Terms of References (ToR)
Study and Technical Assistance for the Rehabilitation and Upgradation of Kotri Barrage

I. Background

The Government of Sindh (GoSindh) has received a credit from the International Development Association to finance the Sindh Barrages Improvement Project (SBIP). The project aims to strengthen the Sindh Irrigation Department's capacity to operate and manage the Guddu, Sukkur, and Kotri Barrages and to rehabilitate the Guddu and Sukkur Barrages to improve reliability and safety. The Project also supports the transition to managing the three barrages as one integrated system in terms of water allocation, sediment management, and maintenance. Under SBIP, the Sindh Irrigation Department is seeking International Consultants for Technical Assistance for the Rehabilitation of Kotri Barrage. This consultancy will include diagnostic studies of Kotri Barrage, design of interventions, and support to their implementation. The consultancy will also help formulate improved Standard Operational Procedures and will inform a Rehabilitation and Upgradation Project for this Barrage.

The Project Management Office (PMO) of the Irrigation Department of GoSindh is the project implementing agency, and the Project Coordination and Monitoring Unit (PCMU) under the Sindh Planning & Development Department is responsible for overall coordination, monitoring, and supervision of SBIP. The Chief Engineer of the Kotri Barrage Region is the administrative head and custodian of Kotri Barrage and its canal commands (KB Feeder & Pinyari). The other two canals downstream of the barrage head regulator (Fulelli and Akram Wah) are under the command of the Left Bank Canal Area Water Board (LBCAWB) and the Sindh Irrigation and Drainage Authority (SIDA). The Irrigation Department has also constituted a Barrage Management Unit (BMU) responsible for overall flow monitoring and control, sediment management, surveillance and management, and emergency preparedness of the three barrages. The Irrigation Department will manage this consultancy through its PMO-SBIP and with technical supervision support of BMU-ID and the Chief Engineer of Kotri Barrage Region.

II. Introduction of Kotri Barrage:

Kotri Barrage is located downstream of Sukkur and Guddu Barrages, and it is the last hydraulic structure on the Indus River. Formally known as Ghulam Muhammad Barrage, the barrage is adjacent to Hyderabad city and 120 km east of Karachi. It was constructed and commissioned on the Indus River in 1955 primarily to irrigate 1.2 million hectares of land in lower southern Sindh. The barrage is 915 meters (m) long with 44 bays, and it incorporates a road bridge, a navigation lock for river traffic, and two fish ladders. The design flood passing capacity of the barrage is 875,000 c.f.s. (24,777.24 c.m.s.). The highest flood volume recorded was 981,000 c.f.s in 1956, and the second highest was 939,000 cusecs in 2010. Four main canals, namely Kalri Baghar Feeder

Canal on the right bank, Akram Wah, New Fulelli, and Pinyari (old Fulelli) on the left bank off-take from the barrage and are the main source for supplying water not only for agriculture but also for drinking and industrial water supply for Karachi through KB Feeder and Keenjhar Lake; Hyderabad through Fulelli Canal; and several small cities and rural areas through tertiary canals, including of Kotri, Jamshoro, and Nooriabad. During the last two decades, the demand for municipal supplies has increased substantially due to population growth. The GoPakistan and GoSindh are also working to increase supplies to Karachi through the K-IV project from Keenjhar Lake. This increased abstraction from the lake will also require additional supplies from Kotri Barrage. Studies indicate that rehabilitation of the Kalgri Baghar Feeder Upper Canal could convey sufficient additional water for K-IV Phase 1. However, supplying water for the subsequent two phases of K-IV would require additional carrying capacity to convey water from Kotri Barrage to Keenjhar Lake.

Since its commissioning in 1955, the barrage performed exceptionally well until the early eighties, when the authorities reported problems in operational procedures, including corrosion of gates. After a diagnostic study, the Irrigation Department implemented a rehabilitation project completed in 2000. The gates of the main barrage and off-taking canals were replaced. The civil works included curing voids in downstream pavement filled through grouting and underwater concreting, the road bridge slab replacement, and motorization of the gate hoisting mechanism, including electrification.

As the last controlling structure on the Indus River, the barrage also releases environmental flows to the Indus Delta. The flow data of the previous two to three decades show a decline in the environmental flows, causing severe environmental degradation in deltaic areas.

Recently, operational managers of Kotri Barrage have reported sedimentation along the right bank of the upstream side, which is impacting the main river flow, changing it to an oblique angle towards the left pocket. The sediment accumulation is also reducing the capacity of the barrage pond. The barrage team has also identified a pit formation near the left pocket divide wall. This requires detailed investigations underneath the pavements and a modeling study to align flows into the barrage and remove sediment.

The off-taking canals are also facing problems, particularly in the left bank. The operation of is the combined channel of the Fulelli and Pinyari canals makes it challenging to maintain the required water levels independently in both canals. The problem may require interventions like bifurcating the combined channel into two independent canals or changing the way flows are controlled at the head and tail of the combined channel.

The preliminary investigations by the Irrigation Department indicate that the barrage needs some serious interventions, including the following: i). rehabilitation of Electro-Mechanical and Civil Components, (ii) Sediment Management, (iii) securing Maximum Flood Passing Capacity and

Flood Routing, (iv) Refurbishing and Improving the Barrage Monitoring Instrumentation for long-term safety of assets, and (v) Improving the delivery of design flows as per schedule to the four canal.

III. Objectives of the Consultancy

The objectives of the proposed consultancy services are to conduct diagnostics surveys, analyze structural, nonstructural, and operational issues faced by the Kotri Barrage, prepare designs for proposed and agreed interventions and also provide implementation support to the client and project partners for urgent interventions. These tasks will be carried out according to international standards and are divided into the following four phases:

1st Phase:	Inception phase
2nd Phase:	Initial investigations phase
3rd Phase:	Analysis and Design Phase
4th Phase:	Implementation Support phase

IV. Tasks and Descriptions

1. Inception Phase

1.1 Visit Kotri Barrage and briefing with the Chief Engineer and operational team

1.2 Develop methodology and work plan

1.3 Collect documentation, past reports, and information

1.4 Update program and budget of physical tests submitted in draft in the Technical Proposal for diagnostic of electro-mechanical equipment and civil structures (and any other need identified by the consultant).

Note: a list of physical tests and surveys will be proposed in the consultant's technical proposal with their cost estimate. The test program will be reviewed at inception phase and implemented following the Employer's approval using the provisional sum in the contract.

1.5 Finalize format and content of reports and submit Inception Report.

2. Initial Investigations Phase

2.1 Condition assessment survey for civil structures and electro-mechanical (EM) components of the barrage, head regulators, and sub-head regulators with a focus on underwater elements of the civil structure.

2.1.1 Condition Assessment Survey of Electro-Mechanical Components:

2.1.1.1 Review the design and operations of EM Components and compare them with international best practices.

2.1.1.2 Identify operational risks.

2.1.1.3 Review Maintenance Program and records and identify gaps in preventive maintenance, including availability of spare parts.

2.1.2.4 Conduct required physical tests for diagnostics of electromechanical components (as per agreed program of physical tests).

2.1.2 Condition Assessment Survey of above-water civil & mechanical components

2.1.2.1 Gather and review available data on the history of the structure,

2.1.2.2 Discuss and review problems and solutions implemented with Barrage Authorities.

2.1.2.3 Conduct condition assessment of concrete and steel structures focusing on preventing deterioration and corrosion.

2.1.2.4 Review the Barrage Maintenance Program and its records and identify gaps in preventive maintenance.

2.1.2.5 Conduct required tests for diagnostics (as per agreed program of physical tests).

2.1.3 Condition Assessment Survey and Modeling of Under-Water Civil and Mechanical Components

2.1.3.1 Gather and review existing underwater surveys by Barrage Authorities.

2.1.3.2 Conduct survey of the entire base area of the barrage structure for delineation of existing or possible scour areas and sediment and debris build-up. Use this survey to develop a 3-dimensional digital image and visualizations of barrage floor suitable to identify underwater structural problems and scour issues.

Note: this does not fall under the provisional sum. Consultants should define the methodology and tools used for this survey and digital imaging in their Technical Proposal and include the cost in their Financial Proposal.

2.2 Investigate Barrage, head, and sub-head regulator instrumentation for flow measurement, structural and operational safety monitoring, etc.

2.2.1 Review flow measurement instrumentation for canal gates (note: flow is controlled at 26 gates in total on head regulators of KB Feeder and Akram Wah and at RD4 regulators for Fulleli and Pinyari Canals).

2.2.1.1 Check completeness and accuracy of records for water levels and flows in canals and provide a clean archive file of flow data.

2.2.1.2 Check the calibration of water levels upstream and downstream gauges and gates opening gauges.

2.2.1.3 Review methodology and results of the flow calibration campaign of canal gates by Barrage Management Unit (BMU) with particular attention to flow regimes. If required, assist BMU to finalize the flow calibration campaign.

2.2.2 Review flow measurement instrumentation for Barrage gates (10 pocket gates and 34 main barrage gates).

2.2.2.1 Check the completeness and accuracy of records for water levels and flows through the Barrage and provide a clean archive file of flow data.

2.2.2.2 Develop a 3D numerical model for barrage bays and use the model to calibrate the gates in different flow configurations.

2.2.3 Review barrage monitoring instrumentation & tools.

2.2.3.1 Check completeness and accuracy of monitoring records for barrage operational safety monitoring equipment (e.g., piezometers and loggers)

2.2.3.2 Review conditions and calibration of these monitoring instruments.

2.3 Collect data and survey sediment deposit and scouring issues upstream and downstream of the Barrage.

2.3.1 Collect Data on upstream and downstream sediment deposition

2.3.1.1 Collect and review all available data on silt deposits and sediment loads from Barrage custodians and Irrigation Department .

2.3.1.2 Procure and analyze satellite imagery to determine inter and intra-annual sedimentation variations over the past 15 to 20 years.

2.3.2 Survey of Sediment Deposits

2.3.2.1 Collect samples and analyze sediment composition upstream of the Barrage on both sides and in the pond.

2.3.2.2 Conduct a bathymetric survey upstream and downstream of the Barrage, starting from and ending at a reasonable distance from the main structure in accordance with requirements for establishment of numerical model of river bed. *Note: this does not fall under the provisional sum. Consultants should provide detailed methodology and survey area in their Technical Proposal and include the cost in the Financial Proposal.*

2.3.3 Survey of Flow Direction and Velocity

2.3.3.1 Physical measurement of flow direction and velocity at different points in the river under different hydraulic conditions. The data should be suitable to calibrate the numerical model of the barrage. *Note: this does not fall under the provisional sum. Consultants should include the detailed methodology and number of flow measurement campaigns in their Technical Proposal and the related cost in their Financial Proposal.*

2.3.4 Conduct consultations with the Barrage Operations Team and veteran Irrigation Engineers on sediment issues

2.4 Investigate the technical issues and risks (notably canal bank stability) faced for the operation of the Pinyari and New Fuleli Canals, their combined channel, and the head and sub regulators.

2.4.1 Consult with Left Bank Canal Area Water Board (LBCAWB) and the Kotri Barrage Regulations Team to identify flow configurations to be analyzed, including normal operations and abnormal situations.

2.4.1.1 Check flow and gauge level records of the combined channel and head of Fulelli and Pinyari Canals at RD 4.

2.4.1.2 Consult with Barrage and AWB regulation team for problems faced in combined channel to maintain the levels in Fulelli and Pinyari Canals.

2.4.1.3 Consultations with Kotri Barrage and the LBCAWB operation team to discuss and identify various flow scenarios to be considered.

2.4.2 Develop and Run 1-D Model for Combined Channel

2.4.2.1 Collect drawings and data from the channel and the upstream and downstream regulators and complement with topographic survey as need be to establish 1-D model of the channel.

2.4.2.2 Run the 1-D model for different scenarios (simulating both steady and unsteady flow conditions) and present the results to the stakeholders.

2.4.2.3 Use the model to determine the most appropriate way(s) to measure and control flows to Fulelli and Pinyari Canals accurately.

2.4.3 Analyze Risks Associated with Canal Operations

2.4.3.1 Assess the physical stability of combined channel's and Fulelli and Pinyari canals' banks and berms under various flow conditions and assess the related risks.

2.4.3.2 Assess the risks related to the stability of the regulators under various flow conditions.

3. Analysis and Design Phase

3.1 Assess the safety conditions of the Barrage and appurtenant structures as per international and national standards, including checking the upstream floor and downstream floor of the barrage for uplift pressure and pavement safety and making recommendations for stability.

3.1.1 Review of Uplift Pressures at Barrage Foundations

3.1.1.1 Check and calculate uplift pressure under normal and extreme conditions and compare with piezometer data.

3.1.1.3 Conduct risk assessment and analysis with relation to structural stability of the barrage and appurtenant structures. Identify options for risk mitigation.

3.1.2 Recommendations for Future Interventions

3.1.2.1 Submit assessments and proposals at the pre-feasibility stage with cost estimates for interventions to increase the structure's resilience in extreme climate change scenarios. The proposals should also include interventions for improved monitoring and structural measures for increased deterrence, structural integrity, etc.

3.1.2.2 Conduct Consultations with the Irrigation Department, PMO-SBIP, BMU-ID, Kotri Barrage Region, SIDA, and LBCAWB for a detailed scope of recommended solutions and consensus.

3.2 Develop recommendations and design reports to rehabilitate, refurbish, and improve the various components of the Barrage and allied structures, including the Old and New Fuleli Head Regulators after agreement with the project partners, specially the Kotri Barrage Region, Irrigation Department

3.2.1 Develop detailed scope of work for each recommendation

3.2.1.1 Listing of works required for refurbishment and rehabilitation of various components of barrage infrastructure.

3.2.1.3 Propose a strategic way forward for the pace and frequency of these works to keep the barrage in safe conditions.

3.2.2 Develop Cost Estimates

3.2.2.1 Determine unit costs based on recent market prices, prepare bills of quantities and cost estimates, and determine annual funding requirements to maintain the infrastructure up to the safety and reliability thresholds.

3.2.3 Submit Recommendations for the implementation of these works.

3.2.3.1 Propose Packaging of works and evaluate implementation modalities of components (e.g. regular annual maintenance contracts or multiyear contracts).

3.2.3.2 Consult project partners regarding the feasibility of proposed approaches considering administrative and financial constraints.

3.2.3.3 Prepare detailed final recommendations based on the above findings and agreements after the above process.

3.2.1 Prepare Detailed Designs

3.2.1.1 Prepare and Submit Detailed Design Reports for each intervention, with specifications and cost estimates. Revise if necessary after the project partners' review.

3.3 Establish Designs for Upgradation of Instrumentations and Standard Operating Procedures (SoPs) for Improved and Reliable Monitoring of Canal Flows

3.3.1 Design and recommend SOPs with required instrumentation for improved monitoring of canal flows data (with +/- 2.5% accuracy level) and develop a system giving online real-time access to flow for all three barrages of Sindh Province. This flow system will work under the command of BMU.

3.3.1.1 Consultations to check the flow measurement requirement, listing the necessary interventions, and final consultations with the Irrigation Department for concurrence. Meanwhile, the PMO-SBIP will complete the construction of observation wells at all Barrages under a separate contract.

3.3.1.2 Check compatibility requirements of infrastructure and instrumentation of Guddu and Sukkur Barrages for consolidation of Sindh Barrages flow measurement.

3.3.1.3 Prepare final proposal and feasibility with recommendations, detailed design, specifications of instrumentation and of data collection, transmission, display and archiving, and cost estimates.

3.4 Analyze and Establish options for resolving the operational issues related to the Pinyari and New Fulelli Canals, including the option of a divide wall within the combined channel.

3.4.1 Options Assessment

3.4.1.1 Based on the results of Task 2.4, determine various solutions at the conceptual stage with a presentation on pros and cons.

3.4.1.3 Prepare a pre-feasibility study for the agreed options with cost estimates.

3.4.1.4 Conduct a performance assessment of the agreed options in terms of measurement and control of flow (using the 1-D model from Task 2.4.2), adaptability of various flow regimes, and flexibility in operating the two canals independently (using risk analysis from Task 2.4.3).

3.4.1.5 Present and discuss the optimal options for agreement of project partners.

3.4.2 Additional Investigations and Design

3.4.2.1 If deemed necessary for assignment, conduct additional investigations, including Topographic Survey and Geo-Technical Study (using provisional sum for physical tests and surveys).

3.4.2.2 Develop the detailed design of the selected solution, including specifications, detailed drawings, and cost estimates.

3.5 Undertake Risk and Dam Safety Assessment under climate change scenarios such as super floods, earthquakes, or other possible disasters.

3.5.1 Hydrological Assessment in purview of Climate Change Scenarios

3.5.1.1 The Irrigation Department has developed a Decision Support System (DSS) for climate change forecasting and timely decision-making. The DSS Model can simulate hydrographs for each Barrages based on historical data or local and global climate change scenarios. The PMO-SBIP will facilitate access to the DSS for incorporation of information in this analysis. The consultants may also work with DSS if required by the client to run existing Indus models to determine hydrographs and water levels at Kotri under different scenarios such as breaches of river bunds upstream or downstream of the Barrage.

3.5.1.2 The Consultants will describe risks related to different flood management scenarios using the outputs of the DSS model. The local modeling of super floods passing through Kotri will be done using the 3D model established under Task 3.6.

3.5.2 Structural Assessment for Earthquakes Resilience

3.5.2.1 Consultants will review the past studies on structural strength.

3.5.2.2 Analyze, review, and confirm structural integrity.

3.5.3 Any other Risk Assessment

3.5.3.1 Identify and assess other risks affecting the structure and its operationality and propose remedies.

3.5.4 Prepare Emergency Preparedness Plan (EPP) for Kotri Barrage

3.5.4.1 Identify the populations at risk in the vicinity of the Kotri Barrage and meet the relevant institutions and partners in charge of managing emergencies.

3.5.4.2 Survey the populations and relevant authorities in the vicinity of the Barrage and its bunds to identify the safe escape routes and shelters (with a specific focus on the needs of the women).

3.5.4.3 Develop and Present a consolidated EPP for Kotri Barrage as informed by the above tasks. The EPP should be a short, simple and practical document easy to use in a context of emergency.

3.6 Analyze the oblique flow behavior of the river upstream of Kotri barrage and related silt deposition on the right side in particular through specific numerical and physical modelling, leading to proposal for centralized flow.

3.6.1 Numerical Modelling

3.6.1.1 Develop, calibrate, and run a numerical model of the river including the entire approach curve upstream of the barrage. The survey data is to be collected under task 2.3. The consultants will be required to present this model to project partners at several stages.

3.6.2 Options Analysis

3.6.2.1 Define various options for centralizing the flow and reducing silt deposition, including structural interventions such as the concept of the vanes (highlighted in the completion report of Kotri Barrage) and non-structural interventions such as sediment flushing measures.

3.6.2.2 Simulate available options using the numerical model.

3.6.2.3 If deemed necessary, consultants can help the Irrigation Research and Hydrology Laboratory at Hyderabad develop a physical model of the Kotri Barrage and use it to confirm the results of the numerical model.

3.6.3.4 Stakeholders consultations to discuss modeling results and agree on final recommendations to be developed.

3.6.3 Design

3.6.3.1 Prepare and submit Detailed design of the agreed solution, including drawings, specifications, and cost estimates.

3.7 Detailed analysis of flow variations throughout the Indus system and recommendations for improved reliability of inflows at Kotri.

3.7.1 Assess Flow Variability

3.7.1.1 Gather hydraulic data from rim stations, main dams, and various barrages including the two southernmost barrages on Indus in Punjab and the three barrages in Sindh.

3.7.1.2 Analyze flow variability through time. Consultants will also review report produced by Dr. Qureshi from Mehran University about the management of environmental flows downstream of Kotri.

3.7.1.3. Simulate inflow variability at Kotri under the assumption that inflows at Guddu remain the same and 10-daily flows abstracted at Guddu and Sukkur are kept constant.

3.7.1.4 Determine the minimum flow through Kotri Barrage required to absorb these flow variations throughout the year.

3.7.2 Assess Water Demand

3.7.2.1 Gather cropping pattern and cultivation data for all main canal commands in Sindh (14 canals).

3.7.2.2 Determine crop water requirements and derive irrigation requirements (including for humectation / germination) and add other water requirements (notably for Karachi City under the various phases of the proposed K-IV Mainstream projects).

3.7.2.3 Develop realistic assumptions on groundwater abstraction and canal conveyance efficiency and derive canal flow requirements. Literature review and focus group discussions can be used to develop these assumptions.

3.7.3 Recommendation for improved reliability of inflows at Kotri

3.7.3.1 Considering the lag period, assess what impact a more responsive release from the main dams upstream would have on 10-daily and monthly flow variations at Guddu and at Kotri.

3.7.3.2 Make detailed recommendations on how to provide a more reliable (stable) inflow at Guddu Barrage (entry point to Sindh Province) and how Sindh can then manage this flow in response to the demand throughout the system and down to Kotri Barrage.

3.7.4 Prepare and Submit a Summary Report

3.7.4.1 Prepare a summary report and a presentation of all the above presenting in succinct and easily comprehensible terms (including impactful visuals) the issues faced and recommended solutions. The report will be used as a communication tool for the next phase.

4. Implementation Support

4.1 Establish Bidding Documents (including Environmental and Social Action assessment and plans) and act as project engineer for the contracting and execution of the following small works (to be financed by SBIP):

4.1.1 Refurbishment / replacement / improvement of Barrage instrumentation, notably the piezometers system

4.1.1.1 Bidding Documents, Procurement support, and contract supervision for Barrage instrumentation

4.1.2 Flow measurement at Kotri, and flow data management for all three barrages.

4.1.2.1 Prepare Bidding documents, provide Procurement and contract supervision support for equipment required. The system shall provide online real-time access to flow data (with +/- 2.5% accuracy level) for all three barrages of Sindh Province. This flow system will work under the command of BMU.

4.1.2.2 Support the operation of the system for one year.

4.1.3 Refurbishment and improvement of electromechanical components (gates, hoisting systems, appurtenant equipment, and structures) for improved reliability and safety of Barrage operations.

4.1.3.1 Bid document, procurement support, and contract supervision for electromechanical equipment (refurbishment or improvement) including solar panels and energy storage (batteries + inverters).

4.1.4 Urgent scouring protection works.

4.1.4.1 Prepare Bidding document, procurement support, and construction supervision for urgent scouring protection works.

4.2 Develop bid documents and Planning Commission Form 1 (PC-1) as well as environmental and social management plans for the following large works items (not included under SBIP financing) and provide technical support through approval of PC-I from relevant forums.

4.2.1 River Training Works

4.2.2 Canal improvement works (to resolve operational issues with Pinyari and New Fuleli Canals and their combined channel)

4.2.3 Structural refurbishment / reconstruction (large works not covered under 4.1)

4.3 Prepare bidding documents and environmental and social management plans and facilitate contracting for maintenance contracts to complement ongoing maintenance (when relevant, the contracts might cover all three Sindh barrages for economies of scale).

4.3.1 Draft Performance-Based Maintenance Contracts

4.3.1.1 Draft several performance-based maintenance contracts to cover hydro-mechanical equipment, electro-mechanical equipment, regular sediment removal (dredging), and other maintenance works as needed. Produce relevant specifications, drawings, and cost estimates as well as Key Performance Indicators (for contract management stage) and relevant selection criteria (for bid stage).

4.3.1.2 Draft environmental and social management plans

4.3.2 Support procurement of maintenance contracts

4.3.2.1 Establish bid documents using quality and cost-based approach, support bidding process (including responses to queries and technical evaluation), support contract negotiations, and provide assistance to contract management during the first year of the contract.

4.4 Capacity building of Irrigation Department Staff, Barrage operations staff, BMU, and PMO-SBIP and development of procedures for Operation and Maintenance.

4.4.1 Training Needs Assessment (TNA)

4.4.1.1 TNA of key technical staff in delivering barrage O&M functions.

4.4.1.2 Identify priority short-term training requirements.

4.4.1.3 Develop training plan for National and International programs.

4.4.2 Update Standard Operating Procedures (SOP)

4.4.2.1 Update all SOPs for Kotri Barrage operation and maintenance, including flow measurement SOP, sediment management SOP, barrage monitoring SOP, maintenance SOP, and emergency response SOP (linked with EPP)

4.4.3 Hands-on training of staff

4.4.3.1 Hands-on training of staff embedded in the consultant's team.

4.4.3.2 Quality review of maintenance tasks implemented by SID

4.4.4 Maintenance management system (for all three barrages)

4.4.4.1 Selection and purchase (on behalf of SID) of computerized maintenance management software

4.4.4.2 Installation of the computerized maintenance management software and support the operation of the system for one year

4.4.4.3 Train the relevant staff and hand over the system to custodians.

4.4.4 4 On-going operational support

4.5 Support the Sindh Irrigation Department in discussions with the Indus Rivers System Regulatory Authority (IRSA) regarding Indus flow monitoring and control.

4.5.1 Facilitate discussions related to Indus flows convened by SID

4.5.1.1 Support SID in presenting its issues to IRSA and WAPDA (based on outputs of Tasks 3.7) and facilitate the discussions by providing high-level technical inputs.

4.5.1.2 Prepare responses to IRSA and WAPDA comments on the proposed approach to improved flow control in the Indus River.

4.5.1.3 Facilitate at least three workshops to discuss the proposed approach.

4.5.2 Detailed recommendations for improved Indus River flow control

4.5.2.1 Review the 1991 Water Accord and the ITRC's Report on Flow Controls at Barrages

4.5.2.2 Produce a detailed proposal for the establishment of a federal flow monitoring unit as recommended in ITRC report and participate in SID discussions with IRSA and WAPDA

4.5.2.3 Propose recommendations for more flexible and adaptive management of storage in upstream dams to address various Provinces' needs.

4.5.2.4 Propose revisions needed, if any, for the Water Accord to implement recommendations

V. Staffing Requirement

The consultants are encouraged to use the expertise available in Pakistan to the extent possible. However, international experience and experience with World Bank-funded finance projects are considered necessary to carry out the assignment. The consultants shall propose a staffing plan and skill mix necessary to meet the objectives and scope of services. If all the required skills are not available within the consulting firms, they may propose joint ventures with other firms. The following is an indicative list of staff skills required for carrying out the assignment:

Staff Skills	Key Staff
1. Team Leader	YES

2. Civil / Structural Engineer	YES
3. Electromechanical Engineer	YES
4. Hydraulic Model Specialist	YES
5. Sediment Specialist	YES
6. Maintenance Specialist	YES
7. Geo-technical Engineer	YES
8. Environmental Specialist	YES
9. Social Specialist	YES
10. Procurement / contract management Specialist	YES

Indicative Job Descriptions and Qualifications of Consultants' person months of the above Key Staff will be provided in the RFP. Similarly, total person months of non-key staff will be provided in the RFP.