

ISLAMIC EMIRATE OF AFGHANISTAN
MINISTRY OF WATER AND ENERGY

TERMS OF REFERENCE (TOR)

FOR

**DETAILED DESIGN AND UPGRADING THE FEASIBILITY
STUDY OF SULTAN-IBRAHIM IRRIGATION PROJECT**



Date: June 2024

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ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
AASHTO	American Association of State Highway and Transportation Officials
Alt. QCM	Alternative Quality Control Manager
ASTM	American Standard for Testing Material
AGMA	American Gear Manufacturers Association
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BS	British Standards
CBR	California Bearing Ratio
CCITT	International Telephone & Telegraph Consulting committee
CECT	European Committee for Manufacturing of Boilers & Kindred Steel Structures
CMAA	Crane Manufacturers Association of America
ČSN	Czech National Standards
DIN	Deutsches Institut für Normung
DM	Design Manual
EMP	Environmental Management Plan
EN	European Standards
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Employers
IIW	International Institute of Welding
ICEA	Insulated Power Cable Employer's Association
ISO	International Standards Organization
IMC	International Mechanical Code
IEC	Important Environmental Component
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
VDE	Verein Deutscher Elektroingenieure
VDI	Verein Deutscher Ingenieure
SIS	Swedish Standards Institute
AWS	American Welding Society
DIN	Deutsches Institut für Normung eV (German Institute for Standardization)
EN	European Standard
HSE	Health and Safety Engineer
MWE	Ministry of Water and Energy
MPa	Mega Pascal
ISO	International Organization for Standardization



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NDT	Non-destructive Testing
NTP	Notice to Proceed
PM	Project Manager
PMF	Probable Maximum Flood
QA	Quality Assurance
QCM	Quality Control Manager
QCS	Quality Control System
REP	Representative
SI	International System of Units
SPT	Standard Penetration Test
TM	Technical Manual
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation

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SECTION 01.00 00

1.1 INTRODUCTION

Afghanistan is a landlocked country, located in the heart of Asia. It encompasses a geographic area of 652,225 sq. km. Most of the rivers and streams in Afghanistan flow only during spring and early summer and remain dry rest of the year, although the total quantum of water available in these rivers and streams on an annual basis are significant. This asymmetry in the demand – resource pattern results in failure to meet agricultural and other developmental requirements. In addition, the peak flows sometimes cause floods, damaging lives and properties. Afghanistan's water and power infrastructure are literally in ruins and its rugged terrain and seasonally harsh climate cause the population to suffer, among others, from shortages of drinking water, irrigation water, floods risks and electricity. The availability of water is a major problem in rural and urban areas due to its scarcity, mismanagement and damaged water systems. The country as a whole use less than one-third of its potential of 75,000 million cubic meters of water resources; regional differences in supply, inefficient use and wastage ensure that a large part of the country experiences scarcity of water. Ravaged for more than four decades by war and civil strife, the irrigation sector in the entire country has suffered enormously, and is in dire need of an accelerated program to expand its agricultural production facilities.

In Afghanistan for developing of large-scale hydropower and irrigation projects, sustainable and reliable sources of water are needed, but In Afghanistan there is normally plenty of water and peak flows in many rivers during spring and early summer and often don't have any flows or small flows in late summer and early fall.

Therefore, development and regulation of the rivers/streams system is needed to provide reliable water supplies throughout the year, control flood damages, supply of water for domestic use, irrigation and hydropower generation, etc.

To achieve the above objectives construction of storage and water diversion dams are needed to be constructed across the rivers in suitable locations. Sultan Ibrahim Irrigation project is one of the above-mentioned projects planned by the Ministry of water and Energy in result of the order No. 3481 dated 1444/9/22 of Amirul Moamineen, letter No. 1156 dated 1445/3/1 of the Economic Assistant of Rayasatul -Wizra where it is stated that "survey of the Sultan Ibrahim dam shall be awarded to National Development Corporation" Order No. 4659 dated 1445/9/13 of the Economic Assistant of Rayasatul -Wizra where it is stated that" contract of the stated project shall be awarded to National Development Corporation" and Order No. 7986 dated 1445/10/9 of the Deputy Minister of Water where it is stated that "TOR for the design of Sultan Ibrahim Dam shall be prepared by the Ministry of water and Energy". Finally based on order No.8759 dated 1445/11/16 of the deputy minister of water where it is stated that" If upgrading of the feasibility study is efficient from the technical point of view, then upgrading of the feasibility study shall be included in the TOR". Considering the above chain of orders and specifically



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the last order of the Deputy Minister of water, TOR for Detail design and upgrade feasibility study of Sultan Ibrahim Dam is initiated in the subsequent sections of this TOR.

- **General project description**

Based on the feasibility study report Sultan Ibrahim Irrigation Project is planned across Abe Safed River near Solmay Village, about 23km from Sar-e-Pul town, Ahmad Aba district of Sar-e-Pul Province in Sar-e-Pul watershed in Northern basin of Afghanistan. The project envisages construction of a barrage at site coordinates Latitude 36°3'31.08" N and Longitude 66°5'43.21" E. The lowest bed level at the site in the river is El. 833 m.

Based on the feasibility study report, another suitable location for barrage construction is available at around 100 meters on the downstream side of the above stated location which needs to be assessed and checked during the detail design stage.

Sultan Ibrahim Project is designed as irrigation project only, along with meeting the domestic water supply needs of the villages in command area, as only construction of a barrage is possible in the area, due to geological constraints of foundation strata. There is limestone on which building a dam to create water storage is not recommended. The project envisages to irrigate about 5640 ha of net command area out of a gross command of 7800 ha, the irrigated cropped area being 6486 ha.

The total period for Detail design of Sultan Ibrahim Irrigation project and upgrading of the feasibility study is 18 months.

The main objective of this TOR is to set out the technical design requirements and outline the methodology needed to be followed in the detail design for the above-mentioned project as per the specified scope of work, and applicable codes and standards.



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• SALIENT FEATURES OF THE PROJECT

Based on the executive summary of the feasibility study, below are some feasibility level salient features of the project which needs to be verified, refined and detailed during the detail design stage.

Sl.No	Parameters	Information
A.	Location Country Nearest City River Basin Sub basin	Afghanistan Sar-e-Pul Abe Safed Northern basin Sar-e-Pul
B.	Hydrology Catchment Area at Dam Site Precipitation Temperature Low High Water Availability Average Dependability 75 % Dependability 90 % Dependability	2920sq. km 200-250 mm (-) 1.5 ° C 38 ° C 104.533 MCM 70.853 MCM 59.742 MCM
C.	Barrage 1. Pond Level 2. FSL of canals at head regulator RMC LMC	El. 838.25 m El. 837.87 m El. 837.83 m El. 836.3 m



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Sl.No	Parameters	Information
	3. U/S high flood Level	1.5 M
	4. Width of each pier	925.0 m
	5. Total width between the two abutments	
	6. Under sluice bay	El. 834.20 m
	a. Level of U/S floor	El. 831.60 m
	b. Level of D/S floor	El. 834.20 m
	c. Crest level	El. 834.20 m
	7. Other bays:	
	a. Level of U/S floor	El. 832.80 m
	b. Level of D/S floor	El. 835.20 m
	c. Crest level	
D.	Irrigation System	
	Gross Command Area	7800 ha.
	Cultivable Command Area	5640 ha.
	Cropped Irrigated Area	6486 ha.
	Irrigation Intensity	115%
	Length of Main Canals	46.25 km
	RMC	22.98 km
	LMC	23.27 km
	Design discharge at head	
	RMC	4.39 m ³ /s
	LMC	4.02 m ³ /s



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Note: Above are the feasibility level design features which needs to be verified, refined, revised and detailed based on the results of the accurate new detailed survey and geo-technical investigations as in the feasibility study the survey is not that much accurate and geo-technical investigation are not conducted at all for design.

- **Summary of the Previous studies:**

A team of engineers from the Ministry of Energy and Water had examined the site in the past and recommended for conducting pre-feasibility studies for a medium height dam in a narrow rocky gorge of Sar-e-pul river downstream of village Quala Sokhta.

Consequent to the award of the job of Small and Medium Dams Project to a Consortium of Consultants led by M/s. Consulting Engineering Services (India) Private Limited, New Delhi under Contract No. MWE/354. The other members of the Consortium are M/s. BETS (Bangladesh), M/s. Hi-Tech (USA/ Afghanistan) and M/s. SMART Engineering Team (Afghanistan). This Contract includes, preparation of pre-feasibility reports of 21 (Twenty-one) small and medium dam projects spread over eleven provinces of Afghanistan, out of which eight projects will be short listed for feasibility studies and four projects will be identified for preliminary design and tender documents in World Bank format with detailed bill of quantities.

A team of experts reconnoitered the proposed dam site under the pre-feasibility study program during May, 2007 and evaluated the suitability of the site, geology, hydrology and related aspects of the project. A report entitled "Pre-feasibility Report for Sultan Ibrahim Project," was submitted to the Ministry of Energy and Water in September 2007, for technical and economic evaluation.

On receipt of approval from MWE, the feasibility stage investigations were carried out during July-September, 2008 summarized below. For detail information please refer to the complete feasibility study report shown in Appendix-D of this TOR.

- **Sultan Ibrahim Irrigation project Characteristics**

Based on the feasibility study report below are some important characteristics of the Sultan Ibrahim Irrigation project which needs to be verified, refined, revised(if needed and technically justified)and detailed :

- **Project Location and Approach**

A Barrage is proposed on Abe Safed River near Solmay Village, about 23km from Sar-e-Pul town in Sar-e-Pul Province to divert required water for utilities of Irrigation, and



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domestic water supplies. Geographical coordinates of the site are 36°03'40" N and 66°05'43" E. Catchment area of the river upto this site is 2920 sq.km.

Sultan Ibrahim Project is designed as irrigation project only, along with meeting the domestic water supply needs of the villages in command area, as only construction of a barrage is possible in the area, due to geological constraints of foundation strata. There is limestone on which building a dam to create water storage is not recommended. The project envisages to irrigate about 5640 ha of net command area out of a gross command of 7800 ha, with an irrigation intensity of 115%, the irrigated cropped area being 6486 ha.

. Catchment

A plan of the catchment showing the main river network is given in **Figure -I**. The catchment of the Sultan Ibrahim is more or less tilted L- shaped. The catchment area of Sare Pul River up to proposed site is 2920 sq. km and it lies between latitude 35°14'22" to 36°05'21" N and longitude 65°23'07" to 66°05'39" E and forms a part of Sare Pul basin. Location of barrage site is near Solmay village having latitude 36°03'40" N and longitude 66°05'43" E. This catchment plan has been prepared using 1:1, 00,000 Survey of Afghanistan toposheet. The elevation at the origin of the river is EL 3500 m and near barrage site is about EL 833 m.



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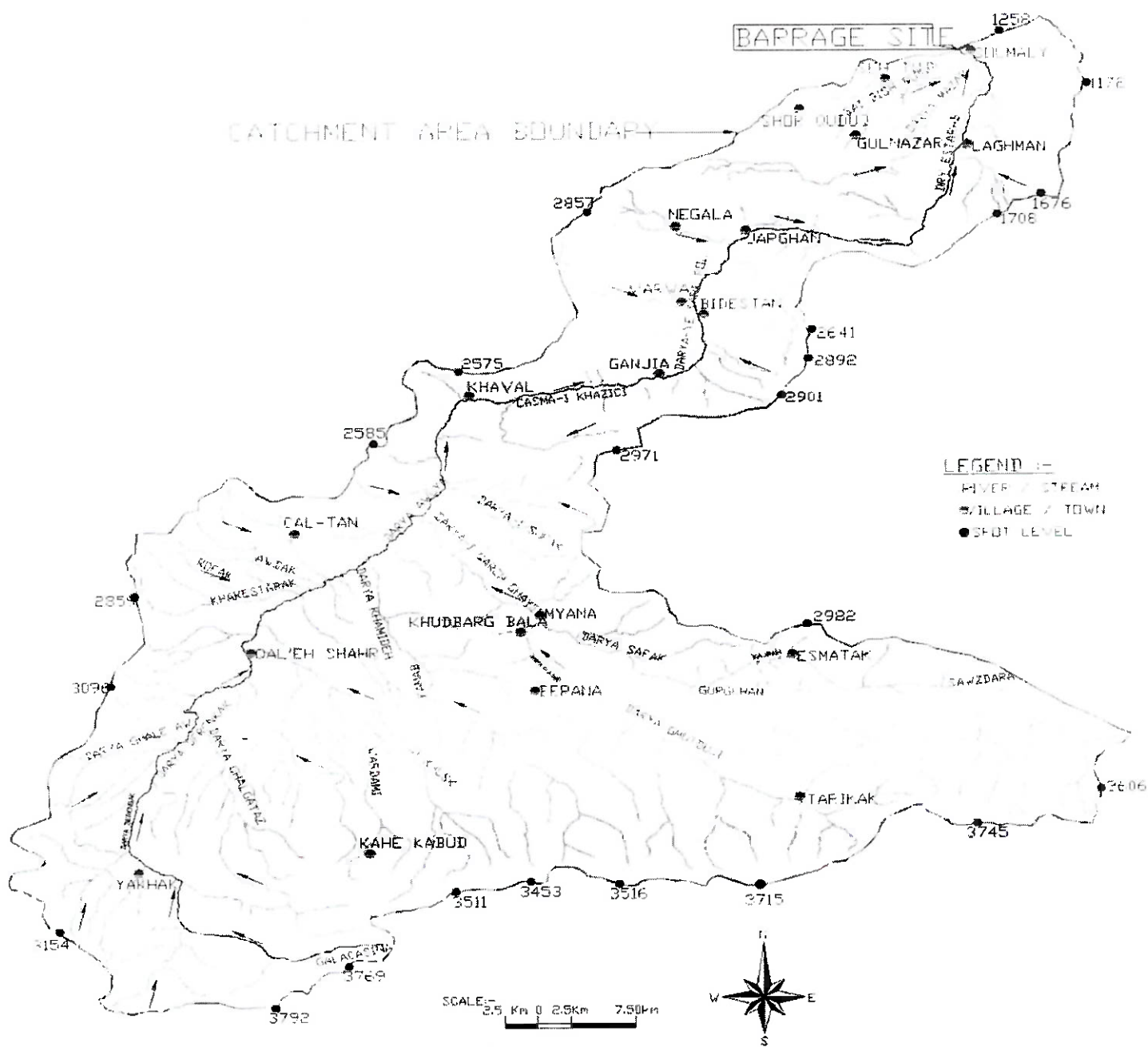


Figure-1.: Watershed of Sare Pul



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1.2. DAM SITE ASSESSMENT DURING THE RECONNAISSANCE STAGE

Dam assessment conducted during the reconnaissance stage is summarised below:

1.2.1. Catchment Characteristics: Agha Jan dam is located in Uruzgan Province on Tirin River. The catchment area to the dam site is about 2400 km².

The catchment area is delineated from SRTM 90 m DEM using the Arc Hydro tools available in Arc GIS software. The dam site is located at an altitude of about 1726 m but the catchment extends upstream above 4000 m; both rainfall and snow melt runoff contribute to river flows. The main stream average slope is about 3.5% and the main stream length to the dam site is about 63 km.

Geology

Regionally, the dam site and the surroundings are occupied by the rocks belonging to Early Cretaceous (red sandstone and Conglomerate), Late Cretaceous (limestone, marl and dolomite), Holocene and Late Pleistocene (conglomerate and sandstone); alluvium, shingly and detrital sediments, gravel, sand more abundant than silt and clay. The dam site is flanked by sub-vertical hills comprising limestone showing solution channels, cavities, etc. along the prominent joint set. The flat area on either side of the river is occupied by old riverine terrace consisting of pebbles, cobbles and gravels with sand silt cement overlain by top soil.

Left Abutment

the left abutment hill slope is near vertical scarp face which exposes limestone. The bedding plane strikes N55°E-S 55°W dipping sub-vertically towards upstream Figure-II). The bedding joints are very prominent and solution channels, cavities, etc. have developed along this joint plane. Several sink holes, about 1-1.5 m dia, are seen on the exposed scarp face of the limestone. In case, the joint planes, along which solution channels have developed, extend deep into the abutment and are inter-connected with each other, then abutment leakage may be expected. However, it is expected that the joints do not extend deep into the abutment and the jointed rock mass will be removed during scraping.





(Figure -II) SULTAN IBRAHIM BRIDGE AND LEFT ABUTMENT HILL SHOWING LIMESTONE

River Bed

The 23 m wide river bed is occupied by present day riverine deposit comprising pebbles, cobbles and gravels of limestone embedded in calcareous sandy matrix. The river channel is entrenched into about 2-4m high terrace (T1) having the level of El. 836-840m. The deeper level of the bed below the bridge is El. 835m. Bed rock is anticipated to be available at about El. ± 825 to El. ± 820 m (10-15m depth); however, this is to be confirmed by indirect/direct method of subsurface geological exploration, i.e., by geophysical (seismic refraction) survey and/or drilling.

Right Abutment

The right abutment hill slope is also near vertical scarp face and exposes bedded limestone. The bedding plane strikes N55°E-55°W with sub-vertical dip towards upstream (Figure -III). The bedding joints are very prominent along which solution channels have developed extending into the abutment. Their extension is, however, expected to be shallow into the abutment and will get removed during stripping. This abutment forms a limb of the anticlinal fold as is evident in Figure-III.

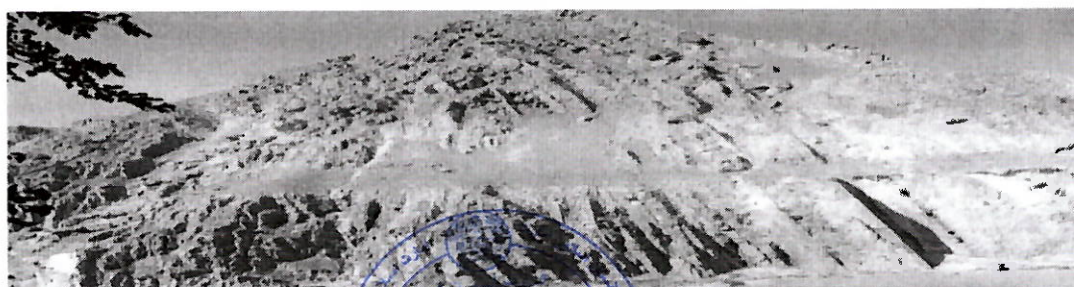


Figure-III. Right abutment



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Interpretation

Surface geological examination of the dam site suggests that the chosen dam is located in the karstic terrain. The dam axis is nearly parallel to the axial plane of an anticline through which the river has cut a gorge. The two abutments expose bedded limestone which shows solution channels/ cavities developed along the prominent bedding planes. These solution channels are not expected to be deeply extending into the abutment. However, abutment leakage may be anticipated if the solution channels are found interconnected necessitating abutment grouting.

Reservoir Competency

Reservoir competency and the tightness of the reservoir studies have been carried out on a limited scale and the study results are as follows:

The reservoir area upstream of the dam site (Figure-IV) is covered with alluvium consisting of flood plain deposit overlain by silty soil presently under cultivation which may be of impervious nature. The rim of the reservoir is of low height rolling hills, made up of in situ weathered bedrock appearing like dunes.

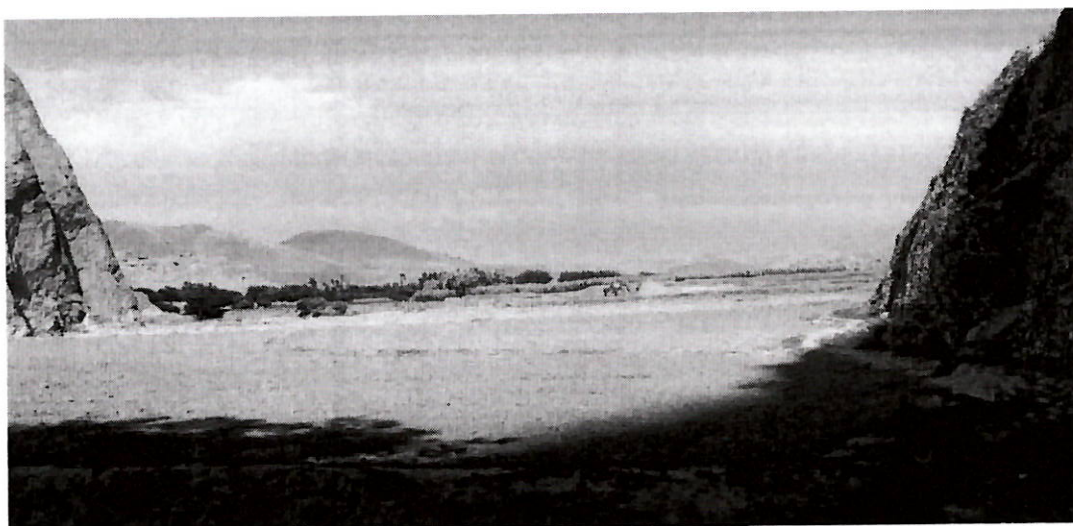


Figure-IV: RESERVOIR AREA LOOKING U/S, SULTAN IBRAHIM DAM PROJECT

The proposed reservoir would get water from three main tributaries which, from west to east, are Sai Bish Quadua, Aq Darya and Sai Abdan. They join together just upstream of the proposed dam site. The rim of the reservoir will stand to an El. 838.5m and spread

southward, over gently sloping ground. The reservoir area exhibits rising topography all around its rim. Since there is no valley with lower elevation than Aq Darya located across the rim of the reservoir, no leakage is possible from the reservoir. Hence, the reservoir may be treated as water tight.

The chances of leakage are anticipated through the two abutments of the dam, since the observed cavities on the abutment faces are expected interconnected. The bedrock in the river bed may be treated by resorting to dam foundation grouting, if required. However, since limestone is soluble in water, the abutments may get deteriorated as the limestone dissolves in the reservoir water in the long run. Hence, a dam at this site is not preferred. In its stead a low height barrage is considered a better option, mainly for diverting the river flow for irrigation purpose.

Proposed Irrigation

The project is designed to irrigate a gross command area of 7800ha, out of which 3650ha is in the left and the balance 4150 ha is in the right side of the river. Both the right and left canals take off from respective head regulators situated at u/s of the barrage perpendicular to the abutments, the length of the main canals being 23.27 km and 22.98 km respectively.

The distributaries are proposed to take off from the main canals, running along the highest contour in the respective blocks. The total length of the distributaries are 31.22 Km on the left side and 28.65 km on the right side of the river. Minors have been designed to take off from the distributaries, the total length of the Minors on the left side is 28.68 km and on the right side 41.33 km.

It has been proposed to provide concrete lining to the main canals in order to make the system efficient. The canals are counter canals and are aligned at the extreme ends of the command to feed the entire area by gravity flow.

For more details, the Consultant should refer to Annex D (Feasibility Study) of Sultan Ibrahim Dam project.

1.3. PRESENT PROJECT OBJECTIVES

The present project objective will cover verification of the Technical and economical feasibility of the project conducted in 2008, upgrading of the feasibility study (if needed, feasible and technically efficient) and detail design of the project after verification of the feasibility of the project, briefly described below:

a. Verification and upgrading (only if feasible and technically efficient) of the feasibility of the project:



Both the technical and economical feasibility of the project shall be verified, completed, upgraded (only if feasible and technically efficient) and revised based on the present water assessment, update hydrology data, climate change, droughts, accurate survey and geo-technical information. Once the feasibility is verified, upgraded (only if feasible and technically efficient) and accepted, then the detail design will be started upon a written instruction of the client.

Upgrading means to assess the neediness, feasibility and technical efficiency of a dam construction in the near or far upstream of the barrage to store water for the periods of low water or no water flow in the river.

b. Detail design of the project:

The project will cover detailed design, calculation, drawings, construction technical specification, complete BOQ, cost loaded schedule for the Sultan Ibrahim Irrigation Project. The Shultan Ibrahim Irrigation Project main features outlined during the feasibility stage are as stated above but shall not be limited to the above-mentioned features.

The consultant shall review, verify and upgrade (if feasible and technically efficient) the feasibility study and determine the most attractive type of barrage and dam ((only if needed, feasible and technically efficient) and axis location. The downstream irrigation configuration and the main right and left canals, distributaries and minors canals network and other related structures and system as described in the feasibility study shall be reexamined by the consultant in the initial stages of the project. A report will be prepared by the consultant (during the inception phase of the project) giving recommendations on the project configuration and type of major structures with particular focus on the main Barrage. The report will be available for presentation and discussion with MWE at the time of inception report presentation.

MWE will examine the recommendations and decide the configuration, size, and type of structures which will be taken to the detail design stage of the project.

1.4. PROJECT SCOPE OF WORK

The contractor's scope of work includes provision of all the required staff, Equipment, material, facilities needed for and to conduct all the required investigations, analysis, verification and upgrading (if upgrading is needed, feasible and technically efficient) of the previous the feasibility study and then perform complete design of the whole project including(not limited to) barrage and its appurtenant components, dam and it's appurtenant structures(if feasible



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and technically efficient), complete irrigation network, drainage network and infrastructures per the TOR's specified standards and codes within the required time frame of (18 months) and budget. Before commencement of the design, the contractor must submit a proposal for design including price for verification and upgrading of the feasibility(if upgrading is needed, feasible and technically efficient) and complete design of the whole project along with the CVs of the design team/Key staff within 15 days after receipt of the client's Request for proposal(RFP)/TOR by the bidding firm/firms, to see if the design price is reasonable and the contractor's design team is as per the TOR requirement stated in Annex-C of this TOR and is eligible to conduct the current design, otherwise the contractor is obliged to hire eligible National/international staff accepted by the client to conduct the design on a professional manner. Once the design price and design team is accepted and no objection is issued by the client, then the contractor shall first verify the feasibility, upgrade the feasibility study of the project(if needed, feasible and technically efficient), and then conduct the detail design of the whole project , profound study of Barrage axis, type of barrage, water supply, max irrigable area, as well as adequate analysis regarding technical, financial and constructability aspects of the project and submit the required deliverables(Inception report, Interim Report No.1, Interim report No.2, Draft Final Report and the Final report) with in the specified time frame of 4 months,8 months,12 months,14 months and 16 months respectively and specified percentage (5%,25%,25%,15% and 30%) respectively of the total agreed contract price.

Consultant will do the following but shall not be limited to:

- Desk study of the existing feasibility report.
- Verification of the feasibility of the project based on the present water assessment, update hydrology data, climate change, droughts, accurate survey and geo-technical information. Complete Site visit of the project to verify and assess the shortages (if any) of the feasibility study and give recommendations for improvement.
- Upgrading of the feasibility study (only if upgrading is needed, feasible and technically efficient) which includes the technical and economic feasibility assessment of a dam in the upstream of the barrage in a suitable location to store water during low water or no water flow periods of the year.

However, in volume-I Main Report, chapter No.4, page No.4-14 items Nos.8 and 9 of the existing feasibility study report it is stated that" Limestone being soluble in water, the abutments may get deteriorated in the long run as the limestone will get dissolved in reservoir water. A dam at this site is therefore not considered suitable; instead, a low height barrage will be a better option, meant for irrigation purpose only".



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- Reexamine and verify the Main Barrage location and configuration recommendation in the feasibility study and recommend the most attractive type of structure and configuration and report on the findings during the inception report/ phase of the project.
- Assess the neediness, feasibility, technically efficiency and suitability of a dam construction in the upstream of the barrage. However, in the feasibility study it is stated that dam construction is not feasible due to presence of lime stone in the foundation and abutments which will be dissolved by water.
- Once the neediness, feasibility, technically efficiency and suitability of a dam construction in the upstream of the barrage is provided by consultant and accepted by client, then the detail design of the dam along with its appurtenant structures shall be conducted by consultant.
- Reexamine any suitable location for barrage construction in the upstream and downstream of the proposed location considering the suitability of the foundation and abutment materials along with the reservoir capacity.
- Reexamine the downstream irrigation and drinking water supply configuration, main, right and left canal network and other related structures and system as described in the feasibility study and recommend the most attractive type of structures and report on the findings during the inception report/ phase of the project.
- Prepare a detailed design and calculations of the recommended barrage structure, gates, hoist mechanism and other appurtenant structures configuration for review, in conformance with international standards and codes, particularly USBR, USACE, ICOLD, ASTM, ACI, AISC and ICID and IS standards.
- Prepare a detailed design and calculations of the main right canal, left canals and complete irrigation and drinking water networks.
- Prepare the complete design of head regulators, cross-regulators, syphons, aqueducts and other structures as required.
- Upon acceptance of the designs the consultant shall provide all final designs, calculations, reports drawings, specifications, cost estimation (BoQ), and schedule for overall project.
- Prepare all barrage/dam safety documents conforming to the requirements of USBR.
- Visit the project site, collect, review and analyze the existing data and information regarding the project site.
- Taking measurements and getting new data if needed.



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- Investigations below are required but shall not be limited to:
 - a. Complete and accurate Topographic survey of the whole project.
 - b. Geological and geophysical investigation
 - c. Complete Geotechnical investigation
 - d. A complete Hydrology data analyzing, filling the Gaps and assessing the optimal amount of water considering the update hydrology data, climate change and droughts.
 - e. Seismology
 - f. A complete sediment report.
 - g. A complete Metrology report.
 - h. Construction material and barrow areas survey.
 - i. Preparation of the update irrigation and water supply demand report.
 - j. Other investigation as required by MWE
- Determine the optimal irrigation, water supply and hydropower potential (if any).
- All the above services shall be arranged and submitted to the Client (MWE) for approval in five reports including the Inception report, Interim report No.1, Interim Report No.2, Draft final report and Final report. The components and reports included in all the above-mentioned reports are described in details in the next sections of the TOR.

The Consultant shall keep in mind that the services and tasks described herein cannot 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.

1.4.1. SHULTAN IBRAHIM IRRIGATION PROJECT

The feasibility study has recommended a low height barrage, the consultant shall initially verify and upgrade the exiting feasibility ((only if upgrading is needed, feasible and technically efficient) and determine the basic type of barrage that is the most attractive alternative in a best-chosen location. The chosen type may or may not be the one presently recommended in the feasibility study. The type of barrage to be taken to detailed design will be agreed with the MWE at the end of an initial investigation by the consultant following a review of the recommendation by a panel of experts appointed by MWE.



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To upgrade the feasibility, study the consultant shall assess the neediness, feasibility, technically efficiency and suitability of a dam construction in the upstream of the barrage. However, in the feasibility study it is stated that dam construction is not feasible due to presence of lime stone in the foundation and abutments which will be dissolved by water.

The following factors will be considered in the final design of the chosen type of the barrage.

Detailed design, technical specifications and BoQ will include (but not limited) the following:

- Determine the need for upstream sediment structures to delay sedimentation in the reservoir.
- A complete design of the barrage, irrigation network, water supply network, drainage network and all the needed structures.
- Make a recommendation on the rate of sediment filling of the reservoir during the operation period, after review of existing information on sediment measurement contributing areas and upper watershed conditions.
- In design of the energy dissipation features an estimate of general degradation that is expected downstream of Sultan Ibrahim barrage will be considered.
- Aggregate sources for concrete structures construction, ancillary works will be identified at the detailed design stage. Required chemical testing of aggregates will be performed to confirm the aggregates compatibility with readily available Portland cement. The aggregate sources must be confirmed during the detailed design stage, prior to going to tender for construction.
- The source of Portland cement to be used in dam construction will be determined during the detailed design stage and the availability of sufficient quantities on a timely basis will be assessed.
- All tests required for design shall be conducted per the requirements of ASTM.
- Both dynamic and static type of calculation will be done for seismic influence on the barrage and the consultant will determine the level of seismic activity that must be considered in determining the barrage stability.
- A geotechnical drilling and testing program including rock testing will be carried out. The testing program will first be developed by the consultant and then approved by the ministry. The geotechnical program will be a part of the consultant's responsibility.
- If tunneling is a part of the diversion works than geotechnical testing and rock mechanics analysis will be required along the tunneling routed. In addition to detail design of tunnel, this will be a part of the consultant's responsibility.
- Slake testing and petrographic analysis will be done on rock/aggregates to be used for concreting
- The design of the barrage/dam and appurtenant structures must be according to the standards specified in TOR.



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- Unit costs related to main barrage construction will be finalized and an engineer's check estimate will be made available at completion of detailed design prior to the tendering process.

1.4.2. MAIN, LEFT AND RIGHT CANAL NETWORK

Although the Feasibility study suggest Canal system for water conveyance and distribution, but the consultant shall reexamine and reassess the type of the conveyance and distribution system, and propose the most attractive alternative system for water conveyance system considering the technical and environmental aspect of proposed system.

Detailed design, technical specifications and BoQ will include (but not limited to) the following:

- The consultant will optimize the alignment, size of irrigation canals, and the extent of canal lining considering technical (water loss potential and possible soil salination) as well as social and environmental considerations. The extent of canal lining will be agreed by MWE.
- An appropriate cropping pattern will be developed for the irrigation command area.
- Environmental and social impacts will be determined for the proposed irrigation development including land acquisition and resettlement
- Design, layout drawings, specifications and contract documents for the proposed new irrigation area will be produced to the level of detail. Connection and operation of the newly constructed canals with the already existing canal system will be developed.
- Access roads will be located along the main and secondary canals
- The designers will consult with the stakeholders in the existing irrigation areas regarding the design of the new irrigation area (to the extent possible)
- Designers of the canal system will consider the influence of sediment accumulation in the canal system and if necessary, sediment mitigation measures will be designed and specified.
- An estimate of the design life of the newly constructed canal system will be reported.
- An operation and maintenance manual will be developed for the irrigation system. The manual will include technical, operational and management aspects.
- Canal lining will be specified where excess water losses can reasonably be expected and where accumulation from seepage will create major soil salination and optimization of the use of canal lining within the newly developed irrigation area will be carried out and reported
- Sufficient crossings will be made for area residents and areas in the canal will have special provision for livestock watering. The primary stakeholders will be consulted regarding the location of pedestrian crossings and livestock watering areas.
- Future operation and maintenance costs of the canal system will be made and reported by the consultant



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- The possibility of introducing fish culture and fish ponds adjacent to or within the canals will be investigated and reported
- Consultation will be made with Ministry of Agriculture and Fisheries as well as NGOs regarding the development of fisheries and cropping within the entire irrigation area.
- The project stakeholders in the existing irrigated areas should participate in the irrigation system design process (to the extent possible).

1.4.3. INFRASTRUCTURE REQUIREMENTS

Sufficient information will be gathered and investigation shall be done on existing access into the Project Area, water and power supply (including groundwater yield assessments), transportation and other services relevant for Project site implementation.

The Consultant shall investigate the existing transportation infrastructure and shall design the required Project infrastructure expansion to support operational and marketing capabilities of the Project, as well as to facilitate the initial construction and Project implementation. The Consultant shall specifically identify upgrading and expansion requirements of existing infrastructure, and design new required facilities for project implementation to be used for project operation and maintenance in future. This will also include but not be limited to the detail design of the following facilities:

- Design of the permanent Accommodations and office facilities.
- Tunnels (if any), roads, culverts and bridges for equipment transportation to site;
- Medical and educational facilities;
- Local supply and secure storage of materials (steel, cement, etc.).
- The support required for the supervision consultancy services during construction

(a) Consultant's Own Support

Consultants' office accommodation (Kabul), international and national personnel accommodation and the field, transport, airfares, field office accommodation and other operating costs, which are the consultant's responsibility, related to the work will be shown in detail in the proposal. The cost for support will be included in the cost given in the financial proposal.

1.4.4. SOCIO- ECONOMIC ASSESSMENT

The consultant will evaluate and revise the socio-economic impact assessment report of the feasibility study based on the present condition as the feasibility was conducted back in 2008, to ensure that the following social aspects have been covered: (1) the social impacts due to construction of the proposed project and (2) the mitigation measures required due to the social impacts including land acquisition.



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The consultant will compile a social assessment report including the following items as a guidance requirement during construction. The guidance requirement will be placed in the bidding documents.

- Assessment of social risks and impacts, both direct and indirect, due to project activities;
- Description of their Methodology of Social Impacts and Impact Assessment and Analysis
- Suggesting of appropriate changes in design to avoid / minimize adverse impacts, and propose suitable mitigation measures;
- Socio-economic surveys to collect relevant information on current socio-economic status of the people of the project area and analyze the expected change including both the project beneficiaries and the affected households; specific on the following Items:
 - Land Acquisition,
 - Involuntary Resettlement,
 - Proposed Location for Resettlement,
 - Cost estimation of reservoir damage,
 - Resettlement cost calculation,
 - Damage cost of agricultural lands,
 - Compensation cost in lands under irrigation network,
 - Employment,
 - Tourism (if applicable),
 - Crop and Livestock Farming,
 - Communication (Roads),
 - Land Values,
 - Social Acceptance,
 - Recreation,
 - Local Landmarks and Character (Archeological and historical sites, monuments...),
 - Domestic Water Supply,
- Protection against Natural Dangers (flooding, drought, famine ...), with Health and diseases
- Preparation of a Resettlement Action Plan (if required) based on SIA findings and covering all the project components;



- Holding of community/ stakeholder consultations to gather inputs/ feedback on the project in general and social safeguard issues in particular
- Creating a detailed computerized database for future reference / use.
- Assessment of land to be acquired on the canal routes and where a temporary easement will be required during construction. Assess the degree of inconvenience that construction will cause the affected persons.
- Prepare a description plan to avoid the disturbing of Monument or historical site.

The consultant will also evaluate, refine and revise the economic impacts of the feasibility study based on the present conditions, quantities obtain during the detail design and current unit rates to ensure that the following economic aspects have been covered.

The Consulting Firm should be cognizant of the requirement for cost-effective projects, sustainability of project and resources, financial viability and sustainability, operational economy and simplicity, widest possible coverage, health improving schemes, and other considerations. The Consulting Firm shall select the best alternative and/or project components that would most appropriately respond to the project objectives and outputs, and yield the highest VfM, e.g., lowest lifecycle/whole-of-life costs.

Specific Objective: Economic Assessment		
Expected Results	Indicators	Means of Verification
Local Businesses Expansion	% of population/smallholders selling some produce to market	Enquiries with business association. M&E framework of support programs of the government of Islamic Republic of Afghanistan. Annual agricultural survey.
Economic diversification increased	Number of domestic products available in the domestic market in geographically targeted area	National sources
Access to electricity increased	% of people with access to electricity in geographically targeted area.	National sources
Employment Opportunity increased	% of Employment in geographically targeted area.	Enquiries from the local people of the target area. National sources.
Economic Viability	BC, ENPV, EIRR	Updated Data collected during the detailed design and



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		feasibility study.
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1.4.5. ENVIRONMENTAL IMPACT ASSESSMENT

The objective of the Environmental Impact Assessment is to evaluate the design of the Sultan Ibrahim Irrigation project, undertake the required Environmental Impact Assessment (EIA) and prepare an integrated Environmental Management Plan or any other associated instruments to ensure the sustainability of project through appropriate preventive, mitigation and monitoring interventions.

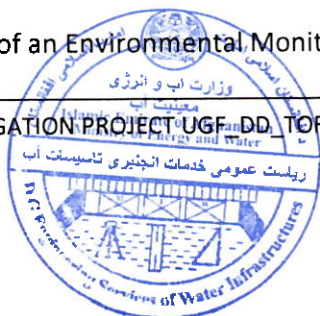
National Environmental Protection Agency (NEPA) of Afghanistan is responsible for issuing permits or licenses for certain regulated activities that have an adverse impact on the quality of environmental resources. According to Article number 21 of Afghanistan Environmental Law (2007), a proponent of any project, plan, policy or activity that is likely to have a significant adverse effect on the environment must carry out Environmental Impact Assessment (EIA) study in regard to such activities, in coordination with the NEPA.

Based on NEPA EIA regulations the proposed Sultan Ibrahim Irrigation project should be categorized and assessed.

All services will adhere to national legislative requirements and international best practice, such as the World Bank safeguard policies, such that they will allow for mobilization of the required resources for the construction of the barrage within the shortest possible time.

The Consultant should thoroughly perform the following guidance requirements, which they will be placed in the bidding documents.

- A. Site Visits
- B. Identification of the Baseline Condition of the project area.
- C. Assessment and Analysis of the Potential Environmental Impacts of the Proposed Project.
- D. Development of Mitigation Measures.
- E. Development and Analysis of Alternatives.
- F. Stakeholder Identification and consultation.
- G. Preparation of an Environmental Management Plan.
- H. Preparation of an Environmental Monitoring Plan.



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I. Preparation of Environmental Impact Statement (EIS) or EIA report.

References should be made, but not limited to, the following:

- National Environmental Protection Agency (NEPA)
- Afghanistan Environmental Law (2007)
- Afghanistan EIA Regulations (2008)
- Afghanistan EIA policy (2009)
- World Bank Environmental Assessment OP/BP 4.01
- World Bank Natural Habitats / Biodiversity & Ecosystem Services OP/BP 4.04
- World Bank Forests OP/BP 4.36

1.5. VALUE ENGINEERING

The consultant's proposal for submission for detailed design, drawings, specification and bid document preparation will include a comprehensive procedure for value engineering which will be followed during the consultant's contract period. A Value Engineering Assessment (VEA) will be part of the quality assurance plan developed by the consultant for the project.

1.6. CONSTRUCTABILITY ANALYSIS

The consultant will prepare a report on analysis to confirm the constructability of major components of the main barrage and irrigation works. The constructability analysis report will be reviewed by the Design Review Panel (DRP). The designer shall be available to answer any requirements of the DRP.

1.7. DESIGN REVIEW PANEL

The consultant will prepare necessary required reports and cooperate with a design review panel which will be set up by MWE consisting of a number of appointed experts. Designs, drawings, specifications and BoQ will be revised according to the reviewers' comments as directed by MWE.

The Consultant services and tasks described herein cannot be considered as the complete and comprehensive description of the Consultant's services and duties. Consultant's proposal in response to the client TOR/[request for proposal] shall be to the details deemed necessary according to its professional expertise and judgment may beyond scope indicated herein. The proposal shall be descriptive enough that the Consultant performs all the services/ work as necessary to fulfill the objectives of the Consultancy Contract.

1.8. ESSENTIAL PLANS

Plans indicated below shall be submitted within approved schedule (time frame) by consultant.



- 1) *Instrumentation Plan* - This detailed plan relates to the installation of instruments to monitor and record Barrage behavior and the related hydro meteorological, structural, and seismic factors. The Instrumentation Plan will be submitted in advance of the construction bid tendering for review by a Panel of Experts (PoE). The Consultant will address and satisfy all comments by the PoE to the satisfaction of the MWE during detailed design.
- 2) *Operation & Maintenance Plan*- The construction bidding documents shall include a detailed plan covering organizational structure, staffing, technical expertise, and training required; equipment and facilities needed to operate and maintain the barrage, and Right & Left pipe lines and its related structures and system taking off from irrigation intake O&M procedures; and arrangements for funding O&M, including long-term maintenance and safety inspections. The plan will be described as being refined and completed during project implementation; the final plan will be stated as due not less than six months prior to the initial filling of the reservoir.
- 3) *Barrage Safety Program*- A barrage safety program including recommended Institutional set-up, training on operation of instrumentation set up for barrage safety monitoring and all necessary barrage safety procedures with in the program will be set out by the consultant.
- 4) *Emergency Preparedness Plan*. The consultant will ensure that the contract documents will contain a requirement for the preparation of a plan during implementation to define the roles of responsible parties when barrage failure is considered imminent, or when expected operational flow releases (in case of gated spillway and outlet work releases) threatens downstream life, property, or economic operations that depend on river flow levels. It will include the following items: clear statements on the responsibility for barrage operations decision making and for the related emergency communications; maps outlining inundation levels for various emergency conditions; flood warning system characteristics; and procedures for evacuating threatened areas and mobilizing emergency forces and equipment. The plan itself will be required to be prepared during implementation and will be provided to the Panel of Experts (PoE) for review not later than one year before the projected date of initial filling of the reservoir.
- 5) *Irrigation System Operation*: The consultant will recommend to MWE the procedure to ensure satisfactory management, maintenance and operation of the system during the entire system design life time down to the level of the water users.
- 6) *Know-how Transfer and Training*: The consultant will assist MWE in establishing suitable procedures and in the capacity building of MWE personnel for.
 - Detailed engineering activities



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- Environmental management and social safeguarding procedures
- Detailed design, drawings and related Quality Assurance

1.9. DELIVERABLES (REPORTS) AND PAYMENT SCHEDULE

The deliverables (reports) and payments will be under the major pay item headings below:

1.9.1. Verification and upgrading the feasibility study(6months)

This activity will be completed with in 6 months and the below two reports shall be submitted to the client.

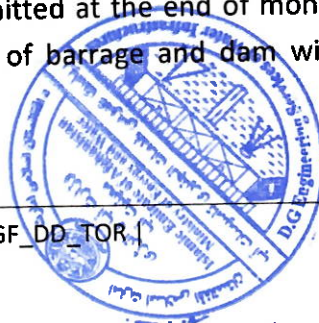
1. Inception Report, which will be submitted at the end of month (2) after NTP and 10% of the verification and upgrading price will be paid on acceptance of this report.
2. Upgrade feasibility study report which includes feasibility study of the dam option (if needed, feasible and technically efficient) and a report on review, verification, completion of the shortages (if any) and revisions in the exiting feasibility study will be submitted at the end of month (6) and the remaining 90% of the of the verification and upgrading price will be paid on acceptance of this report.

1.9.2. Detail design of the project (barrage and Dam option) (12 months)

Once the upgrade feasibility is completed and resulted that the dam construction is needed, feasible, technically efficient and accepted by client then a separate NTP will be issued to go a head with this activity.

This activity will be completed within 12 months and the below reports shall be submitted to the client.

1. Interim Report No. 1, which will be submitted at the end of month (4) after NTP and 30% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
2. Interim Report No. 2, which will be submitted at the end of month (8) after NTP and 20% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
3. Draft Final Report, which will be submitted at the end of month (10) after NTP and 20% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
4. Final Report, which will be submitted at the end of month (12) after NTP and 30% of the contract price for detail design of barrage and dam will be paid on acceptance of this report.



Dr. Sim. P.

Notes:

- A. Payments will be released up on closing of the client comments on the specified main deliverable and receiving the clean one.
- B. If an activity(s)/submittal(s) is (are) required for completion of the project (even not mentioned in the TOR and contract) must be conducted by the consultant without any additional payment.
- C. If there are discrepancies among the contract documents and TOR, TOR will govern, except if there is a mistake in the TOR.

The requirements for each of these major pay items are described in the following sections.

1.9.3. Detail design of the project (Barrage option).

If the upgrade feasibility shows that either the dam is not feasible or technically not efficient or the client does not want the dam, then a separate NTP will be issue for the Barrage option to go a head with this activity.

This activity will be completed within 10 months and the below reports shall be submitted to the client.

1. Interim Report No. 1, which will be submitted at the end of month (4) after NTP and 30% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
2. Interim Report No. 2, which will be submitted at the end of month (7) after NTP and 20% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
3. Draft Final Report, which will be submitted at the end of month (9) after NTP and 20% of the contract price for detail design of barrage and dam will be paid on acceptance of this report
4. Final Report, which will be submitted at the end of month (10) after NTP and 30% of the contract price for detail design of barrage and dam will be paid on acceptance of this report.



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1.10. DELIVERABLE AND REPORTING

1.10.1. PROJECT INCEPTION REPORT (PIR)

The inception report shall include the following (but shall not be limited to):

- 1) Review of the existing Feasibility study reports and site visit to report the shortages (if any) in the exiting feasibility reports along with the recommendations for completion.
- 2) Assess the neediness, feasibility, technically efficiency and suitability of a dam construction in the upstream of the barrage. However, in the feasibility study it is stated that dam construction is not feasible due to presence of lime stone in the foundation and abutments which will be dissolved by water. A separate summary report on the neediness, feasibility and technical efficiency of the dam construction in the upstream of the barrage is needed to be provided by the consultant as part of the inception report.
- 3) Barrage type and location investigation, recommendation and study report
- 4) The consultant's quality control procedures to be followed throughout the assignment. Including value engineering, constructability, and risk analysis
- 5) The consultant's capacity development plan to be followed throughout the project including involvement of government personnel seconded to the project
- 6) The consultant's comprehensive project time schedule based on earned value of design drawing and document preparation deliverables
- 7) Analysis and recommendation of the form of construction contract to be used
- 8) A schedule of site visits and field activities including topographical, geological and geotechnical fieldwork for surveys to be carried out and a reporting schedule for deliverables
- 9) A report on the consultant's mobilization effort and a detailed description of problems encountered and anticipated and recommended solutions
- 10) Irrigation system configuration, recommendation and study report
- 11) A vicinity map showing all the project components
- 12) Other additional requirements of MWE during the inception report stage.

The Draft Inception Report will be submitted at the end of month (1) following the notice to proceed. The inception report will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen days (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final inception report at the end of month (2) following the notice to proceed.

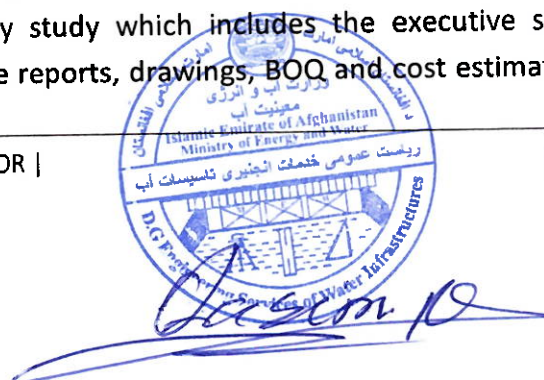


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1.10.2. UPGRADE FEASIBILITY REPORT

Upgrade feasibility report is comprised of two reports. One is the verification report that includes verification of the existing feasibility reports of the project based on the site visit, present site condition, update water assessment, update hydrology data, climate change, droughts, accurate survey and geo-technical information. If the verification report shows the neediness and technical efficiency of the dam construction in the far or near upstream of the barrage, then the consultant shall start the feasibility study of the dam construction in the far or near upstream of the barrage upon a written instruction of the client as summarized below:

1. Searching of a suitable location in the far or near upstream of the barrage for a dam construction.
2. Prepare the update feasibility level hydrology report to ensure the availability of water.
3. Prepare the update water demand report considering the irrigation, power, drinking, industrial and environmental demands to select the volume of the required storage and optimum height of the dam.
4. Conduct at least six borings; two at the deepest section of the dam, one at each of the two abutments, one at the up stream and one at the downstream of the dam. Depth of the borings, type and number of tests to be conducted shall be the requirements of the geo-technical investigation of this TOR.
5. Feasibility level survey of the dam site shall be conducted per the requirements of this TOR.
6. Preliminary design of the dam and its appurtenant structures (intakes, outlets, spillway) shall be conducted per the design standards of this TOR.
7. Preliminary design of the powerhouse (if any).
8. preliminary design of the dam access road and relocation roads.
9. Preliminary design of the tunnel (if any).
10. Preliminary design of the accommodation buildings.
12. Social and Environmental impact assessment reports.
13. quantities and cost estimate of the project.
14. Construction material survey report.
15. Economic and financial analysis report to demonstrate the economic viability of the project.
16. Dam instrumentation preliminary design.
17. Complete package of the feasibility study which includes the executive summary, calculations, compilation of all the above reports, drawings, BOQ and cost estimates along



with a clear recommendation regarding the neediness, technical and economical feasibility and constructability of the dam. **If the dam construction is either economically or technically not feasible, then only the barrage option will go to the detail design stage and the subsequent reports (IR No.1,IR no.2, DFR and FR) are applicable only to barrage option, but if the dam option is feasible and technically efficient, then both the barrage and dam will go to the detail design stage and the subsequent reports(IR No.1,IR no.2, DFR and FR) are applicable to both the barrage and dam.**

The Draft upgrade feasibility study Report will be submitted at the end of month (5) following the notice to proceed. The draft upgrade feasibility study report will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen days (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final upgrade feasibility study report at the end of month (6) following the notice to proceed.

1.10.3. INTERIM REPORT NO. 1(BARRAGE AND DAM OPTION)

Interim Report No. 1 will include preparation and submission of the following reports (but shall not be limited to):

- (1) A complete and detail hydrology report.
- (2) A complete and detail survey and topographic survey report.
- (3) A complete and detail geotechnical, geophysical and barrow area reports.
- (4) A complete and detail geology and interpretation report.
- (5) A complete and detail seismology reports.
- (6) A complete and detail metrology reports.
- (7) A complete and detail sediment management plan.
- (8) A complete irrigation and water supply demand report based on the present site condition.
- (9) A complete package of technical documents ready for bidding including survey, geotechnical investigations, design calculations (Civil, electrical, plumbing and Mechanical) , drawings, specifications, BoQ, cost estimate for site infrastructures including permanent and temporary buildings, water supply system, waste water and storm water drain system,



access roads, bridges, culverts, tunnels (if required), relocation roads (if any) and others. The drawings will be in ready for construction condition.

The Draft interim Report no.1 will be submitted at the end of month (3) following the notice to proceed. The Draft interim Report no.1 will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final interim report no.1 at the end of month (4) after NTP.

A description of the main reports included interim report No.1 is given below:

(1) Survey and Topographic Mapping Fieldwork, Analysis and Design Criteria Report

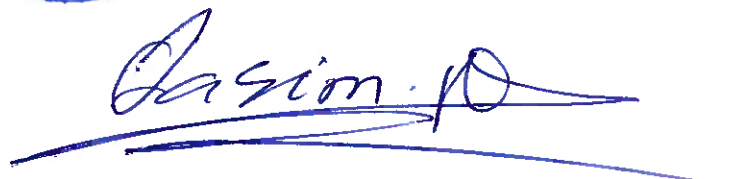
The consultant shall carry out a detail survey and mapping fieldwork program to obtain the necessary topographic information (in addition to that contained in the feasibility report) for detailed design, drawings and bidding documents including specifications for the barrage and appurtenances, dam and its appurtenant structures, powerhouse, irrigation, drinking water supply and drainages networks and related structures. The survey will be done in accordance with the "Topographic Surveys" section of this TOR.

(2) Geotechnical and Geological Investigation and Results Interpretation and Design Criteria Report

The consultant shall carry out the necessary fieldwork program (in addition to that contained in the feasibility report) to obtain sufficient geotechnical and geological information for detailed design, drawings and specifications for the entire project. The survey and investigation will be done in accordance with the "Geotechnical Survey and Investigation" section of this TOR.

(3) Technical Documents ready for bidding including specifications, BoQ and drawings, for site infrastructures including campsite, access roads, culverts and bridges

Sufficient information will be gathered and investigation performed to assess the access into the project area (including the main barrage site and its appurtenances, dam and its appurtenant structures, power house, irrigation and drainages networks, irrigation area, relocation roads, new access roads, permanent accommodation area and water supply network). Water and power supply available as well as transportation facilities will be assessed. The consultant will investigate the existing transportation infrastructure and shall design the required infrastructure improvement sufficient to support the project. Future utilization of the



infrastructure will be considered in the design. The consultant shall also specifically identify, upgrade and expand the requirements of existing infrastructure. The design will be sufficient to minimize operation and maintenance costs in the future for the transportation system. The bidding document and drawing preparation will include design calculation, specifications and drawings for the following main components which will include (but not limited to) the following main components:

1. Complete Geometric design of Access roads including drawings of plans, profiles and sufficient cross sections at interval of 25 meters in ready for construction form per AASHTO policy on Geometric design of highways and streets.
2. Complete pavement design report Per AASHTO Guide for design of pavement structure (1993) including a report of the Soil CBR values along proposed route, traffic count survey reports, pavement design calculation and drawing showing the thickness of the sub-base, base course, Prime coat and asphalt concrete binder and wearing course.
3. Longitudinal road drainage channels and cross drainage structures including transition to existing natural drainage
4. Complete design of Culverts and bridges per AASHTO Standard.
5. Water supply details including pipe lines and pumping arrangement
6. Sewage treatment and solid waste disposal arrangements
7. Complete design of tunnel (if required) as per TOR specified standards
8. Complete Civil, Architectural, structural, electrical and plumbing design of Temporary and Permanent housing accommodation and office arrangements including those for construction site inspection staff per IBC, IPC and other related standards mention in the TOR.
9. A cost estimate as described under the heading "Consultant's Project Cost Estimate" will be prepared for this component to become part of the overall project cost estimate.
10. Preparation of complete construction specification for all the above infrastructures according to the specified standards.
11. Other additional requirements of MWE during this stage.

1.10.4. INTERIM REPORT NO. 2(BARRAGE AND DAM OPTION)

Interim Report No. 2 will include presentation of the following reports (but shall not be limited to):

1. A complete design of Barrage and dam (dam will be included only if the dam is feasible and technically efficient) their appurtenant structures, coffer dam, head works and



other hydraulic structures including executive summary, calculations, Cost estimation, specification and drawings.

as per contract specified standards.

2. A complete design of the powerhouse (if feasible and technically efficient) including executive summary, calculations, Cost estimation, specification and drawings.
3. A complete design of instrumentation for barrage, dam and other parts of the project.
4. Detail Irrigation report including design of the irrigation main left canal, right canal, distributary canals, minors and the related structures along with the crop water requirement, optimal irrigation potential including executive summary calculations, Cost estimation specification, and drawings.
5. A complete design of the drainage network.
6. A complete design of the hydro-mechanical components (gates, hoists and others) of the dam, barrage and head regulators of canals.
7. Barrow area investigation and location configuration.
8. Cost estimate and BoQ for all the above systems.
9. Detail and Complete SIA & EIA analysis reports along with a resettlement action plan.
10. Detail and Complete economic and financial analysis report of the project.
11. Detail design of water supply network (if any) including executive summary, calculations, Cost estimation, specification and drawings.
12. Detail design of the tunnels (if any) including executive summary, calculations, Cost estimation, specification and drawings.
13. Detail design of the weirs (if any).
14. Overall project executive summary, calculations, detail BOQ, Cost estimate package, specification package and complete drawing set.
15. Any other report/reports and drawings needed for the project, but not mentioned here.

The Draft interim Report no.2 will be submitted at the end of month (7) following the notice to proceed. The Draft interim Report no.2 will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final interim report no.2 at the end of month (8) after NTP.

A description of the detail design of the main components included interim report No.2 is given below:



Dasir - R

(1) Barrage

An analysis of the type of barrage will be performed (using existing information) during the inception stage of the project and the final type of barrage will be recommended by the design consultant and accepted by the client. The consultant will continue with the detailed design, drawings, specifications and technical bidding documents preparation for the type of the barrage recommended by consultant and accepted by the Ministry (using the update and more refined information regarding the survey, Hydrology and Geo-technical obtained at the stage of Interim report No.1).

Reference is made to the major components for design described under the previous heading "Sultan Ibrahim Irrigation Project" which should be satisfied as well as the components described below. The barrage components will include (but not limited to) the following main components:

1) Barrage Body (including construction sequence), foundation, cutoffs with the below sub-components:

- Upstream protection arrangement
 - _ Upstream Pucca Floor
 - _ Crest
 - _ Stilling Basin
 - _ End sill
 - _ Downstream protection arrangement
- _ Piers
- _ Divide Walls
- _ Fish Pass
- _ Under sluices
- _ Abutments
- _ Flare out wall
- _ Flank wall
- _ Guide Bunds
- _ Return Walls
- _ Afflux bunds
- _ Cutoffs
- _ Intake Regulator with similar arrangements

- 2) Grouting Plan (if any)
- 3) Abutment treatment (if required)
- 4) Main gates, sluice gates and gates lifting system.
- 5) Stilling basin, energy dissipater and downstream erosion protection



- 6) Diversion during construction and its related appurtenant (pipes, trash rack and other structures and system)
 - 7) Site dewatering plan
 - 8) Barrage safety instrumentation plan
 - 9) Saddle dam (if required)
- 10) A cost estimate as described under the heading "Consultant's Project Cost Estimate" will be prepared for this component to become part of the overall project cost estimate.

(2) The Main, Right and left canals taking Off From irrigation intake.

The supply levels in canals will be set after determining the elevation of the critical point of the command area. canal lining will be optimized considering water loss and tendency of the soil drainage conditions susceptibility to salination. Structure location, size, type and configuration will be optimized. It should (be not limited to) the following main components:

- 1) Canal network alignment drawings showing location of main and auxiliary structures
- 2) Details for head and cross regulating structures.
- 3) Details for drop delivery chambers on canals.
- 4) Details for outlet structures on canals.
- 5) Details for cross drainage structure on canals including transition to existing natural drainage features
- 6) Details for canal and structures rehabilitation and improvement on existing main and secondary canals
- 7) Drainage (showing the main drains and field channels) system for command areas
- 8) A cost estimate as described under the heading "Consultant's Project Cost Estimate" will be prepared for this component to become part of the overall project cost estimate.

(3) The Irrigation and Drainage Networks

The canals and drainages detailed design, drawing, specification and BoQ will include (but not limited to) the following main components:

- The consultant will optimize the location, size of irrigation canals, and the extent of canal lining considering technical (water loss potential and possible soil salination) as well as social and environmental considerations. The extent of pipe lining/ canal lining will be agreed by MWE
- An appropriate cropping pattern will be developed for the irrigation command area



- Environmental and social impacts will be determined for the proposed irrigation development including land acquisition and resettlement
- Design, layout drawings, specifications and contract documents for the proposed new irrigation area will be produced to the level of detail. Connection and operation of the newly constructed pipe line/ canals with the already existing canal system will be developed.
- Access roads will be located along the main and secondary canals
- The designers will consult with the stakeholders in the existing irrigation areas regarding the design of the new irrigation area (to the extent possible)
- Designers of the canal system will consider the influence of sediment accumulation in the canal system and if necessary, sediment mitigation measures will be designed, specified
- An estimate of the design life of the newly constructed canal system will be reported
- An operation and maintenance manual will be developed for the irrigation system. The manual will include technical, operational and management aspects
- Canal lining will be specified where excess water losses can reasonably be expected and where accumulation from seepage will create major soil salination. And, optimization of the use of pipe lining/ canal lining within the newly developed irrigation area will be carried out and reported
- Sufficient crossings will be made for area residents and areas in the canal will have special provision for livestock watering. The primary stakeholders will be consulted regarding the location of pedestrian crossings and livestock watering areas
- Future operation and maintenance costs of the canal system will be made and reported by the consultant
- The possibility of introducing fish culture and fish ponds adjacent to or within the canals will be investigated and reported
- Consultation will be made with Ministry of Agriculture and Fisheries as well as NGOs regarding the development of fisheries and cropping within the entire irrigation area.
- The project stakeholders in the existing irrigated areas should participate in the irrigation system design process (to the extent possible)

(4) Dam (if proves feasible and technically efficient)

The consultant shall initially determine the basic type of dam that is the most attractive alternative in a best-chosen location. The chosen type may or may not be the one presently recommended in the feasibility study. Types of dams to be considered are 1) Concrete dam 2) Earth fill / Rock fill dam 3) Roller Compacted Concrete dam (RCC) 4) any other type of dam. The type of dam to be taken to detailed design will be agreed with the MWE at the end of an initial investigation by the consultant following a review of the recommendation by a panel of experts appointed by MWE.

The following factors will be considered in the final design of the chosen type of the dam.



Detailed design, technical specifications and BoQ will include (but not limited) the following:

- Complete detail design of the dam and its appurtenant structures shall be conducted to withstand the most critical loading conditions as per USACE, USBR, and ICOLD whichever is applicable and on the safe side.
- Determine the type of spillway dissipater to be used.
- Determine the need for upstream sediment structures to delay sedimentation in the reservoir.
- Make a recommendation on the rate of sediment filling of the reservoir during the operation period, after review of existing information on sediment measurement contributing areas and upper watershed conditions.
- In design of the energy dissipation features an estimate of general degradation that is expected downstream of dam will be considered.
- Aggregate sources for concrete structures construction, ancillary works will be identified at the detailed design stage. Required chemical testing of aggregates will be performed to confirm the aggregates compatibility with readily available Portland cement. The aggregate sources must be confirmed during the detailed design stage, prior to going to tender for construction.
- The source of Portland cement to be used in dam construction will be determined during the detailed design stage and the availability of sufficient quantities on a timely basis will be assessed.
- Testing lab facilities to be used during construction will be identified and if required a recommendation will be made to MWE regarding the creation of sufficient laboratory testing facilities
- Both dynamic and static type of calculation will be done for seismic influence on the dam and the consultant will determine the level of seismic activity that must be considered in determining the dam stability.
- A geotechnical drilling and testing program including rock testing will be carried out. The testing program will first be developed by the consultant and then approved by the ministry. The geotechnical program will be a part of the consultant's responsibility.
- If tunneling is a part of the diversion works than geotechnical testing and rock mechanics analysis will be required along the tunneling routed. In addition to detail design of tunnel, this will be a part of the consultant's responsibility.
- Slake testing and petrographic analysis will be done on rock/aggregates to be used for concreting
- Unit costs related to main dam construction will be finalized and an engineer's check estimate will be made available at completion of detailed design prior to the tendering process.



(5) POWERHOUSE

Detailed design, technical specifications and BoQ will include (but not limited to) the following:

- The penstock design with the development of applicable unit cost of materials considering costs for supply and install.
- Complete and detail Architectural and Structural design of the sub-structure and super structure of the power house per the standards specified in the TOR shall be conducted.
- Complete and detail Mechanical, electrometrical and electrical design of the power house shall be conducted per the standards specified in the TOR.
- The diversion tunnel (if required) in rock will be designed using geotechnical information from additional geotechnical investigations along the tunneling route. The cost of diversion tunnel construction will be accurately determined considering the cost of adequate safety measures.
- Communication equipment will be specified giving the physical and operational requirements in sufficient detail
- The penstocks will be designed as a total of (n+1) units so that (n) units can still operate when one unit is shut down for maintenance or repair.
- Operational controls will be designed and specified considering the remoteness of the location and difficulty in maintaining reliable communications.
- The turbine housing will be adequately designed and detailed including the provision of a means of removal of the turbine from below the water level when repair is necessary.
- Fire protection will be adequately designed and specified.
- Draft tube Gates and the associated cranes will be designed specified and costs detailed. The upstream head-gates are essential for maintenance and safety of operation.
- Proper operating procedures (including strict safety requirements) will be part of the design and training session requirements. Training by the supplier, contractor, and subcontractor will be a part of the supply and construction contract packages.
- Equipment placement to provide the required specified spacing will be considered in the design and safety of operation of the power house structure. Equipment will be designed and specified according to the space provisions available.
- Power optimization studies will be redone to confirm the size of the generator units.
- A cooling system and fire protection water supply will be design and specified.
- An adequate building ventilation system will be designed and specified.
- Evacuation and distribution of the generated power to the nearby village should be designed and considered.

1.10.5. DRAFT FINAL REPORT (BARRAGE AND DAM OPTION)

Draft final Report will include submission of technical documents including complete design, Specifications, BOQs, schedules, Drawings (drawings will be in ready for construction form), all approved reports of Interim Report No. 1, Interim Report No. 2 and a few additional reports all (but shall not be limited to) listed and summarized below:



- (1) Design criteria report (Design Basis Memorandum (DBM)) along with the project salient feature summary.
- (2) A complete and detail hydrology report.
- (3) A complete and detail general survey and topographic survey report.
- (4) A complete and detail geotechnical, geophysical and barrow area reports.
- (5) A complete and detail geology and interpretation report.
- (6) A complete and detail seismology report.
- (7) A complete and detail metrology report.
- (8) A complete and detail sediment management plan.
- (9) A complete package of technical documents ready for bidding including survey, geotechnical investigations, design calculations (Civil, electrical, plumbing and Mechanical) , drawings, specifications, BoQ, cost estimate for site infrastructures including permanent and temporary buildings, water supply system, waste water and storm water drain system, access roads, bridges, culverts, tunnels (if required), relocation roads(if any) and others. The drawings will be in ready for construction condition.
- (10) Detail design report of the main Barrage (Barrage type, best location, optimal height, optimal storage capacity and final cross-sections, details and profiles), head regulators, Upstream protection arrangement, Upstream Pucca Floor, Crest, Stilling Basin, End sill, Downstream protection arrangement, Piers, Divide Walls, Fish Pass, Under sluices, abutments, flare out wall, Flank wall, Guide Bunds, Return Walls, Afflux bunds, Cutoffs. Intake Regulator with similar arrangements and other hydraulic structures including executive summary, calculations, Cost estimation, specification and drawings.
- (11) Barrage grouting detail design report (if any).
- (12) Detail design report of the barrage hydro-mechanical work and appurtenant structures (gates, hoists and other related structures) including executive summary, calculations, Cost estimation, specification and drawings.
- (13) Detail Barrage instrumentation design report, including executive summary, calculations, Cost estimation, specification and drawings



- (14) Detail design of report spillway and stilling basin related to barrage including executive summary, calculations, Cost estimation, specification and drawings.
- (15) Detail design report of the main Dam (Dam type, best location, optimal height, optimal storage capacity and final cross-sections, details and profiles) including executive summary, design narratives, calculations, Cost estimation, construction specification and drawings. In free board calculation both the wave run-off and wave set-up shall be taken into account.
- (16) Detail design report of the saddle dams (if any) and coffer dams including executive summary, calculations, Cost estimation, specification and drawings.
- (17) Dams grouting detail design report.
- (18) Detail design report of the dam appurtenant structures (water intake towers and outlets) including executive summary, calculations, Cost estimation, specification and drawings.
- (19) Detail Dams and water intakes instrumentation design report, including executive summary, calculations, Cost estimation, specification and drawings
- (20) Detail structural, mechanical, electro-mechanical and electrical design report of the power house, turbines, generators, transformers and its connection to the main dam along with the optimal installed capacity including executive summary ,calculations, Cost estimation, specification and drawings.
- (21) Detail design of report spillway and stilling basin including executive summary, calculations, Cost estimation, specification and drawings.
- (22) Detail Design report of the hydro-mechanical work related to dam and its appurtenant structures, including executive summary, calculations, Cost estimation, specification and drawings.
- (23) Detail Irrigation report including design of the irrigation main canals and complete Irrigation network system along with optimal irrigation potential including executive summary calculations, Cost estimation specification, and drawings.
- (24) Review and verify the SIA & EIA analysis reports prepared in feasibly study and completion of the missing (if any).
- (25) Detail and Complete economic and financial analysis report of the project based on the detail design of the project.
- (26) Detail design of water supply network (if any) including executive summary, calculations, Cost estimation, specification and drawings.



(27) Detail design of the tunnels including executive summary, calculations, Cost estimation, specification and drawings.

(28) A complete and detail design of the switch yard and generated power distribution to nearby villages and connection to the national grid if advised by client, including executive summary, calculations, Cost estimation, specification and drawings.

(29) Comprehensive concrete report

(30) Report on Site Dewatering Plan

(31) Operation manual for civil structures.

(32) Report on Quality Assurance Activities

(32) Report on Value Engineering

(33) Report on Constructability Analysis

(34) Report on Risk Analysis

(35) Riparian flow analysis report

(36) Operation and maintenance plan

(37) Emergency preparedness plan

(38) Cost loaded schedule for construction phase

(39) QA/QC checklists for construction phase

(40) Dam and barrage breaks analysis reports.

(41) Dam and barrage safety plans.

(42) A complete water demand report (including irrigation demand, domestic and industrial water supply demand).

(43) Preparation of bidding document in ready for construction form which includes but not limited to Overall project executive summary, calculations, detail BOQ and Cost estimate package, specification package and complete set of drawings.

(44) Any Other Report/Reports required for the project but not included in this TOR.

The Draft Final report will be submitted at the end of month (9) following the notice to proceed. The Draft Final Report will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the



client comments within fifteen (15) calendar days and submit the Final draft report to MWE at the end of month (10) after NTP.

Note: If dam is not feasible, then all the reports related to dam and its appurtenant structures shall be ignored from the above list.

1.10.6. FINAL REPORT (BARRAGE AND DAM OPTION)

The final report will be a compilation of all previous reports as required in the draft final report and will be finalized after MWE comments have been included and MWE has accepted the final report.

Final report will be submitted to the client at the end of month (11) after NTP.

MWE will review the Final report within 15 days and the design Consultant will incorporate the MWE Comments if any within 7 days and resubmit it to Client for final review and MWE will review it within 8 days and the project will be closed at the end of month (12).

Note: Four hard copies (reports in A4 size and drawings in A3 size) and four soft copies (reports in word format and PDF formats, data in excel sheets and pdf, drawings both in Auto CAD and PDF formats, Survey data in Civil 3D files) of the final report shall be submitted to the client.

1.10.7. Interim report No.1 (Barrage option)

Interim Report No. 1 will include preparation and submission of the following reports (but shall not be limited to):

- (1) A complete and detail hydrology report.
- (2) A complete and detail survey and topographic survey report.
- (3) A complete and detail geotechnical, geophysical and barrow area reports.
- (4) A complete and detail geology and interpretation report.
- (5) A complete and detail seismology reports.
- (6) A complete and detail metrology reports.
- (7) A complete and detail sediment management plan.
- (8) A complete irrigation and water supply demand report based on the present site condition.



(9) A complete package of technical documents ready for bidding including survey, geotechnical investigations, design calculations (Civil, electrical, plumbing and Mechanical) , drawings, specifications, BoQ, cost estimate for site infrastructures including permanent and temporary buildings, water supply system, waste water and storm water drain system, access roads, bridges, culverts, tunnels (if required), relocation roads(if any) and others. The drawings will be in ready for construction condition.

The Draft interim Report no.1 will be submitted at the end of month (3) following the notice to proceed. The Draft interim Report no.1 will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final interim report no.1 at the end of month (4) after NTP.

1.10.8. Interim report No.2 (Barrage option)

All reports included in interim report no.2 of the dam and barrage option shall be included in this report except of the documents related to dam and its appurtenant structure and power house.

The Draft interim Report no.2 will be submitted at the end of month (6) following the notice to proceed. The Draft interim Report no.2 will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final interim report no.2 at the end of month (7) after NTP.

1.10.9. Draft Final report (Barrage Option)

All reports included in draft final report of the dam and barrage option shall be included in this report except of the dam and its appurtenant structure and power house.

The Draft final report will be submitted at the end of month (8) following the notice to proceed. The Draft final report will be reviewed by client within fifteen (15) calendar days and at the end of the fifteen (15) days a design review meeting will be held in Kabul discussing the client comments with the consultant. The consultant will incorporate the client comments within fifteen (15) calendar days and submit the Final draft final report at the end of month (9) after NTP.



1.10.10. Final report(Barrage option)

The final report will be a compilation of all previous reports as required in the draft final report and will be finalized after MWE comments have been included and MWE has accepted the final report.

Final report will be submitted to the client at the end of month (9) after NTP.

MWE will review the Final report within 15 days and the design Consultant will incorporate the MWE Comments if any within 7 days and resubmit it to Client for final review and MWE will review it within 8 days and the project will be closed at the end of month (10).

Note: Four hard copies (reports in A4 size and drawings in A3 size) and four soft copies (reports in word format and PDF formats, data in excel sheets and pdf, drawings both in Auto CAD and PDF formats, Survey data in Civil 3D files) of the final report shall be submitted to the client.

1.11. CONSULTANT SITE VISIT

Consultant are obligated to visit jobsite on date scheduled and coordinated by Procurement Department.

1.12. DESIGN PACKAGE

Consultants design package shall consist:

- Narrative report describing formulas used, references, basis of selection, description of analysis and findings, and response to the comments.
- Supporting calculations
- Drawings
- Specification
- BOQs

1.13. PROJECT SPECIFICATION AND CHECK LIST

Consultant shall prepare specification explaining codes and standards to be met, materials to be submitted in compliance with applicable standards, and brief description of standard operating procedure for to be followed. Project specification shall be prepared similar to UFGS format in accordance with UFC 1_300_02 guidelines or Construction Specifications Institute (CSI) format. Specification shall be submitted at the same time as design stage.



Checklists shall be a tool for MWE Representative(s) onsite and Contractor's QC(s) to guide construction to the MWE/ Designers expected quality. This shall ensure designer of appropriate construction performance and liability of consultant for design. The Consultant shall review and make recommendations at the inception phase on the following aspects related to the construction contract and the below technical tender documents shall be prepared accordingly:

- a) The use of Standard Specifications
- b) The preparation of Project Special Specifications
- c) Preparation of Method of Measurement, where appropriate and the Bill of Quantities staff and equipment list
- d) Technical review and assistance for the MWE to review / evaluate the bids including the preparation of bid evaluation report(s)
- e) Drawings cleared for construction
- f) TOR for construction phase

The Consultant prepared specifications shall include as a minimum, all applicable specification sections referenced by the CSI. Where the CSI does not reference a specification section for specific work to be performed by this contract, the Consultant shall be responsible for creating the required specification. The Specifications shall be based on internationally accepted standards **with strict confirmation to the TOR specified standards**. Standards referenced in specifications and drawings prepared by the Consultant shall be by specific issue; the revision letter, date or other specific identification shall be included.

Drawings, prepared in the English language with SI units of measure, are a part of each submittal. The working drawings shall be adequately labeled and cross-referenced for review. Complete, thoroughly checked and coordinated contract drawings shall be submitted. The contract drawings submitted for final review shall include the drawings previously submitted which have been revised and completed as necessary. Revisions will be clearly marked dated and numbered and the numbering carried through to final approval of the client. The Consultant shall have incorporated any design review comments generated by previous design review(s), have completed necessary constructability and coordination checks, and have the drawings in a Ready-to-Build condition. The drawings shall be complete at this time and contain all the details necessary to ensure a clear understanding of the work throughout construction. An electronic copy of all drawings submitted will accompany each submittal. All electronic drawings will be completed in a licensed version of AutoCAD.



1.14. CONSULTANT'S PROJECT COST ESTIMATES

Access to each cost estimate and its contents prepared by the Consultant shall be limited to those persons whose duties require knowledge of the estimate. Any request by the public for information on pricing in the estimate shall not be provided until coordination, verification of data, and approval has been given by the MWE. After contract award, only the title page, signature page, and bid schedule are to be disclosed.

Consultant's cost estimates shall encompass all components of Design and Construction of Sultan Ibrahim Irrigation Project including (but not limited to) the following:

- Mobilization
- Location/construction survey.
- detailed cost estimate of infrastructures including offices, accommodation, access roads, culverts, bridges and others.
- Detailed civil works cost estimates for diversion dam and its appurtenance structures including dyke, appurtenant facilities, water conveyance canals , tunnels, pipeline networks, form irrigation/ drainage networks, and rehabilitation of existing irrigation command area;
- Detailed Electro-Mechanical, Electrical, Mechanical and hydro-Mechanical works cost estimate including Procurement, manufacturing, transport, erection, installation, testing, and commissioning of the constructed works.
- Engineering, supervision, administration, post construction activities and legal costs;
- The consultant will identify all lands for acquisition /rights of way for the construction, operation, environmental impact zone and maintenance of all components of the project. Fair compensation will be recommended for voluntary and involuntary resettlement of affected people.
- Cost of financing and insurance;
- Environmental and social mitigation costs as provided to the Consultant by the MWE;
- The consultant will be required to address and assure the MWE that they can document, respond and cover the physical contingencies corresponding to the degree of reliability of the estimate of each major cost item.

Construction costs for the Sultan Ibrahim Irrigation project, the spillway and energy dissipater, and appurtenant facilities as well as all other project elements will be determined on the basis of quantity surveys and developed unit costs derived from comprehensive construction task analyses. Current material and labour rates, valid for the project region, shall be utilized. The cost of any mechanical, electrical, and/or other equipment shall be established on the basis of equipment lists and preliminary quotations from qualified manufacturers, broken down into cost, insurance, and freight (CIF), transportation to site, erection, and commissioning. Costs for engineering and supervision shall be calculated on the



basis of man-month estimates of all tasks to be performed. All costs shall be broken down into local and foreign components. All cost items shall correspond to the same reference date.

All inputs shall be detailed and discussed in the Design Report. In conjunction with the preparation of detailed construction cost estimates, the Consultant shall also prepare a reference construction schedule and a comprehensive implementation schedule (Master Plan including a detailed time line), containing the financial set-up, final preparation of tender documents, international competitive bidding, contracting, detailed / final engineering, manufacturing, transporting to site, constructing, erecting, testing and commissioning. The schedule shall be presented in a CPM – Gantt chart format, and shall be used as the basis for the calculation of interest during construction, preferably using, Primavera or approved equal. All other cost shall be conveniently distributed according to the benchmarks of the time schedule.



Signature

SECTION 02.00 00 METHODOLOGY & TECHNICAL REQUIREMENT FOR DETAIL DESIGN AND UPGRADING OF THE FEASIBILITY STUDY

2.0 TOPOGRAPHIC SURVEY PLAN

The Consultant shall submit a comprehensive topographic survey plan prior to commencing any field survey and investigation to the MWE for review. Once the plan is reviewed and accepted, the Consultant can start the field survey.

2.1 TOPOGRAPHIC SURVEY

Accurate topographic information is required for the verification of reservoir yields, backwater analyses, and design of both downstream conveyance facilities and locating and design of canals network for irrigation and drinking water supply for downstream, and associated appurtenances and systems.

The Consultant will review the existing topographic information and prepare a detailed scope of work necessary to meet the requirements to detail design all of the facilities to International standards. The Topographic survey methods to be considered in the scope of work are as flows.

2.2 TOPOGRAPHICAL SURVEY, MAPPING AND REPORTS

The Consultant shall provide a complete detailed digital terrain model (DTM) and topographical survey of the proposed facility locations including Sultan Ibrahim Irrigation project and the irrigation system, command area and other related appurtenant of the project.

- a) Survey Teams
 - The Consultant shall employ survey team(s) with all the equipment necessary to complete the topographical survey and mapping (like total station, theodolite, level, DGPS etc.). The employment and tasks of the survey team(s) shall be at the discretion of the Consultant.
 - The Consultant shall complete mobilization of his survey team(s) with all necessary equipment and tools to the work area and commence operations no later than (21) calendar days after notification by the Client to proceed with the work.
 - The Client shall assign a representative to the site to oversee the work and provide joint survey checks of selected survey operations and readings. The Consultant shall



coordinate its operations with the assigned Client's representative to assure that this oversight of the work does not affect the continuity and progression of the contractor's operations.

b) Detailed Topographical Survey

b-1: General requirement of a topographic survey

- The Consultant shall establish all necessary permanent leveling polygon bench marks at appropriate intervals. The locations shall be on permanent structures that cannot be disturbed by construction, to the extent possible. The benchmarks shall be marked with red paint and constructed in durable/ stable manner.
- The benchmarks shall be established by using a Station GPS with Real Time Kinematic ability with triple frequency. Other suitable methods may also be used upon approval.
- The topographic survey shall include the locations of all natural (waterways, trees, etc.) and manmade (houses, fences, structures, etc.) features of the area.
- and for reservoir area COGO points interval in mountainous area (15*15) meter, in hilly area (20*20) meter, and in flat area (50*50) meter.

b-2: Barrage topographic survey:

1. An Index Map showing important features in the vicinity of the site shall be prepared.
2. A contour plan of the area (on a scale of 1:4000) around the proposed site of the barrage with contour intervals of not more than 0.5m up to an elevation of about 2.5m above HFL. The contour plan shall extend to about 5 Km. on the upstream and downstream of the proposed site and up to an adequate distance on both flanks up to which the effect of backwater is likely to extend. In case of meandering river, the plan should cover at least 2 meanders on upstream side and one meander on downstream side of the axis.

To take exact digital surface model (DSM) the COGO point's interval for barrage axis area In mountainous area 5*5 meter, in hilly area 10 * 10 meter and in flat area 20 * 20 meter.

3. Cross Sections of the river at the proposed site at intervals of 200m both on upstream and downstream up to at least 600m from the proposed site. Besides this, Cross sections may be taken at 2 Km interval up to the distance; the backwater effect of ponding is likely to extend on the upstream of the site. The points of cross-sections in the river bed may be spaced at 10 to 30 m depending on topography of the river. The cross section should extend on both banks to about 2.5m above HFL.
4. Longitudinal Section of the river up to 5 km on the downstream side and 15 Km on the upstream side or the distance up to which back water effect is likely to extend on the upstream side.

b-3) Command Area Survey: Contour Plan of the area in a horizontal scale of 1:10000



or 1:15000 and contour interval of 0.5 m. This map is to be used for estimating crop water requirement, fixing canal alignment etc.

b-4) Main left and right canals survey

1. Index plan on a scale of 1:15,000 showing the head works and canal alignment.
2. Survey maps shall be prepared or produced preferably to a scale of 1:15000 showing the contours (with contour interval of 0.5 m or less), spot levels and important land features for the whole area to be developed.
3. Alignments of main canals, branches and distributaries shall be tentatively marked on the map. The main canal should be generally carried on a contour alignment, Branch canals and distributaries should take off from main canal from or near the points where the main canal crosses watershed. While selecting the alignment, consideration of economy shall be born in mind. Deep cuttings or high embankments should be generally avoided by suitable detouring, after comparing the overall costs of the alternative alignments. Carrying of a canal in high embankment involves risk of breaches.
4. Strip contour plan covering 250m on either side of center line of the canal alignment or as per site requirement whichever is more. At the cross drainage works, the strip contour plan should cover a distance of 500 m along the flow of drain / river on either side of the center line of the canal. The contour plan shall be plotted at 0.5m contour interval with 1:10000 or 1:20000 H-scale. Levels shall be taken at 50m or less interval along the C/L of Canal

b-5) Survey for cross drainage structures: Grid Plan with contours of the site to cover an area up to 300 m on either side of the center line of the canal in a scale of 1:2000 and contour interval of 0.5 m or up to 100m downstream of the point of exit of water and 100 m upstream of the point of water inlet. Cross-section of drain / nallah along the center line of the canal in a scale of 1:2000 is prepared. Bed level/bank level and FSL of the canal and maximum HFL of drain is to be indicated.

Survey of the drains both upstream and downstream of canal for adequate length is to be taken. The plan should be made in a scale of 1:10000 and the longitudinal and cross-sections of drain / nallah in a scale of 1:2000 should be prepared.

A list of all canal structures, its location and other necessary details like HFL of the drain, bed level / bank level of the drain / nallah etc. is to be prepared.

- The consultant is responsible to survey all barrage appurtenant structures like (access roads, colony, spillway, transmission line, irrigation canals (main, secondary and tertiary), command area and etc.
- Cross sections should be perpendicular to the waterway and extending appropriately beyond the existing river bank and flood plain and shall be taken at 20 m intervals.
- In the irrigation area field survey, sufficient to produce maps of 1:1000 scale horizontal and suitable vertical (1:100) for setting main, secondary canals, power house off takes

and other main structures will be carried out. The accuracy of the irrigation area survey will be adequate to locate and design canals to the main and secondary level of detail.

- The Consultant shall utilize field notebooks to record all survey data in addition to the electronic files. The filed book should be available for inspection at any time.
- The Consultant will refer to Control and Topographic Surveying Engineering and Design Manual (US Army Corps of Engineers, EM 1110-1-1005) as guideline for the survey for the project.
- The Consultant shall submit detailed topographic maps covering the area of the project including the location of the benchmarks. On the map, natural and manmade features shall be shown and labeled in English. Hard copies shall be in scale of 1:1000 with 0.5-meter contour interval (in elevation).

b-6) Dam survey (if dam option is included)

- To take exact digital surface model (DSM) the COGO point's interval for dam axis area in mountainous area 5*5 meter, in hilly area 10 * 10 meter and in flat area 20 * 20 meter, and for reservoir area COGO points interval in mountainous area (15*15) meter, in hilly area (20*20) meter, and in flat area (50*50)meter .
- The consultant is responsible to survey all dam appurtenant structures like (access roads, colony, spillway, diversion tunnel, powerhouse, transmission line
- All topographic survey data (COGO points) shall be submitted to the client in notepad and excel formats.
- A list of benchmarks showing the coordinates shall be provided to the client.
- All electronic copies of topographical surveys including the detailed topographical map shall be submitted in Auto Cad and Auto CAD CIVIL 3D formats.
- The Consultant's final topographical survey report shall include detailed topographical map of the sites, DTM of the area and benchmarks details.
- The extent of the reservoir survey shall be up to the PMF contour plus five meter on the upstream side of the dam and 10KM or up to the nearest head work(whichever is less) on downstream of the dam

The Consultant shall establish a suitable method of transmitting electronic field data back to the client's office in Kabul.



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2.3. DETAIL GEOTECHNICAL INVESTIGATION

2.3.1 GENERAL

Once the most technically and economically feasible location is selected in the result of the comparison of the two alternatives in the feasibility study, then it is the client right to either stop further investigations or will issue a separate NTP to go ahead for the detail design Geo-technical investigations and there will be no any claim from the consultant side in case of stopping further investigation.

These investigations would be primarily composed of detailed drilling, sampling, and testing concentrated on specific features at the selected project site; and should be specifically planned to provide the engineer with information that is necessary to design structures, estimate quantities, determine rates of construction progress, develop cost estimates, prepare plans and specifications, and obtain bids. Number of borings, test pits, and field tests shall be increased than feasibility study stage of project so that the actual and accurate engineering parameters defined for design engineer. The number and depth of boring investigations shall be comprised as per table 2 of this section.

It is worth to mention that location of the borings and test pits in the phase of detailed design shall be different than that of the feasibility study.

2.3.2 METHODS OF INVESTIGATIONS

The adequacy of the analysis of an engineered structure will normally be primarily dependent on the extent of the information known about foundation conditions of the site and the physical properties of the foundation materials. To evaluate these properties, the type and application of sampling methods is important. There is no single sampling method or sampling device that will guarantee the recovery of satisfactory samples in all materials, but the less disturbance to the sample, the more accurate the results will be from testing that sample. Different devices and techniques have been developed for drilling and sampling a wide variety of material types. Proper sampling is a combination of science and art.

Although many procedures have been standardized, the alteration and adaptation of techniques are often dictated by specific investigation requirements.

2.3.3 GEOPHYSICAL INVESTIGATIONS

The consultant shall conduct a more detail geophysical investigation on project site. A suitable method of geophysical investigation regarding site characteristics and or the best practical



geophysical method shall be included in the geotechnical plan and shall be submitted to MWE for approval. Geophysical explorations are an indirect method of obtaining generalized sub-surface geologic information by using special instruments to make certain physical measurements. Geophysical observations in themselves are not geologic facts, but are statistical and orderly measurements. Geophysical explorations complement core drilling, test pits, or other direct methods of sub-surface exploration and can provide a rapid evaluation of certain geologic conditions. The technology for such investigations has improved in recent years; therefore, a geophysical investigation required to be performed by consultant/contractor in feasibility stage of project.

Geophysical survey methods may be used to supplement borehole and outcrop data and to interpret soil profile between boreholes. They can be used to plan borehole locations. ASTM Standards D6429 and D5753 provide guidance on planning and selection of geophysical methods. ASTM Standard D5777 provides guidance on test procedures and interpretation of the seismic refraction method. ASTM Standard D4428/D4428M provides test methods and interpretation of the cross hole seismic test. The geotechnical report must explain the test method and interpretation of the test results.

Design earth quake, Maximum creditable earth quake (MCE) and Operation base earth quake (OBE) along with the values of peak ground acceleration (PGA) and sustained ground acceleration shall be estimated.

2.3.4 TYPES OF EXPLORATION

The general types of explorations used to investigate potential project sites fall into two categories (1) borings, (2) special excavations, these types of exploration methods are discussed in U.S. Corps of Engineers EM 1110-1-1804, and EM 1110-2-1907.

2.3.4a BORINGS

Borings are the most practical and accurate method of obtaining sub-surface information. The most important aspect of the drilling procedures is the recovery of the material penetrated. A boring with low recovery is of limited value, and will generally raise more questions than it answers.

In soil borings the two prevalent methods for obtaining samples are the earth auger and the 2-inch split spoon drive sampler. For investigative sampling it is better to use a rotary drilling machine or bucket auger as the continuous flight auger can provide misleading results in many



situations by mixing the material as it moves up the flights. The 2-inch split spoon sampler is also used in performing the Standard Penetration Test (SPT).

While the samples obtained by these two methods are considered disturbed, they provide the basis for determining if, where, and what types of "undisturbed" samples are needed. The primary method for obtaining undisturbed soil samples is by the Shelby tube sampler. See Reference: EM 1110-2- 1907 (Soil Sampling) for detail on soil sampling.

For rock sampling, core borings are the most common method. Size of the rock core borings can range in diameter from 1 1/2 inches (EX) to 7 3/4 inches (6 x 7 3/4 inches), but the most common size used for exploratory work is 3 inches (NW). The NW size drilling usually produces good core recovery. Large diameter holes and special drilling equipment and methods may be justified in some types of rocks if better recovery and/or identification, sampling and testing of material are required, and in extracting the concrete/rock interface intact. The equipment and procedures for drilling and sampling are given in detail in reference: (Geotechnical Investigations), EM 1110-1-1804.

Equally important as obtaining as complete a sample as possible, with little disturbance, is the need to maintain the natural moisture content of the rock or soil sample. Material that may possibly be used for laboratory testing should be wrapped and/or waxed immediately upon removal from the sampler to preserve the natural moisture content.

2.3.4b LOCATION AND DEPTHT OF EXPLORATIONS DURING THE DETAIL DESIGN STAGE

Adequate information about foundation properties and characteristics is critical to a full understanding of the adequacy of any design or in the evaluation of an existing structure. Therefore, explorations should be adequately distributed over the dam site, including abutments and dam foundation, and in special cases at appurtenant structures, including penstocks, tunnels, spillways, intakes and outlets, at the powerhouse site, (whether surface or subsurface) along the reservoir rim, and at the material borrow sites.

- Exploration shall be carried out in the proposed footprint of main dam axis, upstream and downstream toe of dam, powerhouse, spillway and all appurtenant structures, but not be limited to administration building, accommodation buildings. However, it is highly suggested that strategically locate explorations boreholes or pits in such a manner to maximize subsurface data for interpretation.
- The Consultant shall develop all relevant primary geotechnical design and construction parameters based on outcomes from site investigation, laboratory test and analysis results.



- All geotechnical site and laboratory efforts shall be according to the standards set forth by ASTM International Standard. Consultant shall not use any other standards, unless prior approval from MWE.
- The Consultant should add the codes and standards in Geotechnical Plan that would be applied to the subsoil investigation services and obtain approval from the Client before the commencement of works.
- There is no any specific rule of thumb for the spacing and depth of bore holes, the table below shall be used in selection of the depth and spacing of the bore holes. In case of large variation in soil and rock strata, the spacing shall be reduced.

Table 2: Spacing and depth of the boreholes during the detailed design Stage:

No	Geotechnical Features	Spacing of the bore holes	Depth of the bore holes
1	DAM SITE	<ul style="list-style-type: none"> • The spacing of the boreholes shall be 40 m along main dam axis. The spacing shall be reduced in case of variation in soil or rock strata. • At least two borings at the deepest section shall be made. • Two boreholes shall be made at upstream and Two at the downstream toe. • Two borehole at each of the two abutment is needed • For borrow areas 8 test pits are needed to be evenly spread on the proposed barrow area with minimum depth of 3 meter. 	<p>Depth should be at least 1.5 times the dam height or penetrate into the competent bedrock (deep enough to demonstrate that the rock is not an isolated layer or lens, and deep enough to confirm the assumed parameters of a subsequent stability analysis) whichever is smaller.</p> <p>At least two borings at center or deepest section is required to be continued into the bed rock by 12m for rock with $RQD > 50\%$, 10m for rock with $RQD > 70\%$. If the bedrock is irregular or weathered, the core drilling may have to be deeper until to reach a competent bed rock.</p> <p>At least 12 meters into rock with $RQD > 50\%$. Need continuous sampling towards surface to define flow zones or liquefiable layers or soft</p>



			<p>layers.</p> <p>If the depth of the bed rock is less than 1.5 times the height of dam, then at least one boring shall be conducted into the bed rock by 1.5 times the height of the dam to assure that the rock is not an isolated layer or lens and it is really the bed rock.</p> <p>It should be noted that the depth of exploration at the start of the investigation work may be modified during the drilling operation as exploration proceeds, depending on the subsurface conditions and geological complexity encountered again it depends upon prior approval from client.</p>
2	CANAL	<ul style="list-style-type: none"> Usually canal areas do test pit every 500 m and 300 m incase if the soil is changing. At least on test pit or boring at the location of each cross-structure. 	The depth of the boring shall be at least 3 meters below the proposed bed of the canal. If the canal is to be in a rocky reach, this depth may be reduced. If the strata appear to be changing the depth of exploration should go deep up to an extent of the canal depth below the proposed bed of the canal.
3	ACCESS ROAD	<ul style="list-style-type: none"> One test pit each 500 m, but not less than 3 for roads shorter than 500m. 	Depth of the boring shall be at least 2 meters below the proposed sub-grade level.
4	CUTS	<ul style="list-style-type: none"> A minimum of one boring should be performed for each cut slope. For cuts more than 60 m in length, the spacing between 	Borings should extend a minimum of 5 m below the anticipated depth of the cut at the ditch line. Borings depths should be increased in



		<p>borings along the length of the cut should generally be between 60 and 120 m.</p> <ul style="list-style-type: none"> At critical locations and high cuts, provide a minimum of three borings in the transverse direction to define the existing geological conditions for stability analyses. For an active slide, place at least one boring upslope of the sliding area. 	<p>locations where base stability is a concern due to the presence of soft soils, or in locations where the base of the cut is below groundwater level to determine the depth of the underlying pervious strata.</p>
5	EMBANKMENT (other than Embankment Dams)	<ul style="list-style-type: none"> Use criteria presented above for Cuts. 	<p>Extend borings a minimum depth equal to twice the embankment height unless a hard stratum is encountered above this depth. Where soft strata are encountered which may present stability or settlement concerns the borings should extend to hard material.</p>
6	CULVERTS	<ul style="list-style-type: none"> A minimum of one boring at each major culvert. Additional borings should be provided for long culverts or in areas of erratic subsurface conditions. 	<p>Depth of boring shall be equal the depth where the net increase in the soil stress due to the load of the proposed structure is less than 10% of the exiting effective stress in the soil at that depth. A minimum depth of 10 meters below the footing level has been suggested.</p>
7	BRIDGES	<ul style="list-style-type: none"> For bridges one boring at each pier location and in the two abutments. 	<p>Depth of boring shall be equal the depth where the net increase in the soil stress due to the load of the proposed structure is less than 10% of the exiting effective stress in the soil at that depth. A minimum depth of 10 meters below the footing level has</p>



			been suggested. In-case of bridges at least one boring must be continued to the bed Rock and penetrate at least 3 meters into the bed rock.
8	TUNNEL	For Tunnels at least one boring per each 45 meter of the tunnel length. A detailed investigation and stability studies of tunnels shall be carried out (i.e.: RQD, RMR, Q-system, and geo-mechanically studies and modeling).	The depth of the boring shall be at least one diameter below the bed of the tunnel.
9	Retaining walls	The spacing of borings for retaining walls shall be 30 meters and if the length is less than 30 meters, then one boring at each end of the wall is needed.	The depth of the boring shall be at least two times the height of the wall.
10	<ul style="list-style-type: none"> The below Major structures: Reinforced concrete building > 1000 m² Steel frame building > 3000 m² Structure with height ≥ one and a half stories Steel or concrete tank > 350 m³ 	Minimum two borings within footprint, three for variable soil or earthquake zone and	Minimum Depth = greater of 6 m or twice height of structure
11	Minor structures	3 test pits not less than 1 test	Minimum depth of the test pit



	(includes structures other than the above major structures)	pit for every 225 m ²	shall be 3 m.
12	<p>At the location of the below structures:</p> <ol style="list-style-type: none"> 1. Reservoir (including reservoir tightness, losses if any, and slope stability etc.) 2. Spillway 3. Stilling basin 4. Intake area 5. Cofferdams 6. Headrace tunnel 7. Surge chamber 8. Penstocks 9. Power house site (caverns) 10. Others 	<ol style="list-style-type: none"> 1. For reservoir at least 10 test pits located at critical locations shall be made. 2. For the rest of the structures at least two borings per structure at the specified locations shall be made. 	<ol style="list-style-type: none"> 1. Minimum depth of the test pit shall not be less than 3 meters. 2. Depth of boring shall be equal the depth where the net increase in the soil stress due to the load of the proposed structure is less than 10% of the existing effective stress in the soil at that depth. A minimum depth of 10 meters below the footing level has been suggested.
13	Barrage	The bore holes should be at the rate of at least one in each bay proposed and at least one at the upstream cutoff and another at downstream cutoff, should be obtained.	Depth of boring shall be up to the depth of the bed rock or 25m whichever is smaller, but if the depth of the bed rock is greater than 25meters, then at least one boring shall be continued at the deepest section of the river up to the bed rock and penetrate at least 12m at the bed rock .

Note of highly importance: The Exact location of borings and test pits in the detail design phase shall be different than that of feasibility studies.

2.3.5 GEOTECHNICAL TEAM

- The Consultant shall submit with his Geotechnical Plan, an organizational chart showing the structure of the working team and the number of personnel who will be employed for the works.



- The Consultant shall submit qualifications of its personnel to the client at the time of submissions of the plan.
- Qualification of the key personnel shall be as stipulated on Annex "C" of the TOR.

2.3.6. LABORATORY AND EQUIPMENT

- The Consultant 's Laboratory for sampling and testing shall be a third-party lab both in Geo-Technical and construction phase of the project.
- The third-party lab should be a certified from ABA/US Army Corps of Engineers.
- The third-party lab should be equipped with good quality and calibrated testing machinery and skilled staff along appropriate management.
- The Consultant /Laboratory shall indicate in the plan, the type and number of equipment and facilities he intends to use in the works, and shall use the same during the execution of the contract.
- The Consultant /Laboratory shall maintain the equipment in good working order during the period of the project. If the operations are producing unsatisfactory results, or delayed due to any fault of the equipment, the Client has the right to instruct the Consultant to replace a part or all of the equipment and operators, at the Consultant 's own costs.

2.3.7 Geo-technical tests

2.3.7a FIELD TESTS

Three of the most important field tests performed are permeability, grouting and SPT tests. Permeability tests can be done either by pumping out or hydraulic pressure. These tests are discussed in the U.S. Army Corps of Engineers EM 1110-2-3506. (See References, Paragraph 5-13),

The pumping-out test consists of bailing or pumping water from wells or boreholes and observing the effect of this operation on the water level in these and nearby holes. The test usually is performed in one or more of the exploratory borings.

The hydraulic pressure test consists of pumping water under pressure into an isolated zone in the rock or overburden through a borehole and noting the quantity of water pumped at any given pressure. Descriptions of pressure testing equipment and procedures are contained in EM 1110-2-3506.

Test grouting may be useful. It consists of performing experimental grouting operations on exploratory boreholes to determine, during the design stage, the extent to which subsurface materials are routable.



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While the above field tests may be used to provide information on the foundation, additional field (in-situ) tests for evaluating the physical characteristics of the rock mass as a whole may be justified as follows: Test blasting, rock bolt pull-out tests (RTH 323-80, Reference 16).

SPT test shall be conducted as per ASTM D1586 requirements.

2.3.7b LABORATORY TESTS

- Laboratory tests shall be carried out in accordance with ASTM standards.
- Type and number of tests shall be decided by the Client visualization as per requirement or for each meter of obtained sample.
- The results of all tests shall be submitted in the format approved by the Client.
- Samples shall be dispatched to the laboratory as soon as possible after being obtained and shall not be allowed to accumulate on site without any logical reason.

All necessary tests but not limited to the following shall be done on samples and if some other necessary tests required, the contractor shall be done it.

Soil Tests:

- Sieve Analysis for soil particle size distribution (ASTM D422)
- Atterberg Limits Plasticity Index (PI) determination, Liquid and Plastic limits (ASTM D4318)
- Soil Engineering Classification by USCS system (ASTM D-2487)
- Moisture Content determination (ASTM D2216)
- Specific gravity of Soil (ASTM D- 854)
- Moisture-density relation by modified proctor test (ASTM D1557)
- Direct Shear test (ASTM D-3080)
- Consolidation tests (ASTM D – 2435)
- Triaxial test (ASTM D 2850 – 15)
- Unconfined compression test (ASTM D 2166)
- Soluble sulphate content test
- Hydrometer test (ASTM D 422)
- Collapse potential test (ASTM D 5333)
- California Bearing Ratio (CBR) Test (ASTM D1883) for roads only.
- Permeability tests (constant and falling head) (ASTM D 2434)
- Field Permeability tests Lefranc
- Measurement of Water Level in Boreholes.
- Potential liquefaction determination.
- SPT test
- Shear parameters (C- ϕ values) of the foundation and backfilled material.



- Modulus of sub-grade reaction at the proposed foundation level of the barrage. This value to be obtained by conducting in-situ tests conforming to I.S. 1888-1982 - Method of Load Test on Soils.
- If clayey strata is met, undisturbed sample of clay layers from the proposed foundation level or up to 8m or more depth may be taken. These samples may be analyzed for unconfined compressive strength, swelling index, consolidation characteristics and other parameters of soil as stated above and results furnished.
- Permeability coefficient of foundation material as well as material on banks.
- Water table data in monsoon and spring for past few years.
- If loose sand is met, liquefaction potential studies may be undertaken.

Rock Tests:

- Rock Coring test in compliance with the ASTM D 2113
- Triaxial Compressive Strength of Intact Rock Core ASTM D2664
- Rock-mass classification must follow ASTM Standard D5878. A discussion must be provided on the selection of the classification system.
- Rock Quality Designation (RQD) determination of rock core must follow ASTM Standard D6032.
- Petrographic and Microscopic Analyzing of rock
- Impact Strength Test of Rock Protodyakonov Method (Russian)
- Los Angeles Abrasion Test ASTM C131
- Visual examination
- Unit weight
- Specific gravity
- Water absorption
- Porosity
- Unconfined compressive strength
- Brazilian tensile strength

Water tests:

- Chemical Tests of water (PH test, Soluble sulphate content test, chloride content test and others) per ASTM D516 or ASTM D4130 for the surface water to be stored behind the dam and the underground water which comes in contact with the dam foundation or abutments.
- the water for concreting shall conform the ASTM C1602

2.3.8 GEOTECHNICAL REPORT

The Consultant shall produce and submit a comprehensive geotechnical report to the client review and approval. The Geotechnical report shall be submitted with all submittals as specified



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in SUBMITTAL REQUIREMENTS. Without an accepted geotechnical report, the submittal shall not be deemed complete by anyway.

The geotechnical investigative data, including results of laboratory and field tests, should be submitted in the Geotechnical Report which is part of the supporting design report for new projects. The Geotechnical Report is required because the design of all structures depends on the strengths and weaknesses of the material they are founded on or in. All geotechnical reports should consist of a succinct presentation of those geological conditions that contribute to characterization of the project site and determination of the design of the various structures.

The Geotechnical Report required for new projects should present a comprehensive assessment and description of the geology of the project. It should be limited, however, to an effective combination of brief discussions, tabulated data, and geological illustrations to depict the conditions that are of engineering significance. The information in the reports should focus on the following topics:

- 1- Significant and controlling of topographical conditions
- 2- Description of all aspects of bedrock and recent geology, including discussions of: (a) composition and structure of the rock, (b) engineering description of soils and of their relationship to the bedrock, (c) principal engineering properties of the rocks and soils as determined by field and laboratory investigations, (d) geologic conditions that present special engineering problems, (e) remedies proposed or used for the special problems, and (f) sources and characteristics of construction materials.

The surface and subsurface investigations, laboratory tests, and geological illustrations in geotechnical reports should be sufficiently comprehensive to supply reliable information on all geological conditions that can influence the design, construction and cost of the project. Unless a separate seismological report is required, the geotechnical report should review the earthquake history of the region.

The Geotechnical report must include, but not be limited to, the following:

- A topographic map of the dam site showing locations of boreholes, test pits, trenches, SPT, geophysical tests and other field tests with the footprint of the proposed dam, spillway and other appurtenant structures.
- Logs of boreholes and test pits. ASTM Standard D5434 may be used as guidance and a checklist. Ground elevation of the borehole, test pits and CPT locations must be provided based on the datum established for the project. Also, provide a record of any problems such as borehole instability (cave in, squeezing hole, flowing sands), cobbles, lost drilling fluid, lost ground, obstruction, fluid return color changes, and equipment problems in the logs.



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- Details of the drilling method, drill rig, drilling fluid, sample collection method, measurement of water table etc.
- Details of the field tests such as SPT, geophysical testing and permeability including description of equipment and test methods along with calculations, discussion and interpretation of results.
- Details of the laboratory tests including descriptions of equipment's, sample preparation, test methods, calculations and a discussion of the results. ASTM standards provide guidelines on reporting individual tests. Following those guidelines will suffice in reporting the laboratory and field tests.
- Locations of borrow material with properties based on the field and laboratory tests.
- Subsurface ground profiles based on borehole and test pit logs, field and laboratory tests. At least one rock profile must be shown along the dam axis and spillway.
- The classification and integrity of geological strata beneath the proposed dam and appurtenant structure (including permeability of strata; fractures or seams in rock; and the presence of karstic limestone, gypsum, dispersive soils, etc.)
- the boundaries of soil deposition
- the limits of rock outcrops
- the limits and orientation of geological features such as joints, bedding, sheared zones, etc.
- the geological irregularities (including seismically active fault zones for proposed high- and significant-hazard dams)
- the potential for surface subsistence
- the slide potential of the reservoir rim
- the presence of artesian water conditions if any.
- the potential for landslides at or around the proposed dam and reservoir site
- The potential for liquefaction potential if any.
- Reservoir-Geology map
- Plan of Explorations
- Laboratory Test Plots and Tabulations
- Site Geology Map
- Photographs
- Top of Rock Contour Map
- Geologic Structure Map
- Geologic Sections and Profile
- Ground water conditions
- Bearing capacity calculations
- Foundation Settlement calculations



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- Recommended design parameters in a tabular form based on the objectives of the investigation and requirements of the design. The design parameters must be based on the investigation. Setting aside the results from the investigation and using design parameters from published literature and textbooks is not acceptable. Published correlations, however, can be used to verify reasonableness of the field and laboratory test results. Also, in special circumstances where the testing of the material is recognized to be difficult, use of design parameters based on literature review may be allowed, but adequate justification must be provided in the report.
- Slope stability analysis
- Grouting analysis and cost estimation
- Dam stability analysis

Geologic sections and profiles should show correlation of soil and rock units together with such significant features as water levels, water losses, faults, shear zones, foliations, jointing, and solution zones. The sections should also emphasize geologic structure and show depths of primary and secondary weathering. All sections and profiles should be superimposed with outlines of the principal structures and the depth of foundation excavation for existing or proposed structures.

Further, all geologic and geotechnical investigations and tests required for developing information on any of the following construction items should be completed and included in the report:

Excavation slopes

- Special rock excavation methods for structural excavations.
- Rock bolting for slope stabilization or tunnel rock support.
- Foundation treatment by grouting or dental concrete filling.
- Protection of weather-sensitive foundations, such as shale, pending their burial.
- Special design and construction problems related to elastic rebound in foundation materials.

2.3.9 CONSTRUCTION RECOMMENDATIONS

For construction recommendations, include required materials, execution (e.g. for earthwork, include recommendations for clearing, importation of fill, excavation and compaction, temporary seepage and drainage control measures, slope protection and erosion control measures, etc.), monitoring, testing, or other quality control measures.



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2.3.10 SUMMARY

In summary, it must be remembered that no matter how well a project's structures have been engineered, if the foundation conditions are not understood and taken into account, dam safety problems could occur. This chapter shall not intend to be a detailed text on engineering geology, drilling techniques and program planning, sampling and laboratory testing procedures, or monitoring. It is intended as a guide for the reviewing engineer to determine if the quantity and quality of the investigations and studies performed support the design and/or conclusions presented.

2.4 Detailed Geological Investigation:

The consultant shall carry out close field work and provide a comprehensive information on geological background of the area that must include careful consideration of geologic environment. Knowledge of the principal elements of this environment (Topography, Hydrology and Geology) contributes to the success of the project, geological investigations shall be carried out to deduce the geological conditions in the most relevant site, depth of the foundations and their types, cut-off depth, type of the available construction materials, and type of the expected geological hazards. The necessary steps which should be followed during performing geological investigation for construction of dam is mentioned hereinafter.

The contractor shall perform the geological mapping within the investigation by the experienced geologists and with the contribution of university and other concerned specialists to can provide more regional data which can be used in the interpretation of the acquired data, especially the subsurface data. This is attributed to the need for required necessary regional geological data in the dam site and reservoir area.

2.4.1 Mapping:

Geological Mapping shall be provided at a specific scale (1:500) and should be performed by well experienced geologists having excellent engineering geological background. The geological maps should present;

- Type of the exposed rocks and their thicknesses in the dam site.
- Mechanical and geomechanical properties of the exposed rocks in the dam site and deeper than the foundations (more than cut-off depth).
- To elucidate if there are karstified rocks (gypsum and limestone) and/or expansive clays.
- Presenting all existing faults and other structural elements which shed light on the existence of active faults.
- Presenting all Neotectonics evidences.

2.4.2 Geology of Dam site:

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The thickness, nature, strength, dip, jointing and permeability of the geological foundations at the site are a set of often decisive factors in selection of the dam type, knowledge of the geological situation is essential for the investigation of Dam and reservoir site, the failure to discover geologic details or error in geological interpretations may be costly and sometimes hazardous.

The contractor shall perform a deep investigation on the following factors for suitability of the reservoir site.

- The occurrence of geological structures
- The extent of fracturing
- The extent of weathering it has undergone
- Bedding and its orientations
- The mode and number of rock types
- The thickness of the beds
- The occurrence of intrusions
- The existing rock type at the Dam

2.4.3 Karstification:

The Karstification shall be studied by the contractor to indicate whether the dam site and reservoir area suffer from karstification or otherwise. When karstification is on surface, then its indications can be seen and recognized by experienced geologists, if Karstification is in subsurface it may not be detected in the dam site and it could be dangerous. Therefore, the contractor shall explain the level of karstification and consider those significant problems which is going to arise during and after construction.

2.4.4 Drilling Operations:

The drilling operations shall be implemented according to the geological complexity of the reservoir area, type of the dam and height of the dam. However, the following aspects need to be considered:

All boreholes should be drilled by full core recovery type.

The core recovery should not be less than 85%.

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RQD should be calculated.

Depth of the boreholes should not be less than the deepest karstified bedrocks, expansive clays, fractured and/or sheared zones, active faults (if any); otherwise, deeper than the cut-off depth of the foundations. In such case the depth should be at least $1.5 H$, where (H) is the maximum hydraulic head acting on the foundation as a rule of thumb.

The site geologists should be well experienced in core description, especially karstified rocks and/or karst filling materials.

Systematic sampling of the extracted core in order to apply required geotechnical tests which will provide the mechanical properties of the penetrated rocks.

Applying chemical analyses for the cored rocks and unconsolidated materials, especially those which will be used in construction of different parts of the dam.

Applying colored photography of the extracted core before sampling but after being cleaned from the drilling mud and/or fluids. The colored photos may be used during the construction of the dam or even during commissioning when needed for certain use.

Applying geophysical logging for the all drilled boreholes to indicate:

To correct the drilling depths of the penetrated rocks.

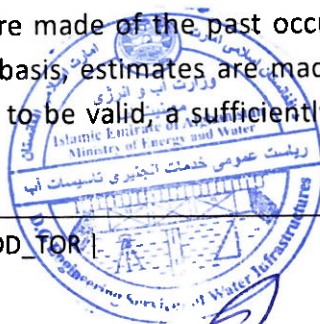
To indicated the mechanical properties of the penetrated rocks.

To indicate cavities, voids, fractured and/or sheared zones in the borehole.

Full scale Lugeon field permeability tests may be necessary in important cases when permeability is questionable.

2.4.5 SEISMOLOGICAL INVESTIGATIONS

The consultant shall verify the feasibly level seismological investigation and conduct a more detail site-specific seismological studies of projects site in detail design stage of project so that the more accurate earthquake design parameters are estimated and utilized in detail design of the project. The seismological studies are made of the past occurrence of earthquakes in the general region of the site, and on that basis, estimates are made of the probability of future earthquakes. In order for this approach to be valid, a sufficiently long seismic history shall be performed by consultant.



Design earth quake, Maximum creditable earth quake (MCE) and Operation base earth quake (OBE) along with the values of peak ground acceleration (PGA) and sustained ground acceleration shall be estimated.

The contractor shall perform a complete seismic hazard analysis that must be provided by the experienced seismologists, earthquakes always played an important role in the design and safety of Dams. therefore, the worst-case earthquake scenarios by both Probabilistic and deterministic procedures need to be considered and all critical and non-critical structures and components must be able to withstand earthquake actions.

The following information should be considered in the seismic analysis of the reservoir site but not limited to.

- Seism-Tectonic overview
- Active faults or discontinuities in the footprint of the Dam which could reactivated during strong earthquakes and maximum possible movements.
- Probabilistic and deterministic procedures
- Quantifying of uncertainties by the logic tree
- Selection of maximum design acceleration
- Source modeling
- PGA in terms of return period

2.5 HYDRAULIC STRUCTURE DESIGN

Detail design, drawings, BOQ, cost estimate and specifications will include, (but not be limited to), the following:

- Detail structural and hydraulic design of spillways, outlet work, falls, siphon, aqueducts, supper passages, head regulators and others as required.
- Type of spillway dissipater will be determined and detailed as required including d/s energy dissipater arrangements applicable to the hydraulic jump anticipated
- In design of the energy dissipation features an estimate of general degradation that is expected downstream of Dam project will be considered
- If tunneling is a part of the diversion works than geotechnical testing and rock mechanics analysis will be required along the tunneling routed. This will be a part of the Consultant 's responsibility
- Tail water influence on downstream structures and river regime has to consider.
- Determine the need for upstream sediment structures to delay sedimentation in the reservoir



- Make a recommendation on the rate of sediment filling of the reservoir during the operation period, after review of existing information on sediment measurement contributing areas and upper watershed conditions.
- In computations regarding open channel flow, overbank flow should be considered and appropriate meanings "n" values assumed
- The design consultation will insure that the proper version of lacey,s Equation is used in local scour calculations, the equation used has to show in the design brief calculations
- Actual appropriate design head based on the MWL should be used in the spillway crest equation
- The reservoir volume required to satisfy the water demand and water inflow will be modeled over consecutive years of river flow and meteorological records to arrive at a dam height giving an acceptable number of years when the reservoir is without water. Sediment accumulation in the reservoir is without water. Sediment accumulation in the reservoir will be considered.
- The applicable codes for design of hydraulic structures are as follow (but not limited to):
 1. USBR design standard no.3
 2. USBR design standard no.14.
 3. EM 110-2-2104.
 4. EM-2-2400
 5. EM- 1110-2-1411
 6. EM-1110-2-1420
 7. EM-1110-2-1603
 8. EM-1110-2-2201
 9. EM-1110-2-2610
 10. EM-1110-2-2702

2.6 DAM DESIGN

2.6.1 GENERAL

The consultant will ensure that the following more specific requirements have been satisfied during the detailed design drawings and specification preparation after completion of the study and design.

Reference is made to the feasibility study which will be used to the maximum extent possible during the detailed design, drawings, and bidding document preparation Provided that the result of the new survey, hydrological and geotechnical investigations carried out shows that the option selected in the feasibility study is the most technically feasible and economically viable option, otherwise another most technically feasible and economically viable option will be selected. However, if needed more different studies will be carried out, the following factors will be considered by the consultant in the final design, drawing and specification preparation.



Signature

2.6.2 STRUCTURAL DESIGN OF DAMS AND APPURTENANT STRUCTURES

Detailed design, drawings, BOQ, cost and specification of the most attractive type of dam and its appurtenant structures shall be conducted using the applicable standards listed below considering the design parameters obtained in the result of detailed geo-technical, seismological, detail hydrology and detail survey.

In the earth quake design the methods of Response Spectrum and Time history analysis shall be used.

The software of Geo-studios, CADAM and Ansys (whichever is applicable) shall be used.

The design shall be checked by at least two different Soft-wares and the results shall be compared with hand calculation wherever possible.

Below references (but not limited to) are part of the TOR and are applicable to this contract.

1. USACE, USBR, ICOLD whichever is applicable and is on the safe side.
2. ASCE7-10.
3. ACI 318-14, ACI 350 and other applicable parts of the ACI.
4. ASTM
5. AASHTO (for roads and culverts)
6. AISC
7. IBC.
8. IPC
8. AWS.
9. ASME
10. EM 1110-2-2100.
11. EM 1110-2-3001.
12. EM 1110-2-2104.
13. ETL 1110-2-584
14. AWWA

Note: where there is a conflict among codes, standards, contract, specification and drawing the safest and conservative code or standard of the TOR will be considered in the design.

2.6.3 CONCRETE GRAVITY DAMS

These guidelines are to be used for the structural stability analysis of concrete and/or masonry sections which form the spillway or non-overflow section of gravity dams.

These guidelines are based on the "Gravity Method of Stress and Stability Analysis". If the gravity dam has keyed or grouted transverse contraction joints, then the "Trial-Load Twist Method of Analysis" used for the stability analysis.



Elastic techniques, such as the finite element method, shall be used to investigate areas of maximum stress in the gravity dam or the foundation. However, the finite element method will only be permitted as a supplement to the Gravity Method. The Gravity Method will be required for the investigation of sliding and overturning of the structure.

2.6.4 LOADING CONDITION

Loading Conditions to be analyzed as follow:

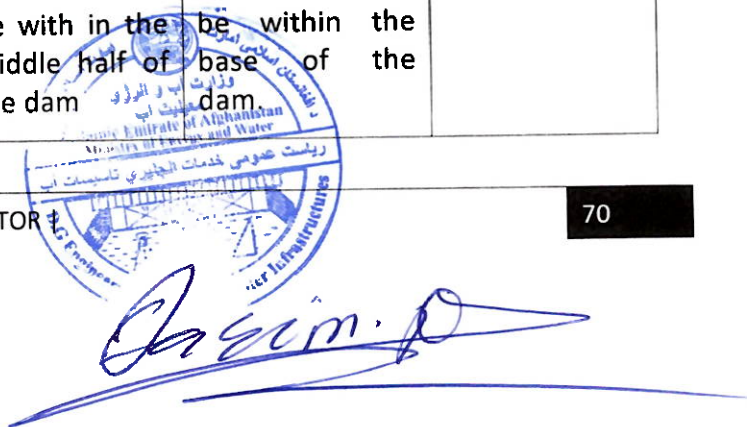
- 1 -Usual loading condition or normal loading condition
- 2- Unusual loading condition
- 3- Extreme loading condition
- 4- Other loading condition

The designer must check the below loading combination in the design and the designed structure must withstand the worst loading combination with a reasonable factor of safety. Both static and dynamic analyses are needed to be conducted.

2.6.5 DESIGN SAFETY FACTOR

The safety factors for different loading condition are summarized in the table below:

Type of stability	Safety factors to be considered in the design for different loading combinations			
	Usual loading condition	Unusual loading condition	extreme loading condition	Other loading combination, which will result the worst loading condition
Sliding with in the dam body or at the concrete –to- rock contact of the dam body and foundation rock	3	2	Greater than 1	
Sliding within the foundation rock or soil located under the dam	4	2.7	Greater than 1.3	
Overturning of the dam	Resultant must be with in the middle third of the base of the dam	Resultant must be with in the middle half of the base of the dam	Resultant must be within the base of the dam	



Tensile stress with in the dam concrete: In order not to exceed the allowable tensile stress, the minimum compressive stress computed without internal hydrostatic pressure should be determined from the expression of $\sigma_{zu}=p.\gamma.h-(f_t/f.s)$, where σ_{zu} =minimum allowable compressive stress at the face of the dam, $P=1$ if drains are not present and $p=0.4$ if drains are used.

γ = unit weight of water, f_t =tensile strength of concrete at the lift surface which is about 5% of the compressive strength.

$f.s$ = factory of safety which will be taken 3 for usual loading condition and 2 for unusual loading condition. The allowable value of σ_{zu} for Usaul loading condition should never be less than zero (0).

Cracking should be assumed to occur if the stress at the upstream face is less than σ_{zu} computed from the above equation with a factor of safety of 1 for



extreme loading condition. In this case the structure will be safe if the stress in the structure do not exceed the specified strength and the sliding stability is maintained.				
Compressive stress with in the dam concrete	Equal to or less than one third of the specified compressive strength and not exceeded 1500 psi(10.3 MPA)	Equal to or less than half of the specified compressive strength of the concrete and not exceeded 2250 psi(15.5 MPA)	Must be less than the specified compressive strength	
compressive stress of the foundation	4	2.7	1.3	If the compressive stress acted on the foundation does not meet the criteria of the safety factor, the foundation must be threatened.

2.6.6 CONCRETE PROPERTIES TO BE CONSIDERED IN THE DESIGN

If no tests or published data is available the below average values of concrete properties may be used for preliminary design until tests data is available and must be verified per the test data.

- Compressive Strength: per table 1 below, unless higher strengths are specified by the designer.
- Tensile strength: 5 % of the compressive strength.
- Shear strength: cohesion about 10% of the compressive strength, coefficient of internal friction=1.
- Poisson ratio: 0.2
- Instantaneous modulus of elasticity: 5000000 psi(34.5GPa)



- f. Coefficient of thermal expansion: 0.000009/C(0.000005/F)

2.6.7 CONCRETE INGREDIENTS

At least 60 days ago and before commencement of the concrete work, quality tests on the concrete ingredients must be conducted as described below:

- Fine and coarse aggregate: Coarse aggregate must be crushed stones or crushed rocks and must comply with the standard specification of ASTM C33.

Fine aggregate must be washed and free of clay, silt and organic material.

All the quality tests mentioned in section 12 of ASTM C33 must be conducted, before using of aggregate in the concrete mix. Only aggregate that meets the requirements of ASTM C 33 is permitted to be used in concrete work.

- Type of cement

Below are the different types of cement to be used in different types of structures.

- a. For mass concrete (e.g. dam body, thick dam facing concrete, bridge piers and mass foundation concrete) ASTM C 150 Portland cement type-II , type-IV cement or Portland cement type-I plus at least 25% fly-ash type F shall be used.
Fly ash and other type of pozzolan must comply with the requirements of ASTM C 618.
- b. For staff accommodation buildings normal Portland cement (ASTM C150 Portland type-1 cement) will be used.
- c. In areas of soil with high sulfate content, sulfate resisting cement (type-V cement) which complies with ASTM C 150 will be used.
- d. For normal hydraulic structures, cement type-I which complies with the specification of ASTM C 150 will be used.

Once the type of cements is selected based on the required type of structure, then the quality tests (chemical composition and physical requirements) will be conducted in a MWE approved laboratory. In addition to this mill certificate of the cement production factory will be submitted by contractor to MWE review.

- Mixing Water: Water must be potable and shall comply with the requirement of ASTM C1602.
- sulfate content of the surface water to be impounded behind the dam and the ground water which comes in contact with the dam foundation and abutment (per ASTM D516 or ASTM D4130) and soil (Per ASTM C1580) which comes in contact with the concrete.
- Air-entraining admixture shall confirm to ASTM C260. Air-entraining admixtures will be selected based on the manufacturer certificate.
- Water reducing and another admixture if any shall confirm to ASTM C494.



All the quality tests shall be conducted and completed within 30 days.

Once the quality tests of the concrete ingredients are completed, then mix design of concrete will be started. Below are the different classes of concrete to be considered in design of the different types of structures during both the feasibility level design and detail design, unless higher strength are specified by the designer:

Table 3:

S/No	Type of Structure	Mini. Cylindrical Concrete strength (MPa)	Cement Type	Max. water cement ratio	Nominal max. size of aggregate (mm)	Slump (mm)
1	Concrete Pavement	28MPA (4000 psi) at 28 days	ASTM C-150 type-I	0.45	25mm	50-75 mm
2	Roller compacted concrete (RCC concrete)	17 MPA at 90 days	Cement Type-I Plus fly ash	Per mix design	50mm	Zero slump
3	Normal hydraulic structure, not in contact with soil or water containing high sulphate.	31 MPA (4500 psi) at 28 days	For normal hydraulic structures, Portland cement type-I and for mass hydraulic structure where the heat of hydration is a matter of concern, either of the Cement type-II, Type-IV, Type-V, or cement type-I plus Fly ash shall be used.	0.45	25 mm	100±25 mm
4	Lean concrete	15 MPA at 28 days	Portland cement	Per mix design	25mm	Reasonable consistency



			type-I			
5	Bridges and culverts	28 MPA (4000 psi) at 28 days	ASTM C-150 type-I	0.45	As per design	100±25 mm
6	Buildings	28 MPA (4000 psi) at 28 days unless specified otherwise by the designer	ASTM C-150 type-I	0.45	25 mm	100±25 mm
7	Concrete exposed to freezing and thawing in saturated condition or to deicing chemicals.	31MPA (4500 psi) at 90 days for mass concrete and 31 MPA at 28 days for non-mass concrete. unless specified otherwise by the designer.	cement Type-II, IV, V, or Type-I Plus fly ash and cement type-I for non-mass concrete	0.42 for exterior shell concrete exposed to freezing, but minimum water cement ratio shall be selected from Table A1.5.3.4(a) of ACI 211.1(2011) or table 12-3 (Metric) of PCA-2011(fifteenth edition)	25mm for non-mass concrete and 37.5 mm for mass concrete.	<ul style="list-style-type: none"> • 100±25mm for non.mass reinforced concrete. • 50-75 mm for plain mass concrete. • 100±25mm for reinforced mass concrete.
8	Concrete in contact with soil or water having high sulfate content	As per design	Cement type V	Per mix design	Per design	Per mix design
9	Spillways	31 MPA at 28 days	In case of mass concrete either of the cement ASTM C 150Type-II, type-IV, type-I plus fly ash and Cement type-V in case of high	0.45	37.5mm, but not more than three-fourth (3/4) of the minimum spacing between the reinforcement bars.	100±25mm



			sulphate content in water or in soil shall be used.			
10	Dam facing self-consolidated concrete (SCC) as specified by the designer where low permeability is required and Concrete exposed to freezing and thawing in saturated condition or to deicing chemicals..	As specified by the dam designer on the design drawings.	Type-I cement for non-mass concrete facing, Type-II cement for mass concrete facing	As specified by the technical specification of RFC concrete, unless directed otherwise by the designer.	As specified by the technical specification of RFC concrete, unless directed otherwise by the designer.	. As specified by the technical specification of RFC concrete, unless directed otherwise by the designer.

Notes:

1. All concrete must be Air-entrained concrete with at $5 \pm 1\%$ air content.
2. All concrete must be plant mixed or road side machine mixed concrete.
3. Concrete clear cover for reinforcement shall be 10cm for all hydraulic structures and 15 cm for stilling basin. For office buildings the concrete cover shall be per ACI 318-014

2.6.8 MIX DESIGN OF CONCRETE

Mix design must be conducted per ACI 211.1 at least 30 days ahead of the concrete commencement and must be submitted to MWE review along with all the quality tests.

2.6.9 REINFORCEMENT STEEL

The reinforcement must be grade 60 and must comply with the requirements of ASTM A 615. Grade 40 steel is not allowed to be used on this project.

Chemical composition will be accepted based on the valid mill certificate of the production factory and strength and bend tests will be conducted for each delivery of the reinforcement.



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2.6.10 STRUCTURAL STEEL

Structural steel must comply with the specification of ASTM A6 and the specific ASTM designations mentioned there for each specific product and type of the steel.

2.6.11 DESIGN OF STEEL STRUCTURES

The steel structures must be design per the requirements of AISC (American Institute of Steel Construction (Thirteen Edition)).

2.6.12 EMANKMENT DAMS

Embankment dams shall be design as per TOR specified standards (USACE or USBR...).

GEOMETRY

Unless the design calculation for the worst loading condition proves steeper or flatter slopes with the specified factor of safety, the downstream slope of earth dams without seepage control measures should be no steeper than 1 vertical on 3 horizontals. If seepage control measures are provided, the downstream slope should be no steeper than 1 vertical on 2 horizontals.

Unless the design calculation for the worst loading condition proves steeper or flatter slopes with the specified factor of safety, the upstream slope of earth dams should be no steeper than 1 vertical on 3 horizontals.

The side slopes of homogenous earth dams may have to be made flatter based on the results of design analyses or if the embankment material consists of fine-grained plastic soils such as CL, MH or CH soils as described by the Unified Soil Classification System.

The minimum allowable top width (W) of the embankment shall be the greater dimension of 10 feet or W, as calculated by the following formula:

$W = 0.2H + 7$; where H is the height of the embankment (in feet)

2.6.13 STRUCTURAL STABILITY CRITERIA EARTH DAMS

The stability of the upstream and downstream slopes of the dam embankment is analyzed for the most critical or severe loading conditions that may occur during the life of the dam. These loading conditions typically include:

- 1) End of Construction — when significant pore pressure development is expected either in the embankment or foundation during construction of the embankment.
- 2) Steady-State Seepage — when the long-term phreatic surface within the embankment has been established.
- 3) Rapid (or Sudden) Drawdown — when the reservoir is drawn down faster than the pore pressures can dissipate within the embankment after the establishment of steady-state seepage conditions.



4) Earthquake — when the embankment is subjected to seismic loading.

For the evaluation of embankment dam stability, the applicable loading conditions need to be determined. These loadings conditions are discussed in the following subsections.

2.6.13.1 END OF CONSTRUCTION

The end-of-construction loading condition is usually analyzed for new embankments that

1) Include fine-grained soils, and 2) are constructed on fine-grained saturated foundations that may develop excess pore pressures from the loading of the embankment. The embankment is constructed in layers with soils at or above their optimum moisture content that undergo internal consolidation because of the weight of the overlying layers. Embankment layers may become saturated during construction as a result of Consolidation of the layers or by rainfall. Because of the low permeability of fine-grained soils and the relatively short time for construction of the embankment, there is little drainage of the water from the soil during construction: resulting in the development of significant pore pressures. Soils with above optimum moisture content will develop pore pressures more readily when compacted than soils with moisture contents below optimum. Both the upstream and downstream slopes of the embankment are analyzed for this condition.

In general, the most severe construction loading condition is at the end of construction.

If the embankment is constructed in stages, however, there may be some intermediate construction stages that require analysis.

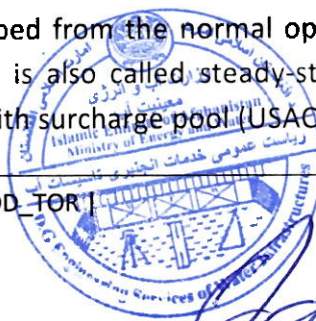
2.6.13.2 STEADY-STATE SEEPAGE: NORMAL POOL

After a prolonged storage of reservoir water, water percolating through an embankment dam will establish a steady-state condition of seepage. The upper surface of seepage is called the phreatic line.

It is general practice to analyze the stability of the downstream slope of the dam embankment for steady-state seepage (or steady seepage) conditions with the reservoir at its normal operating pool elevation (usually the spillway crest elevation) since this is the loading condition the embankment will experience most. This condition is also called steady-state seepage under active conservation pool (USBR), steady seepage with maximum storage pool (USACE).

2.6.13.3 STEADY-STATE SEEPAGE: FLOOD SURCHARGE

Where the maximum flood storage elevation is significantly higher than the normal pool elevation, the effect of the raised reservoir level (or flood surcharge) on the stability of the downstream slope is normally analyzed. The flood surcharge is generally considered a temporary condition causing no additional saturation of the dam embankment; therefore, the steady-state seepage conditions developed from the normal operating pool elevation is used for this analysis. This loading condition is also called steady-state seepage under maximum reservoir level (USBR), steady seepage with surcharge pool (USACE).



2.6.13.4 STEADY-STATE SEEPAGE: PARTIAL POOL

When the reservoir is maintained at an intermediate level or during the filling of a reservoir, an analysis of the partial-pool loading condition may be required by the review agencies. This condition assumes that steady-state seepage has been established at the lower reservoir level. In addition to the downstream slope, the upstream slope is analyzed for this condition to determine the pool elevation that results in the lowest factor of safety.

2.6.13.5 RAPID (OR SUDDEN) DRAWDOWN FROM NORMAL POOL

This loading condition assumes that steady-state seepage conditions have been established within the embankment as a result of maintaining a reservoir at the normal pool elevation and that the embankment materials beneath the phreatic surface are saturated. The reservoir is then drawn down faster than the pore pressures within the embankment materials can dissipate, resulting in a reduced factor of safety. This loading condition is the normal operating case for pumped-storage reservoirs where the drawdown of the reservoir (up to 5 to 10 feet per hour) occurs daily. This loading condition is analyzed for the upstream slope of the dam.

This loading condition is called rapid drawdown from normal pool (USBR), sudden drawdown from spillway elevation (USACE).

2.6.13.6 RAPID (OR SUDDEN) DRAWDOWN FROM MAXIMUM POOL

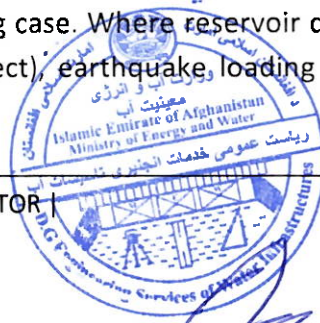
Where the maximum flood storage elevation is significantly higher than the normal pool elevation, an analysis of the effect of the rapid drawdown of the reservoir on the stability of the upstream slope may be required. The maximum pool is considered a temporary condition causing no additional saturation of the dam embankment; therefore, the steady-state seepage conditions developed from the normal operating pool elevation is used for this analysis. This loading condition is called rapid drawdown from maximum pool (USBR) and sudden drawdown from maximum pool (USACE).

2.6.13.7 EARTHQUAKE LOADS

Earthquakes result in an additional loading on the dam embankment materials. The pseudo static analysis does not apply where there may be a loss of soil strength (e.g., liquefaction) in the embankment or foundation materials during a seismic event. Both static and dynamic (Response spectrum and time history) analysis shall be conducted according to USACE standards.

Geo-studio software shall be used the analysis.

The pseudo static method of analysis is not usually applied to short-term to temporary static loading conditions (such as end of construction, flood storage pool, or rapid drawdown), except when this condition is the normal operating case. Where reservoir drawdown occurs on a daily cycle (such as for a pumped storage project), earthquake loading in combination with rapid



drawdown is recommended by respondents. Both static and dynamic analyses are needed to be conducted.

Agency	Loading Condition	Stress Parameter	F.S.
USACE	During Construction and End of Construction	Total and Effective	1.3
	Long-term (Steady seepage, max. storage pool, spillway crest or top of gates	Effective	1.5
	Max. Surge Pool	Effective	1.4
	Sudden Drawdown from Max. Surge Pool	Total and Effective	1.1
	Sudden Drawdown from Max. Storage Pool	Total and Effective	1.3
	Sudden Drawdown when Routine Operating Condition (Pumped storage facility	Total and Effective	1.4-1.5
USBR	End of Construction – Pore pressures in embankment and foundation with laboratory determination of pore pressure and monitoring during construction.	Effective	1.3
	End of Construction – Pore pressures in embankment and foundation with no laboratory determination and no monitoring during construction.	Effective	1.4
	End of Construction – Pore pressures in embankment only with or without field monitoring and no laboratory determination.	Effective	1.3
	End of Construction	Undrained (Total)	1.3
	Steady-State Seepage from Active Pool	Effective	1.5
	Operational – Max. Pool Level	Effective or Undrained	1.5
	Operational – Rapid Drawdown from Normal Pool	Effective or Undrained	1.3



Operational – Rapid Drawdown from Max. Pool	1.3
Unusual	1.2

Notes:

1. The Consultant must check the dam stability based on both USBR and USACE safety factors indicated in the table above.
2. For dams other than concrete and earth dams, follow the USBR, USACE, ACI and ASTM standards whichever is applicable and on the safe side.

2.7 IRRIGATION SYSTEM DESIGN

Detail design, executive summary, calculation, drawings and specifications will include, (but not be limited to), the following:

1. Water requirements for various crops have to be worked out broadly and in detail considering the procedures recommended in the *FAO Publication No. 56*. The software CROPWAT 8.0 developed by FAO based on Penman-Monteith.
2. The feasibility level irrigation report shall be reviewed, verified and any missing and required information shall be added to the report in detail design stage.
3. Irrigation areas and canal networks were both the existing and newly developed areas will be clearly shown on mapping to appropriate detail.
4. The Consultant will optimize the location, size of irrigation main, secondary and tertiary canals, and the extent of canal lining considering technical (water loss potential and possible soil salination) as well as social and environmental considerations. The extent of canal lining will be agreed by MWE.
5. Surface irrigation schemes has to design and operate to satisfy the irrigation water requirements of irrigation system while controlling deep percolation, runoff, evaporation and operational losses.
6. An appropriate cropping pattern will be developed for the irrigation command area
7. Environmental and social impacts will be determined for the proposed irrigation development including land acquisition and resettlement



8. Design, layout drawings, specifications and contract documents for the proposed new irrigation area will be produced to the tertiary canal level of detail. Connection and operation of the newly constructed canals with the already existing canal system will be developed.
9. Access roads will be located along the main and secondary canals
10. The designers will consult with the stakeholders in the existing irrigation areas regarding the design of the new irrigation area (to the extent possible)
11. Designers of the canal system will consider the influence of sediment accumulation in the canal system and if necessary, sediment mitigation measures will be designed, specified and contract bid documents prepared
12. An estimate of the design life of the newly constructed canal system will be reported
13. An operation and maintenance manual will be developed for the irrigation system. The manual will include technical, operational and management aspects
14. Canal lining will be specified where excess water losses can reasonably be expected and where accumulation from seepage will create major soil salination. And, optimization of the use of canal lining within the newly developed irrigation area will be carried out and reported
15. Subsurface drainage has to be design and operate to remove extra water from command area
16. Sufficient crossings will be made for area residents and areas in the canal will have special provision for livestock watering. The primary stakeholders will be consulted regarding the location of pedestrian crossings and livestock watering areas
17. Future operation and maintenance costs of the canal system will be made and reported by the Consultant
18. The possibility of introducing fish culture and fish ponds adjacent to or within the canals will be investigated and reported
19. Consultation will be made with Ministry of Agriculture and Fisheries as well as NGOs regarding the development of fisheries and cropping within the entire irrigation area.
20. The project stakeholders in the existing irrigated areas should participate in the irrigation system design process (to the extent possible)
21. The Consultant has to refer to below manuals for design of irrigation systems and also

Other practical manuals and handbooks:

- FAO Irrigation and Drainage Paper 26, Small Hydraulic Structures, 1982
- Irrigation Water Management Training manual no. 8, structures for water control and Distribution 1993.
- Irrigation Engineering Principles, version 2 CE IIT, Kharagpur
- M.G. Bos and J.Nugteren, on Irrigation Efficiencies, ILRI Publication 19, 1990



2.8 SOCIO-ECONOMIC IMPACT ASSESSMENT

2.8.1 GENERAL

To provide MWE with an understanding of the potential socio-economic impacts of the Proposed project and potential land acquisitions caused by the project. In particular, MWE is seeking a better understanding of the potential socio-economic impacts of the project development and additional activities on the surrounding communities and the national economy as a whole.

REQUIREMENTS

A detailed analysis of the current and future socio-economic impacts (both the costs and benefits) of the project development and related activities. This analysis should include the following information.

2.8.2 AN UNDERSTANDING OF THE CURRENT ECONOMIC PROFILE OF THE REGION

2.8.2a DEFINING THE REGIONAL ECONOMIC PROFILE

The study will start by providing an understanding of the current economic profile of the site areas, including:

- the demographic profile of the population – age, education, household incomes;
- employment and occupations in the region; and
- industry profile.

2.8.2b DEFINING THE PROJECT PROFILE

This study should also collect information to define the key aspects of the proposed development and additional activities, including:

- proposed land acquisitions and the current industry activity associated with this land;
- the nature and location of activities to be undertaken by the personnel, including direct outputs that are likely to generate employment, expenditure and other opportunities for personnel and or their activities to interface with the broader community;
- other inputs or activities attributable to the proposed development, including those activities that may have unintended consequences for the community, or consequences not anticipated by existing planning.

2.8.3 STAKEHOLDER ENGAGEMENT

The study should also provide an understanding of key socio-economic concerns raised by stakeholders – specifically in relation to the potential impacts on existing public facilities and infrastructure, the workforce and businesses; industry (including agriculture and fishing), displacement, and property market impacts.



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The study will take into consideration feedback already collected (if Any). Further, to gain a better understanding of the potential impacts, the study should include consultation with the following representative key stakeholders:

- Department of Environment and Heritage
- Department of Agriculture and Water Resources
- Department of Natural Resources and Mining
- Regional Councils
- Farmers Associations
- Chamber of Commerce and Industry
- Economic Development Committees
- others

In addition to providing feedback directly to a representative from the list above, individual stakeholders should also be able to provide direct feedback to the study through a dedicated email address published on the firm page or the MWE website and advertised locally. The study should also include qualitative research (for example, xx focus groups), and social media analysis (analyzing xx months of past commentary or 2-3-week monitoring) to understand current public opinion on the initiative. This will identify other issues and further inform the design of the public positioning and community engagement plan.

Depending on the nature and detail provided in these initial consultations/forums, the study may include follow-up meetings or calls with particular stakeholders.

2.8.4 CONDUCT SOCIO-ECONOMIC ASSESSMENT

The study should provide a comprehensive evaluation of the socio-economic impacts associated with the proposed project development.

2.8.5 ESTIMATE DIRECT IMPACTS

This assessment should include a current capacity analysis – which will identify any capacity constraints resulting from the infrastructure development and activities associated with it. These will include an assessment of potential:

- workforce impacts;
- property market impacts;
- impacts on the demand for public facilities and infrastructure; and
- displacement of existing industry.

2.8.6 CONDUCT ECONOMIC IMPACT ANALYSIS

The study should include an economy-wide impact assessment using a regional computable general equilibrium (CGE) model. This assessment should quantitatively assess the impact of the proposed project (including any land acquisitions/industry displacement).

The analysis should assess the impact on economic activity including but not limited to the impact on:



- employment; and
- industry activity and employment.

The economic impact assessment should start by developing a baseline economy from which an assessment can be made as to the potential flow-on impact on the project area and regional economies.

This should include an assessment of the change in activities in the region (both the increase and decrease in particular industries and business activities). This information should then be used as input in the CGE model to simulate the economy wide impacts of the site development and the surrounding areas.

The final report should provide a concise, plain language description of the work undertaken and the results produced. The report should be drafted so it is easily accessible to a wide audience.

Technical information should be included in appendices.

2.8.7 INCLUSIONS AND EXCLUSIONS

The study will focus on quantifying the socio impacts as they relate to the economic analysis. Findings from the focus groups, stakeholder meetings and social media monitoring will be summarized to provide MWE with a qualitative understanding of other perceived social impacts.

2.9 HYDRO-MECHANICAL

2.9.1 GENERAL

Detail design of hydro-mechanical components of the project includes, but not limited to the below tasks:

- Fixing the location, levels, size and type of gates, penstocks, trash racks, hoist systems cranes and other hydro-mechanical component of dam.
- Hydraulic and structural design of all hydro-Mechanical components of the Dam to withstand the worst loading condition.
- Preparation of executive summary, calculation, drawings, BOQ, cost and specification of all hydro-Mechanical components of the Dam.

The project includes hydro mechanical and hydropower section which should be investigated, designed and selected. Annex A (Mechanical Technical Requirements) governs if there are any conflicts between documents.

2.9.2 INTRODUCTION

All mechanical equipment shall be as follows:

- Materials should be selected from ASTM diagrams or equivalent standards related to mechanical parts.
- Structural steel embedded in water should be analyzed, calculated and designed according DIN 19704 and DIN 19705 or equivalent British or American standards.
- Mechanical equipment and equipment parts should be manufactured and installed by a recognized manufacturer with ISO certificates.
- Generally mechanical equipment should be electrical and manual operatable this includes governors, gates, cranes and emergency stops.
- Electrical and mechanical parts should be controlled from the control room in the powerhouse, but be also operatable from the local control panel.
- Mechanical equipment should be selected to state-of-the-art technology.
- The manufacturer must demonstrate that it has the shop facilities and the fabrication experience with specialty work of similar size and type within the past five years, as well as an internal quality control system similar to ISO 9001 (ISO 2008)

2.9.3 TURBINE

Turbines should be selected according international standards. It should be verified which turbine type is the best solution with reference to international turbine-selection-diagrams or turbine selection-software. The selection includes vertical or horizontal type, number of turbine units and number of blades.

2.9.4 GATE

Gates shall be manufactured with Class HPS 70W steel of ASTM A 709 or class S 355 JO structural steel whichever is better according to DIN EN 10025 or equivalent British or American standards. Design and calculation and erection should be in accordance with ETL 1110-2-584 or BS 5950 and DIN 19704 whichever is on the safe side. Welding shall be conducted per AWS D1.5 requirements.

2.9.5 PIPING

Piping (Penstock, bottom outlet, draft tube etc.) should be selected, calculated and designed according ASME B31.3 or other international standards. The steel plates shall comply with the EN 10028, P355NL1 or P460NL1 standard or equivalent. Once erected the steel liner will be pressure tested with a factor of 1.5 of max. operating pressure. And manufactured by a recognized manufacturer with ISO certificates. Special attention should be towards material, thickness, diameter, coating and tests.



2.9.6 GENERATORS AND MOTOR GENERATORS

Pre advertising correspondence with turbine and generator suppliers should provide verification that the turbine related stipulations in the generator specification are practicable.

2.9.7 GOVERNORS

In general, the governor operating requirements and characteristics will be determined from the electrical, mechanical, and hydraulic characteristics of the generator, turbine, and penstock.

The turbine is controlled by an electronic governor, which transforms each electric signal into a hydraulic action to be executed by the hydraulic governor. The governor should be operatable from local control panel and the control room in the powerhouse.

The governor is able to start, run and stop the turbine under each operation condition. It is able to provide at least output or speed control functions if pre-selected by the plant operator. Further a reservoir level control mode will be added and others for example black start, isolated grid/frequency shall be included as required. The automatic selection of the units in operation and starts/stops of the units depending on available discharge will be performed by a joint control function.

The hydraulic governing system is equipped with a nitrogen system consisting of an accumulator and a nitrogen bottle bank to keep the system pressurized and ensure closing of the wicket gates in case there is no electricity available for operation the hydraulic pumps.

2.9.8 PENSTOCK SHUTOFF VALVES AT THE POWERHOUSE

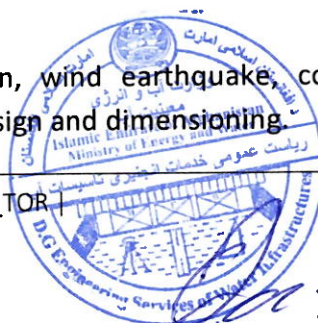
Butterfly and spherical valves are typically used at Hydro projects when shutoff capability is required at the powerhouse end of the penstock. Mechanical design responsibilities for these valves include the determination of need, selection of type and size, selection of auxiliary equipment, coordination of location and space requirements, preparation of contract drawings and specifications and preparation of instruction manuals.

2.9.9 CRANES

Generally, cranes are necessary for each mechanical equipment for installation, operation and maintenance purpose.

The design of crane will consider the dead load, which includes the weight of all parts of the crane, except specified as live load. The maximum live load will include the lifted loads, lifting beams, lifting devices, lower hoist block, hooks, ropes and trolley. Impact shall be taken as 15 % of live load.

Lateral live loads caused by acceleration, wind earthquake, collision forces and braking operation have to be considered during design and dimensioning.



Design criteria: Crane structure: FEM class A3 and crane mechanism FEM class M2 or equivalent.

2.9.10 WATER SUPPLY SYSTEM

Water supplies in mechanical section should cover the following requirements: Generator air coolers and bearing coolers; Turbine bearing coolers, wearing rings, and glands; Transformer cooling; Fire protection; Potable water (domestic water); Air conditioning systems; Pump bearing prelube; Compressors and after coolers; Deck washing.

2.9.11 MAINTENANCE SHOP

Maintenance shops are provided in powerhouses to facilitate preventive maintenance and to provide moderate repair capability. The intent is that each powerhouse has the capability to take care of the average work promptly and efficiently.

2.9.12 COOLING WATER SYSTEM

A cooling water system will be installed to supply sufficient cooling water capacity for the turbine-generator units, the hydraulic governors, lubrication oil system, compressors, air conditioning system and any other equipment installed that requires cooling capacity. Each unit is equipped with a separate cooling water system; however, these are interconnected to facilitate the maintenance of the system.

2.9.13 COMPRESSED AIR AND OIL SYSTEM

Installed systems for two types of oil, governor-lubrication oil (governor-lube) and insulating oil, are required in most powerhouses. The systems are based on the use of a common oil for unit lubrication and governor-systems and for transformers and circuit breakers.

Compressed air systems are required in powerhouses for operation and to facilitate maintenance and repair. Service air, brake air, and governor air comprise the three systems needed in all powerhouses. Reliability, flexibility, and safety are prime design considerations.

2.9.14 PLUMBING SYSTEM

Powerhouse plumbing systems include the following fixtures: water supply piping from in-house treatment plant, storage tank or main at building line, hot water supply, fixture drains and vents, in-house sewage treatment facility, and effluent and sludge pumps.

2.9.15 FIRE PROTECTION SYSTEM

Following fire protection are needed in four specific hazard area: oil storage and purification rooms, a paint and flammable storage room, main power generators, and transformers.



2.9.16 PIEZOMETERS, FLOW METERS, AND LEVEL GAUGES

Piezometers, flow meters, and water level gauges are utilized in a variety of powerhouse applications to determine flows, water levels, and differential heads. The readings obtained are necessary in the evaluation of turbine performance, operational monitoring, trash track clogging, fish facility conditions, and for control purposes. All piezometer taps, installed piping, and float wells are a mechanical design responsibility.

2.9.17 HEATING, VENTILATING, AND AIR CONDITIONING

Powerhouse heating, ventilating, and air conditioning are required to maintain temperature and air quality conditions suitable for operating equipment, plant personnel, and visitors.

The service air system will supply pressurized air at a working pressure of 8 bar to various consumers in the powerhouse, e.g. such as inflatable standstill and maintenance seals on the turbine shaft, generator brakes and service air take-off points located throughout the powerhouse structure for air supply to pneumatic tools and other equipment used during maintenance.

The air conditioning and ventilation system will provide sufficient flow of air to all areas of the powerhouse to control temperature and humidity so that the equipment can operate as reliable as possible. Also, a safe working environment is provided for people working there.

The air conditioning and ventilation system must function as an integral part of the overall fire protection and evacuation plan for the powerhouse complex.

The installed air conditioning system for the control room shall ensure that the minimum temperature will not be less than 18°C and the maximum temperature will not exceed 28°C, with a maximum relative humidity of 50%.

2.10 HYDRO-ELECTRICAL & ELECTRO MECHANICAL

2.10.1 GENERAL

Annex B (Electrical Technical Requirements for Design Stage) governs if there are any conflicts between documents.

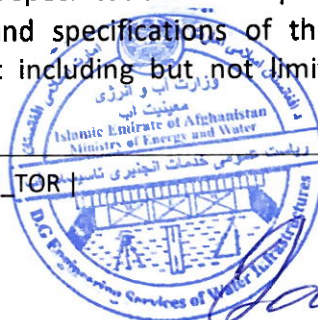
For detailed design of all the electrical works of the Dam, first of all the feasibility study documents should be reviewed and all the calculation and/or selected equipment type in feasibility study should be carefully evaluated; if there be any poor or insufficient calculations, equipment selection and/or any conflict, these issues should be improved and/or corrected in design stage.

When reviewing the feasibility study documents, if there be found any poor, weak and/or insufficient equipment selection, calculation method, construction method and/or any conflict, the consultant should submit the poorness and/or conflict explanations; and proposed improvement and/or corrections with fully justification to client prior to bring change or correction there. After the client approval the consultant can bring change or correct the conflicts according to proposed improvements or corrections. The client will review and compare the conflicts issues, proposed changes and corrections, and will decide for the best solutions; if the client didn't accept the proposed change, the consultant should comply the feasibility study documents.

2.10.2 POWER HOUSE

Detailed design calculations, drawings, BOQ, cost estimate, specifications, and contract document preparation shall be conducted which includes but not limited to the following:

- The feasibility level design, location and configuration of the power house shall be reviewed and confirmed.
- Detailed drawings, calculations and specifications of the Gross head, head loss, net head/Design head, Max. water Discharge, Design discharge and the optimum Power evacuation.
- Complete and detail Architectural and Structural design of the sub-structure and supper structure of the power house per the standards specified in the TOR shall be conducted considering the design parameters obtained in the result of detailed geotechnical, Hydrological and survey investigation.
- Complete and detail Mechanical, electrometrical and electrical design of the power house shall be conducted per the standards specified in the TOR.
- Detailed drawings, calculations and specifications of the optimum type, numbers and size of the turbines, generators and the associated cranes including but not limited to the cooling system, excitation system, bearing system, etc.
- Detailed drawings, calculations and specifications of the penstock numbers, length, diameter, thickness and material.
- Detailed drawings, calculations and specifications of the adequate turbine housing including but not limited to the provision of a means of removal of the turbine from below the water level when repair is necessary
- Detailed drawings, calculations and specifications of the Draft tube, Gates and the associated cranes. The upstream head-gates are essential for maintenance and safety of operation.
- Detailed drawings, calculations and specifications of the power house tailrace.
- Detailed drawings, calculations and specifications of the Transmission system and Switchgear/Switchyard Equipment including but not limited to main transformer(s),



- auxiliary transformer(s), bus bar arrangement/configuration, CTs, PTs/CVTs, CBs, Lightning Arresters, Insulators, disconnect switches, Reclosers, etc.
- Detailed drawings, calculations and specifications of the control and monitoring system for turbine operations, valves, gates and any other hydro-mechanical/mechanical equipment specifications.
 - Detailed drawings, calculations and specifications of the protections system for generator(s), main transformer(s), auxiliary transformer(s), Bus Bar, Outgoing feeders/Lines, etc.
 - Detailed drawings, calculations and specifications of the auxiliary and service system (AC and DC) including but not limited to AC and DC Panels, cables, batteries, rectifier(s), inverter(s), etc.
 - Detailed drawings, calculations and specifications of the Mechanical auxiliaries (if any).
 - Detailed drawings, calculations and specifications of the grounding systems for power house and switchyard (if be needed).
 - Detailed drawings, calculations and specifications of the communication system / SCADA system.
 - Detailed drawings, calculations and specifications of the interior and exterior lighting system and power system for power house and/or any building and Area(s).
 - Detailed drawings, calculations and specifications of the Fire protection system for power house and/or any building (if be needed).
 - Detailed drawings, calculations and specifications of the CCTV system.
 - Detailed drawings, calculations and specifications of the Dam instrumentation system.
 - Detailed drawings, calculations and specifications of the Cabling system.
 - Detailed drawings, calculations and specifications of the HVAC system for power house and/or any building.
 - Detailed drawings, calculations and specifications of the water supply system and sewer system for power house and/or any building.
 - Detailed Cost estimation for supplying, installation and/or construction of the power plant.

The below sessions should be considered when preparing the design and contract documents:

- Proper operating procedures (including strict safety requirements) and training session requirements will be part of the design. Training by the supplier, contractor, and subcontractor will be a part of the supply and construction contract packages
- Equipment placement to provide the required specified spacing will be considered in the design and safety of operation of the power house structure. Equipment will be designed and specified according to the space provisions available.



2.11 GENERAL REQUIREMENT FOR FEASIBILITY STUDY & DETAIL DESIGN (STAGE-1 & STAGE-2)

2.11.1 SUBMITTAL REVIEW PROCEDURE

MWE review and no objection are required for submitted submittals but the design and submittals liability are of the consultant. Response to comments is required within 15 calendar days and MWE review time is 15 calendar days.

Design review will be conducted by the MWE related technical board/technical team members and no objection will be issued by the related Project Manager/Directorate upon closing of the technical board/ technical team comments. The project Manager/related directorate will issue no objection along with the statement of " It is the sole responsibility of the Consultant to ensure that submittals do or do not comply with the Contract documents. MWE review, no objection /approval/clear for construction issued by the MWE Representative shall not relieve the Consultant from responsibility for any errors or omissions in such submittal nor from responsibility for complying with the requirements of this Contract and the future consequences and risks associated with that error or omission".

2.11.2 SOFTWARE

The Consultant should submit and prepare their detailed schedule accordance with the scope of work indicated in TOR.

The scheduling software that will be utilized by the MWE on this project will be Oracle's Primavera P6.

2.11.3 FILE NAME

Each file submitted shall have a name related to the schedule data date, project name, or Contract number. The Consultant shall develop a naming convention that will ensure that the names of the files submitted are unique. The Consultant shall submit the file naming convention to the MWE Representative for approval.

2.11.4 ADHERENCE TO THE DESIGNS STANDARDS

Consultant shall execute design in compliance with international standard (USBR, ACI, ASTM, AASHTO, ICOLD, DIN, IBC, USACE Engineering Regulations & manuals, Technical Manual ...). Complete list of the design standards and codes is attached at the end of this TOR. Any request to deviate or change the standard building designs must be due to changed site conditions ONLY and submitted to the MWE Office administering the Contract. Consultant shall indicate



the changes and provide a narrative justification for the changes proposed, but shall not proceed with deviations without written approval.

2.11.5 RESPONSIBILITY FOR ERRORS OR OMISSIONS

It is the sole responsibility of the Consultant to ensure that submittals do or do not comply with the Contract documents. MWE review, no objection /approval/clear for construction issued by the MWE Representative shall not relieve the Consultant from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with the requirements of this Contract.

2.11.6 STAMPS

Each technical document and drawing shall have the signatures of the designer, checkers and approvers from the consultant side and the design, check and approve liability will be of the consultant.

Stamps shall be used by the Consultant on all design submittals to certify that the submittal meets contract requirements and shall be similar to the following:

Consultant (Firm Name):

Contract Number:

Contract Name:

I certify that this submittal accurate, is in strict conformance with all contract requirements, has been thoroughly coordinated and cross checked against all other applicable disciplines to prevent the omission of vital information, that all conflicts have been resolved, and that repetition has been avoided and, it is complete and in sufficient detail to allow ready determination of compliance with contract requirements by the MWE Representative.

Name of DQC Manager:

Signature of DQC Manager:

Date:

2.11.7 ENGLISH LANGUAGE

All specifications, drawings, design analysis, design calculations, shop drawings, catalog data, materials lists, and equipment schedules submitted shall be in the English language. Except O&M manuals and safety signs which shall be both in English and Dari, Pashto versions.



2.11.8 UNITS OF MEASUREMENT

Design documents shall be prepared in metric measurements. The metric units used are the International System of Units (SI) developed and maintained by the General Conference on Weights and Measures (CGPM); the name International System of Units and the international abbreviation SI were adopted by the 11th CGPM in 1960.

2.11.9 GEO-REFERENCE

All site plans shall be geo-referenced using the WGS 1984 coordinate system, specifically the following: WGS 1984 UTM. If the designer is not able to use the stated coordinate system, the coordinate system used shall be correlated to the stated coordinate system. A table shall be provided within the site drawing set cross referencing the WGS84 system to that utilized. This is required to allow MWE to incorporate the plans into GIS for storage, map production, and possible geospatial analysis of the different work sites.



Signature

2.11.10 DESIGN CALCULATIONS

Calculations shall be in SI units to meet the requirements of the design. Quantities on the Contract drawings stated in SI units shall also be stated in SI units in the design analysis to match the drawings.

2.11.11 SPECIFICATIONS

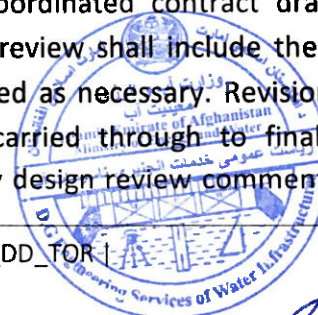
Consultant shall prepare specification explaining codes and standards to be met, materials to be submitted in compliance with applicable standards, and brief description of standard operating procedure for to be followed. Project specification shall be prepared similar to UFGS format in accordance with UFC 1_300_02 guidelines or Construction Specifications Institute (CSI) format complies with ASTM, ACI, USBR, USACE, ICOLD, AWWA and AASHTO specification. _Specification shall be submitted at the same time as design stage.

Checklists shall be a tool for MWE Representative(s) onsite and Contractor's QC(s) to guide construction to the MWE/ Designers expected quality. This shall ensure designer of appropriate construction performance and liability of consultant for design. The Consultant shall review and make recommendations at the inception phase on the following aspects related to the construction contract and the below technical tender documents shall be prepared accordingly:

- g) The use of Standard Specifications
- h) The preparation of Project Special Specifications
- i) Preparation of Method of Measurement, where appropriate and the Bill of Quantities staff and equipment list
- j) Technical review and assistance for the MWE to review
- k) Drawings cleared for construction

The Consultant prepared specifications shall include as a minimum, all applicable specification sections referenced by the CSI. Where the CSI does not reference a specification section for specific work to be performed by this contract, the Consultant shall be responsible for creating the required specification. The Specifications shall be based on internationally accepted standards with strict confirmation to the TOR specified standards. Standards referenced in specifications and drawings prepared by the Consultant shall be by specific issue; the revision letter, date or other specific identification shall be included.

Drawings, prepared in the English language with SI units of measure, are a part of each submittal. The working drawings shall be adequately labeled and cross-referenced for review. Complete, thoroughly checked and coordinated contract drawings shall be submitted. The contract drawings submitted for final review shall include the drawings previously submitted which have been revised and completed as necessary. Revisions will be clearly marked dated and numbered and the numbering carried through to final approval of the client. The Consultant shall have incorporated any design review comments generated by previous design



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review(s), have completed necessary constructability and coordination checks, and have the drawings in a Ready-to-Build condition. The drawings shall be complete at this time and contain all the details necessary to ensure a clear understanding of the work throughout construction. An electronic copy of all drawings submitted will accompany each submittal. All electronic drawings will be completed in a licensed version of AutoCAD.

2.11.12 DESIGN ANALYSIS SUBMITTAL

It shall be written in the English language with SI units of measure. The Design Analysis is a written explanation of the project design which is expanded and revised (updated) as the design progresses. The Design Analysis shall contain all explanatory material giving the design rationale for any design decisions which would not be obvious to an engineer reviewing the final drawings and specifications. The Design Analysis contains the criteria for, and the history of, the project design, including criteria furnished by the MWE, letters, codes, references, conference minutes, and pertinent research. Design calculations, computerized and manual, are included in the Design Analysis. Narrative descriptions of design solutions are also included. Written material may be illustrated by diagrams and sketches to convey design concepts. Catalog cuts and manufacturer's data for all equipment items, shall be submitted.

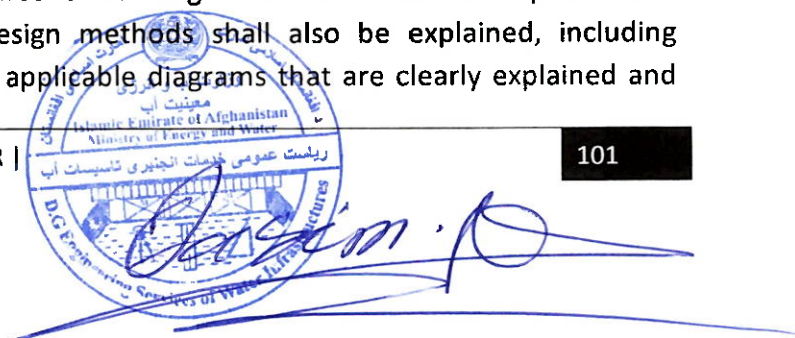
2.11.13 DESIGN CALCULATIONS

All design calculations shall be presented to be easily understood, correlated with requirements specified in TOR and all final conclusions clearly documented and summarized. The Design Submittal must include complete information (Geotechnical Report, concrete design strengths, steel material properties, electrical and mechanical considerations, assumptions, etc.) necessary to support all design calculations in order to easily and efficiently verify the accuracy of this information and the resulting project components shown in plans and specifications.

2.11.14 CALCULATION SUBMITTAL

When design calculations are voluminous, they shall be bound separately from the narrative part of the design analysis. Design calculations will include a title page, table of contents, and be indexed (tabbed) to separate distinct parts of the various analysis and design actions being accomplished to support plan drawings submitted. They shall be presented in a clear, consistent and legible format in order to quickly understand the analysis and design accomplished. Presentation shall be such that a person unfamiliar with the project features and associated analysis and design can quickly understand the overall design process and procedures, review the information in conjunction with the given set of plans and specifications, and verify the suitability of all information submitted.

All design calculations shall explain the source of loading conditions with assumptions and conclusions explained. The analysis and design methods shall also be explained, including assumptions, theories and formulae. Include applicable diagrams that are clearly explained and



correlated with related computations, whether computer or hand generated. The design calculations shall include a complete and comprehensive list of the criteria (and date or version of the criteria) that the design/analysis will be compared to (codes, Engineering Manuals, etc.). Within the separable elements of design calculations, the engineer shall cite the specific code or reference paragraph or section as appropriate to indicate conformance to requirements. At the beginning of each project component design section, present a summary of all load conditions and combinations required per applicable code or Corps of Engineers manual or regulation. Then clearly identify the particular load case governing the design and clearly show how the particular analysis, construction materials to be used, and the specific design meet the governing load combination. Calculation sheets shall carry the names or initials of the engineer and the checker and the dates of calculations and checking. No portion of the calculations shall be computed and checked by the same person.

2.11.15 RESUBMITTALS

The Consultant should resubmit any submittal commented by client incorporating the Client comments and this process will continue until the client comments are completely closed.

The purpose of this system is to avoid deviations from the Submittal Register and tracking purposes.

2.11.16 MWE REVIEW

- a. Within 15 days after Notice to Proceed, the Consultant shall submit, for approval, a complete work schedule for all submittals and review times indicated in calendar dates. The Consultant shall update this schedule monthly. After receipt, the MWE will be allowed FIFTEEN (15) days to review and comment on all Design Submittals, except as noted below. This time period starts on the next full day after delivery of the Design Submittal to MWE.
- b. If a design submittal is deficient (incorrect drawing title block information; missing or incomplete features required in the submittal; etc.), it will be returned immediately without further review for correction and resubmission. The review time will begin when the corrected submittal is received. The Consultant may be liable for liquidated damages owed to the MWE for returned design submittals due to deficiencies.
- c. Clearance for construction does not mean MWE approval. MWE review shall not be construed as a complete check but will evaluate the general design approach and adherence to contract parameters. The MWE Review is often limited in time and scope. Therefore, the Consultant shall not consider any review performed by the MWE as an excuse for incomplete work.
- d. Any no objection or approval issued by the MWE Representative shall not relieve the Consultant from responsibility for any design errors or omissions and any liability associated with such errors, nor from responsibility for complying with the requirements of this Contract.



5.2.11.17 INCORPORATION OF MWE REVIEW COMMENTS

- a. The Consultant shall review each comment, furnish a complete response as to how the comment will be addressed in the Design Analysis, Plans and Specifications, or other Design Submittal stipulations required in this Contract. The Consultant will then incorporate each comment into the design submittal along with other work required at the next Design Submittal stage. The Consultant shall furnish disposition of all comments, with the next scheduled submittal. The disposition shall identify action taken with citation of location within the relevant design document. Generalized statements of intention such as "will comply" or "will revise the specification" are not acceptable. During the design review process, comments will be made on the design submittals that will change the drawings and specifications. The MWE shall make no additional payments to the Consultant for the incorporation of comments. Review comments are considered part of the Contract administration process.
- b. If the Consultant disagrees technically with any comment or comments and does not intend to comply with the comment, he must clearly outline, with ample justification, the reasons for noncompliance within five (5) days after close of review period in order that the comment can be resolved.
- c. The Consultant is cautioned that if he believes the action required by any comment exceeds the requirements of this Contract, he should flag the comment as a scope change, and notify the MWE Rep in writing immediately.

If a design submittal is over one (1) day late in accordance with the latest design schedule, the MWE review period may be extended 3 days.

2.11.18 CONFERENCES

As necessary, conferences will be conducted between the Consultant and the MWE to resolve review comments.

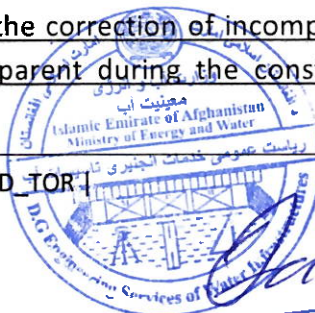
A review conference may be held at the completion of MWE Technical Board/Technical team review for each design submittal. The review conference will be held at Ministry of Energy and Water, Kabul, Afghanistan. The Consultant must bring the related technical personnel (without any excuse) that developed the design submittal to the review conference.

2.11.19 DESIGN DEFICIENCIES

Design deficiencies noted by the MWE shall be corrected prior to the start of design for subsequent features of work which may be affected by, or need to be built upon, the deficient design work.

2.11.20 DESIGN DISCREPANCIES

The Consultant shall be responsible for the correction of incomplete design data, omissions, and design discrepancies which become apparent during the construction/project implementation



phase of the project and the Consultant is liable for resolving design discrepancies, even if, the gap between design and implementation lasts for a longer period of time.

2.11.21 MWE QUALITY CONTROL SYSTEM

2.11.21.1 CORRESPONDENCE AND ELECTRONIC COMMUNICATION

For ease and speed of communications, both MWE and Consultant will, to the maximum extent feasible, exchange correspondence and other documents in electronic format. Correspondence and other documents comprising the official Contract record shall also be provided in paper format, with signatures and dates where necessary. Paper documents will govern, in the event of discrepancy with the electronic version.

2.11.21.2 SUBMITTAL MANAGEMENT

The Consultant shall maintain a complete list of all submittals, including completion of all data columns. Dates on which submittals are received and returned by MWE. The Consultant shall update and track all submittal using master submittal register. Consultant shall submit four (4)-hard and 4-soft copies written on a CD of all submittals.

2.11.21.3 REQUESTS FOR INFORMATION (RFI)

The Consultant shall use the RFI log for tracking all RFI's generated during the contract. Hard copies of all RFI's shall be provided to MWE, and will govern in the event of a discrepancy between electronic and printed mediums.

2.11.21.4 NOTIFICATION OF NONCOMPLIANCE

MWE PM will notify the Consultant of any detected noncompliance with the requirements of this TOR. The Consultant shall take immediate corrective action after receipt of such notice.

2.11.22 CONSULTANT QUALITY CONTROL

2.11.22.1 DESIGN QUALITY CONTROL (DQC) PLAN

The following additional requirements apply to the Design Quality Control (DQC) plan:

a. The Consultant shall provide and maintain a Design Quality Control (DQC) Plan as an effective quality control program which will assure that all services required by this design contract are performed and provided in a manner that meets professional architectural and engineering quality standards. As a minimum, all documents shall be technically reviewed by competent, independent reviewers identified in the DQC Plan. The same element that produced the product shall not perform the independent technical review (ITR). The Consultant shall correct errors and deficiencies in the design documents prior to submitting them to the MWE.

b. The Consultant shall include the design schedule in the master project schedule, showing the sequence of events involved in carrying out the project design tasks within the specific contract



period. This should be at a detailed level of scheduling sufficient to identify all major design tasks, including those that control the flow of work. The schedule shall include review and correction periods associated with each item. This should be a forward planning as well as a project monitoring tool. The schedule reflects calendar days and not dates for each activity. If the schedule is changed, the Consultant shall submit a revised schedule reflecting the change within 7 calendar days. The Consultant shall include in the DQC Plan the discipline-specific checklists to be used during the design and quality control of each submittal. These completed checklists shall be submitted at each design phase as part of the project documentation.

c. The DQC Plan shall be implemented by a Design Quality Control Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated. This individual shall be a person who has verifiable engineering or architectural design experience and is a registered professional engineer or architect. The Consultant shall notify the MWE Representative, in writing, of the name of the individual, and the name of an alternate person assigned to the position.

The MWE Representative will notify the Consultant in writing of the acceptance of the DQC Plan. After acceptance, any changes proposed by the Consultant are subject to the acceptance of the MWE Representative.

2.11.23 VALUE ENGINEERING

The Consultant's proposal for submission will include a comprehensive procedure for value engineering which will be followed during the Consultant's period of performance. Reasonable efforts should be planned to help the client improve efficiency and reduce operating costs. A Value Engineering Assessment (VEA) will be part of the quality assurance plan developed by the Consultant for the project.

2.11.24 CONSTRUCTABILITY ANALYSIS

The Consultant will conduct and report on analysis conducted to confirm the constructability of major components of the Main Dam, and irrigation works. The constructability analysis report will be reviewed by the Design Review Panel (DRP). The Consultant shall be available to answer any requirements of the DRP.

2.11.25 DESIGN REVIEW PANEL

The consultant will prepare necessary required reports and cooperate with a design review panel which will be set up by MWE consisting of a number of appointed experts. Designs, drawings, specifications and BoQ will be revised according to the reviewers' comments as directed by MWE.



2.11.26 CAPACITY DEVELOPMENT

The Consultant shall institute an effective capacity development program for MWE staff which shall integrate national MWE seconded personnel into the feasibility study and detail design Program to the extent possible. The capacity development plan shall be developed during the inception period and an agreed program included in the final inception report. Consideration should be given to a counterpart system of assigning seconded counterpart personnel to various major key task positions, i.e. dam designer, geotechnical expert, hydrologist, Hydro-Mechanical engineer, irrigation network engineer, Hydraulic structures design specialist, EIA specialist, SIA specialist and water supply design specialist. A minimum of 9 counterpart positions should be planned for in the work program each, and shall be described in the capacity development plan.

On job Trainings in soft wares of Geo-studio, Ansys, Civil 3D and onsite training of Geotechnical, Geology, EIA and SIA are must. Some design work shall be assigned to the MWE staff and reviewed and checked by the consultant experts.

The objectives of the Consultant's capacity development program will be to provide knowledge know how and sustained motivation to individuals which are seconded to the program.

At project completion, it is anticipated that participants in the training program will be familiar with the feasibility study and detail design process including the use of Auto CAD methods in preparation of design drawings. MWE will ascertain overall effectiveness of the Consultant's capacity building efforts through periodic briefing sessions with seconded individuals. MWE will make appropriate recommendations for any modifications to the Consultant's program, as may be deemed necessary from these briefing sessions. These recommendations will be adopted through mutual agreement between the Consultant and MWE.

2.11.27 RESPONSIBILITIES OF THE MINISTRY

The Ministry of water and energy will assist the Consultant to procure maps and aerial photographs from the Mapping Authority and AIMS, though the Consultant will be responsible for any payments required. Similarly, if required the Ministry will provide supporting letters to enable the Consultant to procure satellite images from the commercial sector, but again any payments would be the Consultant's responsibility.

MWE will request the Provincial and District Authorities to provide an appropriate level of security for Project personnel whilst working in the field.

2.11.29 RESPONSIBILITY OF THE CONSULTANT

Consultant office, accommodation (Kabul), international and national personnel accommodation and the field, transport, airfares, field office accommodation and other operating costs, which are



the Consultant 's responsibility, related to the work will be shown in detail in the proposal. The cost for support will be included in the cost given in the financial proposal.

2.11.30 CONSULTANT 'S KABUL LIAISON OFFICE

The Consultant shall setup a substantial liaison office in Kabul during the project period. A description of the Kabul office and the extent of project work to be performed in the office will be given in the Consultant's proposal.

When an offeror submits its proposal in response to a [Request for Proposals], and a staffing plan including the names and qualifications of key personnel who are proposed to work on the project is required to be submitted, those personnel who are offered will be the same personnel who will actually perform on the design. If, during performance of the contract, it becomes necessary for the Consultant to substitute personnel for one of those whose qualifications were the basis for evaluation of the offer and award of the contract, the Consultant shall submit to the MWE the same information that was required in the initial proposal regarding the proposed substitute employee. The MWE shall have the right to review the qualifications of the proposed substitute employee and to approve or disapprove his or her qualifications. If the proposed substitute employee's qualifications are disapproved by the MWE, the Consultant will propose another employee who does possess equivalent or better qualifications.

2.11.31 List of Appendices,

Below is the list of the Appendices:

Appendix A (Mechanical technical requirement in separate file)

Appendix B (Electrical technical requirement in separate file)

Appendix C (Qualification)

Appendix-D Feasibility study of Sultan Ibrahim Irrigation project



C1. Requirements of key staff for verification of the existing feasibility study and upgrading of the feasibility study by assessing the technical and economic feasibility of the dam construction in the far or near upstream of the barrage (if the dam is needed, feasible and technically efficient) (6 months).

No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
A	Key Experts (International)			
1	Team Leader / Project Manager	Minimum bachelor's degree in civil engineering or Hydraulics with a total of 20 years of experience in civil engineering with at least 10 years' experience in leadership and management positions on projects of design of hydraulic structures, dams, barrages, and irrigation systems.	1	6
2	Chief Dam and Appurtenant Structures Design Specialist.	Minimum Master degree in Dam design with at least 10 years dam design experience and fully completed the designs of at least two gravity dams and two earth/rock fill dams.	1	3
3	Hydro-mechanical design specialist.	Minimum Master degree in Mechanical engineering/hydraulic structures with a minimum 15 years of experience in design of large gets, penstocks and other hydro mechanical equipment.	1	2
4	Chief Geotechnical specialist	Minimum Master's degree in civil engineering or geology with at least 20 years of experience in geotechnical programs development and at least 10 years' experience in geotechnical/ geophysical investigation of dam projects.	1	3



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No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
5	Topographic Survey Engineer	Minimum bachelor's degree in survey with a minimum of 15 years' general survey experience and at least 5 years' experience in survey of dams and irrigation projects.	1	3
6	Chief Hydrologist	Minimum Master's degree in hydrology with 15 years of experience in hydrology.	1	3
7	Chief Irrigation Engineer	Minimum Master's degree in Irrigation with at least 15 years' experience in design of irrigation systems, canals and pertinent structures.	1	4
8	Environmental specialist	Minimum master's degree in environmental science with 15 years of experience in environmental investigations related to dams, reservoirs and irrigation works.	1	3
9	Chief Economist	Minimum Master's degree in Economics with a minimum of 10 years specific experience in Economic and Financial Assessment/ Appraisal of Infrastructure projects.	1	3
10	Social/Sociology Specialist	Minimum master's degree in social science with 15 years of experience in sociological investigations related to dams, reservoirs and irrigation works.	1	3
11	Cost Estimator	Minimum BSc or recognized professional qualification with a minimum of 7 years' experience in cost estimation of similar projects.	1	3



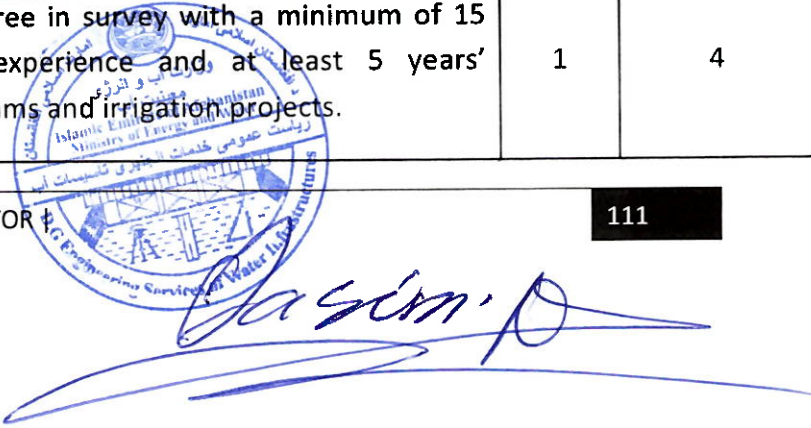
No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
12	Chief electro-Mechanical design specialist.	Minimum Master degree in electro-mechanical engineering with at least 15 years design experience in turbines and other electro-mechanical component of a hydropower project.	1	2
13	Chief agronomist	Minimum Masters degree in agronomy with at least 15 years' experience in the related field.	1	3
14	Chief Engineering geologist	Minimum master degree in engineering geology with at least 15 years' experience in geological investigation of dam projects.	1	2
15	Chief Hydraulic structures design specialist	Minimum master degree in design of hydraulic structures with at least 10 years' experience in design of hydraulic structures i.e. design of spillways, stilling basins, out let works, canals, aqueducts, syphon aqueducts, super passages and others.	1	3
16	Draft Man	Minimum BSc degree in Architectural Engineering with a minimum of 15 years' experience in drafting of dams and appurtenant structures.	1	3
		Total of Key <u>International</u> inputs	16	50

Note: Non-key experts shall be hired as per the project needs.

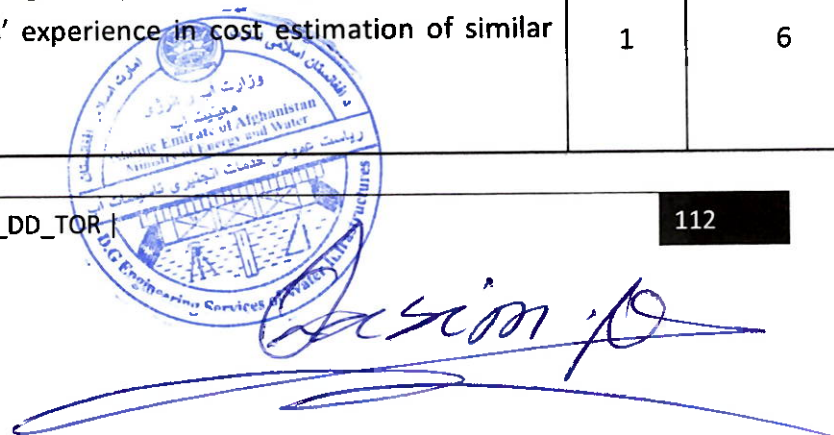


C2. Requirements of key staff for detail design of both the Barrage and Dam (dam is feasible and technically efficient) 12 months

No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
A	Key Experts (International)			
1	Team Leader / Project Manager	Minimum bachelor's degree in civil engineering or Hydraulics with a total of 20 years of experience in civil engineering with at least 10 years' experience in leadership and management positions on projects of design of hydraulic structures, dams, barrages, and irrigation systems.	1	12
2	Chief Dam and Appurtenant Structures Design Specialist.	Minimum Master degree in Dam design with at least 10 years dam design experience and fully completed the designs of at least two gravity dams and two earth/rock fill dams.	1	7
3	Hydro-mechanical design specialist.	Minimum Master degree in Mechanical engineering/hydraulic structures with a minimum 15 years of experience in design of large gets, penstocks and other hydro mechanical equipment.	1	8
4	Chief Geotechnical specialist	Minimum Master's degree in civil engineering or geology with at least 20 years of experience in geotechnical programs development and at least 10 years' experience in geotechnical/geophysical investigation of dam projects.	1	6
5	Topographic Survey Engineer	Minimum bachelor's degree in survey with a minimum of 15 years' general survey experience and at least 5 years' experience in survey of dams and irrigation projects.	1	4



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
6	Chief Hydrologist	Minimum Master's degree in hydrology with 15 years of experience in hydrology.	1	3
7	Chief Irrigation Engineer	Minimum Master's degree in Irrigation with at least 15 years' experience in design of irrigation systems, canals and pertinent structures.	1	7
8	Environmental specialist	Minimum master's degree in environmental science with 15 years of experience in environmental investigations related to dams, reservoirs and irrigation works.	1	3
9	Chief Economist	Minimum Master's degree in Economics with a minimum of 10 years specific experience in Economic and Financial Assessment/ Appraisal of Infrastructure projects.	1	5
10	Social/Sociology Specialist	Minimum master's degree in social science with 15 years of experience in sociological investigations related to dams, reservoirs and irrigation works.	1	3
11	Cost Estimator	Minimum BSc or recognized professional qualification with a minimum of 7 years' experience in cost estimation of similar projects.	1	6



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
12	Chief electro-Mechanical design specialist.	Minimum Master degree in electro-mechanical engineering with at least 15 years design experience in turbines and other electro-mechanical component of a hydropower project.	1	6
13	Chief agronomist	Minimum Masters degree in agronomy with at least 15 years' experience in the related field.	1	4
14	Chief Engineering geologist	Minimum master degree in engineering geology with at least 15 years' experience in geological investigation of dam projects.	1	3
15	Chief Hydraulic structures design specialist	Minimum master degree in design of hydraulic structures with at least 10 years' experience in design of hydraulic structures i.e., design of spillways, stilling basins, out let works, canals, aqueducts, syphon aqueducts, super passages and others.	1	8
16	Chief water supply system design specialist (if required)	Minimum master degree in water supply with a minimum of 10 years' experience in design of the water supply project.	1	4
17	Draft Man	Minimum BSc degree in Architectural Engineering Minimum BSc degree in Architectural Engineering with a minimum of 15 years' experience in drafting of dams and appurtenant structures.	1	6



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
18	Chief Barrage Design specialist	Minimum Master degree in barrage design /hydraulic structures with at least 10 years' experience in design of hydraulic structures design experience and fully completed the designs of at least two barrages.	1	5
		Total of Key <u>International</u> inputs	18	100

Notes:

1. All the above stated experts along with their stated man months may or may not be included in the project as the they depend on the project components.
2. non-key experts shall be hired as per the project needs.
3. The Consultant should recommend office management and support staff which they feel are required to complete the project within the required time frame.



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**C3. Key staff Requirements for Detail design of Barrage Option
(when dam is not included and is either unfeasible or
technically not efficient) 10 months**

No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
A Key Experts (International)				
1	Team Leader / Project Manager	Minimum bachelor's degree in civil engineering or Hydraulics with a total of 20 years of experience in civil engineering with at least 10 years' experience in leadership and management positions on projects of design of hydraulic structures, dams, barrages, and irrigation systems.	1	10
2	Hydro-mechanical design specialist.	Minimum Master degree in Hydro-Mechanical designs/ Mechanical engineering/hydraulic structures with a minimum 15 years of experience in design of dams gates, penstocks and other hydro mechanical equipment.	1	7
3	Chief Geotechnical specialist	Minimum Master's degree in Geo-technical Engineering or geology with at least 20 years of experience in geotechnical programs development and at least 10 years' experience in geotechnical investigation of dam projects.	1	3
4	Topographic Survey Engineer	Minimum bachelor's degree in survey with a minimum of 15 years' general survey experience and at least 5 years' experience in survey of dams and irrigation projects.	1	3



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
5	Chief Hydrologist	Minimum Master's degree in Engineering hydrology with 15 years of experience in hydrology.	1	3
6	Chief Irrigation Engineer	Minimum Master's degree in Irrigation with at least 15 years' experience in design of irrigation systems, canals and their appurtenant structures.	1	7
7	Environmental specialist	Minimum Master's degree in environmental science with at least 15 years of experience in environmental investigations related to dams, reservoirs and irrigation works.	1	3
8	Chief Economist	Minimum Master's degree in Economics with a minimum of 10 years specific experience in Economic and Financial Assessment/ Appraisal of Infrastructure projects.	1	4
9	Social/Sociology Specialist	Minimum master's degree in social science with 15 years of experience in sociological investigations related to dams, reservoirs and irrigation works.	1	3
10	Cost Estimator	Minimum BSc or recognized professional qualification with a minimum of 7 years' experience in cost estimation of similar projects.	1	4



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
11	Chief electro-Mechanical design specialist.	Minimum Master degree in electro-mechanical engineering with at least 15 years design experience electro-mechanical component of a hydropower project.	1	3
12	Chief agronomist	Minimum Masters degree in agronomy with at least 15 years' experience in the related field.	1	4
13	Chief Engineering geologist	Minimum Master degree in engineering geology with at least 15 years' experience in geological investigation of dam projects.	1	2
14	Chief Hydraulic structures design specialist	Minimum Master degree in design of hydraulic structures with at least 10 years' experience in design of hydraulic structures i.e., design of spillways, stilling basins, out let works, canals, aqueducts, syphon aqueducts, super passages and others.	1	5
15	Chief water supply system design specialist (if required)	Minimum master degree in water supply with a minimum of 10 years' experience in design of the water supply project.	1	4



No.	Staff	Minimum Qualifications	Nos. of Key-Expert	Estimated Man Months Not less than that required for completion of the task.
16	Chief Barrage Design specialist	Minimum Master degree in barrage design /hydraulic structures with at least 10 years' experience in design of hydraulic structures design experience and fully completed the designs of at least two barrages.	1	5
17	Draft Man	Minimum BSc degree in Architectural Engineering Minimum BSc degree in Architectural Engineering with a minimum of 15 years' experience in drafting of hydro-Mechanical and Hydraulic structures	1	5
		Total of Key <u>International</u> inputs	17	75

Notes:

1. non-key experts shall be hired as per the project needs.

2. The Consultant should recommend office management and support staff which they feel are required to complete the project within the required time frame.



List of the design standards and codes

List of the standards (not limited to) for feasibility study, detail design and construction of Dams and it's appurtenant structures:

1. USACE, USBR and ICOLD (if applicable) whichever is the safest and conservative.
2. ASCE7-10.
3. ACI 318-14, ACI 350 and other applicable parts of the ACI code.
4. ASTM (for testing Material)
5. AASHTO (for roads and culverts)
6. AISC
7. IBC.
8. IPC.
9. AWS.
10. AWWA
11. EM 1110-2-2100.
12. EM 1110-2-3001.
13. EM 1110-2-2104.
14. ETL 1110-2-584
15. ASME
16. ASHRI

List of the standards but not limited to for design, construction, erection, installation, testing, and commissioning of electrical and electromechanical components of the hydro power plant.

- | | |
|---------|---|
| 1. IEC | International Electro- technical Commission |
| 2. ISO | International Organization for Standardization |
| 3. VDE | Verein Deutscher Elektroingenieure |
| 4. BS | British Standards |
| 5. DIN | Deutsches Institut für Normung |
| 6. IEEE | Institute of Electrical and Electronic Engineers (for grounding) |
| 7. NFPA | National Fire Protection Association (for fire protection) |
| 8. NEMA | National Electrical Manufacturers Association (for fire protection) |

Standards and codes for barrages design:

1. Modul IV: Design of weirs, Barrages and Canals, Pune December 2019.
2. IS 6966 Hydraulic designs of Barrages and Weir Part I Alluvial Reaches;
Cl. 4 Data Required.
3. IS 11130 Criteria for Structural Design of Barrages and weirs.
4. IS 13578 codes of Practice for subsurface exploration of Barrages and weirs;
5. IS 13578 code of Practice for subsurface exploration of Barrages and weirs;

