IDB Inter-American Development Bank

REQUEST FOR EXPRESSIONS OF INTEREST
CONSULTING SERVICES

Selection RG-T4006-P005 – **Hydrodynamic Modeling to Determine the Maximum Probable Flood Level**

Selection Method: Complete Competitive Selection
Country: Suriname
Sector: Energy
Financing - TC #: ATN/JF-19202-RG
Project #: RG-T4006
TC Name: Regional Hydropower Modernization Program

Expressions of interest must be delivered using the IDB Portal for Bank Executed Operations (http://beo-procurement.iadb.org/home) by: *14th May 2023*, 5:00 P.M. (Washington D.C. Time).

This study aims to (i) determine the Probable Maximum Flood level based on meteorological data to manage the reservoir level proactively, (ii) perform a future flood risk analysis, including vulnerability assessment, and propose improvements on the operational rules of the reservoir to reduce risk, and (iii) review and update the Emergency Action Plan.

The total term of the contract will be four (4) months.

Eligible consulting firms will be selected in accordance with the procedures set out in the Inter-American Development Bank: *Policy for the Selection and Contracting of Consulting firms for Bank-executed Operational Work* - GN-2765-4. All eligible consulting firms, as defined in the Policy may express an interest. If the Consulting Firm is presented in a Consortium, it will designate one of them as a representative, and the latter will be responsible for the communications, the registration in the portal and for submitting the corresponding documents.

The IDB now invites eligible consulting firms to indicate their interest in providing the services associated with this assignment. Interested consulting firms must provide information establishing that they are qualified to perform the Services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc, it is recommended not to send more than 30 pages). Eligible firms may associate in a form of a Joint Venture or a sub-consultancy agreement to enhance their qualifications. Such association or Joint Venture shall appoint one of the firms as the representative.

In the Expression of Interest, it is suggested to show **relevant** and **specific** experience in hydrological analyses for hydropower plants, risk analysis for hydropower plants, meteorological data analyses. Please avoid sending general documents of your firm, unless they show specific experience relevant for this consultancy. For example, a table could be included in the EOI:

Project	Start Date	End Date	Amount	Relevance for this consultancy

NOTE: please consider that this stage is ONLY to receive expressions of interest for the selection process. DO NOT send full proposals. DO NOT send price proposals.

Interested eligible firms may obtain further information during office hours, 09:00 AM to 05:00 PM, (Panama Time) by sending an email to: arturoal@iadb.org copying ricardoesp@iadb.org and Sergio Ballon (sballon@iadb.org)

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DRAFT TERMS OF REFERENCE

HYDRO DYNAMIC MODELING TO DETERMINE THE MAXIMUM PROBABLE FLOOD LEVEL

NOTE: These Terms of Reference are just indicative. Official Terms of Reference will be issued once the short list is selected and Request for Proposals are issued.

Country: Suriname

Project Number: RG-T4006-P005

Technical Cooperation Number: ATN/JF-19202-RG

1. BACKGROUND AND JUSTIFICATION

1.1. The Energy Division (INE/ENE) is a functional division within the Infrastructure and Energy Sector Department (INE/INE) of the Inter-American Development Bank (IDB), under the Vice Presidency of Sectors and Knowledge (VPS/VPS). INE/ENE is responsible for developing technical analyzes and identifying and preparing programs, projects, technical cooperation, studies, and sectoral notes in the energy sector.

1.2. The primary responsibility of INE/ENE is the financing with a sovereign guarantee of energy infrastructure projects, including generation, transmission, and distribution of electrical energy, renewable energies, and bioenergy, and without a sovereign guarantee of investments in the productive sectors. It is in the IDB's interest to support and develop energy integration projects; renewable energy; and energy efficiency. In this sense, the possible participation in the rehabilitation or modernization of existing hydroelectric plants, which maximize electricity generation with the same available hydraulic flow, is of great interest.

1.3. The main objective of RG-T4006 is to support the modernization of hydroelectric plants in Latin American countries. The specific goals are: (i) support studies to develop at least four hydroelectric modernization projects; (ii) support the development of regulations to support the modernization of hydroelectric power; and (iii) hold at least one training seminar for hydroelectric modernization in the region.

1.4. Almost half of the electricity in Latin America and the Caribbean (LAC) depends on hydroelectricity, which remains the largest renewable energy source in the region, with more than 200 GW installed. This hydropower capacity has allowed LAC to be the region with the cleanest electricity matrix globally, have low-cost renewable energy, and be in an excellent position to accelerate the penetration of intermittent renewable energy sources, such as wind and solar. Energy.

1.5. The LAC countries are planning a transition to a low-carbon economy, based on a more significant share of variable renewable energy sources and greater electrification of other sectors of the economy (such as transport and industry). The electricity demand is expected to continue growing in the coming decades (2.8 to 3.5% per year), doubling by 2040. In this context, hydropower is essential as the largest source of renewable energy, also capable of providing storage and flexibility to the system.

1.6. The storage services provided by hydropower are critical to ensuring energy security and supporting greater penetration of renewable sources without increasing emissions. Likewise, the digitalization of the hydroelectric infrastructure will be fundamental in the coming years to improve its efficiency, maintenance, and safety. It will also help coordinate its operation with other sources of energy and other uses of water (irrigation, flood control). Since most dams are usually critical infrastructure, any digitalization process must also consider cybersecurity.

1.7. More than half of the installed hydroelectric capacity in LAC has reached a stage in its useful life that requires some level of modernization and rehabilitation. Consequently, evaluating the state of the assets and implementing improvements in the existing hydroelectric infrastructure is one of the fundamental issues to enable the energy transition of LAC in the coming decades. According to the conclusions of several studies carried out by the IDB's Energy Division, the region needs to mobilize at least US$5 billion of investments in the short term and US$30 billion in the medium term for the modernization of hydroelectric plants. These investments would allow the modernization and rehabilitation of around 127 GW of hydroelectric capacity.

1.8. The modernization of hydroelectric energy in LAC is essential to achieve net-zero emissions by 2050. This task requires a multidimensional approach, which includes the development of technical, economic, and environmental evaluations, the financial structuring of projects, and the development of regulatory incentives that promote these investments. Currently, no local or regional institutions provide financial support and technical assistance for hydroelectric modernization in the region with a comprehensive vision, so there is an opportunity for the IDB. As the largest source of financing for development in the LAC region, the IDB Group has a crucial role in promoting hydropower modernization and paving the way for the energy transition.

1.9. Suriname is a small middle-income country with an estimated population of 551,000 concentrated in the coastal areas and a sparsely populated interior that extends to the Amazon Rainforest (locally known as Hinterland).

1.10. The National Power System (NPS) consists of seven isolated power networks served by N.V. *Energie Bedrijven* Suriname (EBS) based on hydro and thermal generation. N.V. *Energievoorziening* Paramaribo (EPAR) is the largest network, serving around 143,485 customers in the urban Paramaribo area, the semi-urban district of Wanica, and the surrounding rural districts Saramacca, Commewijne and Para, with a peak demand of around 203 Megawatts (MW). EPAR mainly depends on power supply from the 189 MW Afobaka hydropower plant and 169.6 MW thermal generation.

1.11. The Afobaka Hydroelectric Plant is owned and operated by the state-owned Staatsolie Power Company Suriname (SPCS). It has an installed capacity of 189 MW (3 Fixed Blade axial flow turbines of 30 MW each with a fixed pitch and 3 axial flow turbines with a variable pitch -Kaplan- of 33MW each). The Afobaka Dam is an embankment dam with a main gravity dam section on the Suriname River near Afobaka in Brokopondo District of Suriname.

1.12. The Afobakadam hydro power plant has been classified as a high-hazard dam. The area immediately downstream of the main dam is the area at most risk, should a catastrophic failure occur. Due to the climate change more precipitation occurred this year resulting in spilling of the excess water for a long period of time. Spilling resulted in flooding of the downstream areas. The objective of this study is to determine the probable Maximum Flood level based on meteorological data so the reservoir level can be managed in a proactive way.

1.13. Saddle Dikes:

The afobaka reservoir capacity is approximately 30.837.000.000 m3 (25,000,000 acre-feet), at an elevation of 273 ft, which is top of the west dike.

Sixteen saddle dikes are associated with the Afobaka project. Twelve saddle dikes are located on the West reservoir rim. All twelve saddle dikes have an impervious core located at the center of the cross section with an impervious cut-off trench cut 1.0 foot into the clay foundation. The typical saddle dike cross section has a crest width of 22 feet, an upstream slope of 2.5H:1V and a downstream slope of 2H:1V.

Table below provides the design crest elevation, low natural ground elevation and embankment height for each of the WSDs.

Table 1. WSD Features

WSD	Design Crest Elevation (Feet)	Low Natural Ground Elevation (Feet)	Embankment Height (Feet)
1	272	260	12

Table 1. WSD Features

WSD	Design Crest Elevation (Feet)	Low Natural Ground Elevation (Feet)	Embankment Height (Feet)
2	272	268	4
3[1]	272	269	3
4[1]	272	272	0
5	272	258	14
6	272	260	12
7	272	270	2
8	272	269	3
9	272	246	26
10[1]	272	268	4
11	272	268	4
12	272	258	14

1.14. Four saddle dikes are located on the east reservoir rim.
All four saddle dikes have a relatively impervious core located at the center of the cross section with an impervious cut-off trench. The upstream and downstream zones are filled with random earth fill. The surface material on the upstream slope is riprap and the downstream slope has 1 foot of random crushed rock. The typical saddle dike cross section has a crest width of 22 feet, an upstream slope of 3H:1V and a downstream slope of 2.5H:1V.

1.15. Table 2 below provides the design crest elevation, low natural ground elevation and embankment height for each of the ESDs.

Table 2. ESD Features

ESD	Design Crest Elevation (Feet)	Low Natural Ground Elevation (Feet)	Embankment Height (Feet)
1	277.0 – 278.5	200±	78
2	276.5 – 278.0	190±	88
3	273.5 – 274.5	220±	54
4	272.5 – 274.0	180±	94

1.16. Spill way section:
There are five Tainter gates, each 35 feet wide by 40 feet high to regulate and control flow over the spillway. The gates were designed for normal pool at El. 264.0 and a design flood event at El. 269.0. The top of the gates when closed are at El. 264.0.

1.17. Hydrology:
The following information is available for the determination of the Probable Maximum Flood level.

- Reservoir Area: 604 Mi^2
- Drainage Area: 4,700 Mi^2
- Flood storage: 1 5,000.000 Acre feet
- Normal Pool: Elev. 264
- Top of Flood pool: Elev 269
- IDF = PMF: 420,000 CFS (44 inch over 18 days)
- Reported out Flow: 207,000 CFS at elev. 269
- Average annual runoff: 12,180 CFS
- Flood of record: 55,000 CFS, outflow
  140,000 CGS inflow
- Normal freeboard: 13 ft main dam
  8 ft west saddle dike
- Flood free board: 8 ft main dam
  3 ft West saddle Dikes

2. GENERAL OBJECTIVE

This study aims to (i) determine the Probable Maximum Flood level based on meteorological data to manage the reservoir level proactively, (ii) perform a future flood risk analysis, including vulnerability assessment, and propose improvements on the operational rules of the reservoir to reduce risk, and (iii) review and update the Emergency Action Plan.

3. PRINCIPAL ACTIVITIES

3.1 Maximum Probable Flood

The consultant shall perform a hydrodynamic modeling study to determine the maximum Probable Flood level in the reservoir in order to manage the reservoir level in a timely manner to prevent overtopping. This analysis should also include a probabilistic assessment oriented to define operation rules to optimize balance between reservoir utilization and flood management

Estimation of surface runoff in the watershed based on the rate of received precipitation with a return period of 5 years, 10 years, 100 years, 500 years 1000 years 5000 years and 10000 years and quantity discharge at outlet is important in hydrologic study. An analysis should be done for developing Hydrologic Model for the calculation of Probable Maximum Flood (PMF) using Probable Maximum Precipitation (PMP), over the Watershed.

The PMP is defined as "the greatest depth of precipitation for a given duration that is physically possible over a given storm area at the particular geographical location at a certain time of the year"[1].
The focus of the study is firmly on PMP estimates derived through Statistical Approach. The Probable Maximum Flood (PMF) "is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in particular drainage area is calculated using a Hydrological model"[2]. SPCS has historical data which can be used to simulate an Intensity, Duration and Frequency curve. Although SPCS has some historic rainfall data, the consultant will have to make assumptions to complete the necessary data and calculate the PMF.

3.2 Future Flood Risk Analysis

Based on the probabilistic analysis, the consultant must perform the future flood risk analysis or the Afobaka Hydrodam compromising:

1) The model will consider a base case scenario and a scenario with changing climate conditions such as sea level rise and rainfall events with increased frequency, duration, and intensity. The consultant shall use industry-accepted assumptions relating global temperature increases over time to rainfall magnitude and sea level elevation increases. Future condition Flood hazard analysis to determine the location, magnitude, and frequency of flooding.
2) Considering information that SPCS has available on flood-prone villas[3], the consultant will perform a desktop analysis to determine: (i) Flood exposure analyses to identify what might be harmed at the upstream and downstream side, and (ii) Vulnerability analyses to identify vulnerabilities of communities and critical facilities.
3) Prepare a map showing areas of inundation for future conditions, including several variables such as water depths, heights, velocities, etc. The consultant should prepare exposure maps, vulnerability data and overall risk maps. The consultant should analyze both: a base case scenario and a scenario with optimized reservoir rules, both with and without changing climate conditions for comparison.

3.3 Review and update the Emergency Action Plan.

Considering (i) the analysis carried out in the previous section, and (ii) national legislation, and international

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[1] "*Assessment of Probable Maximum Flood (PMF) using Hydrologic Model for Probable Maximum Precipitation in Maithon Watershed*". Bhanu Sharma and Kalyan Kumar. 2021.
[2] Idem 1.
[3] Based on the recent spill, whereby the villages were flooded, SPCS will provide information which villages were affected and the water level.

guidelines and codes, the consultant will review the Dam's Emergency Action plan, and suggest improvements and updates.

4. RESULTS AND EXPECTED PRODUCTS

4.1 Work Plan: Two weeks after signing the contract, the consulting firm will submit a proposal to carry out each of the activities described in Section 3 of these terms of reference, including the work schedule, the proposed dates for (i) visits to the hydroelectric plant, (ii) delivery of reports, and (iii) final meeting to present the full results of the consultancy, and discuss recommendations.

4.2 Initial Report: Within sixty (60) calendar days after the signing of the Contract, based on the documentation that has been made available by SPCS, the consulting firm must submit an **Initial Report** including the preliminary model and assumptions to calculate the PMF, and progress on the flood risk analysis. This Report should be discussed with SPCS and the consultant will consider SPCS recommendations to prepare the Final Report.

4.3 Final Report: Within one hundred and twenty (120) calendar days after the signing of the contract, and based on the agreements reached with SPCS, the consulting firm must submit the **Final Report** responding to all the activities described in Section 3.

5. MILESTONES AND PAYMENTS

5.1 The consultancy will be for products and remunerated by a lump sum. The consulting price will include consulting firm team fees and all expenses, including travel, per diem, taxes, and all costs necessary to complete the consulting services. The consulting firm must allocate the necessary resources to meet the required deliverables and schedules.

5.2 Payment Schedule: Payments will be in dollars of the United States of America and will be made according to the following schedule and upon delivery of the corresponding products:

- 20% upon approval of the Work Plan.
- 40% upon approval of the Initial Report.
- 40% upon approval of the Final Report.

6. COORDINATION

6.1 The IDB's Energy Division (INE/ENE) will be the technical unit coordinating and executing this consultancy. The responsible specialists will be Arturo Alarcon (arturoa@iadb.org), Senior Energy Specialist, based in Panama (ENE/CPN); and Sergio Ballon, Energy Specialist based in Suriname (sballon@iadb.org).

7. CHARACTERISTICS OF THE CONSULTANCY

7.1 Consulting category and modality: Consulting Firm.

7.2 Duration and term of execution of the services: The total term of the contract will be four (4) months.

7.3 Workplace and field visits: Consultant offices and field visits to the Afobaka plant and the SPCS headquarters in Suriname. Two visits onsite at the Afobaka, dam of at least three (3) days each with at least two members of the team in each visit, are planned for this consultancy.

8. CONSULTING REQUIREMENTS

8.1 Consulting Firm Experience

The consulting firm or company must demonstrate that it has carried out at least three (3) similar studies related to the calculation of Probable Maximum Flood and flood risk analysis during the last ten (10) years.

8. 2 Requirements for the Consulting Firm Team

The consultant's work team should include an expert on PMF and an expert on flood risks analysis. One of them will act as Project Manager.

The expert on PMF must be a civil or geological Engineer, or hydrologist, with master degree in civil, geological or environmental engineering, or hydrology. The expert should have at least 10 years of experience, and have participated in three (3) studies related to hydrological forecasting, design flood estimation, rainfall-runoff modelling, dam break analysis, or climate modelling during the last five years.

The expert on flood risk analysis must be a hydrologist, Civil or Geological Engineer with master degree in geospatial science, Flood Risk Management, or Flood Risk Assessment, Modelling and Mapping, or hydrology. The expert should have at least 5 years of experience, and have participated in three (3) studies related to flood risk assessments, or vulnerability analysis and mapping.

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