the Study in his proposal. It should include at least sectoral and global methods. Sectoral methods (or end-use analysis methods) should be based in detailed analysis by class of consumers, aggregated for small consumers and specific for large consumers. Global methods (econometric modeling methods) should be based on econometric correlation with sectoral and global economic growth.

- review existing historical data on electricity sales and consumption by location, by consumer category (small, medium, large), sectors (industrial, transport, residential, commercial, agricultural, government, public lighting and water supply), and specific end-uses (lighting, heating, air-conditioning, power, electrochemical operations);

- review the transmission and distribution losses and theft and collusion;

- review the economic and demographic data.

- conduct interviews with the entities responsible for medium and large agricultural communes, mines, manufacturing, industrial, and commercial operations to determine current demand and supply, service reliability, short term and long term requirements for power;

- identify data inconsistencies, gaps and problems in interpreting and utilizing data and should complete and bring data to consistency;

- collect data concerning the macroeconomic variables such as population, gross national product, per capita income and agricultural, industrial and commercial activities and study the relationship between these variables and the use of power to determine power coefficients which shall be applied to projections of the macro-economic variables;

- identify the scope of reducing demand for electricity through technical tools (improvements in the supply system such as transmission, distribution networks; and consumers end – better building construction standards) as well as through economic tools (appropriate pricing);

- Identify the scope for demand management through such mechanisms as CFLs, and Energy Loss Reduction Project.

- prepare the electricity load forecasts using a specifically developed electricity load forecasting model which would include inter alia: (i) the historical trends and growth rates by customer categories and geographical areas, (ii) the effect of modernization and increase in living standards of the population and (iii) the effect of large consumers such as industries and tourism on past and present electric power usage; (iv) the impact of improved efficiency and reliability; (v) the impact of price elasticity (changes in consumption due to tariff increases) and income elasticity (changes in consumption of due to increases in incomes); etc.
Section 5. Terms of Reference

- A scenario based approach should be adopted and at a minimum base case, high growth and low growth scenarios should be presented.

- The Consultant should also assess and take into account appropriately the export demand in summer and winter in the prospective export markets.

The results of the Load Forecasting Phase shall be presented and analyzed for the system as a whole; as well as demand by large power consumers (e.g., TALCO Aluminum smelter, who would buy power directly from the generation company); as well as the export demand and translated into annual and seasonal load duration curves, and typical daily load curves.

Generation Expansion Plan

The purpose of the Generation Expansion Plan subtask is to identify and economically rank the available generation expansion options to meet the incremental electricity demand (including export demand) that would remain unmet after impact of efforts to reduce the demand for energy and electricity consumption has been factored and to verify whether Rogun remains as part of the recommended least cost power development plan. The methodology and computer programs to be used for this purpose will be agreed with the Government/Barki Tajik and the World Bank during the Inception mission.

The Consultant shall:

- consider generation expansion options including: rehabilitation of Nurek generation station, Rogun and other hydro sites; GoRT plans for coal based power generation, Small to medium hydro sites; combined cycle gas turbines based on imported natural gas; and Imports of electricity from neighboring countries.

- study the existing system conditions, how the demand is being met in each sub-system, the present sources of energy and their relative economy, and the means available for transmission.

- make an inventory of all the existing generation power facilities indicating their age, location, type, efficiency, heat rate, water requirements, operating costs, maintenance costs, etc., and recommend retirement dates for the existing units.

- propose several logical and technically feasible sequences of development of generating plants; each sequence meeting the prospective demand for power and energy. These sequences, including hydro developments and thermal options shall all provide the power system with the similar degree of reliability. Sequences with and without Rogun should be considered.

- recommend the desirable degree of reliability (measured by the Loss of Load Probability or LOLP), on the basis of the country's economic development and the cost of outages to the economy.

- Carry out sensitivity analysis to determine the consequences of this parameter (LOLP) on the selection of the alternatives and on the total cost of the program.

- Present the cost estimates as well as their annual phasing for each of the plants in the base case of the expansion option as well as for the alternative case(s).
Section 5. Terms of Reference

- The environmental and social analysis of the generation options and considered alternative generation addition sequences would be carried out by the consultants for the ESIA study and the two sets of consultants work interactively.

In considering the listed plants above as expansion candidates, the Consultant is not expected to carry out any feasibility studies to establish the costs of developing the site. Rather, the Consultant would rely on the studies done to date for the cost information, but update such costs to reflect current world market prices.
Appendix 4.

Information on available Feasibility Studies, Technical Project and Project Revision for Rogun HPP.

There are the following materials available in the OJSC “Rogun HPP”:
1. Technical Project of Rogun HPP 1978 (Annex 1);

Note:
On the issue of the runner and the total weight of hydro turbine:
1. Replaceable runner – D = 4835 mm, weight - 70 tons, P=200 Mwt;
2. Permanent runner – D = 6000 mm, weight – 100 tons P=615 Mwt;
3. Total weight of turbine – 1580 tons
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**Information of “Lomayer” documentation located in Open Stock Company “RoghunGESstroy”**

1. Detailed evaluation of existing facility and equipment. Part 3 from 8.
   
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5. Volume 3F “Project parameters”.
Информация по имеющимся технико-экономическим обоснованиям, техническом проекте, проектным доработкам Рогунской ГЭС.

В ОАО «Рогунская» ГЭС по указанным материалам имеется:
1. Технический проект Рогунской ГЭС 1978. (Приложение 1);
2. Концепция достройки Рогунской ГЭС 2009 г. (Приложение 2);
3. Банковское ТЭО Рогунской ГЭС, Ламайер ЛТД 2006 г.

По вопросу рабочего колеса и общего веса турбины:
1. Временное рабочее колесо – D = 4835 мм, вес = 70 тн, Р= 200 Мвт;
2. Постоянное рабочее колесо – D = 6000 мм, вес = 100 тн, Р=615 Мвт.
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<td>Рогунская ГЭС на р. Вахш. Концепция достройки станции. Технологическое оборудование. Основное и вспомогательное гидросиловое оборудование. 75 стр.</td>
<td>4</td>
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<td>19</td>
<td>1861-2-Альбом 1</td>
<td>Рогунская ГЭС на р. Вахш. Концепция достройки станции. Альбом чертежей.</td>
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<td>20</td>
<td>1861-2-VII-A</td>
<td>Рогунская ГЭС на р. Вахш. Концепция достройки станции. Организация строительства.</td>
<td>4</td>
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### III этап

| 21   | 1861-2-10 | Рогунская ГЭС на р. Вахш. Концепция достройки станции. Общая записка | 4 |
| 22   | 1861-2-10 1 | Рогунская ГЭС на р. Вахш. Концепция достройки станции. Стоимость строительства. | 4 |
Приложения 3

Информация по имеющейся документации «Ломайер» находящейся в АООТ «РогунГЭСстрой»

1. Детальная оценка имеющихся сооружений и оборудования
   Часть 3 из 8
   (книга 1 из 5)
   (книга 2 из 5)
   (книга 3 из 5)
   (книга 4 из 5)
   (книга 5 из 5)

2. Подробная оценка существующих строительных сооружений и оборудования. Часть 2 из 8.
   Детальная оценка имеющихся сооружений и оборудования.
   Часть 5 из 8
   (Книга 1)
   (книга 2)
   (часть 6 из 8)
   (часть 7 из 8)
   (часть 8 из 8)

3. Детальная оценка имеющихся сооружений и оборудования
   часть 4 из 8
   (часть 1 из 10)
   (часть 2 из 10)
   (часть 3 из 10)
   (часть 4 из 10)
   (часть 5 из 10)
   (часть 6 из 10)
   (часть 7 из 10)
   (часть 8 из 10)
4. Том 2 «Основной отчет»
5. Том 3Т «Проектные параметры».