Government of Nepal

Ministry of Energy, Water Resources and Irrigation

Department of Water Resources and Irrigation

Study Norms

2081

Hon'ble Dipak Khadka
Minister
Ministry of Energy, Water Resources & Irrigation

Government of Nepal
Ministry of Energy, Water Resources & Irrigation

Singhdurbar, Kathmandu, Nepal
www.moewri.gov.np

Letter No.

Ref. No.

MESSAGE FROM MINISTER

I am delighted to approve the Study Norms 2081 of the Department of Water Resources and Irrigation. The Department plays a crucial role in the formulation, implementation, and monitoring of large-scale projects and programs related to water resources including irrigation, water-induced disaster management and the conservation of natural resources.

Nepal, once self-sufficient in food production, has increasingly relied on food imports to meet its growing consumption demands. This rising dependency has placed considerable strain on the country's economy, as fluctuating food prices and external trade conditions can affect the availability and affordability of essential food supplies. A combination of factors, including population growth, shifting dietary habits, limited agricultural land, traditional farming practices, and inadequate access to seeds, fertilizers, pesticides and infrastructure, has hindered local production from keeping pace with demand. Moreover, unpredictable climate patterns such as erratic rainfall, frequent droughts, floods, and rising temperatures have led to crop failures, particularly in rain-fed areas. Expanding irrigation systems, especially in water-scarce regions and ensuring year-round irrigation could significantly boost food production and reduce reliance on imports.

Additionally, Nepal faces increasing risks from floods, landslides and unpredictable rainfall, highlighting the urgent need for improved disaster management infrastructure. Effective disaster management requires an integrated approach that includes early warning systems, disaster response planning and climate-resilient infrastructure. The government must prioritize investments in flood control systems, landslide mitigation strategies and water conservation measures, particularly in vulnerable areas.

I believe that Study Norms 2081 will serve as a comprehensive guide for the Department in conducting studies and preparing project documents, ensuring consistency and standardization across all offices. This updated version addresses the limitations of the previous edition, aligning better with the Department's current scope and objectives.

I extend my best wishes for the successful implementation of the Study Norms 2081.

(Dipak Khadka)
Minister

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MESSAGE FROM SECRETARY

The Department of Water Resources and Irrigation plays a crucial role in providing reliable irrigation facility to irrigable land and enhance production and productivity of irrigable land and contribute significantly in achieving the National Goal of Food Security and support in advancing the commercialization of agriculture in the country.

In addition to the various challenges we face, the impact of climate change and climatic variability has further complicated the pursuit of sustainable irrigation development. In this context, it is essential to refine our processes and embrace new technologies to ensure efficient and effective execution of our initiatives. The DWRI has the mandate of sustainable use of Water Resources ensuring food security along with Water Induced Disaster Risk Management and Conservation of Natural Resources. Thus, the Department's scope has broadened, encompassing from large surface irrigation projects to small conservation ponds and lift irrigation systems. This new Study Norms will significantly contribute towards achieving Department's responsibilities by providing direction and ensuring consistency during preparation of estimates for different studies. I am hopeful that this Norms will be resourceful in producing the well-crafted project report and other relevant documents.

I would like to express my sincere gratitude and congratulations to Department of Water Resources and Irrigation and all the experts and staff colleagues who contributed towards the preparation of the norms and offer my best wishes for its successful implementation.

(Sarita Dawadi)
Secretary

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FOREWORD

I am pleased to share that the Study Norms has been approved by the Ministry of Energy, Water Resources and Irrigation, Government of Nepal on 18 October 2024 (2081/07/02) replacing the existing Norms for the Feasibility Study of Irrigation Schemes (approved by the then Ministry of Irrigation, Government of Nepal on 1 July 2015 (2072/03/16)).

This norm has incorporated several items based on the changed scope of the Department of Water Resources and Irrigation. Wide range of studies related to Inter-basin Water Transfer Multipurpose Irrigation Projects, Small Earthen Dam, Pond Storage, Ground Water Irrigation and Geological Survey, Lift Irrigation, Environmental Study, River Morphological Study, Water Management Study have been added. Similarly, to align with the technological advancements, norms for drone survey and LiDAR Technique; and videography are also incorporated.

I would like to extend my gratitude to the Consultant team for their rigorous efforts in collecting, compiling and analyzing the norms. I appreciate all colleagues from the department who worked directly and review committee members for their hard work, insightful suggestions, diligently cross-checking and valuable feedback in finalizing this document.

I believe, newly approved norms will streamline, provide uniformity and build confidence on the estimation procedures according to the Department's evolving scope. Additionally, preparation of the norms is continuous process so upgradation of the norms in future shall be carried out based on the constructive feedback received and technological advancement.

My best wishes for successful implementation of this norms.

Thank you.

....
(Sanjeeb Baral)
Director General
Director General

NORMS REVIEW COMMITTEE

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Consultant:

PRECAR-ERMC-MADI JV in association with SAP Water

Government of Nepal
Ministry of Energy, Water Resources and Irrigation
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Government of Nepal Ministry of Energy, Water Resources and Irrigation Department of Water Resources and Irrigation Jawalakhel, Lalitpur

General Provision

1. Classification of Surface Irrigation Projects

For the study purpose surface irrigation Projects have been classified as follows:

A. Based on the command area under the scheme

- Mega Irrigation Project : command area > 5000 ha in Terai and command area > 1000 ha in hill
- Large Irrigation Project : command area: > 2000 ha ≤ 5000 ha in Terai and command area > 500 ha ≤ 1000 in hill
- Medium Irrigation Project : command area: > 200 ha ≤ 2000 ha in Terai and command area > 25 ha ≤ 500 ha in hill
- Small Irrigation Project : command area: ≤ 200 ha in Terai and command area a ≤ 25 ha in hill

B. Based on the type of water source

- Run off the river (RoR) schemes: Those schemes which divert water from source to irrigation systems by means of weir/barrage where little or no water storage is provided.
- Pond irrigation schemes: Those schemes which supply irrigation water from ponds.
- Dam storage schemes: Those schemes which store water for irrigation in a reservoir or lake impoundment by constructing dam.
- Multipurpose and/or inter basin transfer projects: Those projects which servers one or more than one purpose in addition to irrigation or which involve transfer of water from one river basin to other.

2. Stages of the Study

Following stages of study shall be carried out for the irrigation project development:

A. For all small and medium irrigation projects including run off the river schemes, pond irrigation schemes, dam storage schemes with earthen dam up to 15m height, lift irrigation schemes and multipurpose schemes, it will be sufficient to carry out three levels of study:

- **Identification Study**
- **Feasibility Study**
- **Detail Engineering Design & Tender Documents**

B. For all irrigation projects except those falling under category A, the study will be carried out in four levels as follows:

- **Identification Study**
- **Prefeasibility Study**
- **Feasibility Study**
- **Detail Engineering Design & Tender Documents**

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Notes on Stages of the Study:

1. Feasibility study of the project shall also be treated as Detailed Project Report (DPR)
2. For technically noncomplex (simple) small RoR schemes, small earthen dam schemes, lift irrigation schemes and pond irrigation schemes, feasibility study itself may be sufficient for Tendering purpose.

3. Assumption/Basis of Norms for Departmental consideration

A. i. If the study/part of study has to be carried out by in house personnel, then following compensation for field works shall be provided to the responsible person/s:

- Labour cost = Total labour input (man days) x district rate of labour
- Equipment cost per day
  - =1.5x district rate of labour for Identification Survey
  - = 5x district rate of labour for Pre-Feasibility Study
  - = 6x district rate of labour for Feasibility Study
  - = 6x district rate of labour for Detailed Design and Tendering
- Carrier /Porter Charge per day
  - =1x district rate of labour for Identification Survey
  - = 2x district rate of labour for Pre-Feasibility Study
  - =2x district rate of labour for Feasibility Study
  - =2x district rate of labour for Detailed Design and Tendering
- Accommodation and logistic per day
  - = 6x district rate of labour for Feasibility Study
  - = 6x district rate of labour for Detailed Design and Tendering
- Field Survey allowance per day for GON employee = ((Basic Monthly Salary + Monthly Remote Area Allowance of the field location) x 1.5)/30
- Daily allowance shall not be provided for the employee who is receiving survey allowance; however other allowances (except daily allowances) shall be provided as per GON rules
- Lodging and Travel allowance will not be provided to the locally hired personnel
- Rates for the consumable items (pegs, pillars etc) required for the field survey will be based on the general market available rates and cost for these items shall be provisioned in cost estimate.

A. ii. If the study/part of study has to be carried out by in house personnel, then following compensation for office works shall be provided to the responsible person/s:

- Daily allowance for desk study = 50% of ((Basic Monthly Salary + Monthly Remote Area allowance at the location of desk study) x 1.5/30)

- Rates for the stationeries/ consumable items required for the desk study and report preparation will be based on the general market available rates and cost for these items shall be provisioned in cost estimate.

4. Basis of Norms for Consultant/s consideration

If the assignment has to be performed through the consultant/s, then following provisions shall be made in the cost estimate:

- Estimate shall be prepared based on rate for the different expert approved by DWRI & evaluated salary per day shall be based on considering 30 days of a month.
- 20 % of the daily remuneration (unless specified otherwise) shall be provisioned as per diem for the National professionals for the duration of fieldwork, whereas, such rate for International Professional shall be 5% of the daily remuneration.
- Estimate for equipment (field and office), transportation, accommodation and logistic supports (carriers, porters etc), consumables items (field and office) etc shall be based on the provision/s given in corresponding study's norms.

5. Technical Support Group (TSG)

To enhance the quality of reports received under feasibility and environment study contracts of large/complex irrigation projects, a Technical Support Group may be formed. Professionals of different expertise shall be nominated by the Client to form such Technical Support Group. The TSG shall review the reports, provide comments and suggestions on it and review the revised reports to check whether the comments and suggestions are incorporated or not. List of the TSG experts are presented below:

SN	Experts	Number	Review meeting per person	Remarks
1	Irrigation Engineer/Expert	1	4 to 5	
2	Hydrologist/ Hydrology Experts	1	3 to 5	
3	Geological/Geotechnical Engineers/Experts	1	2 to 4	
4	Mechanical Engineer/Experts	1	2 to 4	
5	Environmental Engineer/Experts	1	2 to 4	
6	Financial/Economic Analyst	1	2 to 4	
7	Other Experts as per the requirement including project team	4	4 to 6	
8	Hydropower Engineers/Experts	1	2 to 4	For multipurpose project with hydropower component
9	Power System/Electrical Engineer/Expert	1	2 to 4	For multipurpose project with

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				hydropower component

Cost of such formed group shall be provisioned in cost estimate.

NOTE: The number of meetings and category of experts shown in table above may be changed based on requirement of project and phases of study

1.1.ROR SCHEMES AND POND IRRIGATION

For the purpose of ROR irrigation schemes study, Rivers in Nepal have been classified into four types as Class 1, Class 2, Class 3 and Classless River as detailed below:

River type	Details
I Class 1 River	Major rivers originated from Himalayas and snow fed, perennial and part of Mahakali, Karnali, Gandaki and Koshi river and their major tributaries, such as Bheri, Marshyangdi, Sunkoshi etc,
II Class 2 River	Rivers originated from Mahabharata range and further north, such as Mechi, Kamala, Bagmati, Tinau, Rapti and Babai and their major tributaries, such as Marin,
III Class 3 River	Rivers originated within the Terai, Bhabar zone or from Siwalik hill formation, prone to flash floods such as Khando river, Banganga, Tilabe, Sirsia, Manusmara, Hardinath, Sunsari. Minor rivers in the mountain and hills may also be classified under this category.
IV Classless River	Smaller class of rivers with small peak flow, large drains with significant discharge. Small tributary of any class of river.

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1.1.1. NORMS FOR IDENTIFICATION STUDIES

FIELD WORK

1.1.1.1.1. HEADWORK SITE

A. Location and Hydrological survey

i- Human Resources required:

Engineer/Sub engineer (SE)	1
Labour	4

ii- Performance criteria:

Small/Medium Projects	1 day
Large/Mega Projects	3 days
Pond Irrigation	1 day

1.1.1.1.2. CANAL ALIGNMENT

A. Layout Verification Survey (by fly level/appropriate tool)

i- Human Resources required:

Engineer/Sub engineer	1
Labour	2

ii- Performance criteria:

Small/Medium Projects	1 day
Large/Mega Projects	3 days
Pond Irrigation	0.50 day

1.1.1.1.3. COMMAND AREA

A. Command Area Verification by GPS/Available Technique

i- Human Resources required:

Engineer/Sub-Engineer	1
Labour	2

ii- Performance criteria:

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Small/Medium Projects	1 day
Large/Mega Projects	3 days
Pond Irrigation	0.50 day

B. Socio-Economical Survey

i- Human Resources required:

Sociologist/Association Organizer (AO)	1
Labour	1

ii- Performance criteria:

iii-

Small/Medium Projects	1 day
Large/Mega Projects	3 days
Pond Irrigation	0.50 day

1.1.1.1.4. MISCELLANEOUS

A. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

OFFICE WORK

DESK STUDY FOR ROR IRRIGATION AND POND IRRIGATION

1.1.1.1.5. DATA COMPILATION, ANALYSIS AND REPORT PRESENTATION

i- Human Resource required:

Engineer	1
Sub-engineer	1
Sociologist/AO	1
Computer Operator	1
Office Assistant	1

ii- Performance criteria:

Small/Medium RoR Projects	7 days

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Large/Mega RoR Projects	15 days
Pond Irrigation	3 days

1.1.1.1.6. OFFICE AND FIELD EQUIPMENT

Field Equipment, Field Consumables and office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+Field)

CRITERIA FOR SELECTION OF ROR IRRIGATION, POND IRRIGATION AND IRRIGATION WATER STORAGE DAM DATA

The criteria for the selection of the project for identification may be:

- Beneficiaries signature in project request forms as per irrigation guidelines/policy;
- No potential water right disputes;
- Beneficiaries' commitment to take future O&M responsibilities, if required;
- Water availability in the Source;
- Recommendation from local level

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TERMS OF REFERENCE FOR IDENTIFICATION OF THE IRRIGATION PROJECT FOR ROR AND IRRIGATION POND

Desk Study

- Review of Farmers' Request Form, if any, and other available documents (topographic map, LRMP map, Aerial photography, Climatological records, Hydrological records, Geological maps, Socio-demographic records etc) related with project area;
- Locate the project area on available Topographic Map/Google/GIS map/s;
- Locate the tentative alignment of canal systems on available Topographic Map/Google/GIS map/s;

Field Visit (Walkthrough Survey)

- Send information to the farmers before field visit informing tentative date of site visit, if required. Identification team should carry but not limited to the following tools:
  - Copy of project request form, if any;
  - Project identification questionnaire, if any;
  - Topographical maps;
  - Note books and necessary stationary;
  - GPS or other appropriate tools;
  - Stop watch;
  - Calculator;
  - Camera;
  - Measuring tape;
- Verify the appropriate Intake/Head Work location
- Measure/Estimate Discharge at Proposed Intake/Head work location
- Walk through along the proposed canal alignment taking coordinates of the required points at specific locations
- During walk through, landslide/erosion should be assessed
- Tentatively delineate command area boundary using GPS or appropriate tools
- Assessment of existing cropping pattern
- Assessment Existing Irrigation Practices, if any
- Assessment of Water Management Practices, if any
- Assessment of Market facility
- Accessibility of Project Area
- Assessment of construction material availability
- Existing WUA & its function, if any
- Assessment of beneficiary Population/HH of the project
- Assessment of Woman Headed HH of the project area
- Assessment of Social Composition of the area
- Assessment of food sufficiency of the project area
- If it is an existing system, brief inventory of the system
- Assessment of willingness of the farmers for providing land for developing system, if required
- Assessment of willingness of the farmers towards cost contribution as per Irrigation

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Policy/Regulation

Reporting

Based on the data and information collected during the field visit the team needs to analyze the project findings and finalize the identification study. The analysis should be based on technical, economic and social aspects of project implementation. In addition to technical details, the analysis should cover but not limited to the following aspects:

- Water Availability;
- Type of Diversion works;
- Length of main canal;
- Size and type of command area (terrace/plain);
- Water right problems;
- Nature of soil in canal alignment & command area;
- Major technical difficulties (cross drainage/landslide/unstable zones);
- Poor farmer's presence;
- Farmer's interest;

Recommendation Report

The recommendation may be based on, but not limited to the followings:

- Genuineness of demands, if any;
- Command area
- Technical complication
- Water availability and Water dispute;
- Potential for increased agriculture production;
- Environmental adverse effect
- Rehabilitation/ Rehab with extension/ New Scheme/Minor improvements

The Recommendation should clearly state whether the project should be abandoned, delayed or proceed for further study.

MODE OF PAYMENT

A. For Departmental Employees :

The amount shall be paid to the employes assigned for the study as follows:

- For mobilization and field work 60% of the total amount as an advance.
- Upon submission and acceptance of Final Survey Report 40% of the total amount.

Final payment shall not be made if the mentioned work is not completed as per TOR, and the assigned team will be fully responsible ensuring the quality of report as per requirement.

B. For Consultant (if employed):

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds

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1.1.2. NORMS FOR PRE-FEASIBILITY STUDIES

FIELD WORK

1.1.2.1.1. HEADWORK SITE

A. Site selection (confirmation by fly level survey/ appropriate technique)

i- Human Resource required:

Team Leader	0.1
Senior Surveyor/Engineer	1
Sub-Engineer	1
Labour	5

ii- Performance criteria :

RoR Schemes Hills	6 km/day
RoR Schemes Terai	8 km/day

B. Profile Survey (L-Section and X-Section Survey)
B.1. Using conventional method
i- Human resource required:

Human Resource	Class 1 river	Class 2 river	Class 3 river	Classless river
Team Leader/Hydraulic Engineer	0.1	0.07	0.05	0.035
Engineer/Surveyor	1	0.7	0.5	0.35
Sub-Engineer/ Supporting staff	2	1.4	1	0.7
Labour	6	4.2	3	2.1

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ii- Performance criteria:

River type	days
I Class 1 river (at least 3 nos of X-section across the river)	5 days/ km length along river
II Class 2 river (at least 3 nos of X-section across the river)	5 days/km length along river
III Class 3 river (at least 3 nos of X-section across the river)	3 days / km length along river
IV Classless River (at least 3 nos of X-section across the river)	2 days/ km length along river

B

.2. Using Bathymetric survey method

The cost for bathymetric survey, if required, can be obtained from prevailing market rates and or other GON Entity's Norms.

C. Hydrological survey

i. Human Resources required

Engineer/Hydrologist	1
Sub-Engineer	1
Labour	2

ii. Performance criteria:

All Projects	2 days

Notes:

1. For large projects collect river bed materials data for grain size analysis @ 50 m interval along headworks axis (pit size 1.5mx1.5mx2 m). Labour required per pit = 3 Nos. Rate for grain size analysis can be taken from approved rates of other GoN entity or prevailing market rates.
2. If there is no gauging station in the vicinity of Headworks site, it is desirable to install a gauging station during early stage of pre-feasibility study.

D. Geological survey

a. Excavation pit

i- Human Resources required:

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Team Leader	0.1
Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Labour	7x4 = 28
	7 labours can dig 1 pit a day of size 1.50m x 1.50m x 5m

ii- - Performance criteria:

All Projects (4 pits, 1 no at each bank and 2 no at river bed)	1 day

Note: Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

b. Geophysical Exploration, if required:

Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

c. Sub soil exploration by Core drilling/bore holes (Rotatory Drill), if required:

Rates of core drilling/ boreholes shall be obtained from the core drilling norms mentioned in Norms of works.

Note: Rate of all pertinent test required from the samples obtained during core drilling shall be taken from prevailing market rate or as norms prepared by other GON entity.

1.1.2.1.2. CANAL ALIGNMENT

A. Layout confirmation by field survey

i- Human Resources required:

Team Leader	0.1
Surveyor/Engineer	1
Sub-engineer	1
Labour	5

ii- - Performance criteria:

RoR Schemes Hills	6 km/day
RoR Schemes Terai	8 km/day

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B. Geological survey

i- Human Resources required:

Team Leader	0.1
Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Labour	3x2 = 6
	3 labours can dig 1 pit a day of size 1.50m x 1.50m x 2m

ii- Performance criteria:

Hand auguring or excavating pit for soil test @ 3 km along main canal	6 km/day

1.1.2.1.3. CROSS DRAINAGE WORKS

A. Hydrological Survey

i- Human Resources required:

Team Leader	0.1
Engineer/Hydrologist	1
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	4 CD/day
Note : Only major cross-drainages with a river width of more than 10 meter bank to bank or with a discharge more than 200 l/s are to be assessed	

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B. Geological survey

a. Pit excavation

i- Human Resources required:-

Team Leader	0.1
Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Labour	4.7x6 =28
	4.7 labours can dig 1 pit a day of pit size 1.5m*1.5m*3m

ii- Performance criteria:

2 pits at each major CD works	3 major CD/day

Note: Pit excavation can be replaced by hand auger or core drilling of 3m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

b. Geophysical exploration in major Terai Cross Drainage, if required:

Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

1.1.2.1.4. COMMAND AREA

A. Area Verification Survey

i- Human Resources required:

Team Leader	0.1
Surveyor/Engineer	1
Sub-engineer	1
Labour	3

ii- - Performance criteria:

Command area up to 1000 ha in hill and 2000 ha in Terai	5 days
Command area more than 1000 ha in hill and 2000 ha in Terai	7 days

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B. Agricultural Survey

i- Human Resources required:

Agriculturist/Agronomist	1
JT/Sub-Engineer	1
Labour	1

ii- Performance criteria:

Command area up to 1000 ha in hill and 2000 ha in Terai	5 days
Command area more than 1000 ha in hill and 2000 ha in Terai	7 days

C. Agricultural Soil Survey

- **Infiltration rate**

Requirements: 1 test in each 100 ha command area.

Note:

i- Agricultural soil survey shall be carried out at selected sites.

ii- The cost of infiltration test can be obtained from prevailing market rates and for approved rate of other GON entity.

D. Socio-Economical Survey (Based on Group Discussion and questionnaire)

i- Human Resources required:

Sociologist/Economist	1
Association Organizer/Sub-Engineer	3

ii- Performance criteria:

Command area up to 1000 ha in hill and 2000 ha in Terai	6 days
Command area more than 1000 ha in hill and 2000 ha in Terai	10 days

1.1.2.1.5. CONSTRUCTION MATERIAL SURVEY

The construction material survey shall be conducted in order to establish quarry sites and borrow area. 2 to 3 samples for each quarry site shall be collected by excavating pit to identify borrow areas and quarry sites for the construction materials. Minimum size for test pit shall be 1.5mx1.5mx 2.0m. Inspection of quarry sites shall be carried out to obtain a qualitative idea of material quantity and quality in relation to project size. Samples collected from each quarry site shall be sent to laboratory to perform standard tests to confirm materials suitability.

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i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineer	1
Labour	3*3 =9
	3 labours can dig 1 pit a day of size 1.50m x 1.50m x 2m

ii- Performance criteria:

Excavating pit for material test @ 3 pit per quarry site	1 quarry site/day

a. Notes:

The rates for laboratory test/s shall be obtained from prevailing Market price and/or approved rate by other GON entity.

b. Geophysical exploration of quarry site/s, if required:

Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

1.1.2.1.6. MISCELLANEOUS

A. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

OFFICE WORK

1.1.2.1.7. DESK STUDY

A. Data collection, Compilation and Report presentation

i- Human Resources required:

Team Leader	0.1
Engineer	1
GIS expert	1
Office Assistant	1

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ii- Performance criteria:

All Projects	4 days

1.1.2.1.8. *HEADWORK SITE*

A. Location, L-section and X-section

i- Human Resources required:

Team Leader	0.1
Engineer	1
Sub-engineer	1
Office Assistant	1

ii- Performance criteria:

All Projects	1 day

B. Hydrology

i- Human Resources required:

Team Leader	0.1
Hydrologist	1
Sub-Engineer	1
Office Assistant/Computer operator	1

ii- Performance criteria:

River type	Days
I Class 1 river	4 days
II Class 2 river	3 days
III Classless / Class 3 Rivers	2 days

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C. Geology

i- Human Resources required:

Team Leader	0.1
Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Computer Operator	1

ii- Performance criteria:

All projects	2 days

Add Laboratory cost for required lab tests of samples collected from the Head works site.

D. Drawings

i- Human Resources required:

Engineer	1
Sub-engineer	1
AutoCAD expert	1

ii- Performance criteria:

All Projects	3 days

1.1.2.1.9. CANAL ALIGNMENT

A. Layout

i- Human Resources required:

Team Leader	0.1
Engineer	1
Sub-engineer	1
Auto CAD expert	1

ii- Performance criteria:

All projects	3 days

B. Geology

i- Human Resources required:

Team Leader	0.1

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Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Computer Operator	1

ii- P
erformance criteria:

All Projects	10 km/ day

Add Laboratory cost for required lab tests for samples collected from the canal alignment, if any.

1.1.2.1.10. CROSS DRAINAGE WORKS

A. Hydrology

i- Human Resources required:

ii-

Hydrologist	1
Assistant	1

iii- Performance criteria:

All Projects	8 CD/day

B. Geology

i- Human Resources required:

Team Leader	0.1
Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Computer Operator	1

ii- Performance criteria:

All Projects	8 CD/ day

Add Laboratory cost for required lab tests of samples collected from the Cross Drainage locations, if any.

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1.1.2.1.11. COMMAND AREA

A. Command Area Mapping

i- Human Resources required:

Team Leader	0.1
Engineer/GIS expert	1
Sub-engineer	1
Auto CAD expert	1

ii- Performance criteria :

All projects	2 days

B. Agriculture and Agriculture Soil Survey

i- Human Resources required:

Agriculturist/Agronomist	1
JT/Sub-Engineer	1

ii- Performance criteria:

All Projects	3 days

C. Hydrology

i- Human Resources required:

Team Leader	0.1
Hydrologist	1
Sub-Engineer	1

ii- Performance criteria:

All Projects	2 days

D. Socio-Economy

i- Human Resources required:

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Economist	1
AO	1

ii- Performance criteria:

All Projects	3 days

1.1.2.1.12. CONSTRUCTION MATERIAL ANALYSIS

i- Human Resources required:

Team Leader	0.1
Engineer	1
Sub-Engineer	1

ii- Performance criteria:

All Projects	2 days

Add Laboratory cost for required lab tests for samples collected from the quarry site.

1.1.2.1.13. MISCELLANEOUS - for Hills and Terai

A. REPORT PREPARATION

i- Human Resources required:

Team Leader/Water Resources Expert	1
Hydraulic Engineer	1
Hydrologist	0.50
Geologist	1
Socio Economist	0.50
GIS/Expert	0.50
Agronomist	0.50
Computer Operator	1

ii- Performance criteria :

All Projects	10 days

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OFFICE SPACE, OFFICE AND FIELD EQUIPMENT & CONSUMABALES

Field Equipment, Field Consumables and Office Space, Office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

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TERMS OF REFERENCE FOR PRE FEASIBILITY OF THE IRRIGATION PROJECT

The pre-feasibility study should be carried out for the irrigation projects that will decide whether detail feasibility study will be required or not. The study tentatively assesses the technical feasibility, economic viability and institutional suitability of the project implementation. The pre-feasibility study is carried out in the following steps:

- **Desk study**
- **Field survey work**
- **Reporting and recommendation**

TERMS OF REFERENCE FOR PRE FEASIBILITY OF THE IRRIGATION PROJECT

Desk study

- Review of Identification Report and Farmers' Request Form, if any, and any other related documents
- Locate the project area on Topographical/Google/GIS map/Arial map/s
- Assessment of Intake/Head Work, Canal Layout & Command Area on above map/s

Field survey work

Send information to the farmers before field visit informing tentative date of site visit. Survey team should carry, but not limited to the following tools:

- Copy of project request form, if required;
- Copy of Identification Report;
- Topographical maps;
- Note books and necessary stationary;
- Level Machine/ other precise tools
- GPS/appropriate tools;
- Stop watch;
- Calculator;
- Camera;
- Measuring tapes

- Verify the appropriate Intake/Head Work location,
- Take Cross Profiles of the river covering at least 0.5 km u/s & 0.5 km d/s (at an interval but not limited to250m) of proposed intake site, and at least one at proposed Intake/Headwork location.
- Measure Discharge at Proposed Intake/Head work location
- Assess the type of Intake/Head Work to be proposed
- Carryout Geophysical survey of the headworks and major structures , if required
- Carryout Sub soil exploration of the headworks, if required and assess bearing capacity of foundation soil for Headworks and major structures

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- Walk through along the proposed canal alignment and verify whether alternative alignment can be considered; take co-ordinates at specific locations.
- Take a fly level along the proposed canal alignment to assess the ground profile.
- Assess the tentative number & type of major/minor structure along the canal including cross drainage works
- Assess landslide, erosion with possible mitigation measures
- Assess soil strata of main canal alignment
- Make Assessment of construction material quantity and quality/equipment availability & cost
- Make Assessment of skilled/unskilled labor availability in the area
- Take close traverse of command area using GPS/appropriate tools
- Make Assessment of existing cropping pattern
- Make Assessment of Existing Irrigation Practices, if any
- Make Assessment of Water Management Practices, if any
- Make Assessment of Market facility
- Make Accessibility of Project Area
- Find and interact with Existing WUA & evaluate its function, if any
- Make Assessment of beneficiary Population/HH of the project
- Make Assessment of Woman Headed HH of the project area
- Make Assessment of Social Composition of the area
- Make Assessment of food sufficiency of the project area
- If it is an existing system, brief inventory of the system
- Make Assessment of willingness of the farmers for providing land for developing system
- Make Assessment of willingness of the farmers towards cost contribution as per Irrigation Policy/Regulation

Reporting & Recommendation

Based on the data and information collected during the field visit the team needs to analyze the project findings and finalize the prefeasibility study. The analysis should be based on technical, economic and social aspects of project implementation. The analysis should cover the following aspects:

- Length of main canal and soil strata;
- Headworks location with alternative plan, if any
- Tentative soil condition of head works and major cross drainage works foundation
- Size and type of command area (terrace/plain); Water right problems;
- Type of soil;
- Major technical difficulties (cross drainage/landslide/unstable zones);
- Poor farmer's presence;
- Farmer's interest;
- Make Assessment of tentative cost of the project

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- Evaluate Cost per ha
- Make Assessment of tentative benefit of the project
- Evaluate economic indicators (NPV, Internal Rate of Return and Benefit Cost Ratio)

Recommendation Report.

The recommendation may be based on:

- Genuineness of demand;
- Command area;
- Technical complication;
- Environmental adverse effect;
- Economic indicators i.e. Cost/ha, EIRR & B/C ratio etc'

MODE OF PAYMENT

A. For Departmental Employees :

The amount shall be paid to the employes assigned for the study as follows:

- For mobilization and field work 60% of the total amount as an advance.
- Upon submission and acceptance of Final Survey Report 40% of the total amount.

Final payment shall not be made if the mentioned work is not completed as per TOR, and the assigned team will be fully responsible ensuring the quality of report as per requirement.

B. For Consultant:

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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1.1.3. NORMS FOR FEASIBILITY STUDIES

FIELD WORK

1.1.3.1.1. HEADWORK SITE

A. Finalization of Headworks location (Total Station or Appropriate Instrument)

i- Human Resource required:

Team Leader/Water Resource Engineer/ Hydraulic Engineer	0.25
Engineer/Surveyor	1
Sub-Engineer	1
Labour	4

ii- Performance criteria :

Hills	6 km/day
Terai	8 km/day

B. Benchmark survey

i- Human Resource required :

Team Leader	0.1
Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

ii- Performance criteria :

Location	BM/day
All Projects	10

C. Contour Survey

i- Human Resource required:

Team Leader/Water Resource Engineer/ Hydraulic Engineer	0.10
Engineer/Surveyor	1
Sub-Engineer	1
Labour	8

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ii- Performance criteria:

I Class 1 river	4 days
II Class 2 river	3 days
III Class 3 river	2 days
IV Classless River	1 day

D. L-section & X-section Survey

i- Human Resource required :

Human Resource	Class 1 river	Class 2 river	Class 3 river	Classless river
Team Leader/Water Resource Engineer/ Hydraulic Engineer	0.1	0.07	0.05	0.035
Engineer/Surveyor	1	0.7	0.5	0.35
Sub-Engineer/ Supporting staff	2	1.4	1	0.7
Labour	6	4.2	3	2.1

ii- Performance criteria:

River type	Days
I Class 1 river (at least 3 nos of cross section across the river in 1 km length of river)	5 days/ km length along river
II Class 2 river (at least 3 nos of cross section across the river in 1 km length of river)	5 days/km length along river
III Class 3 river (at least 3 nos of cross section across the river in 1 km length of river)	3 days / km length along river
IV Classless River (at least 3 nos of cross section across the river in 1 km length of river)	2 days/ km length along river

Note: The cost for Bathymetric Survey, if required, can be obtained from prevailing market rates and other GON entity's norms.

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E. **Geological Survey**

For Irrigation project Command area <= 500 ha

i- Human Resources required:

Team Leader/Senior Geologist/ Senior/Geotech Engineer	1
Geologist	1
Labour	7x3 = 24
	7 labours can dig 1 pit a day in river bed of size 1.50m x 1.50m x 5m

ii- Performance criteria:

All Projects (3 nos of pits at river bed)	1 day

Note: Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

For RoR Irrigation project Command area > 500 ha

<u>For test pit</u>

i- Human Resources required:

Team Leader/Senior Geologist/ Senior Geotech Engineer	1
Geologist	1
Labour	7x5 = 35
	7 labours can dig 1 pit a day in river bed of size 1.50m x 1.50m x 5m

ii- Performance criteria:

All Projects (5 nos of pits, 3 nos at river bed and 1 no in each river bank)	1 day

Note: Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

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Geophysical Exploration, if required:

Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

Sub soil exploration by Core drilling/bore holes (Rotatory Drill), if required:

Rates of core drilling/ boreholes shall be obtained from the core drilling norms mentioned in Norms of works.

Note: Rate of all pertinent test required from the samples obtained during core drilling shall be taken from prevailing market rate or as norms prepared by other GON entity.

F. Hydrological survey + Water quality test

i- Human Resource required :

Human Resource	Class 1 river	Class 2 river	Class 3 river	Classless river
Team Leader	0.1	0.07	0.05	
Hydrologist	1	0.7	0.50	
Sub Engineer	2	1.4	1	0.7
Labour	2	1.4	1	0.7

ii- Performance criteria :

River type	Days
I Class 1 river	3 days
II Class 2 river	3 days
III Class 3 river	2 days
IV Classless River and Pond Irrigation Scheme	2 days

G. River morphology and Sedimentation survey

i- Human Resource required:

Team Leader	0.10
Engineer/Silt Analyst/Geotechnical Engineer	1
Sub-Engineer	1
Labour	3

ii- Performance criteria :

RoR Schemes <= 500 ha	2 days
RoR Schemes > 500 ha	3 days

H. Discharge Measurement and Sediment Study Covering all seasons during

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contract period, if included.

S N	Particular	Quantity/Basis for Quantity Estimation
1	Installation of automatic hydrological station with telemetry as per requirement	1 Set
2	Installation of automatic weather station with telemetry for storage projects	1 Set
3	Establishment of staff gauge at headwork/dam/weir site	1 set (Total height as per requirement)
4	Establishment of staff gauge at power house site (optional)	1 set (Total height as per requirement)
5	Training to Gauge reader for discharge measurement	Lump Sum
6	**Discharge Measurement**	
	Hiring of equipment (current meter or other appropriate equipment) with complete accessories	Number of months allocated for study
	Allowance for technician sub-engineer	5-10 days x number of months for study
	Transportation cost for discharge measurement person and equipment	As per accessibility of Project
7	**Sediment Sampling**	
	a. Utilization cost of sediment sampler with all accessories	Lump Sum
	b. Cost of sediment sampling	One sample per day for wet months (June-September) and 2 samples per month for dry months.
	c. Transportation of sediment sample to lab	Once in a month for total study period
8	**Lab Tests on Sediment Samples**	
	a.Sediment concentration measurement	No of samples as in 6b.
	b. PSD Analysis	Two number per month for wet months and One number in total for dry months (Total Nine PSD analysis each year)
	c. Mineralogical Analysis	Two number per month for wet months and One number in total for dry months (Total Nine Mineralogical analysis each year)
	d. other analysis as per recommendation by the feasibility and environmental study team	Lump Sum
9	Water Quality Analysis	
	Water Quality Test as per TOR	One test per month

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	Other analysis as per recommendation by the feasibility and environmental study team	Lump Sum

The rate of items related to this study shall be obtained from market and/or approved GoN Norms.

1.1.3.1.2. Settling Basin

A. Site Selection

i- Human Resources required:

Team Leader	0.1
Geologist	1
Hydraulic Engineer	1
Surveyor	1
Environmental Expert	0.5

ii- Performance criteria:

Settling basin Discharging capacity ≤ 1 cumec	1 day
Settling basin Discharging capacity ≤ 10 cumecs	1.5 day
Settling basin Discharging capacity > 10 cumecs	2 day

B. Benchmark survey

i- Human Resources required:

Team Leader	0.1
Surveyor	1
Sub-Engineer	1
Labour	6

ii- Performance criteria:

All Projects	10 BM/Day

C. L-Sec & X-Sec Survey

i- Human Resources required:

Team Leader	0.1

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Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	5

ii- Performance criteria:

All Projects	3.0 km/day

D. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	8

ii- Performance criteria:

All Projects	3 Km/day

1.1.3.1.3. CANAL ALIGNMENT

A. Layout Survey

i- Human Resource required :

Team Leader	0.10
Engineer/Surveyor	1
Sub-Engineer	2
Labour	5

ii- Performance criteria :

Hills	3 km/day

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Terai	6 km/day

B. L-section Survey

i- Human Resource required:

Team Leader/Water Resource Engineer	0.10
Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

ii- Performance criteria:

Hills	3km/day
Terai	6 km/day

C. X-section Survey

i- Human Resource required :

Team Leader/Water Resource Engineer	0.10
Engineer/Surveyor	1
Sub-Engineer	1
Labour	8

ii- -Performance criteria :

Location	Distance	Performance
Hills	50 meter	1.5 km/day
Terai	50 meter	3 km/day

D. Bench mark Survey

i- Human Resource required:

Team Leader	0.10
Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

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ii- Performance criteria :

Location	Distance c/c	BM/day
Hills	0.5 km	10
Terai	1.0 km	10

E. Geological Survey

For RoR Schemes command area <= 500ha. and all pond irrigation schemes

i- Human Resources required:

Team Leader	0.10
Senior Geologist/Geotech Engineer	1
Geologist/ Engineer	1
Labour	6x3=18
	3 labours can dig 1 pit a day of size 1.50m x 1.50m x 2m

ii- Performance criteria:

Hand auguring or excavating pit (1.5mx1.5mx2m) for soil test @ 1 km along main canal	6 km/day

For RoR Schemes command area > 500ha

i- Human Resources required:

Team Leader	0.10
Senior Geologist/Geotech Engineer	1
Geologist/ Engineer	1
Labour	6x3=18
	3 labours can dig 1 pit a day of size 1.50m x 1.50m x 2m

ii- Performance criteria:

Hand auguring or excavating pit (1.5mx1.5mx2m) for soil test @ 1 km along main canal)	6 km/day

Infiltration rate Survey for Geological Study (For Surface irrigation schemes > 500 ha only)

Requirement: 1 test in every 500m along the canal alignment.

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Note: Cost of infiltration tests can be obtained from prevailing market rates.

1.1.3.1.3.1.1.1.Dispersion Test of Soil:

Requirements: 1 test in every 1 km and at the locations where soil is susceptible.
Note: The Cost of dispersion test can be obtained from prevailing market rates.

1.1.3.1.4. CROSS DRAINAGE WORKS

A. Contour, L-section and X-section Survey

i- Human Resource required :

Team Leader	0.1
Engineer/Surveyor	1
Sub-Engineer/ Supporting staff	2
Labour	6

ii- Performance criteria:

River type	Days
I Class 1 river	1 CD/day
II Class 2 river	2 CD/day
III Class 3 river	4 CD/day
IV Classless River	6 CD/day

B. Geological Survey

- **For Class 1 and Class 2 River Cross Drainage:**

Test pit

i- Human Resources required:

Team Leader	0.1
Geologist	1
Labour	7x5 = 35
	7 labours can dig 1 pit a day in river bed of size 1.50m x 1.50m x 5m

ii- Performance criteria:

Each CD Works (5 nos of pits, 3 nos at river bed and 1 no in each river bank)	1 CD/ day

Note: Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

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Geophysical Exploration, if required:
Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

Sub soil exploration by Core drilling/bore holes (Rotatory Drill), if required:
Rates of core drilling/ boreholes shall be obtained from the core drilling norms mentioned in Norms of works.
Note: Rate of all pertinent test required from the samples obtained during core drilling shall be taken from prevailing market rate or as norms prepared by other GON entity.

- **For Class 3 and Classless River Cross Drainage Works**

a. **Test Pit**

i- Human Resources required:

Senior Geologist/Geotech Engineer	1
Geologist/ Sub Engineer	1
Labour	4.7*8=37.6
	4.7 labours can dig 1 pit a day of pit size 1.5m*1.5m*3m

ii- Performance criteria:

2 pits at each CD works	4 CD/day

Note: Pit excavation can be replaced by hand auger or core drilling of 3m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

C. **Hydrological survey**

i- Human Resource required :

Team Leader	0.1
Hydrologist	1
Sub Engineer	1
Labour	4

ii- Performance criteria :

River type		Days
I	Class 1 river	1 CD/Day

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II Class 2 river	2 CD/day
III Class 3 river	4 CD/day
IV Classless River and Pond Irrigation Scheme	6 CD/day

1.1.3.1.5. COMMAND AREA - for Hills and Terai

A. Traverse Line Survey

i - Human Resource required:

Team Leader	0.1
Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

ii - Performance criteria :

Command Area (CA)	Days
<=100 ha	2
<=500 ha	3
<=1000 ha	5
>1000ha	(5+(hectarage more than 1000 ha) * (1/1000)

B. Topographical Survey (Ground survey technique)

i - Human Resource required:

Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

ii -Performance criteria :

Hills	20 ha/day
Terai	30 ha/day

- **Topographical Survey using drone : Please refer Drone Survey**
- **Topographical Survey using Lidar Technique : Please refer Lidar Survey**

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C. Bench mark Survey

i - Human Resource required :

Team Leader	0.1
Engineer/Surveyor	1
Sub-Engineer	1
Labour	6

ii - Performance criteria :

Location	Distribution	BM/day
Command Area (CA)	1 BM/ 50 ha	10

D. Agricultural Survey

i - Human Resource required:

Agronomist	1
JT	1
Labour	1

ii - Performance criteria :

Command Area (CA)	Days
<= 100 ha	2
100 to <= 1000 ha	(2 + (hectarage more than 100 ha)*(1/300))
> 1000 ha	(5 + (hectarage more than 1000 ha)*(1/500))

E. Agricultural Soil Survey

- **Infiltration rate**

Requirements: 1 test in each 50 ha command area.

Note:

i- For very large command area, agricultural survey and agricultural soil survey can be conducted in representative selected sample area.

ii- The cost of infiltration test can be obtained from prevailing market rates and/or approved rate by other GON entities.

F. Socio-Economical Survey (Household Survey)

i - Human Resource required:

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Team leader	0.10
Sociologist/Economist/Statistician	2
Assistant/ Social Mobilizer	7

ii - Performance criteria :

House Hold	Day
<= 100 HH	1

Note:

i- For every HH above 100 HH and up to 500HH, the estimate shall be increased by a factor (HH/100) ^0.80.
ii- For every HH above 500HH, the estimate shall be increased by a factor of 0.75 x (HH/100) ^0.80.
iii- For very large command area, socio economic survey can be conducted in representative selected sample area.

1.1.3.1.6. Quarry site Survey

The construction material survey shall be conducted in order to establish quarry sites and borrow area. For the project with Command area upto 500 ha, 2 to 3 samples from quarry site likely to be used, shall be collected by excavating pit to identify borrow areas and quarry sites for the construction materials. For the project with command area more than 500 ha, following the pre-feasibility study, further investigations shall be done collecting samples in 20 to 50m grid. Minimum size for test pit shall be 1.5mx1.5mx 2.0m. Inspection of quarry sites shall be carried out to obtain a qualitative idea of material quantity and quality in relation to project size. Samples collected from each quarry site shall be sent to laboratory to perform standard tests to confirm materials suitability.

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineer	1
Labour	3xnos. of test pits in each quarry sites
	3 labours can dig 1 pit a day of size 1.50m x 1.50m x 2m

ii- Performance criteria:

Excavating pit for material test	1 quarry site/day

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Notes:

i- The cost of required Material Sample tests shall be taken from prevailing norms prepared by other GON entity and/ or market price.

ii- Geophysical exploration of quarry site/s, if required: Rates for Geophysical Exploration (ERT/SRT or any other pertinent tests) shall be obtained from the Geophysical exploration norms mentioned in related chapter.

iii- Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

1.1.3.1.7. Land Acquisition Survey (Personal land for compensation and ownership transfer)

A. Cadastral Map Collection

i- Human Resources required:

Sub Engineer/ Amin	1

ii- Performance criteria:

All Projects (Hill/Terai)	2 day

B. Field Survey: land delineation, marking, area measurement, record maintaining etc

i- Human Resources required:

Surveyor	1
Sub Engineer/ Amin	1
Labour	4

ii- Performance criteria:

Headwork Site	0.5 ha/day
Canal Alignment	0.3 ha/day

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1.1.3.1.8. MISCELLANEOUS - for Hills and Terai

A. Transportation

Estimate for transportation facility shall be made based on means of transportation, numbers of visit to the field, market rate of transportation means and days required for the field works including to and fro to the field. In case of international expat number of visit from his/her country to the site and return back shall also be considered.

NOTES: ANALYSIS AND TESTS TO BE PERFORMED

Based on the scale and complexity of the projects, site condition and nature of site materials, not limited to the following tests may be required for RoR , Irrigation storage dam schemes and multi-purpose projects (Headworks site, major structure locations, canal alignment, borrow area, Quarry site etc) and costs for the same will be added in Study Estimate. The Costs for these tests can be obtained from prevailing market rates and or other GoN entity's norms.

➢ **Soil**

Index Properties of Soil

- Grain Size Analysis including Hydrometer,
- Moisture Content,
- Bulk and Dry Unit Weight,
- Specific Gravity,
- Liquid and Plastic Limit,
- depressiveness or soluble chemical content,
- Slake Durability Test,
- Fusion test,
- Mineralogical analysis of soil (particularly for landslide and tunneling)

Engineering Properties of soil

- Direct shear test,
- Triaxial test,
- Oedometer test,
- Permeability test
- CBR test for dams, embankments, and roads

➢ **Rock**

Index Properties of Rock

- Moisture Content, porosity, permeability
- Bulk and Dry Unit Weight,
- Specific Gravity,

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- Petrography and thin section

Engineering Properties of Rock
- Point Load (6 Nos. in a set),
- UCS,
- Direct Shear Test
- Tensile Strength,
- Triaxial test,
- Permeability (in-situ for jointed rock mass and laboratory for massive rocks),
- Abrasivity test (for tunneling),
- Plate load test (for rock mass strength in tunnel),
- Stress Test (over coring or as appropriate),
- Slake durability test,
- Youngs modulus of elasticity,
- Poisson Ratio,
- Punch Test (for TBM Tunneling)
- Water absorption test,
- If any infill materials (test of soils as and when required)

Construction Material Testing
- Sieve analysis
- Los Angles Test
- Sulphate Soundness Test
- Water Absorption Test
- Specific Gravity Test
- Fineness module
- Aggregate Crushing Value Test
- Aggregate Impact Value Test
- Bulk unit weight of aggregate
- Elongation Test
- Flakiness Test
- Alkali Reactivity
- Organic Content
- Permeability Test

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OFFICE WORK

1.1.3.1.9. DESK STUDY

A. Data collection, Compilation and Report presentation

i - Human Resource required:

Team Leader	0.25
Engineer	1
GIS expert	0.50
Sub-Engineer	1
Auto CAD expert	0.50
Office Assistant	1

ii - Performance criteria:

Pond Irrigation Scheme	1 day
Command area Small/Medium (RoR)irrigation Project	2 days
Large (RoR) Irrigation Project	5 days
Mega (RoR) Irrigation Project	10 days

1.1.3.1.10. HEADWORK SITE

A. Contour, L-section and X-section

i - Human Resource required:

Team Leader	0.10
Engineer/Surveyor	1
GIS expert	1
Sub-Engineer	1
Auto CAD Expert	1
Office Assistant	1

ii - Performance criteria :

River type	Days
I Class 1 River	5

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II Class 2 River	4
III Class 3 River	2
IV Classless River	1

B. Geology

i - Human Resources required :

Geologist	1
Assistant Geologists	0.5
GIS expert	0.5
Auto CAD expert	0.5
Office Assistant	1

ii - Performance criteria :

Class 1 and Class 2 Rivers	5 days
Class 3 and Classless Rivers	3 days

C. Hydrology

i - Human Resource required :

Team Leader	0.10
Hydrologist	1
GIS expert	0.5
Assistant	1
Office Assistant	1

ii - Performance criteria:

River type	days
I Class 1 River	5
II Class 2 River	4
III Class 3 River	3
IV Classless River	2

D. Design and Drawings

i - Human Resource required:

Team leader	0.25

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Hydraulic Design Engineer	1
Structural Engineer	0.50
Geotech Engineer	0.25
Hydrologist	0.25
Mechanical Engineer	0.50
Electrical Engineer	0.50
GIS expert	0.50
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii -Performance criteria:

River type	days
I Class 1 River	60
II Class 2 River	30
III Class 3 River	15
IV Classless River	7
Pond Irrigation	2

Note: For Pond Irrigation Scheme Structural, Geotech, Mechanical and Electrical Engineers may not be required.

E. Estimate

i - Human Resource required :

Team Leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	2
Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 River	7
II Class 2 River	7
III Class 3 River	5
IV Classless River	5
Pond Irrigation	2

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1.1.3.1.11. Settling Basin

A. Layout

i - Human Resource required:

Team Leader	0.10
Water Resource Engineer	1
GIS expert	0.5
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii Performance criteria:

All Projects	0.50 day

B. Contour, L-Sec & X-Sec Survey

i -Human Resources required:

Surveyor	1
Sub-Engineer	1
GIS Expert	0.50
Auto CAD Expert	1
Office Assistant	1

ii -Performance criteria:

All Projects	1 day

C. Geological Survey

i -Human Resources required:

Team Leader	0.10
Geologist	1
Sub-Engineer/Assistant Geologists	1
Assistant	1
Office Assistant	1

ii -Performance criteria:

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All Projects	1 day

D. Design and Drawings of Settling Basin

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	1
GIS expert	0.50
Structural Engineer	0.50
Mechanical Engineer	0.50
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

Discharge	Days
Q < 3 m3/s	2
3 m3/s ≤ Q < 10 m3/s	3
Q ≥ 10 m3/s	4

E. Estimate

i - Human Resource required:

Team leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	2
Office Assistant	1

ii - Performance criteria :

All Projects	1day

1.1.3.1.12. CANAL ALIGNMENT WITH CANAL STRUCTURE

A. Layout

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i - Human Resource required:

Team Leader	0.10
Water Resource Engineer	1
GIS expert	0.50
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria:

Command Area	Days
<=500 ha	2
<= 10000 ha	3
<= 25000 ha	4
>25000 ha	(4 + (hectarage more than 25000 ha)*(1/15000))

B. Contour, L-section and X-section

i - Human Resource required:

Team leader	0.10
Civil Engineer/Surveyor	1
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria :

Command Area	Days
<=500 ha	2
<= 10000 ha	3
<= 25000 ha	4
>25000 ha	(4 + (hectarage more than 25000 ha)*(1/15000))

C. Geology

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i - Human Resource required :

Team leader	0.10
Geologist	1
GIS expert	0.5
Office Assistant	1

ii - Performance criteria:

All projects	5 km/day

D. Design and Drawings of Canal Sections

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	1
GIS expert	0.5
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

Command Area	Days
<=500 ha	3
<= 10000 ha	7
<= 25000 ha	10
>25000 ha	(10 + (hectarage more than 25000 ha)*(3/15000))

E. Design and Drawings of Canal Structures

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	1
Structure Engineer	0.5

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Mechanical Engineer	0.05
Geologist/Geotech Engineer	0.10
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria:

Type	Km (canal length)/day
All types of canal structures along canal alignment except cross drainage in small and medium	5
All types of canal structures along canal alignment except cross drainage in Large and Mega	3

F. Estimate

i - Human Resource required:

Team leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	2
Office Assistant	1

ii - Performance criteria :

All projects	6 km/day

1.1.3.1.13. CROSS DRAINAGE WORKS

A. Contour, L-section and X-section

i - Human Resource required :

Team leader	0.10
Engineer/Surveyor	1
GIS expert	0.5
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

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Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 river	2 CD/day
II Class 2 river	3 CD/day
III Class 3 river	4 CD/day
IV Classless River	6 CD/day

B. Geology

i - Human Resource required:

Team leader	0.10
Geologist	1
GIS expert	0.5
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria :

All project	6 CD/day

C. Hydrology

i - Human Resource required :

Team leader	0.10
Hydrologist	1
GIS expert	0.5
Assistant	1
Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 river	2 CD/day
II Class 2 river	3 CD/day
III Class 3 river	4 CD/day

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IV Classless River	6 CD/day

D. Design and Drawings

i - Human Resource required :

Team leader	0.10
Hydraulic Engineer	0.5
Structural Engineer	0.25
Geologist/Geotech Engineer	0.10
GIS expert	0.25
Sub-Engineer	0.5
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 river	1 CD/ 5day
II Class 2 river	1 CD/ 4day
III Class 3 river	1 CD/ 2day
IV Classless River	1 CD/ day

E. Estimate

i - Human Resource required :

Team leader	0.1
Engineer/Quantity Surveyor	1
Sub-Engineer	1
Office Assistant	1

ii - Performance criteria :

All Projects	2 CD/day

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1.1.3.1.14. COMMAND AREA - for Hills and Terai

A. Traverse Line Survey

i - Human Resource required :

Team Leader	0.1
Engineer	1
GIS expert	0.5
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria :

Command area (CA)	Days
<= 200 ha	2
<=500 ha	3
<=1000 ha	4
> 1000 ha	(4 + (hectarage more than 1000 ha)*(1/500))

B. Topography (Ground Survey method)

i - Human Resource required :

Team Leader	0.1
Engineer	1
GIS expert	1
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

Hills	25 ha/day
Terai	50 ha/day

- **Topography using Drone : See Drone Survey**
- **Topography using Lidar Technique : See Lidar Survey**

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C. Agriculture

i - Human Resource required:

Team Leader	0.1
Agronomist	1
Assistant	1
Office Assistant	1

ii - Performance criteria :

Command area (CA)	Days
<= 1000 ha	5
<=5000 ha	7
<=25000 ha	10
> 25000 ha	(10 + (hectarage more than 25000ha) * (5/20000))

D. Socio-Economy

i - Human Resource required :

Team leader	0.10
Sociologist	4
Economist/Statistician	1
Assistant/Social-Mobilizer	4

ii - Performance criteria :

Households	Days
<= 100 HH	1
For HH above 100 HH, the estimate shall increase by a factor (HH/100)^0.8	

1.1.3.1.15. Material Quarry

i - Human Resource required :

Team leader	0.10
Geologist	1

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Engineer	1
Office Assistant	1

ii - Performance criteria :

Quarry site	Days
1 quarry site	1

1.1.3.1.16. Land Acquisition Map Collection, Overlapping and Report Preparation:

i- Human Resources required:

Surveyor	1
Sub Engineer/ Amin	1

ii- Performance criteria:

Headwork Site	5 ha/day
Canal Alignment	3 ha/day

1.1.3.1.17. Construction Planning and Management

i - Human Resource required:

Team leader	0.10
Engineer/Construction Planner	1
Sub Engineer	1
Office Assistant	1

ii - Performance criteria:

Small irrigation scheme	5 days
Medium irrigation scheme	7 days
Large irrigation schemes	10 days
Mega Irrigation Schemes	15 days

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1.1.3.1.18. Rate Analysis

i - Human Resource required:

Team leader	0.10
Engineer	1
Sub-Engineer	2
Office Assistant	1

ii - Performance Criteria

Small irrigation scheme	5 days
Medium irrigation scheme	7 days
Large irrigation schemes	10 days
Mega Irrigation Schemes	15 days

1.1.3.1.19. Economical Analysis

i - Human Resource required :

Team leader	0.10
Economist	1
Assistant	1
Office Assistant	1

ii - Performance criteria:

Small irrigation scheme	5 days
Medium irrigation scheme	7 days
Large irrigation schemes	10 days
Mega Irrigation Schemes	15 days

1.1.3.1.20. Report Preparation

i - Human Resource required :

Team leader	1
Hydraulic Engineer	1

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Surveyor	0.25
Structural Engineer	0.25
Hydrologist	0.25
Geologist/Geotech Engineer	0.25
Agriculturist	0.20
Sociologist	0.20
Economist	0.10
Legal Expert	0.10
Construction planner	0.05
Procurement Specialist	0.05
Assistant	2
Office Assistant	1

ii - Performance criteria

Small Irrigation Schemes	10 days
Medium Irrigation Schemes	20 days
Large Irrigation Schemes	30 days
Mega Irrigation Schemes	45 days

MISCLLEANEOUS:

1.1.3.1.21. Office Space, Office and Field equipment & Consumables;

Field Logistics, Field Equipment, Field Consumables, office space and furnishing, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc.	15 % of Total Cost of Human Resources (Office+ Field)

1.1.3.1.22. Transportation Cost:

Estimate for transportation facility shall be allocated based on means of transportation, numbers key personnel entitled to use vehicles, market rate of transportation means and days required to complete the works. In case of international expert number of visit from his/her country to the working station shall also be considered.

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Sample Terms of Reference for Feasibility Study of Irrigation Schemes

INTRODUCTION

Background to ToR

Department of Water Resources and Irrigation (DWRI) is a government organization, with a mandate to plan, develop, maintain, operate, manage and monitor different modes of environmentallysustainable and socially acceptable irrigation and drainage systems - from small to larger scale surface systems and from individual to community groundwater schemes. Apart from this, the DWRI also has to carry outriver training activities to protect the floodways, floodplains and agricultural lands in the form of river bank protection such that the loss of properties caused by flooding is reduced. Its ultimate aim is to provide year round irrigation facilities and increase the irrigable area of the country to higher limits. This giving a primary input in increasing the productivity of the land and providing a major input to the Gross Domestic Product (GDP) and eventually improve thestandard of living of the beneficiary farmers. The Feasibility Study is the basis for the project implementation and is carried out by a team of experts having engineering, agriculture, environmental, and socio-economic professionals. This study normally forms the basis of financing by external funding agencies or by the Government. The study assesses the technical feasibility, friendly environment, economic viability and institutional suitability of the project implementation.

A survey Norms was prepared and implemented in Oct 1988 to carryout ID, PF or DFS and same was revised, updated and approved by the Ministry of Irrigation, Nepal on 1 July 2015.With the introduction of new technologies, methodology and extended scope of work, it is felt necessary to revise above mentioned Norms, so the proposed Norms needs to be approved and implemented in order to facilitate different studies which will be carried out by department or individual consultant or firms.

Objective of the Study

The overall objective of the study is to formulate technically sound, environmentally friendly, socially acceptable and economically viable Irrigation System is to be designed for a design life of more than 25-years and with low maintenance cost. The canal & related structures must harmonize with the surroundings and present a pleasing appearance. The maximum possible use of locally available materials & technology in the feasibility study/design will be appreciated.

Scope of Works

The detail survey team (here onwards "the team") will perform detailed technical, social and economic analysis (techno-socio- economical) along with related works herein to attain the desired objectives. The team will be responsible for accuracy, interpretation, analysis of all data received and for the conclusion and recommendations in their report. The mentioned scope of work to be carried by the team will broadly include but not limited to the following;

a) Desk study

A desk study will be carried out collecting all the data, maps and information relevant to the project and review of Identification/Pre-feasibility Report for planning of further field survey and investigation works as well as detailed design; this study needs to see generally two aspects.

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- **List of outstanding matters to be studied, and**
- **Any possible scheme alternatives**

There may be several outstanding issues not touched during previous studies, which will be addressed during feasibility study (FS). The scheme alternatives need to be reviewed in the FS, which may include the following:

For New Schemes

i) Possibility of alternative water sources from different river, supply, groundwater or supplementary rivers, conjunctive use etc.

ii) Alternative intake site, canal alignment etc.

For Rehabilitation Schemes

i) Possibility of command area extension

ii) Combining several schemes

iii) Revised intake site/canal alignment

b) Field Survey, Data Collection and Preparation of Maps

The field survey work may differ slightly based on the type of the scheme whether it is new or rehabilitation. In general, the following main activities to be carried out for data collection, planning and designing of headworks/intakes, canal networks and detailed feasibility study:

i) System Planning

ii) Benchmark Survey

iii) Intake/Head Work site survey

iv) Discharge measurement

v) Canal alignment survey

vi) Settling basin survey

vii) Command area survey

i) System Planning

Digital topographical maps (1:25,000 scales) of the area from Survey Department shall be acquired and layout plan of irrigation and drainage network shall be prepared. An interactive procedure shall be followed in the irrigation system planning. The planning shall be overlaid on recent Google Earth maps or other satellite images and refined considering recently added infrastructure and development in the area. Once the tentative plans are verified in the field during rapid appraisal, more detailed planning for the irrigation and drainage system shall be started. The major activities that shall be carried out during the irrigation canal system planning are;

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- Location of Headworks/Intakes;
- Location of settling basin, if any;
- Delineation of proposed gross command area and net command area to be covered by the study, existing and potential surface irrigation schemes, standalone groundwater irrigation schemes and conjunctive use of water;
- Identification and marking of the natural features including existing drainage, high ground, roads, villages, forests and public places;
- Identification and marking the alignment for canals and corresponding drains;
- Identification and locating the appropriate locations of off-take points.

ii) Benchmark Survey

Reference bench mark and its value shall be obtained from Department of Survey/Project. Specified bench marks shall be established in the vicinity of Headworks/Intakes, settling basin location, command area at the spacing of one BM per 50 ha and at 1 km in Terai and at 0.50 km interval along canals. D-card shall be prepared and attached with the field report. All benchmarks will be located in sites that should remain stable and undisturbed throughout project construction activities and will be constructed as per specifications.

Bench mark levelling shall be conducted precisely using appropriate tools. Each survey section shall be levelled in two directions and the difference in levels shall not exceed $7\sqrt{k}$ mm where k is the distance between benchmarks in kilometers.

iii) Intake/Head work Site Survey

- The location of Headworks/Intakes located during system planning and rapid appraisal shall be verified and finalized in the field using appropriate survey tool.
- Site plan for an Intake/Head works to be investigated situated on the River Bankwill be prepared (Covering total width of the river & at least 100 m both side from the firm bank (depending upon the site condition) or 5 meters above highflood level wherever possible or depending upon the site conditions).
- The profile and cross-section will be taken 1 km u/s and 1 km d/s of intake location (with at least an interval of 100 m, depending upon layout & topography, interval can be shorter). All the cross section and profile of the river must showthe river bed level, high flood level mark and bank top levels.
- River morphology and Sedimentation study will be carried out during field survey.
- All mapping work will be performed using appropriate instrumentation and procedures for establishing control, field data acquisition, and compilation in accordance with the functional accuracy requirements to include all quality control associated with these functions.

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- A surface model for the entire survey area (head work, canal alignment & command area) will be developed using CAD compatible Digital Terrain Modeling software, or its equivalent.
- The digital terrain model will be developed from cross sections, spot elevations, and break lines (when applicable). Break lines will include ridges, drainage, road edges, surface water boundaries, top of bank and other linear features implying a change in slope.
- The surface model will be prepared of adequate density and quality to produce 0.25 m, 0.50 m or 1.00 m contour interval (as per requirement).
- The contour data will be incorporated as a reference file into the final data set. The contours should be developed in the DTM. The contours should be provided in one or more master database DGN files attached as a reference file to all sheetfiles utilizing the clip bounds methods. Each contour will be drawn sharp and clear as a continuous solid line. Every index contour will be accentuated as a heavier line than the intermediate and will be annotated according to its actual elevation above datum. Labeling or numbering of contours should be inserted in breaks along the contour lines, so that the elevation is readily discernible. Labeling of intermediate contours may be required in areas of low relief.
- Topographic and Planimetric feature detail maps will be compiled at a target scale of 1:1000 for the head works delineated on exhibits.
- Planimetric feature detail will be compiled in accordance with the horizontal accuracy.
- Contours will be developed at 0.25 m intervals for Terai and 0.5 m or 1.0 m intervals (for terrain slope < 10^0, contour interval 0.50 m and for terrain slope > 10^0, contour interval 1.0 m) for hill.

iv) Discharge Measurement

The discharge measurement will be done at the headwork/intake location, using appropriate methods.

v) Canal Alignment Survey

General activities and extent of survey works during the canal alignment survey shall be as follows:

- Initially, a baseline shall be established for L-section survey along the refined canal alignment by marking on the ground the turning points and other reference points using wooden pegs or concrete pillars as appropriate. Then the longitudinal survey at an interval of 50 m along the proposed canal alignment shall be done using level instrument and tape.
- X-Section survey along the proposed canal alignment with reference to the baseline and the BMs shall be carried out using level instrument and tapes. The X-sections shall be taken at an interval of not exceeding 100 m in Terai and at an interval of 50m in Hill along the alignment or at closer intervals in case of sharp changes in the topography. In case of steep area, the X-sections shall be taken suitably by other

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methods. The width of each of the X-Sections shall cover an area at least 100 m to the left and 100 m to the right in case of Main Canal and at least 50 m to the left and 50 m to the right in case of other canals of the proposed canal alignment in Terai and cover suitable width in both left and right direction as permitted by terrain slope in case of hill. Each of the X-sectional readings shall bear latitude and longitude values along with elevation, which shall be compatible to the available topographic maps.

- Off-take points from the canal under consideration shall be located. For this, walk through along with the project representatives and beneficiary farmers, shall be made along the canal alignment to identify and finalize the off-take points. Process shall be repeated for all the canals under consideration. The finalized off-take points shall then be marked and superimposed on the topographic maps.

- In the course of the walkthrough important structures of the systems shall be located and marked.

- Similarly, topographical survey shall be carried out, marking the location of all the cross-drainage and road crossing points along the proposed canal alignments. The topographical survey shall cover an area up to 500 m upstream and up to 500 m downstream of the alignment for major cross drainage structures, i.e. cross drainage having width more than 50 m. Similarly, the topographical survey shall cover an area up to 100 m upstream and up to 100 m downstream of the alignment for other cross drainage structures, i.e. span less than 50 m. Each of the topographical points shall bear latitude, longitude and elevation values compatible to the topographic maps of Department of Survey. The topographic points shall be close enough to depict the geographical features and contours on a map of scale of 1:250.

- The L-section and X-section survey of the existing major natural drains in the area that could be used as the part of proposed drainage network shall be conducted. The extent and methodology of survey shall be in line with the Main Canal survey mentioned above.

- The inventory of structures, mainly structures for road crossings with canals and drains, shall be carried out. Photographic as well as detailed measurements with adequate sketches shall be made so that further work on the structures, as rehabilitation or replacement, could be carried out independently at the design office. The topographic survey of the proposed sites for cross drainage structures shall be carried out, which shall be utilized for design and layout of structures.

- All the private and public buildings that lie within the strip 100 m to the left and 100 m to the right of the proposed alignment shall be marked on the topographic maps.

- Data pertaining to the existing canal systems, such as name and type of source, canal capacity, area being commanded in summer and winter, crops and status of canal system, etc., in a suitable format using means such as field enquiry or field measurement as appropriate, shall also be collected during the field survey.

- All the longitudinal and cross sections shall be prepared using automated software, so that design parameters could be easily superimposed into these profiles. Moreover, any revision and alteration could be easily incorporated into CAD drawings.

vi) Settling basin survey

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Same procedure mentioned above for cross drainage works shall be followed.

vii) Command area survey

Closed Traverse Survey of the command area indicating Gross Command Area, Culturable Command Area and Net Command Area including minor canals network and other important physical features will be carried out.

Feature and terrain data should be delivered in both hard copy and digital format.

The detailed survey will be completed in four parts;

1. Benchmark Survey (Closed loop traverse)
2. Topographic Survey
3. Command Area Survey (Closed loop traverse)
4. Profile and Cross-Section Survey

1. Bench Mark Survey

In the first step of the survey, Surveyor needs to start vertical & horizontal control point survey by closed traverse. All of the calculations for error adjustments and distribution of errors will be carried out properly; once the benchmark is finalized, the Surveyor should proceed with the second step. The benchmarks will be established in every 50 ha and at permanent structures or as per requirement. All benchmarks will be located in sites that should remain stable and undisturbed throughout project construction activities and will be constructed as per specifications.

2. Topographic Survey

Once control points (benchmarks) are fixed, the Surveyor will start topographic surveys that will also cover fixing of alignment (for new canal/embankments). The topographic map will be prepared in soft and hard copies. All of the readings (co-ordinate readings) will be submitted in Excel Spreadsheet form or as per requirement. Interpolation for contours should comply with the actual site conditions and accurately reflect changes in slopes and ground configuration. Topographic surveys in structure locations should be detailed and complete, to accurately reflect conditions and elevations related to design requirements.

3. Command Area Survey

A closed loop traverse survey will be carried out to find the Gross Irrigable Command Area and Net Cultural Command Area. In the command area map all minor (secondary/sub secondary) canals and other important physical features should be shown.

4. Profile and Cross Section Survey

Along the finalized alignment, the profile and cross-section survey will be carried out independently to the topographic survey at an interval but not limited to 50 m. Whenever alignment crosses special features (Structures, Depressions or other geographical features etc.), the closer cross-sections of that portion(i.e. u/s and d/s of structure) must be taken. The plotted profile and cross section will be prepared in soft

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and hard copies along with data in excel spread sheets.
Detail cross section and profile for the cross drainage work will be carried out independently clearly indicating drain/river bed level and high flood level as mentioned above. Similarly, detail cross section and profile for the settling basin location/s will be carried out independently.

Field Data

All field survey data will be gathered by use of electronic field book.

1. Using a total station/appropriate tool and an electronic data collector with Electronic Field Book Software, locate all topography, infrastructure, and natural features to fifteen (15) meters outside the existing main canal and secondary canal rights of way or fifteen (15) meters outside the existing main canal and secondary canalembankment break lines, if applicable.
2. Using a total station/appropriate tool and electronic data collector with Electronic Field Book software, collect sufficient data to generate Digital Terrain Models (DTM) at the proposed intake/head works site to be investigated. The DTM shouldencompass the swath of topography measuring approximately 500 meters in length running along the bank of the River to an elevation approximately 5 meters above flood level. The topography coverage should facilitate the spatial requirements for the future design of canal head works and desiltingfacilities.
3. Locate all above ground evidence of underground water conveyance facilities.
4. Locate and obtain invert elevations on all pipelines, side drains, cross drains, etc.) Within the prescribed limits of the project. NOTE: In all cases when an appurtenant facility falls outside these limits but is needed to determine grade and location of a hydraulic feature, pipeline or culvert within these limits, it should be located and inverts obtained.

Horizontal Control

Horizontal control should refer existing project area control. Control points will be occupied as a station within a closed traverse, 1:10,000 accuracy mapping standards. The traverse will initiate and close upon acceptable control monument used to establish the existing project grid system. All grid coordinates shown on the map products will be expressed in or converted to meters. Coordinates should be referenced to the local UTM zone.

Vertical Control

Vertical Control will be referenced to a datum. Controlling points will be established within a closed level loop, 1:5000 for vertical control accuracy, as established for mapping standard. Elevations will originate and close on acceptable benchmarks to be established in the project area.

Existing Project Network Control

a. The Surveyor will perform the necessary surveys to connect existing project

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control to assure that such control has sufficient relative accuracy to adequately control the overall project. The Surveyor will furnish appropriate data indicating a deficiency in network control.

b. Suitable control monument will be set as required to adequately control during constructionphases. All Monumentation will be constructed as per requirements and should be in locations that will remain stable and unchanged throughout the construction period.

c. At each station, angle and distance measurements will be made between a network stationand reference and azimuth marks established in accordance with the requirements. All observations will be recorded in a standard bound field book or comparable electronic notebook.

Map Compilation Scale
The surveyor will produce strip maps and profiles at a scale of 1:1000 plotted on A3 – size sheets.

Topographic and Planimetric Features
The maps will contain all topographic and Planimetric features encountered within the project limits. The maps will properly depict the existing site conditions as necessary for the proper use of their intended purpose. The final mapping product generated by the surveyor will comply with and contain but not be limited to the following:

a. Terrain features/contour development. The contour interval will be 0.5 m or 1.0 m(for terrain slope < 10^0, contour interval 0.50 m and for terrain slope > 10^0, contourinterval 1.0 m) for hill and 0.25 m for Terai. Contours will be legible and drawn sharp and clear as solid lines. Every second contour will be accentuated as a heavierline than the intermediate contour. Half-interval or 0.25 m supplemental contours will be added as designated. Labeling or numbering of contours will be placed so the elevations are readily discernible. Labeling of intermediate contours may be required in areas of low relief.

(1) Turning points that define drainage channels, ditches, etc., will be consistent in depicting correct alignment and direction of drainage.

(2) Spot elevations will be established and shown on the maps at water surfaces on shorelines of rivers, lakes, reservoirs, ponds, canals and like high and low points at hilltops and depressions; at intersections and along center lines of linear elements and, where applicable, on canal embankments; at top and bottom of vertical walls and other structures and at center lines of ends of bridges. Ground spot elevations should sufficiently supplement contoured elevations. Spot elevations shown on the map sheets will be accurate to 1.0m or 0.5 m/0.25 m designated contour interval.

(3) Digital Elevation Models (DEM) should be generated by grid or trace methods on a network of random pointssupplemented with break-line

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points to properly establish the terrain model. Contours will be generated using standard DTM/CAD application software.

b. Planimetric feature data detailing. The strip maps should contain all Planimetric features encountered within the project limits and compatible with the objectives of conceptual planning through final design and construction. Features should include all infrastructure, but not be limited to hydraulic structures, buildings, walls, roads, pipelines; surface and subsurface utility and irrigation facility systems including all appurtenances, such as water supply pipelines, overhead power lines, storm drainage features, and structures, bridges, culverts, ramps, waste ways, channel systems; forest areas, landscapes and individual trees that are recognized as such; water supply access areas; cemeteries; etc. Features should be sketched in detail and shown on the map sheet(s) properly indexed in relation to location.

(1) **Surface utility data:** Locate and identify all hydraulic structures, irrigation turn-outs, culverts (pipes or box drains – dimensions, end points crowns and inverts), water systems including valves and flow measuring devices, catch basin inlets and outlets, manholes, meter/valve boxes, overhead powerpole location and type, low wire heights, overhead towers, and transformers. Obtain photographs and/or sketches as designated.

(2) **Roads and cart tracks:** Obtain names, descriptions, classifications; center- line profiles or sections as designated; route classification; pavement widthand type and condition of surface. Where applicable, show curb and gutter and joint layout for concrete pavement.

(3) **Bridges and culverts:** Obtain dimensions and structural type and condition; measure deck, flow line, and clearance elevations; horizontal clearances between abutments and piers, if any; and width of piers. Include detailed plan and elevation sketches, obtain photographs upstream and downstream.

Final Site Plan Map and/or Digital Data Contents.

The Surveyor should incorporate the following criteria into the final site plan maps and Digital data contents:

a. Coordinate grid. The grid system will be established on the Universal Transverse Mercator (UTM). Grid ticks will be placed on the map sheets at 125 mm intervals with coordinate values properly annotated and shown at the top and right edge of each map sheet.

b. All horizontal and vertical controls will be plotted on the maps to accuracy relative to their true position. Primary control set to control construction phasesshall be labeled as such.

c. Multiple map sheets should contain an index of the sheet layout oriented north on each sheet. Clear dashed lines/match grid will be provided and properly labeled such that each sheet may be joined accurately to adjacent

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sheets.

d. Symbols used on the map sheets will be in accordance with CAD standards.

e. The title block, sheet index, and legend should be placed on the map sheets to thedesignated size and arrangement per CAD standards

f. All design files with supporting data will be furnished on transferable media.The format specified will be dependent on the operating system of the designworkstation [dxf] [dgn] other.

Master DGN Files

1) The survey data (DTM data points) points will be provided in one or more master DGN file, attached as a reference file to all sheet files utilizing the clip bounds methods.

2) The contours will be provided in one or more master DGN files, attached as a reference file to all sheet files utilizing the clip bounds methods.

3) The control and baselines will be provided in one or more master DGN file, attachedas a reference file to all sheet files utilizing the clip bounds methods.

4) The Planimetric detail, canal prescribed limits, and alignments will be providedin master DGN files, attached as a reference file to all sheet files utilizing the clip bounds methods.

5) The break lines will be provided in master DGN files, attached as a reference file toall sheet files utilizing the clip bounds methods.

6) The cadastral data will be depicted in one or more master DGN files, attached as areference file to all sheet files utilizing the clip bounds methods. Label bearings anddistances on Section lines.

7) The Survey Data and Deliverables finished products will be delivered in CAD (*.dgn) and *.dtm format, or equivalent.

1.1.3.1.23. OTHER ACTIVITIES ON THE FIELD

Geological Study & Geomorphologic study (Optional)

In this study the following points related to river, its catchment area and all the considered head work/canal alignment/command area will be studied in detail.

i) Topography

ii) Nature and structure of the surface soil

iii) Nature and structure of local as well as regional geology

iv) Possibility of change of catchment

v) Nature, size and quantities of debris carried by the river

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vi) Intensity, duration and distribution of rain in the catchment

vii) Vegetation, cultivation etc. of the catchment

viii) Existence of reservoirs, lakes etc in the catchment

ix) Existing and/or existed head work/intake/canal alignment or other hydraulic structures across the river/drainage in the vicinity of the proposed head work site with their details as much as possible. If the proposed head work/canal is suggested to build in lieu of the existing/damaged structure, the salvage value of the same must be worked out and provided in the report

x) Other information as per need

Seismological Study (Optional)
Nepal being a seismic prone zone, a seismic consideration needs to be taken into account while designing a major hydraulic structure. To work out the seismic coefficient – the design standard and criteria RRRSDP (recently proposed by BS) or IRC: 6-2017 (Reprint 2019) may be followed.

Subsurface Exploration (Optional)
After the selection of proposed headwork/major structure site with alternatives and preparation of topo sheets, the surveyor along with the hydrological data and the following points will consider to carry out the soil exploration.

- Design discharge
- Scour depth, maximum scour depth
- Waterway
- Anticipated soil condition for foundation
- The most feasible proposed site
- River training and access roads
- Type of proposed foundation, sub-structures and superstructure

The soil investigation will be carried out including relevant required tests etc. as mentioned hereunder

A. **Bore holes/Core drilling**
- ➢ No. of bore holes (depending upon the river) each to a depth as explained in preferably at a possible location of abutments and piers with conduction of Standard Penetration Test (SPT).
- ➢ No. auger holes in the river to a required depth for determination of mean particle size of riverbed materials in each layer.
- ➢ The depth of soil exploration from existing ground level must not exceed as mentioned below (unless otherwise necessitated by the type of structure):
  - In the silty sand and other sand strata – 4 times of the designed scour depth

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- In strata of gravel and boulders – 2.5 times of designed scour depth
- In soft rock – a maximum of 8m, and
- In hard rock – a maximum of 3 m

- Depth of soil exploration carried out must be certified by the concerned authority for each bore hole and should be submitted in plastic bags duly labeled for further testing.
- Determination of bearing capacity including other engineering properties of each layer of soil with respect to assumed factor of safety and proposed type of foundation
- Recommendation of type of headwork/structure, and its foundation, depth of foundation
- Other necessary soil survey as found essential for design and construction of the headwork/structure and canals.

B. Geophysical exploration

- As and when required in headworks with command area more than 500 ha and in very large cross drainage works.

Hydro- meteorological Study

Hydro-meteorological survey is one of the important tasks for assessing crop water requirements of various crops to be proposed in the project area and the design flood discharge of the headworks/drain crossings. Under this task, relevant hydro-meteorological data of the rivers/drains will be collected, if they are gauged, from secondary sources (published and unpublished data of DHM). The long-term data of these rivers shall be collected and the low flow as well as flood discharge will be analyzed. The hydrological analysis of these river systems shall be carried out with the help of frequency analysis in case the long-term data are available. In case of absence of long-term data, other methods such as regional, rational, or empirical methods shall be adopted to analyze the hydrological information. Climate change risks shall be assessed, adaptation measures to climate proof infrastructures shall be suggested and climate risk assessment report shall be prepared.

Beside collection of hydro & meteorological data from DHM, for determination of all design data the hydrologist will carry out a detailed hydrometrical survey and hydrological study of the river along with the headwork/intake and cross drainage site which will include but not limited to the following:

i) Catchment area of the river up to head work/intake and cross drainage site

ii) Length of the river from origin up to head work/intake and cross drainage site

iii) Slope of the river from the critical point (origin) of the river up to head work/ intake site and cross drainage site

iv) Cross-sections covering 100 m beyond flood lines/firm bank (depending on sitecondition) of the river at proposed head work/intake site, at about 1000 m up- stream and 1000 m down-stream wherein High Flood Level (HFL), Low

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WaterLevel (based on local enquiry, LWL), Lowest Bed Level (LBL), area of cross-section, and geological profile with silt factor of each strata (at proposed head work/intake site only) shall be indicated. However, the scale of the drawing forhorizontal and vertical should be the same.

v) The drawing should include the slope of the river at the proposed head work/ intake axis which should be extended 1000 m U/S and 1000 m D/S along the thalweg (lowest level) of the river

vi) Maximum discharge shall be calculated by established formulas with 50 yr/100 yr return periods

vii) 80% reliable flow of the source river at headworks/intake site shall be calculated.

viii) The peak discharges calculated for a returned of 50/100-years shall be taken as a maximum discharge

ix) Area of flow, velocity and depth of the flow at the time of survey (for Discharge Calculation) and sediment concentration for design of silt excluding devices, settling basin etc.

x) Study of horizontal & vertical shifting of the river

xi) Other information required for river control, design, construction and/or maintenance of the head work/intake and cross drainage

After the selection of proposed head work/intake site with alternatives and preparation of topo sheets, the surveyor must evaluate along with the collected hydrological data and the following points to carry out the soil exploration and design of the head work/intake:

- Design discharge
- 80 % reliable flow
- Sediment concentration
- Scour depth, maximum scour depth
- Waterway
- Anticipated soil condition for foundation
- The most feasible proposed site
- River training and approach roads
- Type of proposed foundation, sub-structures and superstructure

Soil Test (Optional)
Soil exploration will be carried out (for command area sample from a 90 cm depth will be collected whereas for head work depending on site requirements). Soil sample will be collected from head work site, cross drainage site, canal alignment and different location of command area (head, middle & tail) as follows;

- For Headwork with command area upto 500 ha: 3 nos of excavation pit at river bed of size 1.50m x 1.50m x 5m
- For Headwork with command area more than 500 ha: 3 nos of excavation pit at

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river bed and 1 no in each bank of size 1.50m x 1.50m x 5m

- For canal alignment: excavation pit of size 1.50m x 1.50m x 2m in every 1 km length of main canal
- For very large Cross drainage: 3 nos of excavation pit at river bed and 1 no in each bank of size 1.50m x 1.50m x 5m
- For other Cross drainage: 2 nos of excavation pit at river bed of size 1.50m x 1.50m x 2m

Generally Following Tests will be carried out

Head Work/Intake Site and cross drainage site

a) Natural moisture content

b) Sieve analysis

c) Hydrometric analysis

d) Atteberg's limit

e) Specific gravity

f) Unconfined compression test

g) Direct shear test

h) Consolidation test

i) Tri-axial tests

j) Other tests as per need

Canal alignment

a) Infiltration Test

b) Dispersion Test

Command Area

c) Infiltration Test

d) Percolation Test

Environmental Study:

Initial Environmental Examination/Environmental Impact Assessment as per TOR prepared (TOR for IEE/EIA will be prepared separately), Environment Management Plan (EMP) based on Environment Safeguard Guideline (ESG) will be prepared. If environmental study is not included in the contract even then consultant shall take into account following environmental aspect:

The most suitable site for the headwork/canal alignment based on the above characteristics of the site as well as the catchment area will be selected. The selected site will be clearly indicated in the map and all the characteristic features of the chosen head work site/ canal alignment will be given, in order to facilitate easy reference while designing the head work/canal. The environmental study will be carried out i.e.

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identifying the environmental changes due to the proposed structures and the outcomes of the study need to be presented clearly in the form of recommendations and subsequently be considered in detail design. DWRI Environmental Safeguard Guideline is to be followed.
Vulnerable area of landslide/soil erosion will be evaluated & mitigation measures will also be proposed.

Socio-Economic Study
The socio-economic survey will be carried out to determine the social structure of the community and its economic status. The survey includes the collection of quantitative and qualitative data and information on social structure, socio-cultural institutions, and economic activities of the farmers of the scheme command area. Some of social and economic indicators of the community are as follows:
Social indicators:

- Willingness/commitment- verbal request, formation of committee, submission of request form;
- Social composition- homogeneity, diversity;
- Education- literacy, school and college, awareness about irrigated agriculture,prior experience on irrigation;
- Rural organization- Parma, Guthi, etc;
- Family size- male/female, economically active members,
- Migration- temporary, permanent, foreign/urban areas;
- Economic indicators:
- Land holding size- land less, marginal land holding (for Terai < 1 ha & for hills < 5 ropani), land lords (for Terai> 10 ha & for hills > 2 ha);
- Main occupation- agriculture, service, labor, foreign service, business;
- Source of income- agriculture, service, remittance etc;
- Standard Formats will be used
- Expenditure- food, cloth, schooling, festivals, livestock, agriculture

Social Safeguard (SS) Studies & Gender Equality and Social Inclusion (GESI) studies will be carried out complying Social Safeguard & GESI guidelines prepared for Department of Irrigation.
With reference to above guidelines, Indigenous People (IP) inventory & Involuntary/Voluntary Resettlement (IR) plan, and Gender Action Plan (GAP) will be prepared.
An assessment of activities of WUA will be made, if exists; if a WUA doesn't exist, what is the possibility of creating a viable WUA?
With interaction with beneficiary farmers/Municipalities records, the number of beneficiary households/population, woman headed HH/population and presence of marginalized farmers, disadvantage group, landless population, land holding size, land

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use will be evaluated.

With interaction with beneficiary farmers/ Municipalities, the average income of the project area & other economic parameters will be assessed, including seasonal migration/permanent migration, education level & other source of income than agriculture, percentage of population involve in agriculture, gross income from agriculture & other business.

Agriculture Survey

For Irrigation schemes agricultural survey will include data and information regarding the soil type, land use and agriculture practices of the command area to be proposed. The soil survey will include the assessment of the type of soil in the command area and its suitability for irrigated agriculture. The soils may be alluvial, sandy, gravel and boulder mixed.

The land use survey will include the general assessment on land use in the command area which may classify in percent the agricultural land, forest land, grazing land, wetlands, National Parks and reserve forest area.

The agriculture survey includes the collection of data and information on:

- Existing cropping pattern,
- Existing crop yields,
- Inputs used and its availability,
- Marketing facility and labor situation
- Food Security
- Existing & Anticipated Irrigation/Water Management Practices
- Accessibility

Existing cropping pattern

An assessment of existing cropping calendar/pattern interacting with beneficiary farmers/ nearby Agriculture Service Center & other related offices will be made, Based on above interaction, assessment will also be made for anticipated cropping calendar/pattern & possibility of commercial agriculture (introduction or extension of cash crops)

Existing crop yields

An assessment of existing crop yield interacting with beneficiary farmers/nearby Agriculture Service Center & other related offices will be made.

Inputs used and its availability

An assessment of agriculture input interacting with beneficiary farmers/nearby Agriculture Service Center & other related offices will be made.

Marketing facility and labor situation

An assessment of market facilities for selling of agriculture products, buying of seeds, fertilizer etc., in case of implementation of the project availability of construction materials will be made.

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Food Security

Assessment of the Food Security Situation of the project area will be made with preparing list of food unsecured areas/ Municipalities with Higher Index & it will be clearly mentioned whether the project area has excess food to supply or shortage to import (if yes ! for how many months)

Existing & Anticipated Irrigation/Water Management Practices

With existing users' group or beneficiary farmers' interaction, existing Irrigation/Water Management Practices will be carried out, if any.

With the proposed intervention and assessment of anticipated cropping pattern will evaluate possible Water Management Plan.

Construction Material Survey

Borrow Pits:

Borrow pits may be situated on both sides of the embankment depending on the availability of the soil. It shall be located in places approved by the client, but shall not be within ten (10) metres from the toe of a completed embankment or other works. Possibility of utilizing the borrow pits in future as fish ponds by the owners of the land shall be explored. In case the owners wish to use borrow pits as fish ponds, the depth of the pits may be up to 3 m. In such cases, the borrow pits shall not be continuous over lengths of more than 100 m. A strip of no less than 30 m at the level of the original ground shall be left between the pits. In other cases, borrow area shall be arranged in such a manner that the ground elevation of so arranged borrow areas will be more or less the same as the neighboring area, so that rain water will not stagnate in the borrow areas. The required type of tests of borrow material shall be carried out as per standard set by the project.

Other construction materials:

Source of other natural construction materials, such as course and fine aggregates, sand, stone etc shall be explored in the vicinity of construction sites as far as possible. The required of tests of these materials shall be carried as per standard set by the project.

Accessibility

Distance of the project area from the nearest road head, cost of construction material at site, district rates for labor, materials & equipment shall be assessed.

Preparation of Maps

Canal alignment, strip covered by cross-section survey/topographic survey, details around the proposed structures using appropriate software shall be plotted. Each of this information shall be plotted in suitable layers to be overlaid on the topographical maps.

- Prepare strip contour maps of suitable contour interval of the strip covered by cross-section survey/topographic survey using appropriate software and make a separate layer of the same.
- Prepare L-Section along the alignment using the canal alignment layer and strip contour layer using appropriate software and plot them in a scale of 1:5000 (H)

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and 1:100 (V) using AutoCAD. Plot on the L-section features such as design bed level, water level, bed width, freeboard, longitudinal slopes, side slopes etc as per existing condition. Prepare Cross-sections of all the canals based on the survey data and plot them using AutoCAD. Show in the cross-section the designed section of the canal, bed level, water level and top level of the canal embankment suitably.

- Prepare detailed designed drawings of all the individual structures proposed to be constructed new ones and replacement or rehabilitation of existing, if any.

DATA ANALYSIS, EVALUATION AND DESIGN

The detailed data obtained from field survey and investigation shall be analyze and evaluated with respect to:

- Available discharge in the source river for round the year irrigation.
- Type of headworks/intake
- Safety of headworks/intake with respect to surface flow, sub surface flow and floatation
- Command area and FSL in the main canal
- X-section, L-profile, berm width, side slope, bank top-width, service road and corresponding existing data
- Safety of canal section with respect to design discharge carrying capacity, surface drainage system, public encroachment and use, and life span of structures etc.
- River bed level at, upstream and downstream of all individual cross-drain structures,
- Location of individual or combination of structures and their type (HR, CR, Drops, Escapes, VRBs, H-W Bridges etc)
- Location and capacity of settling basin and flushing arrangements
- Existing cropping pattern and cropping intensity
- Incorporation of other existing/pipe lined/potential surface/ground water irrigation systems in the planning and designing of this study
- Conjunctive use of ground and surface water.

The above-mentioned analysis and evaluation will be followed by the following detailed design:

- On the basis of proposed cropping pattern and calculated field crop water requirement, the design capacity of different canals shall be calculated for different reaches including intakes, main canals and their structures, flow diagrams will have to prepared for the whole command area and L-section and x-section shall have to be designed accordingly.
- Design of settling basin shall be based on the size and concentration of sediments to be settled, available volume for settling basin, available head to flush sediment deposited for hydraulic flushing, silt/sand excluding mechanism (hydraulic, mechanical), arrangement of and type of settling basin (continuous or intermittent).
- Design of head works and settling basin shall be validated using additional river discharge and sediment data collected during contract period, if any.

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- All the canal structures shall be designed and drawn individually by making use of Auto CAD software.
- Design discharge of headworks and all cross-drains shall be estimated separately and the structures will be designed for the designated returned period flood for the headworks and CD structures
- Quantity calculation shall be done for individual structures. Earthwork calculation shall include different category for different haulage distance and lift.

Detail Cost - Estimate

Approved District Rates for labor and materials at the project sites will be collected or analyzed. Detail rate analysis, detail quantity & cost estimates along with bill of quantity (BOQ) will be prepared.

The following methodology shall be applied for estimation of the cost of each component of the project.

1. **For Civil Works**

- The cost estimates shall be based on unit rates developed from prevailing labour rate, construction equipment rate and materials taking also into account the local situation and bill of quantities derived from design drawings.
- The cost estimate shall be done by breaking down major structures into a number of distinct construction activities or measurable pay items.
- Due consideration shall be given to local labours. The rates for locally available labours can be obtained either from District Rates of concerned districts or prevailing market rates of the project area and can be used after appropriate adjustments.
- The rates of construction equipment can be taken from regularly updated cost data, a quotation from the suppliers/manufacturers.
- The construction materials to be used for construction work shall be divided into:
    - Materials locally available nearby project area.
    - Materials available in local market.
    - Materials to be imported from neighboring countries.
    - Materials to be imported from overseas.
- The rates of construction materials shall be derived as per their source of supply. While calculating the construction materials' rate, sufficient attention shall also be given to the mode of transportation and their corresponding costs shall also be included.
- From labour cost, material cost and equipment cost, the direct cost per unit of construction activity can be calculated.
- The estimate shall be of contractor's type and, therefore, shall also include all other indirect costs such as office overheads, contractor's financing cost, insurance bonds, and profit and risk margin.

2. **Hydraulic Steel Works:**

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- The cost of hydraulic steel works shall be based on a quotation of supplier(s) or on market price, if they are locally available. Transportation and installation cost shall also be added.

3. **Land Acquisition and Access Road:**

- Due attention shall be given to the cost of land acquisition and construction of access roads.
- Cost of land acquisition shall be determined considering detailed risk assessment, future development of project area, accessibility and public demand.

4. **Camp and Other Facilities:**

- The costs of construction camps and permanent buildings required for operation and also of construction power facilities required shall be included in cost estimation. A lump sum amount for this can be allocated depending upon the size of the project.

5. **Diversion of Flow:**

- The cost of diversion of river flow during construction shall be incorporated in cost estimate.

6. **Resettlement/Rehabilitation**

- Relocation and environment impact mitigation costs shall be as per existing Environmental Protection Act and Rules. This cost can be derived as a lump sum taking a reasonable percentage of the project base cost.

Economic Analysis

Crop Budget without and with Irrigation System will be prepared and Benefit/Cost Ratio and Economic Internal Rate of Return (EIRR) will be evaluated; Conclusion and Recommendation will be made based on economic & other indicators.

1.1.3.1.24. Annexes

Annexes will include details of compiled data, designs and calculations, bidding drawings, minutes of community meetings and consent letters of land donation, besides that photographs of sites/location (Intake, command area, alignment, community meeting) will be included. Total station/GPS data will be presented in hard copy.

Terms of Reference for Design of the Irrigation Project

After completion of required field surveys and data collection, data shall be processed, analyzed and evaluated for different alternatives and designed for the best one. Innovative idea shall be employed to address the present problems making allowances for the future prospect while carrying out design of canal and structures. PDSP manuals, hand books/text books, relevant literature and the design data of existing similar nature and size project, shall be referred while designing and drawing canals and structures.

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The study would include sound engineering designs, quantity of work and cost estimate as well as proposals and analysis related to the following matters: institutional management; implementation and beneficiary participation, arrangements in detailed design, construction, and operation activities; agriculture development and benefits; environmental impact assessments and mitigation measures, if included in the contract; economic and financial aspects and investment program. The detailed design report shall include all the design calculations that would be at par with the report acceptable to any funding agency.

- The report should clearly enunciate how the planned and designed work shall be implemented to fit in the present context making provision for the future prospect.
- Lay out the system on suitable base maps will be prepared.
- If necessary, new features such as roads and houses will be added from field survey.
- Cadastral maps or ALOS Satellite Imagery can also be used for base mapping
- The location of the headwork, settling basin location, canal layout, major structures' locations, land slide or other vulnerable zone and command area will be shown in base map; beside base map, irrigation infrastructures should also be shown on GIS/Google map

Hydrological Analysis and Water Requirement Assessment

The criteria for the selection of maximum design discharge are based on technical and economic considerations. The major criteria for the selection of design flood are:

- Importance of structure to be constructed,
- Effect of overtopping of the structure,
- Potential loss of life and downstream damage, and
- Cost of the structure
- Climate Change effect on flood hydrograph hence design flood

Flood Frequency Analysis

The flood frequency analysis is a statistical method to show that flood events of certain magnitude may on average is expected once every n year. It is generally carried out to estimate the design flood from the recorded flow data of more than 10 years. The most commonly used methods for frequency analysis are:

- Gumbel's distribution,
- Log Pearson Type III distribution, and
- parameter Log Normal distribution

The details of these methods are available in the chapter 5 of updated PDSP Planning and Design Manual Volume I or chapter 6 of PDSP Design Manual M3. Hydrology and Agro-Metrology, beside above analysis; climate change risk should also be given due consideration (if such analysis is available with DHM or other agencies)

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Regional Analysis

When the recorded hydrological data of the river is absent or too short a regional analysis is adopted to estimate the flood flow, and low flow of required return periods. In this method a hydrological homogeneous region is considered from statistical point of view. There are various methods of estimating flood flow of given return period based on regional analysis. In Nepal following methods are used to estimate the flood flow: WECS/DHM (1990) Method- based on regression analysis, Tahal et al (2002) Method – based on Index Flood Method,

Sharma and Adhikari (2004) – based on regression analysis

In addition, there are rational method and empirical methods such as Modified Dickens method, Ryve's method. The most commonly used methods in Nepal is Sharma and Adhikari Method based on regional analysis and Rational Method as empirical method; if available, analysis based on climate change risk will be given due consideration.

Besides above methods Design Flood will be evaluated using appropriate method/software which includes climate change effects

Evaluation of Stage Discharge Curve will be made at Intake/Head Work location with appropriate method/software

Water Availability for Irrigation

The assessment of water availability for irrigation is carried out on 80% reliability of full supply. This means 80% of the time there is at least enough water available to meet full demand of irrigation. For gauged river the reliability assessment is carried out by frequency analysis while for ungauged river regional regression analysis for long term mean flow is adopted in Nepal. As far as possible, the recorded flow of the source at the diversion point shall be used to calculate available reliable flow for irrigation. DHM's evaluation of 80% reliable flow considering climate change impact will be taken as reliable flow.

The details of these methods are available in the chapter 5 of PDSP revised Planning and Design Manual Volume I or chapter 3 of PDSP Design Manual M3. Hydrology and Agro- Metrology

Effective Rainfall

The total crop water requirement is met from two sources: rainfall and irrigation. However, not all rain falling on the field will be "effective" in terms of crop growth; some percolates to depths below the root zone, some is lost to evaporation, and some runs off to contribute to stream flow. For calculation of effective rainfall (Pe), 80% homogeneous reliable rainfall values based on DHM's new climate change parameter will be used.

Irrigation Water Requirement & Water Balance

Calculation of Irrigation Water Requirement should follow the steps mentioned in the chapter 5 of CMIASP/PDSP revised Planning and Design Manual Volume I but the evaluation will be based on irrigation scheduling & crop arrangements using CROPWAT8 or appropriate software (mentioned in FAO-56 or FAO-66); hence finalizing water balance with optimization of water use and irrigation efficiency

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The diversion requirement should be evaluated based on above mentioned water balance
Design of canal & related structures should be carried out based on bottom up approach, hence the pond level will be fixed
Selection of type of head work/intake and design will be carried out using standard hydraulic & structural engineering concepts
Sensitivity analysis of hydraulic design of head works & other hydraulic structures will be carried out using available software (WINFLUME/HEC-RAS or other soft wares)
Detail Cost Estimation of the project making sure that proper allocation has been made for Resettlement Plan (RP), Environment Management Plan (EMP)
Detail Economic Analysis and Evaluation of EIRR & BC ratio will be made.

MODE OF PAYMENT

A. For Departmental Employees:

The amount shall be paid to the employees assigned for the study as follows:
For mobilization and field work 40% of the total amount as an advance.
Upon submission of brief field Report 30% of the total amount.
Upon submission and acceptance of Final Survey Report 30% of the total amount.

Final payment shall not be made if the mentioned work is not completed as per TOR, and the assigned team will be fully responsible ensuring the quality of report as per requirement.

B. For Consultant (if employed):

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

Key Person Qualifications

The general guidelines for qualification of key persons have been given below, however qualifications of key persons may be project specific and client may modify accordingly.

1. Team Leader
Academic Qualification

Master's Degree in Water Resources/Irrigation/Hydraulic structure/Dam Engineering.

Work experience

Minimum 15 years general work experience with minimum 10 years' experience in irrigation

2. Hydraulic Design Engineer
Academic Qualification

Master's Degree in Water Resources/Irrigation/Hydraulic structure.

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Work experience

Minimum 10 years general work experience with minimum 5 years' experience in irrigation

3. Structural Engineer

Academic Qualification

Master's Degree in structure.

Work experience

Minimum 10 years general work experience with minimum 3 years' experience in water related structure design.

4. Surveyor

Academic Qualification

Bachelor's Degree in Civil Engineering/Surveying.

Work experience

Minimum 10 years general work experience with minimum 3 years' experience in irrigation related survey

5. Hydrologist

Academic Qualification

Master Degree in Water Resources/Hydrology.

Work experience

Minimum 10 years general work experience with minimum 3years' experience in hydrological survey, river morphology survey and hydro-metrological data analysis.

6. Agronomist/Agriculturist

Academic Qualification

Master Degree in agricultural science or equivalent.

Work experience

Minimum 5 years general work experience with minimum 3years' experience in estimating crop water requirement, cropping pattern design and cropping intensities forecast.

7. Sociologist/Socio-economist

Academic Qualification

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Master Degree in economics.

Work experience

Minimum 5 years working experience in economic analysis of agriculture related sector.

8. Geologist

Academic Qualification

Master Degree in Engineering Geology/Geo-technical Engineering

Work experience

Minimum 5 years working experience in geological/geo-technical survey, geological mapping, geotechnical analysis and geo technical design of hydraulic structures.

9. GIS Expert

Academic Qualification

Master Degree in GIS/remote sensing, computer science, earth science, or equivalent.

Work experience

Minimum 5 years working experience in GIS mapping.

10. Procurement Expert

Academic Qualification

Bachelor Degree in civil engineering or related fields

Work experience

Minimum 5 years working experience procurement sector.

11. Construction Planner

Academic Qualification

Bachelor Degree in civil engineering or related fields

Work experience

Minimum 5 years working experience construction planning and/or construction activities.

12. Engineer

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Ministry of Energy, Water Resources and Irrigation
Government of Nepal
Singh Durbar, Kathmandu, Nepal

Academic Qualification

Bachelor Degree in civil engineering or related fields

Work experience

Minimum 5 years working experience in related assignments.

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1.1.4. NORMS FOR DETAILED ENGINEERING DESIGN & TENDER DOCUMENTS

1.1.4.1.FIELD WORK

1.1.4.1.1. CANAL ALIGNMENT

A. Setout of the Layout of the canal network including canal structures

i- Human Resource required :

Team Leader	0.10
Engineer/Surveyor	1
Sub-Engineer	2
Labour	5

ii- Performance criteria:

Hills	3 km/day
Terai	6 km/day

B. New canal alignment and/or canal alignment not surveyed during feasibility, if any

Follow the Feasibility norms.

1.1.4.1.2. MAJOR STRUCTURES

C. Major structures that have been relocated and/or not surveyed during feasibility, if any

Follow the Feasibility norms.

1.1.4.1.3. HYDROLOGY

Generally, data gathered during Feasibility Study will be sufficient, no further data will be required.

1.1.4.1.4. AGRICULTURE AND SOIL SURVEY

Soil and land survey shall be carried out in specific areas identified during Feasibility study, if any. In such case, Feasibility norms will be used but the intensity of infiltration tests will be between 1IT per 1m to 15m grid.

1.1.4.1.5. SOCIO-ECONOMIC SURVEY

No further study will be required.

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1.1.4.1.6. CONSTRUCTION MATERIAL SURVEY

No further data will be required.

1.1.4.1.7. SITE INVESTIGATION

Further site investigations will be required if structures are relocated or added and/or feasibility study recommends. In such case, follow the feasibility norms.

1.1.4.1.8. MISCELLANEOUS - for Hills and Terai

A. Transportation

Estimate for transportation facility shall be made based on means of transportation, numbers of visit to the field, market rate of transportation means and days required for the field works including to and fro to the field. In case of international expat number of visit from his/her country to the site and return back.

OFFICE WORK

1.1.4.1.9. DESK STUDY

A. Additional map Collection & Updating, Compilation and Report presentation

i - Human Resource required:

Team Leader	1
Engineer	1
GIS expert	0.5
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria:

Pond Irrigation Scheme	Not required
Command area: Small/ Medium (RoR)irrigation Project	Not required
Large (RoR) Irrigation Project	3 days
Mega (RoR) Irrigation Project	5 days

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1.1.4.1.10. TOPOGRAPHIC SURVEY

A. Updating of topographic map prepared during feasibility with additional data collected, if any

i - Human Resource required:

Team Leader	0.1
Engineer	1
GIS expert	0.5
Sub-Engineer	2
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

All project	500 ha/day

1.1.4.1.11. HEADWORK SITE

A. Review of Contour, L-section and X-section

If the Headworks site is not relocated no need, otherwise follow feasibility norms.

B. Review of Hydrological data

i - Human Resource required :

Team Leader	0.10
Hydrologist	1
GIS expert	0.25
Assistant	1
Office Assistant	1

ii - Performance criteria:

River type	days
I Class 1 River	1
II Class 2 River	1
III Class 3 River	Not required
IV Classless River	Not required

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C. Review of hydraulic design and drawings and prepare detail structural Design and Drawings. Review of hydro mechanical and electro mechanical design, drawing

i - Human Resource required:

Team leader	0.25
Hydraulic Design Engineer	0.25
Structural Engineer	1
Geotech Engineer	0.1
Mechanical Engineer	0.1
Electrical Engineer	0.1
GIS expert	0.25
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii -Performance criteria:

River type	days
I Class 1 River	30
II Class 2 River	20
III Class 3 River	10
IV Classless River	7
Pond Irrigation	Not required

D. Review and updating of cost Estimate

i - Human Resource required :

Team Leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	1
Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 River	5
II Class 2 River	5
III Class 3 River	3

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IV Classless River	2
Pond Irrigation	1

1.1.4.1.12. Settling Basin

A. Review of Contour, L-section and X-section

If the Settling basin site is not relocated no need, otherwise follow feasibility norms.

B. Review of hydraulic design and drawings and prepare detail structural Design and Drawings. Review of hydro mechanical design, drawing

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	0.50
Structural Engineer	1
Mechanical Engineer	0.25
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

1 settling basin	2 days

1.1.4.1.12.1. Review and updating of cost Estimate

i - Human Resource required :

Team Leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	1
Office Assistant	1

ii - Performance criteria :

1 settling basin	1 day

1.1.4.1.13. CANAL ALIGNMEN WITH CANAL STRUCTURE

A. Layout verification

i - Human Resource required:

Team Leader	0.10

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Water Resource Engineer	1
GIS expert	0.5
Sub-Engineer	1
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria:

Command Area	Days
<=500 ha	2
<= 10000 ha	3
<= 25000 ha	4
>25000 ha	(4 + (hectarage more than 25000ha)*(1/15000))

B. Contour, L-section and X-section

Not needed if alignment is not changed, otherwise follow feasibility norms

C. Review of Design and Drawings of Canal Sections

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	1
GIS expert	0.25
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

Command Area	Days
<=500 ha	1
<= 10000 ha	3
<= 25000 ha	4
>25000 ha	(4 + (hectarage more than 25000 ha)*(1/15000))

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D. Hydraulic Design and Drawings review and prepare detailed structural design and drawings of Canal Structures

i - Human Resource required:

Team leader	0.10
Hydraulic Design Engineer	0.25
Structure Engineer	1
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria:

Type	Km (canal length)/day
All types of canal structures along canal alignment except cross drainage	5

E. Review and update of cost Estimate

i - Human Resource required:

Team leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	1
Office Assistant	1

ii - Performance criteria :

All projects	10 km/day

1.1.4.1.14. CROSS DRAINAGE WORKS

A. Contour, L-section and X-section

Not required if structures are not relocated or changed, otherwise follow feasibility norms

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B. Review of Geological data

Not required if structures are not relocated or changed or feasibility study has not recommended for additional study, otherwise follow feasibility norms

C. Review of Hydrological data

i - Human Resource required :

Team leader	0.10
Hydrologist	1
Office Assistant	1

ii - Performance criteria :

River type	Days
I Class 1 river	5 CD/day
II Class 2 river	7 CD/day
III Class 3 river	10 CD/day
IV Classless River	15 CD/day

D. Review of hydraulic Design and Drawings and prepare detailed structural Design and Drawings

i - Human Resource required :

Team leader	0.10
Hydraulic Engineer	0.25
Structural Engineer	1
Geologist/Geotech Engineer	0.10
GIS expert	0.25
Sub-Engineer	0.50
Auto CAD expert	1
Office Assistant	1

ii - Performance criteria :

River type	days
I Class 1 river	1 CD/ 3day
II Class 2 river	1 CD/ 2day
III Class 3 river	1 CD/ 1day
IV Classless River	2CD/ day

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E. Review and Update of Cost Estimate

i - Human Resource required :

Team leader	0.10
Engineer/Quantity Surveyor	1
Sub-Engineer	1
Office Assistant	1

ii - Performance criteria :

All Projects	5 CD/day

1.1.4.1.15. COMMAND AREA - for Hills and Terai

A. Review of Topography maps

i - Human Resource required :

Team Leader	0.1
Engineer	1
GIS expert	0.25
Sub-Engineer	1
AutoCAD expert	1
Office Assistant	1

ii - Performance criteria :

All Project	500 ha/day

B. Agriculture and Soil Survey

Not required if feasibility study has not recommended.

C. Material Quarry (Verification of Quality and Quantity and preparation of Quarry Location Maps)

i - Human Resource required :

Team leader	0.10

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Geologist	1
Engineer	1
Office Assistant	1

ii - Performance criteria :

Quarry site	Days
1 quarry site	1

1.1.4.1.16. Review and update Construction Planning and Management

i - Human Resource required:

Team leader	0.10
Engineer/Construction Planner	1
Sub Engineer	1
Office Assistant	1

ii - Performance criteria:

Small irrigation scheme	2 days
Medium irrigation scheme	3 days
Large irrigation schemes	5 days
Mega Irrigation Schemes	7 days

1.1.4.1.17. Review and update of Environmental Study

Scope of the study will depend on the status of previously carried out study. Generally, one of the following studies is carried out during detailed design based on the size and complexity of the project and status of the available environmental study:

- Update IEE (if there are changes in project design)
- Carry out EMP updates in EIA, if there are minor changes in the project design and get approved from the Ministry of Forrest and Environment.
- Carry out supplementary EIA, if there are major changes in project design and get approved from the Ministry of Forest and Environment.

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1.1.4.1.18. Specifications and Tender Documents preparation

i - Human Resource required :

Team Leader	0.25
Specification Expert	1
Procurement Expert	1
Legal Expert	1
Office Assistant	1

ii - Performance criteria :

Small irrigation scheme	5 days
Medium irrigation scheme	10 days
Large irrigation schemes	15 days
Mega Irrigation Schemes	30 days

1.1.4.1.19. Review, Update and Revision of Rate Analysis

i - Human Resource required:

Team leader	0.10
Engineer	1
Sub-Engineer	2
Office Assistant	1

ii - Performance Criteria

Small irrigation scheme	2days
Medium irrigation scheme	3 days
Large irrigation schemes	5 days
Mega Irrigation Schemes	7 days

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1.1.4.1.20. Update and Revision of Economic Analysis

i - Human Resource required :

Team leader	0.10
Economist	1
Assistant	1
Office Assistant	1

ii - Performance criteria:

Small irrigation scheme	2 days
Medium irrigation scheme	3 days
Large irrigation schemes	5 days
Mega Irrigation Schemes	7 days

1.1.4.1.21. Numerical and /or Physical Hydraulic Modelling:

For large projects numerical and / or physical hydraulic modelling may be carried out, if needed.

The rate of numerical and physical modelling can be obtained from prevailing market price or approved rate from other GoN entity.

1.1.4.1.22. Report Preparation

i - Human Resource required :

Team leader	1
Hydraulic Engineer	1
Surveyor	0.25
Structural Engineer	0.25
Hydrologist	0.25
Geologist/Geotech Engineer	0.25
Agriculturist	0.20
Sociologist	0.20
Economist	0.10
Legal Expert	0.10
Construction planner	0.05

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Procurement Specialist	0.05
Assistant	2
Office Assistant	1

ii - Performance criteria

Small Irrigation Schemes	10 days
Medium Irrigation Schemes	20 days
Large Irrigation Schemes	30 days
Mega Irrigation Schemes	45 days

MISCLLEANEOUS:

c. ***Office Space, Office equipment and consumables & Field equipment and consumables;***

Field Equipment, Field Consumables and office space, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

1.1.4.1.23. Transportation Cost:

Estimate for transportation facility shall be allocated based on means of transportation, numbers key personnel entitled to use vehicles, market rate of transportation means and days required to complete the works. In case of international expert number of visit from his/her country to the working station shall also be considered.

Sample Terms of Reference for Detailed Design and Tender Documents

1.1.4.1.24. OBJECTIVE OF THE STUDY

The overall objective of the study is to dimension and specify the works to a sufficiently accurate standard for tenders for construction to be held. The project works are normally packaged into one or number of contracts, depending on the scale and time of contracts.

<u>Scope of Works</u>

The product of detailed designs are sets of tender documents comprising:

- Instructions for tendering;

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- Condition of contracts;
- Specifications;
- Bills of quantities;
- Drawings.

Design team (here onwards "the team") will perform detailed technical study along with related works herein to attain the desired objectives. The team will be responsible for accuracy, interpretation, analysis of all data received and packaging of the works in their report. The mentioned scope of work to be carried by the team will broadly include but not limited to the following;

a) Desk study

A desk study will be carried out collecting all the data, maps and information relevant to the project and review of previous study reports including feasibility Report. In addition to this additional maps and updated images shall be collected as required.

b) Topographical Survey:

1. The topographical maps prepared during the feasibility study shall be reviewed and updated them to reflect the changes, if any.
2. Additional survey shall be carried out if there are changes in alignment or any addition or change of location of project component(s).
3. The coordinates of control points established during the feasibility study shall be verified and revised, if necessary.
4. When and where necessary, updated topographic maps shall be used by updating topographic maps prepared during feasibility study.

c) Hydrology and Sediment

1. All the Information regarding hydrological data and analysis obtained from the feasibility study shall be reviewed, verified and updated.
2. Findings of feasibility study regarding sediment data and analysis shall be reviewed and updated, if necessary.

d) Geology and Geotechnical Investigations

1. Review, and update maps and reports of previous geological studies. Conduct detailed mapping, if major component's locations are changed.
2. All geotechnical investigations including exploratory core drillings recommended in the feasibility study shall be carried out.
3. Conduct additional geophysical investigations, if required.

e) Construction Material Survey

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1. Collect previous laboratory reports and results and verify the quality and quantity of construction materials.
2. Carry out further investigations and laboratory tests, if required.
3. Prepare construction materials quarry site and burrow area location map.

f) Selection of Project Components and Project Layout

1. Review and verify the project layout and components' design.
2. In case of significant changes to the layout, update the feasibility study.
3. Carry out the detailed design of all components such as weir, intake, settling basin, cross drainages etc.
4. Follow the relevant national and international guidelines, norms and codes to design the project components.

g) Project Description and Design

✓ **Civil Components**

1. The final project layout recommended in the feasibility study and the approved IEE/EIA report shall be reviewed and verified, if necessary.
2. Component-wise detailed design shall be carried out for the final/updated project layout.
3. Project definition report defining all project information, parameters and components shall be prepared.
4. Detailed hydraulic design and dimensioning of all components/structures carried out during the feasibility study shall be reviewed and updated/refined/revised where necessary.
5. Foundation Design
    - The results from the geophysical investigation shall be used to design the foundations.
    - If foundation has to be placed in inferior soil type, a suitable foundation treatment method shall be specified.
    - Detailed seepage analysis under the weir/barrage foundation and other water retaining structures shall be carried out. Uplift pressure and under piping mechanism for cutoff wall, apron and protection works shall be analyzed and proper measures shall be proposed to prevent damage related to foundation undermining.
    - The allowable bearing capacity of the foundation may be increased in extreme loading conditions as provisioned in the design codes. Similarly, the allowable bearing capacity may need to be reduced when fully water saturation conditions occur and placing foundation on steep slopes or adjacent to them.
6. Stability Analysis of Structures
   The following loadings shall be considered for stability analysis of project components:
    - Dead load

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- Live load
- Water pressure
- Weight of water
- Hydro-dynamic load
- Active earth pressure
- At rest pressure
- Passive earth pressure
- Earthquake load
- In-situ stresses
- Impact load
- Thermal
- Uplift (buoyancy and seepage)
- Surcharge/overburden loads
- Wind
- Construction and moving surface loads:
- Additional loads, if any

For the purpose of evaluating the stability and structural analysis, different load combinations that may occur during different phases of the project implementation and operation shall be considered. Individual components/elements must be designed for the most unfavorable load combination.

7. Detailed Structural Analysis and Design
   - Appropriate codes (concrete, steel) should be referred for the detail design. All possible loading conditions shall be considered.
   - The durability of the structure shall be ensured in the design.
   - Material properties and allowable stresses for concrete, structural steel, reinforcement, etc. shall be specified.
   - The structures shall be analyzed using acceptable methods manually or by using software.
   - All structures shall be safe against internal and external forces/stresses and all kind of climatic conditions.
   - Reinforcement calculation shall be done considering temperature and shrinkage effects.

8. Water Tightness
   - Control of cracking in concrete shall be as per the requirement specified in IS 456:1978 and 2000 or BS 8007:1987 or BS 8110 Part II, BS 2007 or equivalent codes.
   - The type and location of joints shall be specified. Contraction/expansion joints shall be located in appropriate spacing. Construction joints shall be provided considering construction sequence.
   - The appropriate type of water stops shall be provided at expansion/contraction/construction joints.

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9. Detailing and Drawings
    - The reinforcement shall be detailed considering the ductility of the structure.
    - Reinforcement arrangement shall be shown in drawings in appropriate scale. Special attention shall be given at joints.
    - Prepare construction drawings, reinforcement drawings and bar bending schedules.

10. Field Verification of Design/Layout
    The arrangement of all project components shall be verified at the site by laying setting out points. Any changes that may occur shall be addressed in the design.

11. Report Preparation
    After finalizing the design, a detailed design report shall be prepared showing all hydraulic, geotechnical, stability and structural analyses calculations. Based on the detailed design report, a draft operation and maintenance manual shall be prepared.

✓ **Hydro- Mechanical Components**

- This design is generally carried out by hydro-mechanical equipment manufacturers/suppliers, thus only preliminary design for preparing Terms of Reference of tender/contract documents shall be carried out in consultation with potential manufacturers/suppliers.
- Design and dimensioning of all components/structures carried out during the feasibility study shall be reviewed and updated where necessary and presented in the project definition report.
- The type of gate/stoplogs with embedded parts and its hoisting mechanism shall be fixed.
- The materials to be used for skin plates, stiffeners, girders, embedded parts and other components shall be specified.
- Types and material of seals shall be mentioned.
- Power-operated gates shall normally be capable of operation by alternate means in case of power supply failure.

h) After finalizing the design, a report shall be prepared showing all hydraulic, and structural calculations. Similarly, operating conditions, hoisting mechanisms, opening sizes, design pressures, and dimension of all major components/elements shall be mentioned. Based on the detailed design report, a draft operation and maintenance manual shall be prepared.

i) Environmental Study

- Update IEE (if there are changes in project design).
- Carryout EMP updates in EIA, if there are minor changes in project design and get it approved from Ministry of Forests and Environment.
- Carryout supplementary EIA, if there are major changes in project design and get it approved from Ministry of Forests and Environment

j) Resettlement Study, if any

- Review and update the data/information taken in previous studies.

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- Estimate the total resettlement cost including all requirements such as opportunity loss, educational and environmental effects, physiological, mental and physical health effect, security, social and economic impacts etc.
- Update and finalize resettlement schedule and settlement area.

k) Benefit Estimation

Benefit estimated in feasibility study shall be updated, if required.

l) Cost Estimation

- The criteria and assumptions for feasibility level study shall be applied but shall be based on detailed design with inclusion of items not included in the feasibility level study.
- The methodology for feasibility level study shall be applied but shall be based on a detailed design with inclusion of items not included in the feasibility level study.
- Carry out necessary updates such as revision of rate analysis.

m) Base Cost and Total Project Cost

At the detailed design level, due to use of more detailed information collected and minor items included and designs updated/improved, level of uncertainties will decrease particularly in civil works/HM works component.

n) Cash Disbursement Schedule

Cash disbursement schedule shall be based on updated project implementation schedule, if required.

o) Construction Planning and Schedule

- Review the construction planning and schedule prepared during the feasibility study and update as necessary
- Plan and confirm the availability, quality and quantity of all construction materials.

p) Project Evaluation

Update the economic analysis based on additional information and data available at this stage.

q) Sensitivity Analysis

Update the sensitivity analysis carried out in the feasibility study based on current market conditions and new information/data available at this stage.

r) Presentation Drawings, Maps, Charts and Tables

- Prepare location map in appropriate scale.
- Map showing physiographic regions and geographical regions shall be included.
- Updated (if any) survey maps, data and d-cards with photographs shall be documented and presented
- Control survey benchmarks or traverse stations with their x, y, z coordinates (in separate sheet) shall be given in general arrangement drawings (with contours) for

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all components for reference and further use during construction and operation phases of the project.

- Updated geological drawings, if any.
- Updated hydrology report.
- Prepare civil general arrangement drawings of all components, showing benchmarks, setting out points with their coordinates and all necessary details.
- Reinforcement drawings of all structures with bar bending schedules shall be prepared.
- Preliminary drawings of all hydro- mechanical components with necessary dimensions/schedules shall be prepared.

✓ **Drawing of Civil Structures**

Civil Structures drawings, but not limited to the followings shall be prepared and provided:

- General arrangement/layout of selected project in appropriate scale.
- Headworks (general arrangement, elevations and sections) in appropriate scale
- Headworks components, weir, under sluice, intake etc. plan, sections (L-section, cross sections) and elevations in appropriate scale.
- Settling basin plan, L-section and cross sections in appropriate scale.
- Canal system plan, L-section and cross sections in appropriate scale.
- Cross Drainage works plan, L-section and cross sections in appropriate scale.
- Other canal structures drawings.
- Reinforcement drawings shall be prepared based on Civil General Arrangement drawings in appropriate scale.
- Protection works drawings in appropriate scale

✓ **Drawing of Hydro-Mechanical Components**

Hydro mechanical component's drawings, but not limited to the followings shall be prepared and provided:

- Gates and accessories parts shall be shown in appropriate scale.
- Expansion joints, gates driving system etc. shall be shown in appropriate scale.
- Other HM components shall be prepared in appropriate scale.

s) Detailed Design Report:

- Project Definition Report: This is generally prepared at the beginning of detail design phase as guidelines for further design/development of the project. In the report, all base line data, up to date salient features of the project and project engineering parameters including relevant codes adopted, cost and benefit calculations, economic indices, project implementation schedule, etc. shall be briefly described.
- When numerical and physical hydraulic model studies are carried out, separate reports shall be prepared recommending further design refinements based on the outcomes of such studies.

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Main outcomes of the detailed design are reports, drawings (general arrangement and reinforcement), and specifications. The reports, drawings and specifications together with design calculation sheets can be structured in different volumes. An example of detailed design report volume is suggested below:

- Volume-1: Detailed design main report
- Volume-2: Detailed design annexes and appendices
- Volume-3: Detailed design drawings:
    - Volume-3A: Detailed design civil drawings
    - Volume-3B: Reinforcement drawings
- Volume-4: Technical specifications

The abovementioned report and documents will be the basis for the preparation of tender documents which are prepared during detailed design phase

In case of significant change(s) to the layout, design and or any other project parameters, such change(s) should be reported on time to the client and regulating authorities with necessary supporting documents for necessary approval.

t) **Tender Documents and Procurement Plan**

- Procurement risk assessment shall be carried out.
- Capacity of national contractors shall be assessed for executing works of similar nature and size.
- Procurement plan including packaging of works (NCB and/or ICB, as per requirement) with estimated time and cost shall be prepared.
- Bidding documents following national and/or international practices shall be prepared. A bidding document shall comprise the followings:
    - Instructions For Biddings;
    - Condition Of Contracts;
    - Specifications;
    - Bills Of Quantities;
    - Drawings.

MODE OF PAYMENT

A. For Departmental Employees:

The amount shall be paid to the employees assigned for the study as follows:
For mobilization and field work 30% of the total amount as an advance.
Upon submission of Draft Report 40% of the total amount.
Upon submission and acceptance of Final Survey Report 30% of the total amount.

Final payment shall not be made if the mentioned work is not completed as per TOR, and the assigned team will be fully responsible ensuring the quality of report as per requirement.

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B. For Consultant (if employed) :
Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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1.2. IRRIGATION STORAGE DAM: SMALL EARTHEN DAM (HEIGHT UPTO 15M)

1.2.1. NORMS FOR IDENTIFICATION STUDIES

Office Works

1.2.1.1.1. Report Preparation

A. Compilation, Analysis and Report Preparation

i- Human Resources required:

Engineer / Surveyor	1
Computer Operator	1
Sub Engineer/Supporting Staff/ Assistant	1
Association organizer	1
Office Assistant	1

ii- Performance criteria:

All Projects	7 day/ project

Field Works:

1.2.1.1.2. Headworks/ Dam site:

A. Location and Hydrology Survey

i- Human Resources required:

Engineer / Surveyor	1
Sub-Engineer	1
Labour	4

ii- Performance criteria:

All Projects	1 day/ project

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1.2.1.1.3. Canal Alignment:

A. Layout Survey

i- Human Resources required:

Engineer / Surveyor	1
Labour	2

ii- Performance criteria:

All Projects	1 day/ project

1.2.1.1.4. Command Area

A. GPS Survey

i- Human Resources required:

Sub Engineer/Supporting Staff / Assistant	1
Labour	2

ii- Performance criteria:

All Projects	1 day/ project

B. Socio-economical Survey

i- Human Resources required:

Association Organizer	1
Labour	1

ii- Performance criteria:

All Projects	1 day/ project

1.2.1.1.5. MISCELLANEOUS

i. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

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ii. Office and Field Equipment and consumables

Field Equipment, Field Consumables and office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

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1.2.2. NORMS FOR DETAILED FEASIBILITY STUDIES

Office Works

1.2.2.1.1. Desk study- Data collection, compilation and preparation of secondary data

i- Human Resources required:

Engineer / Surveyor	1
Sub Engineer/Supporting Staff/ Assistant	1
GIS Expert	1
AutoCAD Expert	1
Office Assistant	1

ii- Performance criteria:

All Projects	5 day/ project

1.2.2.1.2. Headworks/Dam site

A. Contour, L Section and X section

i- Human Resources required:

Team Leader/Water Resources Engineer/ Hydraulic Engineer	0.1
Engineer / Surveyor	1
Sub Engineer/Supporting Staff/ Assistant	1
GIS Expert	1
AutoCAD Expert	1
Office Assistant	1

ii- Performance criteria:

Projects – Reservoir Area --up to 10 Ha	4 days/ project
Projects – Reservoir Area –up to 20 Ha	6 days/ project
Projects – Reservoir Area –20 Ha+ every 10 Ha	6 +1 days/ project

B. Geology

i- Human Resources required:

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Geologist	1
GIS Expert	1
AutoCAD Expert	1
Office Assistant	1

ii- Performance criteria:

All Projects	5 days/ project

C. Hydrology

i- Human Resources required:

Team Leader	0.25
Hydrologist	1
GIS Expert	1
AutoCAD Expert	1
Office Assistant	1

ii- Performance criteria:

All Projects	3 days/ project

D. Design and Drawing

i- Human Resources required:

Team Leader/Water Resources Engineer/ Hydraulic Engineer	0.5
Engineer	1
Sub Engineer	2
GIS Expert	1
AutoCAD Expert	1
Office Assistant	1

ii- Performance criteria:

All Projects	5 days/ project

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E. Estimate

i- Human Resources required:

Engineer/Surveyor	1
Sub Engineer	2
Office Assistant	1

ii- Performance criteria:

All Projects	4 days/ project

Field Works

1.2.2.1.3. ***Headworks/ Dam Site***

A. Site Selection
Follow Feasibility Study Norms of RoR Schemes

B. Contour Survey
i- Human Resources required:

Engineer / Surveyor	1
Sub Engineer/Supporting Staff/ Assistant	1
Labour	8

ii- Performance criteria:

Projects – Reservoir Area –up to 10 Ha	1 days/ project
Projects – Reservoir Area –10 Ha+ every 10 Ha	1+0.5 days/ project

C. L-section and X-section Survey
i- Human Resources required:

Engineer / Surveyor	1
Sub Engineer	1
Labour	5

ii- Performance criteria:

All Projects	1 day/ Project

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D. Benchmark survey

Follow Feasibility Study Norms of RoR Schemes

E. Geological Survey

i- Human Resources required:

Team Leader	1
Geologist/Senior Geotechnical Engineer	1
Labour	7x3 = 21
	7 labours can dig 1 pit a day in river bed of size 1.50m x 1.50m x 5m

ii- Performance criteria:

All Projects (3 nos of pits at river bed of size 1.50m x 1.50m x 5m)	1 day

Note: Pit excavation can be replaced by hand auger or core drilling of 5m depth. Cost of hand auger or core drilling can be obtained from related work norms or market price.

F. Hydrological Survey

i- Human Resources required:

Team Leader	1
Hydrologist	1
Engineer	1
Sub Engineer	1
Labour	3

ii- Performance criteria:

All Projects	4 day/ Project

G. Lake routing and Sedimentation Survey

i- Human Resources required:

Silt Expert/Geotechnical Engineer	1
Water Resource Engineer	1
Hydrologist	1

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Assistant	3

ii- Performance criteria:

All Projects	2 day/ Project

H. Operation and Maintenance Plan Preparation

i- Human Resources required:

Water Resource Expert	1
Engineer	1
Hydrologist	1
Office Assistant	2

ii- Performance criteria:

All Projects	4 days/ project

- Field and office works for Canal alignment, Command Area, Cross Drainage works, Socio-economical study, and Construction material survey shall be taken same as ROR Scheme feasibility Study.
- Miscellaneous works, geophysical exploration, Socio-economical study, economic analysis, Rate analysis, Report preparation other study required will shall be taken same as ROR Scheme feasibility Study.

MISCLLEANEOUS:

1.2.2.1.3.1.Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

1.2.2.1.3.2.Office Space , Office and Field Equipment and consumables

Field Equipment, Field Consumables and Office space, Office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc.	15 % of Total Cost of Human Resources (Office+ Field)

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SAMPLE TERMS OF REFERENCE FOR WATER STORAGE EARTHEN DAM UPTO 15M HEIGHT

d. *OBJECTIVE*

The Main objective of the study is preparation of the Detailed Feasibility Study Report for storage dams with gravity/lift irrigation system within the capacity of storage water.

e. *SCOPE OF WORKS*

- Interact with client personnel to understand and prepare plan of activities to conduct the job.
- Carry out desk study
- Review/update available relevant past reports/data.
- Identify the appropriate dam site in the rivers/rivulets of assigned storage sites by considering the hydrological study, topography, uses of river in multipurpose use etc.
- Identify the dam axis, dam height, dam body, volume and influence project areas including possible submergence area due to the construction.
- Identify the approximate volume of storage water.
- Study the environmental impact due to dam construction in prefeasibility level.
- Prepare project cost estimate including distribution system using either gravity or lifting.
- Prepare financial analysis based on project cost, implementation schedule etc.
- Preparation of design, drawings and report of above storage dams including distribution system using either gravity or lifting.
- Prepare cost estimate of the project based on approved district rates and market rates
- Conduct stakeholder consultation meeting along with local governments
- Prepare Draft and Final report including all above mentioned points
- Prepare operation and maintenance plan of Dam considering dam safety and safe passage to excess water.

f. *Field Survey, Data Collection and Preparation of Maps*

In general, the following main activities to be carried out for data collection, planning and designing of headworks/intakes, canal networks and detailed feasibility study:

i) **System Planning**
ii) **Benchmark Survey**
iii) **Head Work site survey**
iv) **Discharge measurement**
v) **Canal alignment survey**
vi) **Command area survey**

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i) System Planning

Digital topographical maps (1:25,000 scales) of the area from Survey Department shall be acquired and layout plan of irrigation and drainage network shall be prepared. An interactive procedure shall be followed in the irrigation system planning. The planning shall be overlaid on recent Google Earth maps or other satellite images and refined considering recently added infrastructure and development in the area. Once the tentative plans are verified in the field during rapid appraisal, more detailed planning for the irrigation and drainage system shall be started. The major activities that shall be carried out during the irrigation canal system planning are;

- Location of Headworks/Dam;
- Delineation of proposed gross command area and net command area to be covered by the study, existing and potential surface irrigation schemes, standalone groundwater irrigation schemes and conjunctive use of water;
- Identification and marking of the natural features including existing drainage, high ground, roads, villages, forests and public places;
- Identification and marking the alignment for canals and corresponding drains;
- Identification and locating the appropriate locations of off-take points.

ii) Benchmark Survey

Reference bench mark and its value shall be obtained from Department of Survey/Project. Specified bench marks shall be established in the vicinity of Headworks/Intakes, settling basin location, command area at the spacing of one BM per 50 ha and at 1 km in Terai and at 0.50 km interval along canals. D-card shall be prepared and attached with the field report. All benchmarks will be located in sites that should remain stable and undisturbed throughout project construction activities and will be constructed as per specifications.

Bench mark levelling shall be conducted precisely using appropriate tools. Each survey section shall be levelled in two directions and the difference in levels shall not exceed 7 $\sqrt{k}$ mm where k is the distance between benchmarks in kilometers.

iii) Intake/Head work Site Survey

- The location of Headworks/Dam located during system planning and rapid appraisal shall be verified and finalized in the field using appropriate survey tool.
- Site plan for an Intake/Dam to be investigated situated on the River Bank will be prepared (Covering total width of the river & at least 100 m both side from the firm bank (depending upon the site condition) or 5 meters above high flood level wherever possible or depending upon the site conditions).
- The profile and cross-section will be taken 1 km u/s and 1 km d/s of intake location (with at least an interval of 100 m, depending upon layout & topography, interval can

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be shorter). All the cross section and profile of the river must show the river bed level, high flood level mark and bank top levels.

- River morphology and Sedimentation study will be carried out during field survey.
- All mapping work will be performed using appropriate instrumentation and procedures for establishing control, field data acquisition, and compilation in accordance with the functional accuracy requirements to include all quality control associated with these functions.
- Topographic and Planimetric feature detail maps will be compiled at a target scale of 1:1000 for the head works upto storage limit.
- Planimetric feature detail will be compiled in accordance with the horizontal accuracy.
- Contours will be developed at 0.25 m intervals for Terai and 0.5 m or 1.0 m intervals (for terrain slope < 10^0, contour interval 0.50 m and for terrain slope >10^0, contour interval 1.0 m) for hill.

iv) Discharge Measurement

The discharge measurement will be done at the headwork/intake location, using appropriate methods.

v) Canal Alignment Survey

General activities and extent of survey works during the canal alignment survey shall be as follows:

- Initially, a baseline shall be established for L-section survey along the refined canal alignment by marking on the ground the turning points and other reference points using wooden pegs or concrete pillars as appropriate. Then the longitudinal survey at an interval of 50 m along the proposed canal alignment shall be done using level instrument and tape.
- X-Section survey along the proposed canal alignment with reference to the baseline and the BMs shall be carried out using level instrument and tapes. The X-sections shall be taken at an interval of not exceeding 100 m in Terai and at an interval of 50m in Hill along the alignment or at closer intervals in case of sharp changes in the topography. In case of steep area, the X-sections shall be taken suitably by other methods. The width of each of the X-Sections shall cover an area at least 100 m to the left and 100 m to the right in case of Main Canal and at least 50 m to the left and 50 m to the right in case of other canals of the proposed canal alignment in Terai and cover suitable width in both left and right direction as permitted by terrain slope in case of hill. Each of the X-sectional readings shall bear latitude and longitude values along with elevation, which shall be compatible to the available topographic maps.
- Off-take points from the canal under consideration shall be located. For this, walk through along with the project representatives and beneficiary farmers shall be made along the canal alignment to identify and finalize the off-take points. Process

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shall be repeated for all the canals under consideration. The finalized off-take points shall then be marked and superimposed on the topographic maps.

- In the course of the walkthrough important structures of the systems shall be located and marked.

vi) Command area survey
Closed Traverse Survey of the command area indicating Gross Command Area, Culturable Command Area including minor canals network and other important physical features will be carried out.

Feature and terrain data should be delivered in both hard copy and digital format.

The detailed survey will be completed in four parts;

1. Benchmark Survey (Closed loop traverse)
2. Topographic Survey
3. Command Area Survey (Closed loop traverse)
4. Profile and Cross-Section Survey

1. Bench Mark Survey
In the first step of the survey, Surveyor needs to start vertical & horizontal control point survey by closed traverse. All of the calculations for error adjustments and distribution of errors will be carried out properly; once the benchmark is finalized, the Surveyor should proceed with the second step. The benchmarks will be established in every 50 ha and at permanent structures or as per requirement. All benchmarks will be located in sites that should remain stable and undisturbed throughout project construction activities and will be constructed as per specifications.

2. Topographic Survey
Once control points (benchmarks) are fixed, the Surveyor will start topographic surveys that will also cover fixing of alignment (for new canal/embankments). The topographic map will be prepared in soft and hard copies. All of the readings (co-ordinate readings) will be submitted in Excel Spreadsheet form or as per requirement. Interpolation for contours should comply with the actual site conditions and accurately reflect changes in slopes and ground configuration. Topographic surveys in structure locations should be detailed and complete, to accurately reflect conditions and elevations related to design requirements.

3. Command Area Survey
A closed loop traverse survey will be carried out to find the Gross Irrigable Command Area and Net Cultural Command Area. In the command area map all minor (secondary/sub secondary) canals and other important physical features should be shown.

4. Profile and Cross Section Survey
Along the finalized alignment, the profile and cross-section survey will be carried out independently to the topographic survey at an interval but not limited to 50 m.

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Whenever alignment crosses special features (Structures, Depressions or other geographical features etc.), the closer cross-sections of that portion(i.e. u/s and d/s of structure) must be taken. The plotted profile and cross section will be prepared in soft and hard copies along with data in excel spread sheets.

Detail cross section and profile for the cross drainage work will be carried out independently clearly indicating drain/river bed level and high flood level as mentioned above. Similarly, detail cross section and profile for the settling basin location/s will be carried out independently.

vii) Geological Study & Geomorphologic study

In this study the following points related to river, its catchment area and all the considered head work (Dam)/canal alignment/command area will be studied in detail.

i) Topography

ii) Nature and structure of the surface soil

iii) Nature and structure of local as well as regional geology

iv) Possibility of change of catchment

v) Nature, size and quantities of debris carried by the river

vi) Intensity, duration and distribution of rain in the catchment

vii) Vegetation, cultivation etc. of the catchment

viii) Existence of reservoirs, lakes etc in the catchment

ix) Existing and/or existed head work/intake/canal alignment or other hydraulic structures across the river/drainage in the vicinity of the proposed head work site with their details as much as possible. If the proposed head work/canal is suggested to build in lieu of the existing/damaged structure, the salvage value of the same must be worked out and provided in the report

x) Other information as per need

viii) Hydro- meteorological Study

Hydro-meteorological survey is one of the important tasks for assessing crop water requirements of various crops to be proposed in the project area and the design flood discharge of the headworks/drain crossings. Under this task, relevant hydro-meteorological data of the rivers/drains will be collected, if they are gauged, from secondary sources (published and unpublished data of DHM). The long-term data of these rivers shall be collected and the low flow as well as flood discharge will be analyzed. The hydrological analysis of these river systems shall be carried out with the help of frequency analysis in case the long-term data are available. In case of absence of long-term data, other methods such as regional, rational, or empirical methods shall be adopted to analyses the hydrological information. Climate change risks shall be assessed, adaptation measures to climate proof infrastructures shall be

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suggested and climate risk assessment report shall be prepared.

Beside collection of hydro & meteorological data from DHM, for determination of all design data the hydrologist will carry out a detailed hydrometrical survey and hydrological study of the river along with the headwork/intake and cross drainage site which will include but not limited to the following:

- Catchment area of the river up to head work/intake and cross drainage site
- Length of the river from origin up to head work/intake and cross drainage site
- Slope of the river from the critical point (origin) of the river up to head work/ intake site and cross drainage site
- Cross-sections covering 100 m beyond flood lines/firm bank (depending on site condition) of the river at proposed head work/intake site, at about 1000 m up-stream and 1000 m down-stream wherein High Flood Level (HFL), Low Water Level (based on local enquiry, LWL), Lowest Bed Level (LBL), area of cross-section, and geological profile with silt factor of each strata (at proposed head work/intake site only) shall be indicated. However, the scale of the drawing for horizontal and vertical should be the same.
- The drawing should include the slope of the river at the proposed head work/ intake axis which should be extended 1000 m U/S and 1000 m D/S along the thalweg (lowest level) of the river
- Maximum discharge shall be calculated by established formulas with 50 yr/100 yr return periods
- 80% reliable flow of the source river at headworks/intake site shall be calculated.
- The peak discharges calculated for a returned of 50/100-years shall be taken as a maximum discharge
- Area of flow, velocity and depth of the flow at the time of survey (for Discharge Calculation) and sediment concentration for design of dam for possible siltation.
- Study of horizontal & vertical shifting of the river
- Other information required for river control, design, construction and/or maintenance of the head work/dam/intake and cross drainage

ix) Environmental Study

The most suitable site for the headwork/canal alignment based on the above characteristics of the site as well as the catchment area will be selected. The selected site will be clearly indicated in the map and all the characteristic features of the chosen head work site/ canal alignment will be given, in order to facilitate easy reference while designing the head work/canal. The environmental study will be carried out i.e. identifying the environmental changes due to the proposed structures and the outcomes of the study need to be presented clearly in the form of recommendations and subsequently be considered in detail design. DWRI Environmental Safeguard Guideline is to be followed.

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Vulnerable area of landslide/soil erosion will be evaluated & mitigation measures will also be proposed.

x) Socio-Economic Study

The socio-economic survey will be carried out to determine the social structure of the community and its economic status. The survey includes the collection of quantitative and qualitative data and information on social structure, socio-cultural institutions, and economic activities of the farmers of the scheme command area. Some of social and economic indicators of the community are as follows:

Social indicators:

- Willingness/commitment- verbal request, formation of committee, submission ofrequest form;
- Social composition- homogeneity, diversity;
- Education- literacy, school and college, awareness about irrigated agriculture, prior experience on irrigation;
- Rural organization- Parma, Guthi, etc;
- Family size- male/female, economically active members,
- Migration- temporary, permanent, foreign/urban areas;
- Economic indicators:
- Land holding size- land less, marginal land holding (for Terai < 1 ha & for hills <5 ropani), land lords (for Terai> 10 ha & for hills > 2 ha);
- Main occupation- agriculture, service, labor, foreign service, business;
- Source of income- agriculture, service, remittance etc;
- Standard Formats will be used
- Expenditure- food, cloth, schooling, festivals, livestock, agriculture

Social Safeguard (SS) Studies & Gender Equality and Social Inclusion (GESI) studies will be carried out complying Social Safeguard & GESI guidelines prepared for Department of Irrigation.

With reference to above guidelines, Indigenous People (IP) inventory & Involuntary/Voluntary Resettlement (IR) plan, and Gender Action Plan (GAP) will be prepared.

An assessment of activities of WUA will be made, if exists; if a WUA doesn't exist, what is the possibility of creating a viable WUA?

With interaction with beneficiary farmers/Municipalities records, the number of beneficiary households/population, woman headed HH/population and presence of marginalized farmers, disadvantage group, landless population, land holding size, land use will be evaluated.

With interaction with beneficiary farmers/ Municipalities, the average income of the project area & other economic parameters will be assessed, including seasonal migration/permanent migration, education level & other source of income than

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agriculture, percentage of population involve in agriculture, gross income from agriculture & other business.

xi) Agriculture Survey

For Irrigation schemes agricultural survey will include data and information regarding the soil type, land use and agriculture practices of the command area to be proposed. The soil survey will include the assessment of the type of soil in the command area and its suitability for irrigated agriculture. The soils may be alluvial, sandy, gravel and boulder mixed.

The land use survey will include the general assessment on land use in the command area which may classify in percent the agricultural land, forest land, grazing land, wetlands, National Parks and reserve forest area.

The agriculture survey includes the collection of data and information on:

- Existing cropping pattern,
- Existing crop yields,
- Inputs used and its availability,
- Marketing facility and labor situation
- Food Security
- Existing & Anticipated Irrigation/Water Management Practices
- Accessibility

xii) Construction Material Survey

Borrow Pits: Borrow pits may be situated on both sides of the embankment depending on the availability of the soil. It shall be located in places approved by the client, but shall not be within ten (10) metres from the toe of a completed embankment or other works. Possibility of utilizing the borrow pits in future as fish ponds by the owners of the land shall be explored. In case the owners wish to use borrow pits as fish ponds, the depth of the pits may be up to 3 m. In such cases, the borrow pits shall not be continuous over lengths of more than 100 m. A strip of no less than 30 m at the level of the original ground shall be left between the pits. In other cases, borrow area shall be arranged in such a manner that the ground elevation of so arranged borrow areas will be more or less the same as the neighboring area, so that rain water will not stagnate in the borrow areas. The required type of tests of borrow material shall be carried out as per standard set by the project.

Other construction materials:

Source of other natural construction materials, such as course and fine aggregates, sand, stone etc shall be explored in the vicinity of construction sites as far as possible. The required of tests of these materials shall be carried as per standard set by the project.

1.2.2.1.4. DATA ANALYSIS, EVALUATION AND DESIGN

The detailed data obtained from field survey and investigation shall be analyzed and evaluated with respect to:

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- Available discharge in the source river for round the year irrigation.
- Type of Dam and height of Dam
- Storage Capacity
- Submergence area
- Safety of Dam/intake with respect to surface flow, sub surface flow and floatation
- Type and Capacity of Spillway
- Operation and Maintenances Plan of Dam with due consideration of Maximum Design flow and spillway capacity
- Gravity pipe/open canal system or lift system
- Existing cropping pattern and cropping intensity
- Incorporation of other existing/pipe lined/potential surface/ground water irrigation systems in the planning and designing of this study
- Conjunctive use of ground and surface water.

1.2.2.1.5. DETAIL COST - ESTIMATE

Approved District Rates for labor and materials at the project sites will be collected or analyzed. Detail rate analysis, detail quantity & cost estimates along with bill of quantity (BOQ) will be prepared.

1.2.2.1.6. ECONOMIC ANALYSIS

Crop Budget without and with Irrigation System will be prepared and Benefit/Cost Ratio and Economic Internal Rate of Return (EIRR) will be evaluated; Conclusion and Recommendation will be made based on economic & other indicators.

1.2.2.1.7. TENDER DOCUMENTS AND PROCUREMENT PLAN

- Procurement risk assessment shall be carried out.
- Capacity of national contractors shall be assessed for executing works of similar nature and size.
- Procurement plan including packaging of works (NCB and/or ICB, as per requirement) with estimated time and cost shall be prepared.
- Bidding documents following national and/or international practices shall be prepared.

1.2.2.1.8. ANNEXES

Annexes will include details of compiled data, designs and calculations, bidding drawings, minutes of community meetings and consent letters of land donation, besides that photographs of sites/location (Intake, command area, alignment, community meeting) will be included. Total station/GPS data will be presented in hard copy.

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1.2.2.1.9. STUDY TEAM

The working team for field and office work shall consists of minimum but not limited, to the following key personnel together with adequate supporting Human Resources.

S.N.	Personnel
A	**Professional Staff**
1	Team Leader/Civil Engineer
2	Geotechnical Engineer/Civil Engineer
3	Hydrologist
4	RS/GIS Expert
B	**Supporting Staff**
1	Agronomist
2	Sociologist
3	Economist
4	GESI Expert
5	Sub Engineer
6	Auto Cad Expert
7	Assistant
8	Office assistant
9	Prism man
10	Labour

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1.3. INTERBASIN TRANSFER MULTIPURPOSE IRRIGATION PROJECTS

Note : This section covers all components of Interbasin Transfer Multipurpose Irrigation Projects till tail race or H/W site of Canal intake. Field work and desk work related to H/W site of Canal Intake, settling Basin, Command area, Canal Alignment, Cross Drainage Works; etc shall refer from Section 1.1. ROR Schemes and Pond Irrigation from respective stage of study.

1.3.1. IDENTIFICATION OF INTERBASIN TRANSFER MULTIPURPOSE IRRIGATION PROJECTS

Field Work

i- Human Resources required:

Team leader/Water Resource Expert	1
Hydropower Engineer	1
Hydraulic Design Engineer	1
Geologist	1
Environment Engineer	1
Transmission line Engineer	1
Sociologist	1
Surveyor	1
RS/GIS Expert	1
Hydrologist	1
Sociologist	0.50
Supporting Staff	2
Labour	4

ii- Performance criteria:

All Projects	7 days

Office Work

1.3.1.1.1. Compilation, Analysis and Report presentation

i- Human Resource required:

Team leader/Water Resource Expert	1

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Hydropower Engineer	1
Hydraulic Design Engineer	1
Geologist	1
Environment Engineer	0.5
Electrical Engineer	1
Transmission line Engineer	0.5
Surveyor	0.25
RS/GIS Expert	1
Draft Person	1
Financial Analyst	0.5
Hydrologist	1
Sociologist	0.5
Construction Planner	0.25
Road Engineer	0.25
Office Assistant	1

ii- Performance criteria:

All Projects	21 days

1.3.1.1.2. Office space, Office and Field Equipment

Field Equipment, Field Consumables and office space, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

1.3.1.1.3. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling(to reach the field (work site) and return back).

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TERMS OF REFERENCE FOR IDENTIFICATION OF INTERBASIN TRANSFER MULTIPURPOSE IRRIGATION PROJECTS

1.3.1.1.4. GENERAL:

Department of Electricity Development (DoED) has prepared and issued the national standard guidelines for studies of hydropower projects in Nepal. The DoED Guidelines, in general, cover the scope of work in defined formats for different phases of studies and also provide specific details for each of the phases. The Guidelines have categorized the study phases in following manners:

- Reconnaissance/Preliminary or Desk Study
- Pre-feasibility Study
- Feasibility Study and
- Detailed Design Study

It has been assumed that scope of hydropower component studies (different phases of studies as mentioned above) cover the study work from headworks (Dam, weir/barrage) up to the tail race of power house and from there the study fall under the scope of irrigation component studies.

1.3.1.1.5. IDENTIFICATION/ RECONNAISSANCE/ DESK STUDY:

Hydropower studies often start from a reconnaissance or desk study phase where a quick assessment is made to determine whether a full feasibility study of the project should be carried out. This is because feasibility studies of a hydropower project require more time and investments based on the size of the project. A multi-disciplinary team of experts is required to carry out the feasibility study. Similarly, a number of investigations and tests (flow measurements, sediment analysis and geophysical tests etc.) have to be carried out during the course of the study.

The desk study, on the other hand, is done based on available information about the site, although a quick site visit is also sometimes carried out. If the findings of the desk study indicate the project could be technically feasible and financially viable, then a full feasibility study (or a pre-feasibility study) can be carried out.

The identification/reconnaissance or desk study report, for all capacity ranges and types, should include at a minimum, the following salient features of the project with following information:

1. Project location including boundary points (four corners) of the project area in longitude and latitude.
2. Basic information about the river hydrology such as catchment area, expected mean annual flow, minimum mean monthly discharge and proposed design discharge.
3. Proposed project components with design parameter
   a. Dam/weir location and type, type of intake (side, frontal) weir, side intake, settling basin Settling basin: length, width and number of chambers.
   b. Details about other waterways such as headrace tunnel, headrace canal or pipe, forebay or surge shaft and penstock pipe.
   c. Powerhouse: tentative dimensions of the structures and whether this will be a

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surface or underground type of structure

d. Generating units: number of turbine/generator units, type and capacity

4. Transmission line: estimated length to interconnection point in the national electricity grid and voltage level.
5. Power and energy estimate:
    a. Gross head
    b. Installed capacity
    c. Total annual energy
    d. Total dry energy
    e. Total wet energy

If based on the information available, the installed capacity cannot be ascertained, then a feasible range for the capacity can also be proposed. The proposed layout should be tentatively shown on the available topographic map.

The requested study area coordinates should also be shown in this topographic map. A brief description of the regional geology, as well as the geology of the project area, should be provided. This should also include discussions on seismicity in the project site. Based on current market prices or unit cost of recently built hydropower plants in the vicinity of the project area (or in similar areas), attempts should be made to estimate the cost of the proposed project. Based on estimates of energy generation and project cost, the desk study should recommend whether a full feasibility study should be carried out.

Similarly, any environmental study (IEE or EIA) that is required according to the prevailing acts of the Government of Nepal should be mentioned. If there are water sharing issues in the project area or downstream requirements, these issues should also be mentioned in the study.

1.3.1.1.6. MODE OF PAYMENT

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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1.3.2. PRE-FEASIBILITY STUDY OF INTERBASIN TRANSFER MULTIPURPOSE IRRIGATION PROJECTS

Field Work

1.3.2.1.1. Headwork Site, Intake and Settling Basin

A. Site Selection

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	1
Geologist	1
Dam Expert	1
Hydrologist	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	5
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	2
Labour	4

ii- Performance criteria:

River Width ≤ 25 m	2 day
River Width 25-100m	2.5 day
River width ≥ 100m	3 day

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Labour	4

ii- Performance criteria:

All Projects	10 BM/Day

C. Geological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	1 Sq. Km/day

D. Hydrological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	0.1
Hydrologist	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

E. River Morphology & Sedimentation

i- Human Resources required:

Geologist	1
Hydraulic Engineer	0.1
Structural Engineer	0.1
Hydrologist	1

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Surveyor	1
Civil Engineer	6
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

1.3.2.1.2. Canal Alignment/Tunnel Alignment

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	0.1
Geologist	1
Hydrologist	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	4
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5km/day

Secretary

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Labour	4

ii- Performance criteria:

All Projects	5 km/day

C. Geological Survey

i- Human Resources required:

Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	5 Km/day

1.3.2.1.3. Surge shaft/Forebay

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical	1

Secretary

Engineer	
Hydraulic engineer	1
Structural engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	1
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Dam Expert	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

C. Geological Survey

i- Human Resources required:

Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1day

1.3.2.1.4. Powerhouse

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Sociologist	1

Environmental Expert	1
Civil Engineer	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

C. Geological Survey

i- Human Resources required:

Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Office Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 sq km/day

1.3.2.1.5. *Tailrace Tunnel/Canal*

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic engineer	1
Structural engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	5
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

Secretar

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

C. Geological Survey

i- Human Resources required:

Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	3 km/day

1.3.2.1.6. Penstock Alignment

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1

Secretary

Director General

Structural Engineer	1
Mechanical Engineer	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Benchmark survey

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

C. Geological Survey

i- Human Resources required:

Geologist	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	3 km/day

Director General

Secretary

1.3.2.1.7. *Study of Water Recipient River*

A. Geological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5 km/day

B. Hydrological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	1
Dam Expert	1
Hydrologist	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

Director General

Secretary

C. River Morphology and Sedimentation

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	1
Structural Engineer	0.1
Dam Expert	1
Hydrologist	1
Surveyor	1
Civil Engineer	6
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

1.3.2.1.8. Transmission Line (Power Supply and Evacuation)

A. Electrical Survey

i- Human Resources required:

Hydraulic Engineer	0.1
Dam Expert	1
Hydrologist	1
Electrical Engineer	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	5 km/day

Director General

Secretary

B. Geological/Geotechnical Survey

i- Human Resources required:

Team Leader	1
Engineering Geologist/ Geotechnical Engineer	0.1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5 km/day

Office Work

1.3.2.1.9. Compilation and Report Preparation

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1

ii- Performance criteria:

5 days	Irrigation Project without Hydropower component
10 days	Irrigation Project with Hydropower <5 MW
20 days	Irrigation Project with Hydropower 5 -20 MW
30 days	Irrigation Project with Hydropower >20 MW

Director General

Secretary

1.3.2.1.10. Socio Economic Analysis

i- Human Resources required:

Team Leader	1
Surveyor	1
Agronomist	1
Sociologist	1
Economist	1
Office assistant	1

ii- Performance criteria:

2 days	Irrigation Project without Hydropower component
3 days	Irrigation Project with Hydropower <5 MW
5 days	Irrigation Project with Hydropower 5 -20 MW
7 days	Irrigation Project with Hydropower >20 MW

1.3.2.1.11. Rate Analysis and Cost Estimation

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	2
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Sociologist	1
Economist	1
Civil Engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1

Director General

Secretary

Office assistant	1

ii- Performance criteria:

1 days	Irrigation Project without Hydropower component
2 days	Irrigation Project with Hydropower <5 MW
3 days	Irrigation Project with Hydropower 5 -20 MW
5 days	Irrigation Project with Hydropower >20 MW

1.3.2.1.12. Report Preparation and Printing

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	2
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Sociologist	1
Economist	1
Civil Engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Office assistant	1

ii- Performance criteria:

2 days	Irrigation Project without Hydropower component
3 days	Irrigation Project with Hydropower <5 MW
5 days	Irrigation Project with Hydropower 5 -20 MW
7 days	Irrigation Project with Hydropower >20 MW

Secretary

1.3.2.1.13. Geotechnical Investigation

Geophysical Investigations (seismic or electrical or electromagnetic) at main structural locations i.e. axis of headworks, settling basins, tunnel entry and exit portals, faults, shear zones, folds along tunnel alignment or other location, surge shaft/ forebay, penstock alignment, power house, tailrace and other geological abnormalities that shall be encountered during the construction of the project shall be carried out as per the norms of geophysical investigation that gives the subsurface information up to the depth of 30m.

1.3.2.1.14. Office Space and Office and Field Equipment

Field Equipment, Field Consumables and office space, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

1.3.2.1.15. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back). Local transportation facility shall also be provisioned, if required. In case of International Expat provision shall also be made for his/her transportation from country of origin to and from Nepal.

Note 1: Guidelines for Study of Hydropower Projects prepared by Department of Electricity Development (DoED) shall be referred for the Terms of Reference and scope of work for the Pre-Feasibility Study.

Note 2: Survey related to Command area like Area verification survey, Agricultural Survey, Agricultural Soil Survey, Socio-Economical Survey and others as per required shall be followed from 1.1 ROR Schemes and Pond Irrigation respective level of Study

1.3.3. FEASIBILITY STUDY OF HYDROPOWER /INTERBASIN TRANSFER COMPONENT OF MULTIPURPOSE/ IRRIGATION PROJECTS

Field Work

1.3.3.1.1. Headwork Site and Intake

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	2
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	5
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Labour	8

ii- Performance criteria:

River Width ≤ 25 m	2 day
River Width 25-100m	2.5 day
River width ≥ 100m	3 day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	0.5 sq km/day

C. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydraulic Engineer	1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq.km/day

D. L-Sec & X-Sec Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	0.1

Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5 days/km

E. Benchmark Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Labour	4

ii- Performance criteria:

All Projects	5 km/day

F. Geological Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Assistant	1
Labour	4

Director General

Secretary

ii- Performance criteria:

All Projects	1 Sq.km/day

G. Hydrological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	1
Dam Expert	1
Hydrologist	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

H. River Morphology & Sedimentation

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	1
Geologist	1
Hydraulic Engineer	1
Structural Engineer	0.1
Dam Expert	1
Hydrologist	1
Surveyor	1
Civil Engineer	6
Assistant	1
Labour	3

Director General

Secretary

ii- Performance criteria:

All Projects	2 days

1.3.3.1.2. Settling Basin /Desander

A. Site Selection

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Economist	1
Environmental Expert	1
Civil Engineer	2
CAD Expert	1

ii- Performance criteria:

River Width ≤ 25 m	1 day
River Width 25-100m	1.5 day
River width ≥ 100m	2 day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1

Director General

Secretary

Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	~~1~~ 0.550 Km/Day

C. **Benchmark survey**

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Hydraulic Engineer	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

D. **L-Sec & X-Sec Survey**

i- Human Resources required:

Hydropower Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

Director General

Secretary

ii- Performance criteria:

All Projects	5 days/km

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	8

ii- Performance criteria:

All Projects	3 Km/day

1.3.3.1.3. Canal Alignment/Tunnel Alignment

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Agronomist	1

Director General

Secretary

Sociologist	1
Economist	1
Environmental Expert	1
Civil Engineer	4
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5km/ day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	6 Km/Day

C. Benchmark survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/	2

Director General

Secretary

Assistant Hydrologists/Assistant Surveyor	
Assistant	2
Labour	4

ii- Performance criteria:

All Projects	5 Km/day

D. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq km/day

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 sq.km/day

1.3.3.1.4. Surge shaft/Forebay

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Expert	1
Structural Expert	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	1
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	0.5 Sqkm/day

C. Benchmark survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Dam Expert	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

D. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1

Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq km/day

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1day

1.3.3.1.5. Powerhouse

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Hydrologist	1

Secretary

Mechanical Engineer	1
Electrical Engineer	1
Construction planner	1
Agronomist	1
Sociologist	1
Economist	1
Environmental Expert	1
Civil Engineer	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	0.55 ~~0~~ Km/ Day

C. Benchmark survey

i- Human Resources required:

Team Leader	0.1

Director General

Secretary

Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

D. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	0.2 Sq km/day

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

Director General

Secretary

ii- Performance criteria:

All Projects	1 sq km/day

1.3.3.1.6. Tailrace Tunnel/Canal

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	5
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

Director General
Secretary

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	6 km/ Day

C. Benchmark survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	10 BM/day

D. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1

Secretary

Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq km/day

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	3 km/day

1.3.3.1.7. Penstock Alignment

A. Site Selection

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Agronomist	1

Director General

Secretary

Sociologist	1
Economist	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

B. Layout survey

i- Human Resources required:

Team Leader	0.1
Structural Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	6 km/ Day

C. Benchmark survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

Director General

Secretary

ii- Performance criteria:

All Projects	10 BM/day

D. Topographic survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq km/day

E. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	3 km/day

1.3.3.1.8. Study of Water Recipient River

A. Topographic survey

i- Human Resources required:

Director General

Secretary

Team Leader	0.1
Hydropower Engineer	0.1
Hydraulic Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	0.2 sq.km/day

B. L-Sec & X-Sec Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	0.1
Surveyor	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5 days/km

C. Benchmark Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Surveyor	1
Civil Engineer	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2

Director General

Secretary

Assistant	2
Labour	4

ii- Performance criteria:

All Projects	5 km/day

D. Geological Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	1 Sq.km/day

E. Hydrological Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	1
Dam Expert	1
Hydrologist	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

Director General

Secretary

F. River Morphology & Sedimentation

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	1
Geologist	1
Hydraulic Engineer	1
Structural Engineer	0.1
Dam Expert	1
Hydrologist	1
Surveyor	1
Civil Engineer	6
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	2 days

1.3.3.1.9. Transmission Line (Power Supply and Evacuation)

A. Electrical Survey

i- Human Resources required:

Hydropower Engineer	0.1
Hydraulic Engineer	1
Dam Expert	1
Hydrologist	1
Electrical Engineer	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

Director General

Secretary

All Projects	5 km/day

B. Geological/Geotechnical Survey

i- Human Resources required:

Team Leader	1
Hydropower Engineer	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Assistant	1
Labour	4

ii- Performance criteria:

All Projects	5 km/day

Office Work (Data Collection, Compilation, Conceptual Design & Report Preparation)

1.3.3.1.10. Headwork Site and Intake

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1

Director General

Secretary

Environmental Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	3 days
River Width 25-100m	5 days
River width ≥ 100m	7 days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	10 days
River Width 25-100m	15 days
River width ≥ 100m	20 days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1

Director General

Secretary

Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	5 days
River Width 25-100m	7 days
River width ≥ 100m	10 days

D. Hydrological Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Hydrologist	1
Civil Engineer	1
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	5 days
River Width 25-100m	7 days
River width ≥ 100m	10 days

E. Design, drawing of Headworks and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2

Director General

Secretary

Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	2
Structural Engineer	2
Dam Expert	2
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	20 Days
River Width 25-100m	25 Days
River width ≥ 100m	30 Days

1.3.3.1.11. Settling Basin /Desander

A. Site Selection

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2

Director General

Secretary

Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	5 Days
River Width 25-100m	7 Days
River width ≥ 100m	10 Days

B. Geological Survey

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	2 Days
River Width 25-100m	3 Days
River width ≥ 100m	5 Days

C. Hydrological Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Hydrologist	1
Civil Engineer	1
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2

Secretary

Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	2 days
River Width 25-100m	3 days
River width ≥ 100m	5 days

D. Design, drawing of Settling basin/Desander and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	2
Structural Engineer	2
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	2 Days
River Width 25-100m	3 Days
River width ≥ 100m	5 Days

Secretary

1.3.3.1.12. Canal Alignment/Tunnel Alignment

A. Alignment Finalization

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	0.1
Structural Engineer	1
Hydrologist	0.1
Construction Planner	1
Surveyor	1
Civil Engineer	2
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	1

ii- Performance criteria:

Tunnel Length<5 Km	2 Days
Tunnel Length 5-10 km	3 Days
Tunnel Length >10 km	5 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Surveyor	1
CAD Expert	2

Director General

Secretary

Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2

ii- Performance criteria:

Tunnel Length<5 Km	5 Days
Tunnel Length 5-10 km	7 Days
Tunnel Length >10 km	10 Days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2

ii- Performance criteria:

Tunnel Length<5 Km	2 Days
Tunnel Length 5-10 km	3 Days
Tunnel Length >10 km	5 Days

D. Design, drawing of Tunnel/Canal and Including entry and exit portal

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1

Director General

Secretary

Structural Engineer	1
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	4
Assistant	2

ii- Performance criteria:

Tunnel Length<5 Km	20 Days
Tunnel Length 5-10 km	25 Days
Tunnel Length >10 km	30 Days

1.3.3.1.13. Surge shaft/Forebay

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1

Director General

Secretary

Environmental Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	2 Days
Project with Hydropower Capacity of 5-20 MW	3 Days
Project with Hydropower Capacity of >20 MW	5 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	5 Days
Project with Hydropower Capacity of 5-20 MW	7 Days
Project with Hydropower Capacity of >20 MW	10 Days

C. Geological Study

i- Human Resources required:

Director General

Secretary

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	3 Days
Project with Hydropower Capacity of 5-20 MW	5 Days
Project with Hydropower Capacity of >20 MW	7 Days

D. Design, drawing of Surge shaft and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1
Structural Engineer	1
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2

Director General

Secretary

Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	10 Days
Project with Hydropower Capacity of 5-20 MW	15 Days
Project with Hydropower Capacity of >20 MW	20 Days

1.3.3.1.14. Tailrace Tunnel/Canal

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Surveyor	1
Sociologist	1
Environment Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	2 Days
Project with Hydropower Capacity of >20 MW	3 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Director General

Secretary

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	2 Days
Project with Hydropower Capacity of 5-20 MW	3 Days
Project with Hydropower Capacity of >20 MW	5 Days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	1.5 Days
Project with Hydropower Capacity of >20 MW	2 Days

Secretary

Director General

D. Design, drawing of Tailrace and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	1.5 Days
Project with Hydropower Capacity of >20 MW	2 Days

1.3.3.1.15. Penstock Alignment

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1

Director General

Secretary

Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environment Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	2 Days
Project with Hydropower Capacity of >20 MW	3 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

Director General

Secretary

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	2 Days
Project with Hydropower Capacity of 5-20 MW	3 Days
Project with Hydropower Capacity of >20 MW	5 Days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	1.5 Days
Project with Hydropower Capacity of >20 MW	2 Days

D. Design, drawing of Penstock and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1

Director General

Secretary

Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	5 Days
Project with Hydropower Capacity of 5-20 MW	7 Days
Project with Hydropower Capacity of >20 MW	10 Days

1.3.3.1.16. Powerhouse and Switch Yard Complex

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environment Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/	1

Director General

Secretary

Assistant Hydrologists/Assistant Surveyor	
Assistant	3
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	2 Days
Project with Hydropower Capacity of >20 MW	3 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	2 Days
Project with Hydropower Capacity of 5-20 MW	3 Days
Project with Hydropower Capacity of >20 MW	5 Days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical	0.1

Director General

Secretary

Engineer	
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	1.5 Days
Project with Hydropower Capacity of >20 MW	2 Days

D. Design, drawing of Powerhouse and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Director General

Secretary

Project with Hydropower Capacity of <5 MW	5 Days
Project with Hydropower Capacity of 5-20 MW	7 Days
Project with Hydropower Capacity of >20 MW	10 Days

1.3.3.1.17. Transmission Line

A. Alignment Selection

i- Human Resources required:

Team Leader	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Environment Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

All Project	10 Km/Days

B. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2

Director General

Secretary

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Office Assistant	2

ii- Performance criteria:

All Project	10 Km/Days

C. Design, drawing of Transmission Line

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	1
Hydraulic engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

All Project	10 Km/Days

1.3.3.1.18. Water Recipient River Study

A. Site Selection

i- Human Resources required:

Team Leader	1

Director General

Secretary

Hydropower Engineer	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Hydrologist	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	1
Environment Expert	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	1 Days
River Width 25-100m	2 Days
River width ≥ 100m	3 Days

B. Topographic Survey including Benchmark and Layout Survey

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Surveyor	1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

Director General

Secretary

ii- Performance criteria:

River Width ≤ 25 m	2 Days
River Width 25-100m	3 Days
River width ≥ 100m	5 Days

C. Geological Study

i- Human Resources required:

Team Leader	0.1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	1 Day
River Width 25-100m	2 Days
River width ≥ 100m	3 Days

D. Hydrological Analysis

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	0.1
Hydrologist	1
Civil Engineer	1
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	2
Assistant	2
Office Assistant	2

Director General

Secretary

ii- Performance criteria:

River Width ≤ 25 m	5 days
River Width 25-100m	7 days
River width ≥ 100m	10 days

E. Design, drawing of Tail water mixing arrangement

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist /Geotechnical Engineer	0.1
Hydrologist	0.1
Hydraulic engineer	1
Structural Engineer	1
Mechanical Engineer	0.1
Electrical Engineer	0.1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/ Assistant Geologist/Assistant Hydrologist/ Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	20 days
River Width 25-100m	25 days
River width ≥ 100m	30 days

1.3.3.1.19. Socio Economic Analysis

i- Human Resources required:

Secretary

Director General

Team Leader	0.1
Surveyor	1
Agronomist	1
Sociologist	1
Economist	1
Office Assistant	1

ii- Performance criteria:

Irrigation Project without Hydropower component	10 Days
Irrigation Project with Hydropower <5MW	15 Days
Irrigation Project with Hydropower 5 -20 MW	20 Days
Irrigation Project with Hydropower >20 MW	30 Days

1.3.3.1.20. Rate Analysis and Cost Estimation

i- Human Resources required:

Team Leader	0.1
Hydropower Engineer	2
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	2
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Sociologist	1
Economist	1
Civil engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Office Assistant	1

Director General

Secretary

ii- Performance criteria:

Irrigation Project without Hydropower component	5 Days
Irrigation Project with Hydropower <5MW	20 Days
Irrigation Project with Hydropower 5 -20 MW	30 Days
Irrigation Project with Hydropower >20 MW	45 Days

1.3.3.1.21. Report Preparation and Printing

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	2
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Sociologist	1
Economist	1
Civil engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Office Assistant	1

ii- Performance criteria:

Irrigation Project without Hydropower component	5 Days
Irrigation Project with Hydropower <5MW	15 Days
Irrigation Project with Hydropower 5 -20 MW	20 Days
Irrigation Project with Hydropower >20 MW	30 Days

Director General

Secretary

1.3.3.1.22. Geotechnical Investigation

Geophysical Investigations (Core Drilling, Insitu testing and Laboratory Testing of collected samples) at main structural locations i.e. axis of headworks, settling basins, tunnel entry and exit portals, faults, shear zones, folds along tunnel alignment or other location, surge shaft/ forebay, penstock alignment, power house, tailrace and other geological abnormalities that shall be encountered during the construction of the project shall be carried out. The cost estimate for the same shall be based on the market rate and depth of the investigation may vary from envisaged subsurface structure during prefeasibility level of study but in no case shall be less than the influence zone of the foundation or the invert level of the structure.

1.3.3.1.23. Office Space and Office and Field Equipment

Field Equipment, Field Consumables and office space, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

1.3.3.1.24. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back). Local transportation shall also be provisioned, if required. If International Expat is provisioned then transportation of his/her from country of origin to and from Nepal shall also be considered.

1.3.3.1.25. Numerical modelling for Interbasin water transfer projects and storage projects shall be carried our during feasibility study. The cost of numerical modelling shall be based on prevailing market rate as it's solely dependent on the cost of the software, technical Human Resources and size of the project which is difficult to quantify in the norms.

Note:

i- For hydropower component of large dam/reservoir multipurpose type project, the norms prepared by DoED shall be followed.

ii- Guidelines for Study of Hydropower Projects prepared by Department of Electricity Development (DoED) can be referenced for the Terms of Reference and scope of work for the Feasibility Study.

iii- Survey related to Command area like Area verification survey, Agricultural Survey, Agricultural Soil Survey, Socio-Economical Survey and others as per required shall be followed from 1.1 ROR Schemes and Pond Irrigation respective level of Study.

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1.3.4. DETAILED ENGINEERING DESIGN OF HYDROPOWER /INTERBASIN TRANSFER / COMPONENT OF MULTIPURPOSE IRRIGATION PROJECTS

Field Work

1.3.4.1.1. Review of Site selection and Survey Works

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Environmental Expert	1
Civil Engineer	1
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	3
Labour	4

ii- Performance criteria:

River Width ≤ 25 m	0.5 day

River Width 25-100m	1 days
River width ≥ 100m	1.5 days

1.3.4.1.2. Settling Basin /Desander

A. Review of Site selection and Survey Works

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Hydrologist	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Economist	1
Sociologist	1
Environmental Expert	1
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	2

ii- Performance criteria:

River Width ≤ 25 m	0.25 day
River Width 25-100m	0.5 day
River width ≥ 100m	1 day

1.3.4.1.3. Surge shaft/Forebay

A. Site Selection and Review

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Sociologist	1
Civil Engineer	2
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	2

ii- Performance criteria:

All Projects	1 day

1.3.4.1.4. Powerhouse

A. Review of Site selection and Survey Works

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1

Environmental Expert	1
Civil Engineer	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	1 day

1.3.4.1.5. Tailrace Tunnel/Canal

A. Review of Site selection and Survey Works

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	0.1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Hydrologist	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	1
Sociologist	1
Environmental Expert	1
Civil Engineer	5

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Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

1.3.4.1.6. Penstock Alignment

A. Site Selection

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

1.3.4.1.7. Study of Water Recipient River

A. Review of Site selection and Survey Works

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Civil Engineer	3
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	1
Assistant	1
Labour	6

ii- Performance criteria:

All Projects	1 day

1.3.4.1.8. Transmission Line (Power Supply and Evacuation)

A. Review of Site selection and Survey Works

i- Human Resources required:

Team Leader	1
Hydropower Engineer	0.1
Hydraulic Engineer	1
Dam Expert	1
Hydrologist	1
Electrical Engineer	1
Civil Engineer	3
Assistant	1
Labour	3

ii- Performance criteria:

All Projects	5 km/ day

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Office Work (Data Collection, Compilation, Design, Drawing & Report Preparation)

1.3.4.1.9. Headwork Site and Intake

A. Design, drawing of Headworks and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	2
Structural Engineer	2
Dam Expert	2
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	10 days
River Width 25-100m	15 days
River width ≥ 100m	20 days

1.3.4.1.10. Settling Basin /Desander

A. Design, drawing of Settling Basin and Associated Structures

i- Human Resources required:

Team Leader	1

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Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	2
Structural Engineer	2
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

River Width ≤ 25 m	1 days
River Width 25-100m	2 days
River width ≥ 100m	3 days

1.3.4.1.11. Canal Alignment/Tunnel Alignment

A. **Site Selection**

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic engineer	1

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Structural Engineer	1
Hydrologist	0.1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Assistant	2

ii- Performance criteria:

Tunnel Length<5 Km	5 Days
Tunnel Length 5-10 km	7 Days
Tunnel Length >10 km	10 Days

1.3.4.1.12. Surge shaft/Forebay

A. Design, drawing of Surge shaft and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2

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Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	5 Days
Project with Hydropower Capacity of 5-20 MW	7 Days
Project with Hydropower Capacity of >20 MW	10 Days

1.3.4.1.13. Tailrace Tunnel/Canal

A. Design, drawing of Tailrace and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	1 Days
Project with Hydropower Capacity of 5-20 MW	1.5 Days
Project with Hydropower Capacity of >20 MW	2 Days

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1.3.4.1.14. Penstock Alignment

A. Design, drawing of Penstock and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	3 Days
Project with Hydropower Capacity of 5-20 MW	5 Days
Project with Hydropower Capacity of >20 MW	7 Days

1.3.4.1.15. Powerhouse and Switch Yard Complex

A. Design, drawing of Penstock and Associated Structures

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical	1

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Engineer	
Hydraulic Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	3 Days
Project with Hydropower Capacity of 5-20 MW	5 Days
Project with Hydropower Capacity of >20 MW	7 Days

1.3.4.1.16. Transmission Line

A. Design, drawing of Transmission Line

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Surveyor	0.1

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Civil Engineer	4
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

All Projects	5 Km/day

1.3.4.1.17. Water Recipient River Study

A. Design of Tail water mixing arrangement

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Geologist	0.1
Engineering Geologist/ Geotechnical Engineer	0.1
Hydraulic engineer	1
Structural Engineer	1
Hydrologist	0.1
Mechanical Engineer	0.1
Electrical engineer	0.1
Construction Planner	1
Surveyor	0.1
Civil Engineer	4
CAD Expert	4
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Assistant	2
Office Assistant	2

ii- Performance criteria:

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River Width ≤ 25 m	7 day
River Width 25-100m	10 day
River width ≥ 100m	15 day

1.3.4.1.18. Socio Economic Analysis

i- Human Resources required:

Team Leader	1
Surveyor	1
Agronomist	1
Sociologist	1
Economist	1
Office Assistant	1

ii- Performance criteria:

Project with Hydropower Capacity of <5 MW	5 Days
Project with Hydropower Capacity of 5-20 MW	10 Days
Project with Hydropower Capacity of >20 MW	15 Days

1.3.4.1.19. Rate Analysis and Cost Estimation

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	2
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Sociologist	1
Economist	1

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Civil Engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Office Assistant	1

ii- Performance criteria:

Irrigation Project without Hydropower component	3 Days
Irrigation Project with Hydropower <5MW	5 Days
Irrigation Project with Hydropower 5 -20 MW	10 Days
Irrigation Project with Hydropower >20 MW	15 Days

1.3.4.1.20. Report Preparation and Printing

i- Human Resources required:

Team Leader	1
Hydropower Engineer	1
Engineering Geologist/ Geotechnical Engineer	1
Hydraulic Engineer	1
Structural Engineer	1
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	1
Sociologist	1
Economist	1
Civil Engineer	4
CAD Expert	1
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	4
Office Assistant	1

ii- Performance criteria:

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Irrigation Project without Hydropower component	3 Days
Irrigation Project with Hydropower <5MW	5 Days
Irrigation Project with Hydropower 5 -20 MW	10 Days
Irrigation Project with Hydropower >20 MW	15 Days

1.3.4.1.21. Preparation of Bidding Documents including technical specifications and Tender Drawings

i- Human Resources required:

Team Leader	1
Hydropower Engineer	2
Geologist	0.1
Hydraulic Engineer	1
Structural Engineer	1
Dam Expert	1
Mechanical Engineer	1
Electrical engineer	1
Construction Planner	0.1
Surveyor	1
Agronomist	1
Civil Engineer	2
CAD Expert	2
Sub-Engineer/Assistant Geologists/ Assistant Hydrologists/Assistant Surveyor	2
Assistant	2
Office Assistant	2

ii- Performance criteria:

Irrigation Project without Hydropower component	30 Days
Irrigation Project with Hydropower <5MW	45 Days
Irrigation Project with Hydropower 5 -20 MW	60 Days
Irrigation Project with Hydropower >20 MW	75 Days

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1.3.4.1.22. Office Space and Office and Field Equipment

Field Equipment, Field Consumables and office space, office equipment such as Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary, All Consumables etc	15 % of Total Cost of Human Resources (Office+ Field)

1.3.4.1.23. Transportation

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

Local transportation shall also be provisioned, if requires. In case of International Expat provision of transportation from his/her country to and from Nepal shall also be provisioned.

1.3.4.1.24. Exclude the Input of Dam Expert if the project under consideration does not involve the construction of dam of height greater than 15m.

1.3.4.1.25. Numerical modelling for Interbasin water transfer projects and storage projects shall be carried our during feasibility study. The cost of numerical modelling shall be based on prevailing market rate as it is solely dependent on the cost of the software, technical Human Resources and size of the project which is difficult to quantify in the norms.

Note:

i- *Guidelines for Study of Hydropower Projects prepared by Department of Electricity Development (DoED) can be referenced for the Terms of Reference and scope of work for the Detailed Engineering Design.*

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SECTION 2: GROUNDWATER IRRIGATION AND GEOLOGICAL STUDY

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Hydrogeological and Engineering Geological Survey

- Mapping
  - 1:1000
  - 1:5000
  - 1:10000
- Geophysical Investigation
- Hydrogeological Survey
  - Identification.
  - Pre-Feasibility
  - Detail Feasibility
- Sampling and testing of soil and rock
  - Surface sampling of in-situ materials
  - Sub-surface sampling
  - Auger method (for unconsolidated fine sediments):
  - Core drilling method (for consolidated sediments):
  - Analysis and testing of field samples
  - Soil
  - Rock

2.1. MAPPING

2.1.A. (Geological, Engineering Geological, Hydrogeological, Soil Depth Survey, Rock Slope Stability, Joint Analysis for (1:1,000; 1:5,000; 1:10,000 per topographical grid/1 km2)

Desk Study

(Collection of data, Literature review, Preparation of survey plan and preparation of inception report)

i- Human Resource required:

Expert/Senior geologist	0.5
Geologist/Eng. Geologist	1
GIS/RS expert	1
Assistant Geol. /Asst. Geo Tech	0.5
Computer operator	1
Office assistant	2

ii- Performance criteria (all scale)

1 km^2	4 days
n km^2	(3*n+1) days

Field Work

(Survey command area/ geol. structure mapping and collection of data from the command area)

i- Human resources required:

Human resources	1:1,000	1:5000	1:10,000
Expert/Senior geologist	2	1.5	1
Geologist/Eng. Geologist	4	3	2
Assistant Geol./Asst. Geo Tech	8	6	4
Surveyor/Peg man	4	3	2
Unskilled	8	6	4

ii- Equipment required:

Equipment	All Scale
Four-Wheeler Drive	1.5
Total station set	1.0

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iii- Performance criteria:

Terrain (1 km^2)	1:1,000	1:5000	1:10,000
a. Hill Slope/ Intermountain Basin/ Tunnel face/ Rock exposure (days)	6	4.5	3
b. Terai /Dun Valley (days)	2	1.5	1
c. For n km^2	n*a; n*b	n*a; n*b	n*a; n*b

Report Preparation

(Data processing, Analysis, interpretation of surface and geological features including preparation of map in digital format, draft, report preparation)

i- Human resources required:

Expert/Senior geologist	0.5
Geologist/Eng. Geologist	1
GIS/RS expert	1
Assistant Geol. /Asst. Geo Tech.	0.5
CAD expert	1
Computer Operator	1
Office Assistant	2

ii- Performance criteria (all scale):

1 km^2	7 days
n km^2	(4*n+3) days

Stationaries, Satellite imaginary, Topographical map and consumable, Software for interpretation, survey equipment, Report Preparation etc @ 15 % of Total Cost of Human Resources (Office+ Field)

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

Field allowances: DWRI survey norms.

Mode of Payment: DWRI survey norms and according to TOR.

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2.2. GEOPHYSICAL SURVEY

2.2.A. *(Electrical, Seismic, Radio Frequency Survey)*

Desk Study

(Collection of geological terrain data; geophysical survey site selection; survey method and array selection; determination of best electrode spacing, investigation depth, resolution of geophysical data; finalization of survey plan and preparation inception report)

i- Human Resources required:

Expert/Senior geologist	0.5
Hydro./Eng. Geologist	1
Geophysicist	1
Assistant Geol.	0.5
Computer Operator	1
Office Assistant	2

ii- Performance criteria for all types of surveys:

a. For a single survey site (B.4)	3 days
b. For n >a	(n+2) days

Field Work

(Optimum area/alignment selection, topographical and geological alignment survey, equipment layout, field data acquisition based upon survey selection criteria A.4)

i- Human Resources required:

Expert/Senior geologist	0.5
Hydro. /Eng. Geologist	1
Geophysicist	1
Asst. Hy. Geologist	2
Surveyor	1
Unskilled	6

ii- Equipment required:

Four-wheeler drive	2.0
Geophysical instrument	1.0
Total station set	1.0

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iii- Performance criteria:

a. 2D, Electrical/ERT, For a single line survey site of 1000 m with spacing 10 m electrode spacing (B.4)	1 day
b. 2D, Electrical/ERT, For a single line survey site of 600 m with spacing 5 m electrode spacing (B.4)	0.9 day
c. 2D, Electrical/ERT, For a single line survey site of 300 m with spacing 1 m electrode spacing (B.4)	0.8 day
d. 1D, Electrical/Vertical Electrical Sounding	0.8 Day
e. 2D, Radio Frequency, GPR 00 m profile length	1 Day for Plain Surface 1.5 days for hills and mountains rough surface
f. 2D, Seismic, SRT, Micro seismic survey 200 m profile length	1 day
g. For n >a	n*(n+1) days

Report Preparation

(Data processing, analysis, identification of geological features, interpretation in terms of depth, lateral spread, resolution, correlation with surface features and nearby geological parameters, including preparation of inverted map and interpreted profile figure in digital format, draft report preparation)

i- Human Resources required:

Man-power	All Scale
Expert/Senior geologist	0.5
Hydro./Eng. Geologist	1
Geophysicist	1.5
Assistant Geologist	0.5
Computer Operator	1
Office Assistant	1

ii- - Performance criteria:

a. Single survey site (B.4)	6 days
b. For n >a	3*(n+1) days

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Geophysical survey method selection table (For single survey site):

S.N.	(a)Type of Geophysical Survey profile (Single survey site)	(b)Relation between the lateral spread of geophysical profile and depth of investigation. {Geophysical Profile Length (m)/ Area of survey (m^2)}			
		(b1) Approximate subsurface information depth (m)	(b2) Total profile spread length (m) / Area (m^2)	(b3) Maximum electrode spacing (m)	(b4) Data array(s)
1	3D, Electrical/Tomography	60-120	(360mx360m ; 2x2 grid) or (720m by 720m; 1X1 grid)	6-12	two
2	2D, Electrical/ERT(CST) for Hydrogeological Survey	200	1000	10	two
3	2D, Electrical/ERT(CST)	100	500	5	two
4	2D, Electrical/ERT(CST) for Sub surface engineering survey	100	300	3	two
5	2D, Electrical/ERT(CST)	12	180	1	two
6	1D, Electrical/Vertical Electrical Sounding	300	AB:1500 m*2 nos	A/B=10	Perpendicular profiles
7	1D, Electrical/Vertical Electrical Sounding	100	AB:600 m*2 nos	A/B=2.5	Perpendicular profiles
8	2D, Radio Frequency, GPR	250m - 50m	1200	-	10 MHz - 250 MHz
9	2D, Seismic, SRT, Micro seismic	300	900	30	-
10	2D, Seismic, SRT, Micro seismic	10-100	300	10	-

2.2.1.1.1. *Single survey site (unit) of a geophysical survey is defined as follows:*

1. Deep tube well irrigation scheme: Terai plain: <=50 Ha; Hill: <=25 Ha, for command area greater than Terai plain: 50 Ha; Hill: 25 Ha, number of geophysical investigation profiles depends upon either recommendation from identification survey or field requirement from the hydrogeological aspect.
2. Landslide and Slope stability study: 0.25 Ha area, if CA>0.25 Ha, the number of geophysical investigation profiles depends upon either recommendation from

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identification survey or field requirement from engineering geological aspect.

3. Unit geophysical survey point: Investigation well, Mountain aquifer, Tunnel face, Rock exposure, Single abutment foundation. (Remark: additional survey points can be calculated in 'n' multiple survey locations.)
4. For Headworks, Cross drainage, Dam, Headworks, Trail race, Canal alignment, Reservoir, Basins, and other Engineering structures where the unit cost is required for estimation purposes; the total cost resulting from the sum of B.1+B.2+B.3 should be divided by the length or area in the **(b2) Total profile spread length (m)/Area (m2) of 1. Geophysical survey method selection table to calculate cost per meter or square meter after maintaining constant factors from b1; b3; b4.**

2.2.1.1.2. Geophysical method of the survey:

For each single survey site; the geophysical survey type is not limited to one but may combine Electrical Resistivity Survey, Vertical Electrical Sounding, Ground Penetrating Radar, and Seismic method of subsurface investigations as per field conditions and verification purposes for the same site.

Stationaries, Satellite imaginary, Topographical map and consumable, Software for interpretation, survey equipment etc @ 15 % of B of respective areas.

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

Field allowances: DWRI survey norms.

Mode of Payment: DWRI survey norms and according to TOR.

2.3. HYDROGEOLOGICAL SURVEY

2.3.A. IDENTIFICATION SURVEY

Desk Study

(Collection of data, Literature review, Preparation of survey plan and Inception report)

i- Human Resources required:

Expert/Senior Geologist	0.25
Hydrogeologist	1
Engineer	0.5
Asst. Hydrogeologist	2
Computer operator	1
Office assistant	2

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ii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	1 day
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	2 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	3 days

Field Work

(Survey command area for existing irrigation system, Hydrological and Hydrogeological data collection, Tubewell Irrigation System area identification and Commend area verification)

i- Human Resource required:

Hydrogeologist	2
Irrigation Engineer	0.5
Asst. Geologist/ Sub-Engineer	3/1
Labour	4

ii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	2 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	4 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	6 days

Socio-Economical Survey

i- Human Resources required:

Sociologist/Association Organizer (AO)	1
Labor	1

ii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	1 day
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	2 days

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Large Projects (>=1000 ha at Terai and >=500 ha at hill)	3 days

Office work and Report Preparation

(Compilation, Analysis and Report presentation)

i- Human Resource required:

Expert/Senior geologist	0.5
Hydrogeologist	1
Irrigation Engineer	0.5
Sociologist/AO	1
Computer operator	1
Office assistant	2

ii- Performance criteria

Small Projects (<=500 ha at Terai and <=250 ha at hill)	7 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	11 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	15 days

- Stationaries, Satellite imaginary, Topographical map and consumable, survey equipment Report Preparation etc @ 15 % of Total Cost of Human Resources (Office+ Field)
- Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).
- Field allowances: DWRI survey norms.
- Mode of Payment: DWRI survey norms and according to TOR.

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SEQUENCE OF ACTIVITIES:

(General activities/steps performed before and after initiation of groundwater project are provided in following tables.)

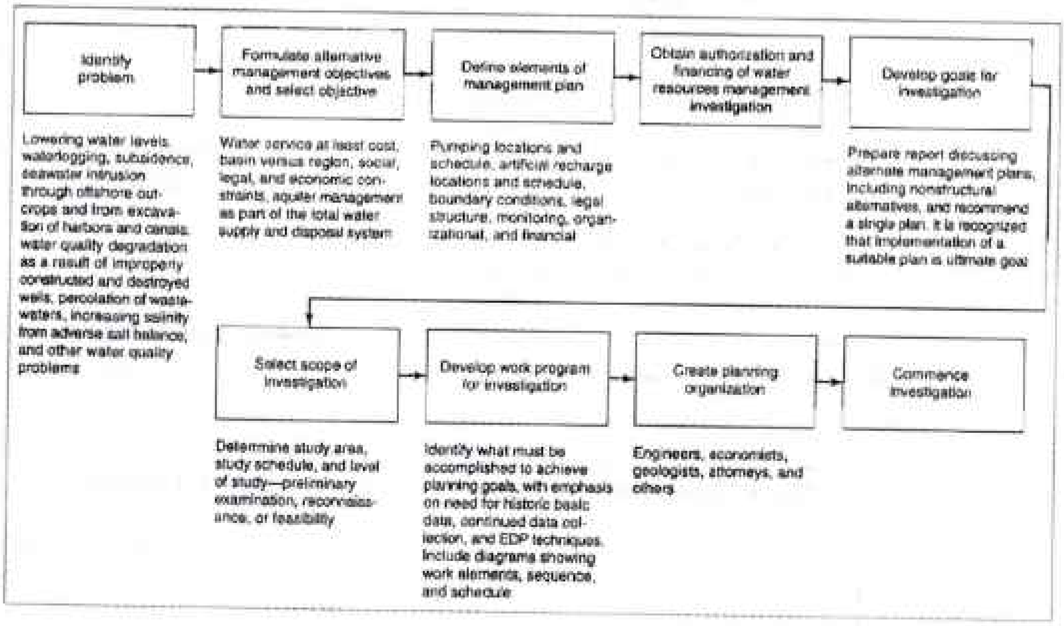

Figure: Sequence of activities preceding start of a groundwater management investigation (after Amer. Soc. Civil Engrs.).

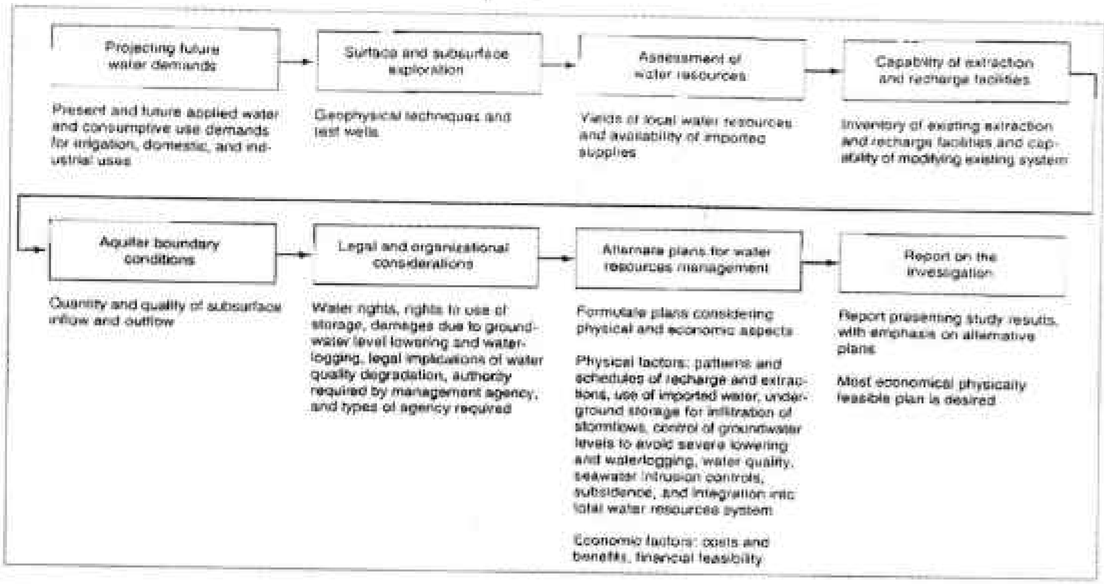

Figure: Sequence of activities during a feasibility investigation for groundwater management (after Amer. Soc. Civil Engrs.).

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CRITERIA FOR SELECTION

The criteria for the selection of the project for identification may be:

- Beneficiaries signature in project request forms as per groundwater irrigation guidelines /policy;
- No potential water right disputes;
- Beneficiaries' commitment to take future O&M responsibilities, if required;
- Water availability in the source/subsurface aquifer;

For groundwater irrigation schemes less or equal to 500 ha command area in hill and 1000 ha command area in Terai will be enough to carry out two levels of the study only:

- **Identification Study**
- **Pre-Feasibility Study & Estimate**

For groundwater irrigation schemes more 500 ha in hill and 1000 ha in Terai the study will be carried out in three levels as follows:

- **Identification Study**
- **Prefeasibility Study**
- **Detail Feasibility Study including Detailed Design & Estimate**

The time span needed for different type of survey depends upon depth of investigation and components to be investigated as specified in TOR/Identification/Prefeasibility, however generalized minimum time span for various kinds of study will be as follows:

Identification study	1-2 month
Prefeasibility study	3-6 months
Detail feasibility study and estimate	6-12 months

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TERMS OF REFERENCE FOR IDENTIFICATION OF THE GROUNDWATER IRRIGATION PROJECT (Study specific only, additional criterion could be derived from DWRI and other GoN body TOR's)

Desk Study

- Review of Farmers' Request Form, if any, and other available documents (topographic map, Borehole logs, Geophysical survey report, Aerial photography, Climatological records, Hydrological records, Hydrogeological records, Geological maps, Socio-demographic records etc) related with project area;
- Locate the project area on available Topographic Map/Satellite Imaginary /GIS map/s;
- Locate the tentative alignment and type of open or buried pipe distribution systems on available topographic Map/ Satellite Imaginary /GIS map/s;

Field Work and Command Area

- Identify existing all types of irrigation system.
- Verify gross command area by excluding all type year-round irrigated land.
- Assessment of groundwater/ water availability.
- Identify type of aquifer (shallow or deep) and best economical method to extract ground water.
- Reach out all potential tube-well construction sites (if possible).
- Acquire GPS coordinates of TW construction site and boundaries of commend area.
- Existing WUA & its function, if any.
- Assessment of willingness of the farmers for providing land for developing system, if required.
- Assessment of willingness of the farmers towards cost contribution as per Irrigation Policy/Regulation (if possible).

Reporting

Based on the data and information collected during the field visit the team needs to analyze the project findings and finalize the identification study. The analysis should be based on technical, economic and social aspects of project implementation. In addition to technical details, the analysis should cover but not limited to the following aspects:

- Groundwater availability;
- Declining levels of groundwater;
- Type of groundwater irrigation system (DTW/STW) requirements;
- Size and type of command area (rain fed; partially irrigated; round-year irrigated);
- General hydrogeological condition of subsurface aquifer (unconfined/confined aquifer; aquitards; aquifer; karst topography; primary and secondary structures);
- Farmer's interest/absence;

Recommendation Report

The recommendation may be based on, but not limited to the followings:

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- Genuineness of demands, if any;
- Gross and total command area;
- Groundwater/water availability;
- Purpose least cost groundwater extraction method and sustainability project;
- Hydrogeological complication;
  - Type of study needed further;
  - Number, location, and type of geophysical survey (If required);
  - Depth, location, and size of investigation tub wells. (If required);
  - Groundwater level measurement and water degradation analysis (If required);

The Recommendation should clearly state whether the project should be abandoned, proceed for further study, or adopt alternative irrigation approach.

Director General

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2.3.B. *PREFEASIBILITY STUDY*

Desk Study

(Collection of data, Literature review, Preparation of survey plan and Inception report preparation)

i- Human Resource required:

Expert/Senior Geologist	1
Hydrogeologist	2
GIS/RS expert	1
Engineer	0.5
Asst. Hy.Geol./Sub-Engineer	2/1
Computer operator	1
Office assistance	4

ii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	3 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	5 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	7 days

Field Work and Command Area

(Survey & command area mapping, command area delamination; collection of field data from command area for hydrological, hydrogeological agricultural, demographic, Socio economic and Environmental assessment)

i- Human Resource required:

Expert/Senior Geologist	1
Hydrogeologist	2
Irrigation Engineer/Hydrologist	1
Agriculturist/Agronomist	1
Sociologist/ Economist	1
Environmentalist	1
Mech./ Elec.Sub-Engineer	1/1
Asst. Hy.Geol./Sub-Engineer	3/1
Surveyor	2
Labor	12

ii- Equipment required:

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Four-Wheeler Drive	3
Total station set	2

iii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	4 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	8 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	14 days

Hydrogeological Survey

(Possible geophysical survey site and alignment selection; aquifer, discharge, and other hydrogeological data collection; hydrogeological/geological parameter survey and verification)

i- Human Resource required:

Expert/Senior Geologist	0.5
Hydrogeologist	1
Asst. Hy.Geologist	2
Labor	3

ii- Equipment required:

Four-Wheeler Drive	1.5

iii- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	4 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	7 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	10 days

Geophysical Survey

(Total number of geophysical survey profiles and their types needed to deploy in the study area could be analyzed from geophysical survey norms).

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Construction of Investigation Tube well and water level monitoring

(Total number of required Investigation Tubewell and their depth required in the study area can be analyzed from DWRI Tubewell Drilling Norms).

Water quality test; source contaminant and degradation analysis (If needed):

(Water sample collection, identification of contaminants source, agricultural soil analysis, testing of samples and labwork).

i- Human Resource required:

Hydrogeologist	0.25
Geochemist	0.5
Contaminant expert	0.5
Microbiologist	0.25
Labor	1.5

ii- Equipment required:

Four-Wheeler Drive	1.0

iii- Testing of samples and lab work: (Derive from competitive market or other GoN body's norm)

iv- Performance criteria:

Small Projects (<=500 ha at Terai and <=250 ha at hill)	7 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	14 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	21 days

Office work and Report Preparation

(Data processing, Analysis, Interpretation including cost estimate and economic analysis.)

i- Human Resource required:

Expert/Senior Geologist	1
Hydrogeologist	2
Irrigation Engineer/Hydrologist	1
Agriculturist/Agronomist	1
Sociologist/ Economist	1
Environmentalist/Geochemist	1

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Economist	1
GIS/RS expert	1
Asst. Hy.Geol./Sub-Engineer	2/1
CAD expert	1
Office assistant	6

ii- Performance criteria

Small Projects (<=500 ha at Terai and <=250 ha at hill)	7 days
Medium Projects (<=1000 ha at Terai and <=500 ha at hill)	11 days
Large Projects (>=1000 ha at Terai and >=500 ha at hill)	15 days

Stationaries, Satellite imaginary, Topographical map and consumable, survey equipment Report Preparation etc @ 15 % of Total Cost of Human Resources (Office+ Field)

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

Field allowances: DWRI survey norms.

Mode of Payment: DWRI survey norms and according to TOR.

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TERMS OF REFERENCE FOR PRE-FEASIBILITY OF THE GROUNDWATER IRRIGATION PROJECT (Study specific only) additional criterion can be derived from DWRI and other GoN body TOR's)

The detail-feasibility study should be carried out for the large irrigation projects that will decide project should be implemented or not. The study tentatively assesses the technical feasibility, economic viability and institutional suitability of the project implementation. The pre-feasibility study is carried out in the following steps:

- **Desk study**
- **Field survey work**
- **Hydrogeological survey**
- **Geophysical survey**
- **Construction of Investigation Tube well**
- **Water quality test and contamination analysis**
- **Reporting and recommendation**

Desk study:

- Assessment of groundwater irrigation availability zonation & command area delamination.
- Review of farmers' request forms, if any,
- Revision available documents (Topographic map, Borehole logs, Geophysical survey report, Aerial photography, Climatological records, Hydrological records, Hydrogeological records, Geological maps, Socio-demographic records etc) related with project area;
- Locate the project area on Topographical/ Satellite Imaginary/GIS map/Arial map/ Hydrogeological map/s;
- Locate the tentative alignment and type of open or buried pipe distribution systems on available topographic Map/ Satellite Imaginary /GIS map/s;
- Assess location of geophysical investigation in the command area;
- Assess investigation tubewell construction location in the command area;
- Assess density of ground water sampling; representative location of samples in the command area;
- Send field visit date and information to the farmers/local communities;

Field survey work

- Identify existing all types of irrigation system.
- Verify gross command area by excluding all type year-round irrigated land.
- Assessment of groundwater/water availability and seasonal water demand.
- Reach out all potential tube-well construction sites/ demand area.
- Acquire geolocation of tubewell construction site and boundaries of commend area.

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- Verify the appropriate groundwater irrigation availability zonation & command area location,
- Take geolocation of total number proposed tube well construction site and clearly demarcate the command area in field maps.
- Survey and measure total length of subsurface water distribution system, total number of surge riser and water outlet and acquire their geolocations.
- Assess the availability of sources of electricity or it's alternatives and acquire geolocation of their access point around the command area.
- Survey along the perimeter of proposed command area and verify net command area; take geolocation at specific locations.
- Assess localized existing subsurface water extraction techniques and viability of extraction condition.
- Make Assessment of existing cropping pattern and water demand.
- Make Assessment of Existing Irrigation Practices, if any
- Make Assessment of Water Management Practices, if any
- Make Assessment on Accessibility of Project Area.
- Make Assessment of beneficiary Population/HH of the project
- Make Assessment of Social Composition of the area
- Make Assessment of market availability and food sufficiency of the project area
- Make Assessment of willingness of the farmers for providing land and cost contribution for developing system.
- Existing WUA & its function, if any.

Hydrogeological Survey

- Identify types of aquifer (shallow or deep) and best economical method to extract ground water.
- Make assessment of ground water availability and zonation based on discharge capacity.
- Collect Borehole log data, geophysical survey data of nearby tube wells.
- Correlate borehole logs. Geophysical report and asses' subsurface aquifer status.
- Acquire pump test data and locate existing drinking/ irrigation tube wells.
- Collect and verify data with existing nearby functioning tube wells.
- Provide guideline for geophysical survey team and correlate hydrogeological data with geophysical data (If necessary).
- Provide guideline for investigation tube well construction team and correlate hydrogeological data.
- Provide guideline for investigation tube water quality and contaminant analysis team.
- Make assessment on quality and quantity of inflow and outflow and water balance condition.
- Schedules of artificial recharge system, managed aquifer recharge to balance groundwater equilibrium.

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- Make assessment on severe lowering of ground and subsidence due to over exploitation.

Geophysical Survey

- Assess best alignment, depth of investigation, resolution of survey.
- Make sure depth of geophysical investigation covers the tentative depth of investigation tube well and future production deep tube well.
- Perform at least two types of survey along/across the same profile with at least two electrode configurations (arrays).
- Correlate acquired data with existing geophysical reports, hydrogeological survey data and borehole logs.
- Provide tentative thickness of water bearing aquifer, aquifer material identification, aquifer status in terms of discharge and screen length for cost estimation purpose.

Construction of Investigation Tube well

- Access investigation tube well construction location at typical anomalous hydrogeological locations.
- Make record of drilling time rate, collection of samples at appropriate intervals of depth and determine position and nature of subsurface aquifers.
- Sieve analysis of samples to determine screen opening/size and correlation with grain size obtained from geophysical logs.
- Perform and correlate drilling time log, lithological log, resistivity logs, self-potential log, radiation logs, other borehole logs and reports.
- Perform pump test (Continuous, Recovery, Step drawdown) to determine pump capacity, specific capacity, discharge, aquifer properties needed to extract subsurface water to meet project requirement and farmer demand.
- Determine method of tubewell construction, total depth of tubewell to be constructed, primary housing, screen length and optimum well size.
- Well interference, subsurface interchange through wells, water table variation, declining water level and other aquifer properties.
- Schedules of artificial recharge system, managed aquifer recharge to balance groundwater equilibrium.

Water quality test and contamination analysis

- Geochemical analysis of water samples and agricultural soils and their treatment.
- Sources of contaminations (natural, artificial, agricultural).
- Effect of wastes on hydrologic system.
- Water quality degradation due to improper management of constructed and destroyed wells.

Reporting:

Based on the data and information collected during the field visit the team needs to analyze the project findings and finalize the prefeasibility study. The analysis should be

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based on technical, economic, and social aspects of project implementation. In addition to technical details, the analysis should cover but not limited to the following aspects:

- Farmer's interest/absence; number of beneficiaries; local job creation by project.
- Groundwater availability, zonation, well interference, Tubewell spacing;
- Hydrogeological complications and declining levels of groundwater;
- Best economic type of groundwater irrigation system (DTW/STW) and its requirements;
- Size and type of command area (rain fed; partially irrigated; round-year irrigated);
- General hydrogeological condition of subsurface aquifer (unconfined/confined aquifer; aquitards; aquifer; karst topography; primary and secondary structures);
- Suitability of subsurface water quality for irrigation purpose.
- Depth of primary housing, screen length, total depth of tube well based on locality;
- Total amount of discharge, pump and transformer capacity, length of transmission line length per deep/shallow tube well irrigation system.
- Length and spread of subsurface distribution system, surge riser, number of outlets per irrigation system.
- Total number of groundwater tube well irrigation systems in single command area.
- Quality of surface soil, groundwater, and possible treatment method;
- Preparation of Project area/hydrogeological/contaminant map//other maps at 1:10,000 scale.
- Make Assessment of cost of the project and cost per hector.
- Evaluate economic indicators (NPV, Internal Rate of Return and Benefit Cost Ratio).
- Final cost estimate, Procurement schedule, Packaging, Implementation schedule.

Recommendation Report:

The recommendation may be based on, but not limited to the followings:

- Genuineness of demands;
- Gross and total command area;
- Water balance and recharge vs discharge condition;
- Hydrogeological complication;
- Groundwater/water availability, aquifer boundary conditions;
- Need of further study;
- Most economical physically feasible groundwater irrigation plan;
- Integration of subsurface water with other irrigation system, novel methods of groundwater irrigation;
- Sustainability of project and environmental adverse effect;
- Economic indicators i.e. cost/ha, EIRR & B/C ratio etc'
- Need of rehabilitation and managed aquifer recharge;
- Economical alternative method of irrigation;

The Recommendation should clearly state whether the project should be abandoned, proceed for further study, or adopt alternative irrigation approach.

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2.3.2 *DETAIL FEASIBILITY STUDY*

Desk Study

(Collection of data, Literature review, Preparation of survey plan and Inception report)

i- Human Resource required:

Expert/Senior Geologist	2
Hydrogeologist	4
GIS/RS expert	2
Engineer	1
Asst. Hy.Geol./Sub-Engineer	4/1
Computer operator	2
Office assistance	8

ii- Performance criteria:

a. Large Projects (>=1000 Ha at Terai and >=500 ha at hill)	5 days
b. Major Projects (>1000 Ha at Terai and >500 ha at hill)	3*(b/a)+2 days

Field Work and Command Area

(Survey & command area mapping Command area delamination; Collection of field data from command area for hydrological, agricultural, demographic, socio economic, electromechinacal and environmental assessment)

i- Human Resource required:

Expert/Senior Geologist	2
Hydrogeologist	4
Irrigation Engineer	1.5
Agriculturist/Agronomist	1.5
Sociologist/ Economist	1.5
Environmentalist	1.5
Senior Mechanics/ Electrical overseer	1.5/1.5
Asst. Hy.Geol./Sub-Engineer	5/1.5
Surveyor	4
Labor	18

ii- Equipment required:

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Four-Wheeler Drive	4
Total station set	3

iii- Performance criteria:

a.Large Projects (>=1000 ha at Terai and >=500 ha at hill)	12 days
b. Major Projects (>1000 Ha at Terai and >500 ha at hill)	6*(b/a)+6 days

Hydrogeological Survey

(Possible geophysical survey site and alignment selection; aquifer, discharge and other hydrogeological data collection; hydrogeological/aquifer parameter survey and verification)

i- Human Resource required:

Expert/Senior Geologist	1
Hydrogeologist	2
Asst. Hy.Geologist	3
Labor	5

ii- Equipment required:

Four-Wheeler Drive	2

iii- Performance criteria:

a.Large Projects (>=1000 ha at Terai and >=500 ha at hill)	8 days
b. Major Projects (>1000 Ha at Terai and >500 ha at hill)	5*(b/a)+3 days

Geophysical Survey

(Total number of geophysical survey profiles and their types needed to deploy in the study area can be analyzed from Geophysical Survey Norms and recommendation from prefeasibility study).

Construction of Investigation Tube well

(Total number of required Investigation Tubewell and their depth in the study area can be analyzed from Deep Tubewell Drilling Norms and recommendation from prefeasibility study).

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Water quality test; source contaminant and degradation analysis:

(Water sample collection, identification of contaminant source, agricultural soil analysis, testing of samples and lab work and recommendation from prefeasibility study).

i- Human Resource required:

Hydrogeologist	0.5
Geochemist	1
Contaminant expert	1
Microbiologist	0.5
Labor	3

ii- Equipment required:

Four-Wheeler Drive	2.0

iii- Testing of samples and lab work: (Derive from competitive market or other GoN body's norm)

iv- Performance criteria:

a.Large Projects (>=1000 ha at Terai and >=500 ha at hill)	18 days
b. Major Projects (>1000 Ha at Terai and >500 ha at hill)	12*(b/a)+6 days

Office work and Report Preparation

(Data processing, Analysis, Interpretation including cost estimate and economic analysis.)

i- Human Resource required:

Expert/Senior Geologist	1.5
Hydrogeologist	3
Irrigation Engineer	1.5
Agriculturist/Agronomist	1.5
Sociologist/ Economist	1.5
Environmentalist/Geochemist	1.5/2
Economist	2
GIS/RS expert	1.5
Asst. Hy.Geol./Sub-Engineer	3/2
CAD expert	2
Office assistant	10

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ii- Performance criteria

1.1.Large Projects (>=1000 ha at Terai and >=500 ha at hill)	12 days
b. Major Projects (>1000 Ha at Terai and >500 ha at hill)	8*(b/a)+4 days

Stationaries, Satellite imaginary, Topographical map and consumable, survey equipment, Report Preparation etc @ 15 % of Total Cost of Human Resources (Office+ Field)

Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).

Field allowances: DWRI survey norms.

Mode of Payment: DWRI survey norms and according to TOR.

TERMS OF REFERENCE FOR PRE-FEASIBILITY OF THE GROUNDWATER IRRIGATION PROJECT (Study specific only) additional criterion can be derived from DWRI and other GoN body TOR's)

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The detail-feasibility study should be carried out for the large to major irrigation projects that will decide whether project will implement or not. The study assesses the technical feasibility, economic viability and institutional suitability of the project implementation in detail. The detail-feasibility study is carried out in the following steps:

- **Desk study**
- **Field survey work**
- **Hydrogeological survey**
- **Geophysical survey**
- **Construction of Investigation Tube well**
- **Water quality test and contamination analysis**
- **Reporting and recommendation**
- **Project design and Cost estimate**

Desk study:

- Assessment of groundwater irrigation availability zonation & command area delamination.
- Review of farmers' request forms, if any,
- Revision available documents (Topographic map, Borehole logs, Geophysical survey report, Aerial photography, Climatological records, Hydrological records, Hydrogeological records, Geological maps, Socio-demographic records etc) related with project area;
- Locate the project area on Topographical/ Satellite Imaginary/GIS map/Arial map/ Hydrogeological map/s;
- Locate the tentative alignment and type of open or buried pipe distribution systems on available topographic Map/ Satellite Imaginary /GIS map/s;
- Assess location of geophysical investigation in the command area;
- Assess investigation tubewell construction location in the command area;
- Assess density of ground water sampling; representative location of samples in the command area;
- Send field visit date and information to the farmers/local communities;

Field survey work

- Identify existing all types of irrigation system.
- Verify gross command area by excluding all type year-round irrigated land.
- Assessment of groundwater/water availability and seasonal water demand.
- Reach out all potential tube-well construction sites/ demand area.
- Acquire geolocation of Tubewell construction site and boundaries of commend area.
- Verify the appropriate groundwater irrigation availability zonation & command area location,

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- Take geolocation of total number proposed tube well construction site and clearly demarcate the command area in field maps.
- Survey and measure total length of subsurface water distribution system, total number of surge riser and water outlet and acquire their geolocations.
- Assess the availability of sources of electricity or it's alternatives and acquire geolocation of their access point around the command area.
- Survey along the perimeter of proposed command area and verify net command area; take geolocation at specific locations.
- Assess localized existing subsurface water extraction techniques and viability of extraction condition.
- Make Assessment of existing cropping pattern and water demand.
- Make Assessment of Existing Irrigation Practices, if any
- Make Assessment of Water Management Practices, if any
- Make Assessment on Accessibility of Project Area.
- Make Assessment of beneficiary Population/HH of the project
- Make Assessment of Social Composition of the area
- Make Assessment of market availability and food sufficiency of the project area
- Make Assessment of willingness of the farmers for providing land and cost contribution for developing system.
- Existing WUA & its function, if any.

Hydrogeological Survey

- Identify types of aquifer (shallow or deep) and best economical method to extract ground water.
- Make assessment of ground water availability and zonation based on discharge capacity.
- Collect Borehole log data, geophysical survey data of nearby tube wells.
- Correlate borehole logs, geophysical report and asses subsurface aquifer status.
- Acquire pump test data and locate existing drinking/ irrigation tube wells.
- Collect and verify data with existing nearby functioning tube wells.
- Provide guideline for geophysical survey team and correlate hydrogeological data with geophysical data (If necessary).
- Provide guideline for investigation tube well construction team and correlate hydrogeological data.
- Provide guideline for investigation tube water quality and contaminant analysis team.
- Make assessment on quality and quantity of inflow and outflow and water balance condition.
- Schedules of artificial recharge system, managed aquifer recharge to balance groundwater equilibrium.
- Make assessment on severe lowering of ground and subsidence due to over exploitation.

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Geophysical Survey

- Assess best alignment, depth of investigation, resolution of survey.
- Make sure depth of geophysical investigation covers the tentative depth of investigation Tubewell and future production deep Tubewell.
- Perform at least two types of survey along/across the same profile with at least two electrode configurations (arrays).
- Correlate acquired data with existing geophysical reports, hydrogeological survey data and borehole logs.
- Provide tentative thickness of water bearing aquifer, aquifer material identification, aquifer status in terms of discharge and screen length for cost estimation purpose.

Construction of Investigation Tube well

- Access investigation tube well construction location at typical anomalous hydrogeological locations.
- Make record of drilling time rate, collection of samples at appropriate intervals of depth and determine position and nature of subsurface aquifers.
- Sieve analysis of samples to determine screen opening/size and correlation with grain size obtained from geophysical logs.
- Perform and correlate drilling time log, lithological log, resistivity logs, self-potential log, radiation logs, other borehole logs and reports.
- Perform pump test (Continuous, Recovery, Step drawdown) to determine pump capacity, specific capacity, discharge, aquifer properties needed to extract subsurface water to meet project requirement and farmer demand.
- Determine method of tube well construction, total depth of tube well to be constructed, primary housing, screen length and optimum well size.
- Well interference, subsurface interchange through wells, water table variation, declining water level and other aquifer properties.
- Schedules of artificial recharge system, managed aquifer recharge to balance groundwater equilibrium.

Water quality test and contamination analysis

- Geochemical analysis of water samples and agricultural soils and their treatment.
- Sources of contaminations (natural, artificial, agricultural).
- Effect of wastes on hydrologic system.
- Water quality degradation due to improper management of constructed and destroyed wells.

Reporting:

Based on the data and information collected during the field visit the team needs to analyze the project findings and finalize the detail feasibility study. The analysis should

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be based on technical, economic, and social aspects of project implementation. In addition to technical details, the analysis should cover but not limited to the following aspects:

- Farmer's interest/absence; number of beneficiaries; local job creation by project.
- Groundwater availability, zonation, well interference, tube well spacing;
- Hydrogeological complications and declining levels of groundwater;
- Best economic type of groundwater irrigation system (DTW/STW) and its requirements;
- Size and type of command area (rain fed; partially irrigated; round-year irrigated);
- General hydrogeological condition of subsurface aquifer (unconfined/confined aquifer; aquitards; aquifer; karst topography; primary and secondary structures);
- Suitability of subsurface water quality for irrigation purpose.
- Depth of primary housing, screen length, total depth of tube well based on locality;
- Total amount of discharge, pump and transformer capacity, length of transmission line length per deep/shallow tube well irrigation system.
- Length and spread of subsurface distribution system, surge riser, number of outlets per irrigation system.
- Total number of groundwater tube well irrigation systems in single command area.
- Quality of surface soil, groundwater, and possible treatment method;
- Preparation of Project area/hydrogeological/contaminant map/other maps at 1:5000 scale.
- Make Assessment of cost of the project and cost per hector.
- Evaluate economic indicators (NPV, Internal Rate of Return and Benefit Cost Ratio).

Recommendation Report:

The recommendation may be based on, but not limited to the followings:

- Genuineness of demands;
- Gross and total command area;
- Water balance and recharge vs discharge condition;
- Hydrogeological complication;
- Groundwater/water availability, aquifer boundary conditions;
- Need of further study;
- Most economical physically feasible groundwater irrigation plan;
- Integration of subsurface water with other irrigation system, novel methods of groundwater irrigation;
- Sustainability of project and environmental adverse effect;
- Economic indicators i.e. Cost/Ha, EIRR & B/C ratio etc'
- Need of rehabilitation and managed aquifer recharge;
- Economical alternative method of irrigation;

Project design and Cost estimate

- Collection of demand; management of water user association components/member and

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verification of exact quantity of groundwater irrigation system to be implemented in project.

- Detail design of each and every component of groundwater irrigation project.
- Final cost estimate, procumbent schedule, Packaging, Implementation schedule.

2.4. SAMPLING AND TESTING OF SOIL AND ROCK

(Form landslide, unstable slope, Jointed surface, Rock exposure to determine engineering as well as geotechnical properties of soil and rock)

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Surface Sampling of in-situ materials

(Grid preparation for sampling points, inhomogeneity of sample, labeling and storage)

i- Human Resource required:

Geologist/Eng. Geologist	1
Asst. Geo/ Tech/Surveyor	2
Labors	4

ii- Equipment required:

Four-Wheeler Drive	1 day
Total station set	1 day

iii- Performance criteria:

a. Grid of 0.25 km^2 / 20 points	3 days
b. or n km2	2*(b/a)+1 days

iv- Minor tools, sample storage box and headload transportation.

Add 15% extra cost of i and ii in accessible area and Add 35% of i and ii in remote area

Sub-Surface Sampling

A.1.1. Auger Method (for unconsolidated fine sediments):

(Grid preparation and site selection for sampling points, core logging of sample, labeling and storage)

i- Human Resource required:

Team Leader	0.5
Geologist/Eng. Geologist	1
Asst. Geol/ Geotech/Surveyor	2
Driller	2
Labors	8

ii- Equipment required:

Four-Wheeler Drive	1 day

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Pickup truck	1 day
Hand Auger	1 day
Total station set	1 day

iii- Performance criteria:

Up to 10 m depth	1 days
n m depth	(1+n/20) days
z locations	z*(1+n/15) days

iv- Minor tools, sample storage box and headload transportation.

Add 15% extra cost of i and ii in accessible area and Add 35% of i and ii in remote area

A.1.2. Core drilling Method (for consolidated sediments):

(Grid preparation and site selection for sampling points, inhomogeneity of sample, labeling and storage)

i- Human Resource required:

Team Leader	0.5
Geologist/Eng. Geologist	1
Asst. Geo./ Tech/Surveyor	2
Driller	1
Skilled labor	3
Unskilled Labors	13

ii- Equipment required:

Four-Wheeler Drive	1 day
Pickup truck	1 day
Core drilling rig	1 day
Electrical generator	1 day
Total station set	1 day

iii- Performance criteria:

Up to 10 m depth	1.5 days
n m depth	1.5*(1+n/20) days
z locations	z*1.5*(1+n/15) days

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iv- Minor tools, sample storage box and headload transportation.

Add 15% extra cost of i and ii in accessible area and Add 35% of i and ii in remote area

A.1.3. Analysis and Testing of field samples

(Geo-mechanical Test for Soil and Rock; sample test makes a set unless otherwise stated; rate analysis can be derived from competitive market rate or other GoN body's norms).

2.3.1 Soil

2.3.1.1 Index Properties of Soil

- Grain Size Analysis including Hydrometer,
- Moisture Content,
- Bulk and Dry Unit Weight,
- Specific Gravity,
- Liquid and Plastic Limit,
- depressiveness or soluble chemical content,
- Slake Durability Test,
- Fusion test,
- Mineralogical analysis of soil (particularly for landslide and tunneling)

2.3.1.2 Engineering Properties of soil

- Direct shear test,
- Triaxial test,
- Oedometer test,
- Permeability test
- CBR test for dams, embankments, and roads

2.3.2 Rock

2.3.2.1 Index Properties of Rock

- Moisture Content, porosity, permeability
- Bulk and Dry Unit Weight,
- Specific Gravity,
- Petrography and thin section

2.3.2.2 Engineering Properties of Rock

- Point Load (6 Nos. in a set),
- UCS,
- Direct Shear Test
- Tensile Strength,
- triaxial test,
- Permeability (in-situ for jointed rock mass and laboratory for massive rocks),

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- Abrasivity test (for tunneling),
- Plate load test (for rock mass strength in tunnel),
- Stress Test (over coring or as appropriate),
- Slake durability test,
- Youngs modulus of elasticity,
- Poisson Ratio,
- Punch Test (for TBM Tunneling)
- Water absorption test,
- If any infill materials (test of soils as and when required)

Report Preparation

(Data processing, Analysis of engineering properties of soil and rock, interpretation of surface and subsurface geological features including preparation of diagram in digital format, draft report preparation)

i- Human Resource required:

Team Leader	0.5
Geologist/Eng. Geologist	1
Assistant Geol. /Asst. Geo Tech	0.5
CAD expert	1
Computer operator	1
Office assistant	2

ii- - Performance criteria (all scale):

a. 5 soil samples/20 m rock samples	7 days
b. n samples	3*(b/a)+4 days

- Stationaries, Satellite imaginary, Topographical map and consumable, software interpretation, survey equipment, Report Preparation etc @ 15 % of Total Cost of Human Resources (Office+ Field) etc.
- Estimate for travel expenses shall be made based on means of transportation, market rate of transportation means and days required for travelling (to reach the field (work site) and return back).
- Field allowances: DWRI survey norms.
- Mode of Payment: DWRI survey norms and according to TOR.

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SECTION 3: LIFT IRRIGATION

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Notes:
For the study purpose lift irrigation system/cluster of systems is prepared for 100 ha command area. Cost estimate of irrigation system or cluster of systems other than 100ha shall be calculated applying formula given in corresponding survey norms (Identification and Detailed) below:

3.1. IDENTIFICATION SURVEY

3.1.1. Field Works

3.1.1.1.1. Headwork Site

A. Location and Hydrological survey

i - Human Resources required:

Hydraulic Engineer	1
Sub Engineer/Auto Cad Expert	1
Labour	1

ii Performance criteria:

All Projects	0.5 day/project

3.1.1.1.2. Canal Alignment

A. Layout Survey

i - Human Resources required:

Hydraulic Engineer	1
Sub Engineer/Auto Cad Expert	1
Labour	2

ii Performance criteria:

All Projects	0.5 day/project

3.1.1.1.3. Command Area

A. Socio-Economic & Command Area Survey

i - Human Resources required:

Association Organizer	1
Labour	1

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ii Performance criteria:

All Projects	1 day/project

3.1.1.2. Office Works

3.1.1.2.1. Data Compilation and Report Presentation

i - Human Resources required:

Hydraulic Engineer	1
Association Organizer	1
Sub Engineer/Auto Cad Expert	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii Performance criteria:

All Projects	2 day/project

3.1.1.3.Miscellaneous:

3.1.1.3.1. Add transportation cost to site and return back as per market rate.

3.1.1.3.2. Add 15% of total human resource cost for site and office equipment, consumables and report production.

Note:

For command area for a project or cluster of projects other than 100 ha. The estimated cast shall be calculated as follows:

1. For area more than 100 ha, estimated cost = estimated cost for 100 ha x (area to be surveyed in ha/100 ha) ^0.5

2. For area less than 100 ha, estimated cost = estimated cost for 100 ha x (area to be surveyed in ha/100 ha) ^0.2

Example:

Suppose estimate amount for 100 ha survey = Rs. 35,000

i. Then estimated amount for 300 ha = Rs. 35000x (300 ha/100 ha) ^0.5 = Rs 60,622.00

ii. Then estimated amount for 40 ha = Rs. 35000x (40 ha/100 ha) ^0.2= Rs 29,139.36

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3.2. DETAILED FEASIBILITY STUDY

3.2.1.1. Field Work

3.2.1.1.1. HEADWORK / INTAKE

A. Intake site selection/Power Assessment

i - Human Resources required:

Engineer/Hydraulic Engineer	1
Energy Expert	1
Sub Engineer/Assistant/Social Mobilizer	1
Labour	4

ii Performance criteria:

All Projects	1 day/project

B. Geological Survey & River Morphology

i - Human Resources required:

Geologist/Geotechnical Engineer	1
Sub Engineer/Assistant/Social Mobilizer	1
Labour	2

ii Performance criteria:

All Projects	1 day/project

3.2.1.1.2. PIPELINE ALIGNMENT

A. L-Section Survey

i - Human Resources required:

Engineer /Hydraulic Engineer	1
Sub Engineer/Assistant/Social Mobilizer	1
Labour	4

ii - Performance criteria:

All Projects	6 km/ day

3.2.1.1.3. COMMAND AREA

A. Traverse Line Survey

i - Human Resources required:

Engineer/Hydraulic Engineer	1
Sub Engineer/Assistant/Social Mobilizer	1
Labour	4

ii - Performance criteria:

All Projects	1 day/site

B. Agricultural & Socio Economic Survey

i - Human Resources required:

Agriculturist/Agronomist	1
Sociologist /Economist	1
Sub Engineer/Assistant/Social Mobilizer	1
Labour	2

ii - Performance criteria:

All Projects	2 day/site

3.2.1.2. Office Work

3.2.1.2.1. Desk Study

A. Data Collection, Compilation & Presentation

i -Human Resources required:

Engineer /Hydraulic Engineer	1
Sub Engineer/Assistant/Social Mobilizer	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii - Performance criteria:

All Projects	2 days/projects

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3.2.1.2.2. Intake Site and Pump

A. Geology

i - Human Resources required:

Geologist/Geotechnical Engineer	1
Autocad expert	1
Assistant/Accountant/ Computer Operator	1

ii Performance criteria:

All Projects	1 day/project

B. Design, drawings and estimate

i - Human Resources required:

Engineer/Hydraulic Engineer	1
Energy Expert	1
Autocad expert	1
Assistant/Accountant/ Computer Operator	1

ii Performance criteria:

All Projects	2 day/project

3.2.1.2.3. Command Area

A. Agriculture Survey

i - Human Resources required:

Agriculturist/Agronomist	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii Performance criteria:

All Projects	1 day/project

B. Socio-Economy Survey

i - Human Resources required:

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Economist	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii - Performance criteria:

All Projects	1 day/project

3.2.1.2.4. Economic Analysis

i - Human Resources required:

Economist	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii Performance criteria:

All Projects	1 day/project

1.3.4.1.26. Rate Analysis Detailed Feasibility Report Preparation

i - Human Resources required:

Engineer/Hydraulic Engineer	1
Geologist/Geotechnical Engineer	0.5
Sub Engineer/Assistant/Social Mobilizer	1
Assistant/Accountant/ Computer Operator	1
Labour	1

ii Performance criteria:

All Projects	5 day/project

Miscellaneous:

3.2.1.2.5. Add transportation cost to site and return back as per market rate.

3.2.1.2.6. Add 15% of total human resource cost for site and office equipment, consumables and report production.

Note:

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For command area for a project or cluster of projects other than 100 ha. the estimated cast shall be calculated as follows:

1. For area more than 100 ha, estimated cost = estimated cost for 100 ha x(area to be surveyed in ha/100 ha)^0.5

2. For area less than 100 ha, estimated cost = estimated cost for 100 ha x(area to be surveyed in ha/100 ha)^0.2

Example:

Suppose estimate amount for 100 ha survey = Rs. 250,000

i. Then estimated amount for 300 ha = Rs. 250000x (300 ha/100 ha)^0.5 = Rs 433,013.00
ii. Then estimated amount for 40 ha = Rs. 250000x (40 ha/100 ha)^0.2= Rs. 208138.30

Sample Terms of Reference for Lift Irrigation

Terms of Reference for the Development of Lift Irrigation Project/Sub-Projects

Background

Development and expansion of electricity supply infrastructures and access roads in the interior of hills and mountains in recent years and advancement in solar power technology during past few years has opened up tremendous scope for development of lift irrigation in the cultivable lands that were deemed non-irrigable earlier. Furthermore, the access provided to the remote areas through the development of highways across the regions and along the river corridors by government agencies has provided additional infrastructure for further development. The larger network of village roads built by local government agencies and subsequent erection of electricity distribution network along the corridor provides remarkable opportunity for the development of lift irrigation systems utilizing hydro as well as solar power.

Large lift irrigation systems such as Koshi Pump canal, Narayani lift system, Marchawar lift are some of the lift systems developed by GON. Due to their large nature, they are mostly dependent on government exchequer for maintenance and operation. However, small lift irrigation systems that are operated and maintained by user groups have demonstrated promising outcome especially when they are "demand driven" and utilized for commercial farming. There has been a steady rise in the popularity of lift irrigation which has resulted into the overwhelming demand from the beneficiary farmers. Efforts by Department of Water Resources and Irrigation (DWRI) through implementation of Non-Conventional Irrigation Project (NITP) and the experience of DWRI over past few years in Bheri corridor has shown encouraging result.

On its effort to further explore the possibility of tapping the water in the hilly as well as mountainous aquifers the DWRI plans to conduct studies which would in turn not only suggest the potential but also the appropriate technology for harvesting the ground water resources. With the availability of sufficient Sunshine hour even at the mountainous regions one cannot deny the possibility of utilizing the solar power for lifting the ground water for irrigation purpose.

Thus, through the utilization of available best technologies it is pertinent to provide irrigation facilities to the arable land which were thought un-irrigable earlier. The availability of not only the abundance of water resources but also the longer Sunshine hour in our country can be considered as a boon towards the production of energy and their subsequent utilization for the overall development of the nation. Developing and providing year-round irrigation facilities to the arable land depending upon the availability of resources and by the adoption of feasible technologies including the consumptive use principle.

The development and the installation of small to medium lift irrigation systems along the river corridors would be an important approach to materialize governments' Plans, policies, programs and economic development targets for agricultural development, through the adaptation of commercial agriculture. The availability of year-round assured water for irrigation would certainly attract the farmers towards the cultivation of high value commercial crops. The production of vegetables in the targeted arable land would not only make the availability of fresh product but also would push the country towards self-sufficiency.

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Objective:

Main objective of the study is to develop Detailed Feasibility Report (DFS) of lift irrigation systems in the study area focusing on lifting of water from available source by using electric or solar power for pumping.

Specific objectives are as following:

1. Carry out field work to delineate the command area, identify source point and delivery point and alignment of delivery pipe in lift irrigation system.
2. Carryout fieldwork to identify the type of energy (electrical or solar) required for the system.
3. To prepare detail design, drawings and cost estimate along with economic analysis of Project/sub-project.
4. To prepare a comprehensive plan covering all technical, economic, social, agriculture and environmental and implementation aspects for implementation of the project/sub-project.

Scope of Works

The scope of the work of proposed study shall include the followings:

- Identify assured source of water and location of sump well / tube well / collection tank to be constructed / drilled as per surface geological and hydrogeological survey.
- Conduct necessary survey to identify location of pump house, Intake site with best feasible type, identify the nearest three phase electric transmission line, reservoir tanks and other necessary major and minor structures for development of a complete lift irrigation systems.
- Determine best delivery pipeline alignment, lift head and length of the delivery line.
- Preparation of design and drawing as per the study e.g., Collection Pond, L-section, Layout plan, delineation of command area with the location of delivery / outlet points and proposed water application mechanism, Schematic line diagram etc.
- Preparation of detailed quantity estimate (Lump-sum items should be minimized) based on the real design. The cost estimate shall be evaluated based on the latest district rates for the development of the project as per the prevailing norms and standards of DWRI.
- Assessment of the crop water requirement and design discharge and designing of sustainable cropping patterns with various alternatives compatible to optimum use of irrigation water in order to gain the highest economic return.
- Determine pump capacity.
- Prepare a power requirement plan showing location and capacity of transformer;
- Identify location of solar power installation point if electrical transmission line isn't possible in the study area.
- Detail design/drawing of the project / sub project for implementation.

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- Data collection and compilation on social, economic and institutional aspect of beneficiaries together with their involvement potential during the implementation of the project. Also highlighting the constraints, if any.
- Economic analysis of the project considering with and without project. Evaluation of direct benefits of the project, Cost Benefit Ratio (BCR) and EIRR shall be made.

Methodology

Field work

The field work consists of the following:

- Site Selection
- L-Section Survey for Delivery Distribution Alignment
- Agriculture as well as Socio-economic Survey
- Distribution outlet survey as per design/available head

Site Selection

Site plan for an Intake to be investigated and / or situated on the River Bank shall be prepared. The selection of the intake site should be such that the location of the well, reservoir or any irrigation structures should be in less vulnerable to flood and landslide. The location should be chosen such that no water right as well as land accusation problems occur.

Distribution Alignment

Along the finalized alignment, the profile survey will be carried out independently. Whenever alignment crosses special features (Structures, Depressions or other geographical features etc.), the closer details of that portion (i.e. u/s and d/s of structure) must be taken. The plotted profile will be prepared in soft and hard copies.

Socio-economic and Agricultural Survey

Social, Economic and Agricultural Situation of the project area will be assessed that will also include existing and proposed command area, cropping pattern and intensity. An assessment of availability and linkage to agricultural service providers, willingness of the farmers for providing land for developing system, willingness of the farmers towards cost /kind / labor contribution as per Irrigation Policy/Regulation will be made.

Office work

Desk Study

The desk study shall be started immediately after the commencement of the work and shall consist of, but not limited to, the following activities:

The Consultant shall collect all the relevant documents and feasibility study reports of previous studies related to the projects from various sources. Such information would involve completed, ongoing or planned irrigation projects in study area. The Consultant shall then review the information and identify the gaps that would be addressed during field investigation.

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A work plan shall be prepared to carry out field work for making the detailed inventory of irrigation system. The consultants shall verify the new proposed command area and submit the comment regarding the new proposed command area.

Design, Drawing and Estimate

According to the Field data including maps, GPS data and Desk work detail Design with Drawing and Estimate of different structures and provisions proposed for Intake site, pump, electric transmission line, canal/pipes, reservoirs and Distribution System should be prepared. The Design should be based on general engineering principles and departmental norms.

Approved District Rates for labor and materials at the project sites shall be collected or analyzed. Detail rate analysis, detail quantity & cost estimates along with bill of quantity (BOQ) should be prepared.

Reports and Outputs

The Consultant shall prepare and submit following reports in specified number of copies and within the specified time during the course of the consulting services contract. The Consultant shall prepare the reports in the format agreed with the Client. The reporting schedule and deliverables have been listed below.

S. N.	Reports/Deliverables	No of Copies	Submission Period (starting from commencement date)
1.	Inception Report	Five	Within 15 days from commencement date
2,	Field Report	Three	Within One months from commencement date
3.	Draft Report	Three	Within 45 days months from commencement date
4.	Final Report	Three	Within two months from commencement date

Digital and editable copy of the final report including layout, design, shape file, KMZ AutoCAD file etc. shall be submitted by the consultant as required by the client. After acceptance of the final report, copyright of the study solely belongs to IRBIWRMP.
The draft and final reports shall include the detailed cost estimate of project/sub - project with command area delineation, water requirement assessment, social and agricultural information and economic analysis etc. depicting as complete DFS report ready for DWRI approval.
Consultant will have to make the power point presentation as required by the client to the different organizational level such as project office/Department/Ministry/National Planning commission etc.
Consultant will have to incorporate all the comments and suggestions pointed out during the presentation and get it authenticated by the client.
It is the obligation of the consultant to rectify, amend, and make necessary changes as suggested by the client to bring about the study report a comprehensive one.
Consultant shall arrange presentation of the study report(s) at his own cost including cost of hall/audio visual system if necessary and snacks;
Record and Proceedings of meetings/workshop held with Stakeholders: This shall be submitted within one week of the holding of such meetings/workshop etc.

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Mode of Payment

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

Services and Facilities from the Project and Consultants' obligation

IRBIWRMP shall provide the Consultant drawings, maps and other contract related documents that are available with the Project. All other requirements needed to carry out the consulting services, unless otherwise mentioned in the ToR, shall be the responsibility of the Consultant. All equipment, goods and materials shall be the obligation of Consultant. Cost of arranging meetings with stakeholders and cost for all activities for any type of presentations shall be borne by Consultant.

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SECTION 4: ENVIRONMENTAL STUDY

4.1 PREPARATION OF PRIOR CONSENT

Preparation of Prior Consent (Permission) for Environmental Study Report								
(As per conservation area management rules 2053)								
Section A : Human Resource			**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	3	2	2	7	Key Staff	0.24
2	Water Resources Expert	Days	2	2	0	4	Key Staff	0.14
3	Biodiversity/Forestry Specialist	Days	2	2	1	5	Key Staff	0.17
4	Socio-Economist	Days	2	2	0	4	Key Staff	0.14
5	GIS Expert	Days	2	1	1	4	Key Staff	0.14
6	Assistant	Days	6	0	0	6	Non-Key Staff	0.2
								Sub-Total A
Section B: Reimbursable								
1	Travel Cost	Estimate Based on the transportation means, duration and market price						
2	Equipment & Stationary	15% of Section A						
3	Laboratory Analysis	7% of Section A						

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4.2 BRIEF ENVIRONMENTAL STUDY

Brief Environmental Study for Lift Irrigation Project (GCA ≥25 Hectare)										
Section A : Human Resource			**ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			**Total Input**
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	1	2	3	4	2	12	Key Staff	0.4
2	Water Resources Expert	Days	1	1	2	2	1	7	Key Staff	0.24
3	Biodiversity/Forestry Specialist	Days	1	1	1	1	1	5	Key Staff (Optional-Project Specific)	0.17
4	Socio-Economist	Days	1	1	2	2	1	7	Key Staff	0.24
5	Geologist/ Er. Geologist/ Hydrologist	Days	1	1	1	1	1	5	Key Staff (Optional-Project Specific)	0.17
6	GIS Expert	Days	0	1	1	1	1	4	Key Staff	0.14
7	Legal Expert	Days	0	0	0	1	1	2	Non-Key Staff	0.07
8	Language Expert	Days	0	0	0	0	1	1	Non-Key Staff	0.04
9	Assistant	Days	2	0	6	0	4	12	Non-Key Staff	0.4
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication				As per Nepal Advertisement Board Rate					
2	Public Hearing and Other Expenses				15% of Section A					
										Sub-Total C
									Total	D=A+B+C

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For Irrigation Projects above 25 ha GCA, the total person input shall be increased by a factor ((GCA-25)/10000)
5% of the total input shall be added if the proposal consist of any pond/storage structure
70% of the total cost estimate shall be allocated for updating brief environmental study report

4.3 IEE STUDY OF LIFT IRRIGATION

Initial Environmental Examination (IEE) Study for Lift Irrigation Project (GCA≥100Hectare)										
Section A : Human Resource			**ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	2	2	6	8	4	22	Key Staff	0.73
2	Water Resources Expert	Days	2	2	4	4	2	14	Key Staff	0.47
3	Biodiversity/Forestry Specialist	Days	2	2	4	4	2	14	Key Staff	0.47
4	Socio-Economist	Days	2	2	4	4	2	14	Key Staff	0.47
5	Geologist/ Er. Geologist/ Hydrologist	Days	2	2	2	2	1	9	Key Staff (Optional- Project Specific)	0.3
6	GIS Expert	Days	1	1	4	4	2	12	Key Staff	0.4
7	Legal Expert	Days	0	1	0	4	2	7	Non-Key Staff	0.23
8	Language Expert	Days	0	2	0	4	2	8	Non-Key Staff	0.27
9	Assistant	Days	4	4	12	16	8	44	Non-Key Staff	1.47
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipment & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								

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Section C: Notice and Allowances			Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board Rate	
2	Public Hearing and Other Expenses	15% of Section A	
			Sub-Total C
		Total	A+B+C=D

For Irrigation Projects above 100 ha GCA, the total person input shall be increased by a factor ((GCA-100)/10000)

5% of the total input shall be added if the proposal consist of any pondage/storage structure

70% of the total cost estimate shall be allocated for updating Initial Environmental Examination Report

20% of the total cost estimate shall be allocated for revision Environment Managements Plan (EMP)

4.4 IEE STUDY OF RIVER TRAINING PROJECT

Initial Environmental Examination (IEE) Study for River Training (River Bank Length ≤20 km)

Section A : Human Resource			**ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	2	2	6	8	4	22	Key Staff	0.73
2	Water Resources Expert	Days	2	2	4	4	2	14	Key Staff	0.47
3	Biodiversity/Forestry Specialist	Days	2	2	4	4	2	14	Key Staff	0.47
4	Socio-Economist	Days	2	2	4	4	2	14	Key Staff	0.47
5	Geologist/ Er. Geologist/ Hydrologist	Days	2	2	2	2	1	9	Key Staff (Optional- Project Specific)	0.3
6	GIS Expert	Days	1	1	4	4	2	12	Key Staff	0.4
7	Legal Expert	Days	0	1	0	4	2	7	Non Key Staff	0.23

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8	Language Expert	Days	0	2	0	4	2	8	Non Key Staff	0.27
9	Assistant	Days	4	4	12	16	8	44	Non Key Staff	1.47
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
										Sub-Total B
Section C: Notice and Allowances										
1	News Paper Notice Publication					As per Nepal Advertisement Board' Rate				
2	Public Hearing and Other Expenses					15% of Section A				
										Sub-Total C
									Total	A+B+C=D
For River Training Work above 20 km length the total person input shall increase by a factor Sqrt(Length-20)/500)										
70% of the total cost estimate shall be allocated for updating Initial Environmental Examination Report										
20% of the total cost estimate shall be allocated for revision Environment Management Plan (EMP)										

4.5 EIA STUDY OF RIVER TRAINING PROJECT

Environmental Impact Assessment (EIA) Study for River Training (River Bank Length ≤ 20 km)										
Section A : Human Resource			**ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
S N	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	4	6	15	15	5	45	Key Staff	1.5
2	Water Resources Expert	Days	4	5	12	12	5	38	Key Staff	1.27
3	Biodiversity/Forestry Specialist	Days	3	3	8	10	5	29	Key Staff	0.97
4	Socio-Economist	Days	3	3	15	15	5	41	Key Staff	1.37

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5	Geologist/ Er. Geologist/ Hydrologist	Days	1	1	2	2	1	7	Key Staff (Optional-Project Specific)	0.23
6	GIS Expert	Days	2	2	5	5	3	17	Key Staff	0.57
7	Legal Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3
8	Language Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3
9	Assistant	Days	8	12	30	30	0	80	Non-Key Staff	2.67
Section B: Reimbursable										Sub-Total A
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C
									Total	A+B+C=D
For River Training Work above 20 km length the total person input shall increase by a factor Sqrt(Length-20)/1000)										
70% of the total cost estimate shall be allocated for updating Initial Environmental Examination Report										
20% of the total cost estimate shall be allocated for revision Environment Management Plan (EMP)										

4.6 IEE STUDY OF IRRIGATION PROJECT

Initial Environmental Examination (IEE) Study for Irrigation Project (GCA: ≤ 500 ha, Canal Length≤ 5 km)						
Section A : Human Resource	**ToR Preparation**	**Draft Preparation**	**Final Report Preparation**			Total Input

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SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	2	2	6	8	4	22	Key Staff	0.73
2	Water Resources Expert	Days	2	2	4	4	2	14	Key Staff	0.47
3	Biodiversity/Forestry Specialist	Days	2	2	4	4	2	14	Key Staff	0.47
4	Socio-Economist	Days	2	2	4	4	2	14	Key Staff	0.47
5	Geologist/ Er. Geologist/ Hydrologist	Days	2	2	2	2	1	9	Key Staff (Optional-Project Specific)	0.3
6	GIS Expert	Days	2	2	4	4	2	14	Key Staff	0.47
7	Legal Expert	Days	0	1	0	4	2	7	Non-Key Staff	0.23
8	Language Expert	Days	0	2	0	4	2	8	Non-Key Staff	0.27
9	Assistant	Days	4	4	12	16	8	44	Non-Key Staff	1.47
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication		As per Nepal Advertisement Board' Rate							
2	Public Hearing and Other Expenses		15% of Section A							
										Sub-Total C
									Total	A+B+C=D
For Irrigation Projects above 500 ha GCA, the total person input shall be increased by a factor ((GCA-500)/10000)										
For the length of main canal above 5 Km, the total person input shall be increased by a factor Sqrt((Length-5)/500)										
70% of the total cost estimate shall be allocated for updating Initial Environmental Examination Report										
20% of the total cost estimate shall be allocated for revision Environment Management Plan (EMP)										

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4.7 EIA STUDY OF IRRIGATION PROJECT

Environmental Impact Assessment (EIA) of Irrigation Project (GCA: ≤ 2000 ha, Canal Length≤ 10 km)

Section A : Human Resource			**SD/ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	days	4	6	15	15	5	45	Key Staff	1.5
2	Water Resources Expert	days	4	5	12	12	5	38	Key Staff	1.27
3	Biodiversity/Forestry Specialist	days	3	3	8	10	5	29	Key Staff	0.97
4	Socio-Economist	days	3	3	15	15	5	41	Key Staff	1.37
5	Geologist/ Er. Geologist/ Hydrologist	days	1	1	2	2	1	7	Key Staff (Optional-Project Specific)	0.23
6	GIS Expert	days	2	2	5	5	3	17	Key Staff	0.57
7	Legal Expert	days	0	2	0	5	2	9	Non-Key Staff	0.3
8	Language Expert	days	0	2	0	5	2	9	Non-Key Staff	0.3
9	Assistant	days	8	12	30	30	0	80	Non-Key Staff	2.67
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C
									Total	A+B+C=D

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For Irrigation Projects above 2000 ha GCA, the total person input shall be increased by a factor ((GCA-2000)/200000)
For the length of main canal above 10 Km, the total person input shall be increased by a factor Sqrt((Length-10)/500)
70% of the total cost estimate shall be allocated for Supplementary Environmental Impact Assessment Report
20% of the total cost estimate shall be allocated for revision Environment Management Plan (EMP)

4.8 IEE STUDY OF HPP

Initial Environmental Examination of Hydropower Project (Capacity≤5 MW)

Section A : Human Resource			ToR Preparation		Draft Preparation		Final Report Preparation			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	days	2	2	6	8	4	22	Key Staff	0.73
2	Water Resources Expert	days	2	2	4	4	2	14	Key Staff	0.47
3	Biodiversity/Forestry Specialist	days	2	2	4	4	2	14	Key Staff	0.47
4	Socio-Economist	days	2	2	4	4	2	14	Key Staff	0.47
5	Geologist/ Er. Geologist/ Hydrologist	days	2	2	2	2	1	9	Key Staff (Optional-Project Specific)	0.3
6	GIS Expert	days	2	2	4	4	2	14	Key Staff	0.47
7	Legal Expert	days	0	1	0	4	2	7	Non Key Staff	0.23
8	Language Expert	days	0	2	0	4	2	8	Non-Key Staff	0.27
9	Assistant	days	4	4	12	16	8	44	Non-Key Staff	1.47
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								

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3	Laboratory Analysis	7% of Section A	
Section C: Notice and Allowances			Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board Rate	
2	Public Hearing and Other Expenses	15% of Section A	
			Sub-Total C
		Total	A+B+C=D
For increase in capacity above 5 MW, the input shall be increased by a factor Sqrt((Capacity-5)/200)			
For every addition of headwork/water abstraction infrastructure 5% of input required (person days) shall be added to the estimate			

4.9 EIA STUDY OF HPP

Environmental Impact Assessment of Hydropower Project (Capacity ≥ 5 MW)										
Section A : Human Resource			**SD/ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
S N	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	4	6	15	15	5	45	Key Staff	1.5
2	Water Resources Expert	Days	3	4	10	10	5	32	Key Staff	1.07
3	Biodiversity/Forestry Specialist	Days	3	3	8	10	5	29	Key Staff	0.97
4	Socio-Economist	Days	3	3	15	15	5	41	Key Staff	1.37
5	Geologist/ Er. Geologist/ Hydrologist	Days	2	2	3	3	2	12	Key Staff (Optional-Project Specific)	0.4
6	GIS Expert	Days	2	2	5	5	3	17	Key Staff	0.57
7	Legal Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3
8	Language Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3

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9	Assistant	Days	8	12	30	30	0	80	Non-Key Staff	2.67
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C
									Total	A+B+C=D
For increase in capacity above 50 MW, the input shall be increased by a factor Sqrt((Capacity-50)/1000)										
For every addition of headwork/water abstraction infrastructure 5% of input required (human days) shall be added to the estimate										

4.10 EIA STUDY OF INTERBASIN TRANSFER PART OF IRRIGATION PROJECT INCLUDING RECEPIENT RIVER WITHOUT HYDROPOWER OR WITH HYDROPOWER ≤ 50 MW

Section A : Human Resource			**SD/ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
S N	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	6	6	17	17	7	53	Key Staff	1.77
2	Water Resources Expert	Days	4	4	12	12	7	39	Key Staff	1.3
3	Biodiversity/Forestry Specialist	Days	4	4	10	10	7	35	Key Staff	1.17
4	Socio-Economist	Days	4	4	15	15	7	45	Key Staff	1.5

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5	Geologist/ Er. Geologist/ Hydrologist	Days	3	3	4	4	3	17	Key Staff (Optional-Project Specific)	0.57
6	GIS Expert	Days	3	3	5	5	3	19	Key Staff	0.63
7	Legal Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3
8	Language Expert	Days	0	2	0	5	2	9	Non-Key Staff	0.3
9	Assistant	Days	10	12	35	35	0	92	Non-Key Staff	3.07
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C
									Total	A+B+C=D
For increase in capacity above 50 MW, the input shall be increased by a factor Sqrt((Capacity-50)/1000)										
For every addition of headwork/water abstraction infrastructure 5% of input required (human days) shall be added to the estimate										

4.11 IEE STUDY OF TRANSMISSION LINE

IEE Study of Transmission Line Project (TL Length≤ 5 km, RoW≤ 15m)										
Section A : Human Resource			**ToR Preparation**		**Draft Preparation**		**Final Report Preparation**			Total Input
S N	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	Days	2	2	6	8	4	22	Key Staff	0.74

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2	Biodiversity/Forestry Specialist	Days	2	2	4	4	2	14	Key Staff	0.47
3	Socio-Economist	Days	2	2	4	2	2	12	Key Staff	0.4
4	Electrical Engineer	Days	2	2	4	2	2	12	Key Staff (Optional-Project Specific)	0.4
5	GIS Expert	Days	2	2	4	4	1	13	Key Staff	0.44
6	Legal Expert	Days	0	1	0	4	2	7	Non Key Staff	0.24
7	Language Expert	Days	0	2	0	4	2	8	Non Key Staff	0.27
8	Assistant	Days	2	4	12	16	8	42	Non Key Staff	1.4
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C
									Total	A+B+C=D
or Transmission Line above 5 km length the total person input shall be increased by a factor Sqrt((Length-5)/100)										
70% of the total cost estimate shall be allocated for updating Initial Environmental Examination Report										
For the transmission width above 15m right of way, the total person input shall increase by a factor (RoW/15)^0.1										

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4.12 EIA STUDY OF TRANSMISSION LINE

Environmental Impact Assessment of Transmission Line Project (TL Length≤ 10 km, RoW ≤ 15m)

Section A : Human Resource			ToR Preparation		Draft Preparation		Final Report Preparation			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environmentalist (TL)	days	4	6	15	15	5	45	Key Staff	1.5
2	Biodiversity/Forestry Specialist	days	3	3	8	10	5	29	Key Staff	0.97
3	Socio-Economist	days	3	3	15	15	5	41	Key Staff	1.37
4	Electrical Engineer	days	3	3	12	12	5	35	Key Staff	1.17
5	Geologist/ Er. Geologist/ Hydrologist	days	1	1	1	1	1	5	Key Staff (Optional- Project Specific)	0.17
6	GIS Expert	days	2	2	3	3	2	12	Key Staff	0.4
7	Legal Expert	days	0	2	0	5	2	9	Non Key Staff	0.3
8	Language Expert	days	0	2	0	5	2	9	Non Key Staff	0.3
9	Assistant	days	8	12	30	30	0	80	Non Key Staff	2.67
										Sub-Total A
Section B: Reimbursable										
1	Travel Cost	Estimate Based on the transportation means, duration and market price								
2	Equipments & Stationary	15% of Section A								
3	Laboratory Analysis	7% of Section A								
Section C: Notice and Allowances										Sub-Total B
1	News Paper Notice Publication	As per Nepal Advertisement Board' Rate								
2	Public Hearing and Other Expenses	15% of Section A								
										Sub-Total C

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4.13 SOCIAL SURVEY

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Social Survey of Water Resources and Irrigation Projects (≤100 HH)

Section A : Human Resource			**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Socio-Economist	100 Household	2	3	2	7	Key Staff	0.23
2	Assistant/Social Mobilizer	100 Household	7	4	0	11	Non Key Staff	0.37
								Sub-Total A
Section B: Travel, Logistics, Stationary								
1	Travel Cost	Estimate Based on the transportation means, duration and market price						
2	Stationary	10% of Section A						
								Sub-Total B
Section C: Stakeholders Meeting								
1	Discussion with stakeholders		10% of Section A					
								Sub-Total C
							Total	A+B+C=D
For every HH above 100 HH the estimate shall increase by a factor (HH/100)^0.8								

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4.14 FOREST SURVEY AND INVENTORY

Forest Survey and Inventory (Forest Area ≤ 1 hectare)								
Section A : Human Resource			**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Number of Staffs	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environment/Forestry/Botanist	1	4	1	2	7	Key Staff	0.23
2	Assistant	2	4	1	0	10	Non Key Staff	0.33
Section B: Travel, Logistics, Stationary								Sub-Total A
1	Travel Cost and local transportation	Estimate Based on the transportation means, duration and market price						
3	Stationary	10% of Section A						
Section C: Stakeholders Meeting								
1	Discussion with DFO/CF/NP	10% of total of Section Total Input						Sub-Total B
								Sub-Total C
							Total	A+B+C=D
For every hectare of forest above 1 hectare the estimate shall increase by a factor (Hectare/1)^0.7								

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4.15 FOREST SURVEY AND INVENTORY FOR REMOVAL OF TREES FROM CONSTRUCTION SITE

Forest Survey and Inventory (Forest Area ≤ 1 hectare)								
Section A : Human Resource			**Draft Preparation**		**Final Report Preparation**			**Total Input**
SN	Expertise	Number of Staffs	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environment/Forestry/Botanist	1	8	4	4	16	Key Staff	0.53
2	Assistant/Forester	2	8	4	4	32	Non-Key Staff	1.06
3	Labour for blazing and marking number on trees	5	16			80	Non-Key Staff	2.67
								Sub-Total A
Section B: Travel, Logistics, Stationary								
1	Travel Cost & Local Transportation	Estimate Based on the transportation means, duration and market price						
3	Stationary including required paint and brush	15% of Section A						
								Sub-Total B
Section C: Stakeholders Meeting								
1	Discussion with DFO/CF/NP		10% of total of Section A					
								Sub-Total C
							Total	A+B+C=D

Note:
(a)For every hectare of forest area above 1 hectare but less than or equal to 25 hectare, the estimate shall increase by a factor (Area in ha/1ha)^0.7
(b) For every area of forest greater than 25 hectare, the estimate in Note (a) shall be increased by factor 1.75.

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SCOPE OF WORK FOR FOREST SURVEY/INVENTORY FOR REMOVAL OF TREES FROM CONSTRUCTION SITE

- Preparation and approval of forest survey and inventory checklist by the project.
- Complete count and enumeration of total species of the specified project area as per the methodology approved by authorized entity of government of Nepal.
- Blazing and marking of trees to be removed from specified project area (construction area) using appropriate paint and brushes as required.
- Calculation of volume of each species identified for removal applying formula approved by Department of Forest and Soil Conservation under Ministry of Forest and Environment, for volumetric calculation.
- Consolidation and analysis of data.
- Preparation and presentation of draft report.
- Preparation of final report
- Approval of report by the competent authority.

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4.16 GENERAL ENVIRONMENT SURVEY/MONITORING/AUDITING

General Environment Study/Monitoring/Auditing (One Project)								
Section A : Human Resource			**Draft Preparation**		**Final Report Preparation**			Total Input
SN	Expertise	Unit	Field Work	Desk Work	Desk Work	Total Person Days	Remarks	Person Month
1	Environment Expert	days	7	8	3	18	Key Staff	0.6
2	Water Resources Expert	days	5	5	2	12	Key Staff	0.4
3	Biodiversity/Forestry Expert	days	5	5	2	12	Key Staff	0.4
4	Socio-Economic Expert	days	5	5	2	12	Key Staff	0.4
5	Assistant	days	7	0	0	10	Non Key Staff	0.33
								Sub-Total A
Section B: Travel, Logistics, Stationary, Lab Work								
1	Travel Cost	Estimate Based on the transportation means, duration and market price						
2	Equipments & Stationary	15% of Section A						
3	Laboratory Analysis	7% of Section A						
Section C: Stakeholders Meeting								Sub-Total B
1	Discussion with Stakeholders		10% of total of Section A					
								Sub-Total C
							Total	A+B+C=D

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4.17 GENERAL PROVISIONS

SN	General Provisions
1	In case of donor funded projects additional experts and human input may be incorporated as per the scope of study.
2	The cost for public notice and public hearing shall be added as per the requirements of the terms of reference.
3	In case of multipurpose purpose projects the estimate shall be done by taking 100% of the human input of main purpose and adding 70 % of human input from estimate for each additional purpose.
4	General scope of work for BES, IEE and EIA shall be as per Environment Protection Act, 2076 and Environment Protection Rules, 2077.
5	Complete census shall be considered for household survey and forest survey/inventory.
6	Qualification of experts shall be as per Environment Protection Rules, 2077.
7	Study period for 1. BES shall be of minimum 4 months, 2. IEE shall be of minimum 6 months, EIA shall be of minimum 1 year.
8	Study period for household survey, forest survey/inventory and environment monitoring and auditing shall be of minimum 3 months
9	If forest area exceeds than 25 hectare, 75% of the human input shall be added as per the estimate for forest survey/inventory above 25 hectare.
10	70% of the total cost for BES, IEE and EIA shall be allocated for updating BES/IEE and Supplementary EIA study report
11	Value added tax and contingency shall be added to the estimate as per prevailing rules

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4.18 GENERAL SCOPE OF WORK

6.20.1.1.1.1.1. SCOPE OF WORK FOR PRIOR CONSENT

- Review of DPR/DFS/BES/IEE/EIA and other published and unpublished reports pertaining to proposal.
- Field investigation and collection of physical, chemical, biological, social and cultural data of the proposal.
- Preparation and submission of report for Prior Consent (permission) for environmental study in the format prescribed by MoEWRI/MoFE/DNPWC/DoFSC or concerned agency.
- Consultation with concerned approving authority, correction/presentation (if necessary).

6.20.1.1.1.1.2. SCOPE OF WORK FOR BES

a. **General**: To prepare terms of reference (ToR) and Brief Environmental Study (BES) report and present the report at concerned ministry/authority on behalf of the proponent as per Environment Protection Act (2076) and Environment Protection Rules (2077) and other guiding document(s),manual(s) published by authorized entity in the context.

b. **Specific**
   - Review all the existing documents such as Detailed Feasibility Study Report (DFSR),
   - Detailed Project Report (DPR), and Master Plan (MP) pertaining to proposal impact zone.
   - Briefing and debriefing meeting with the proponent regarding proposal.
   - Area delineation, categorization of Zone of Influence (ZoI), Indirect Impact Zone(IIZ), Direct Impact Zone (DIZ), depiction of Area Delineation on map indicating all the impact zones.
   - Analysis of land use, geology and seismicity by preparing/depicting appropriate map.
   - Complete primary/secondary information regarding air, water, noise, demography, economy and culture of all the affected people of the direct impact zone.
   - Public consultation with proposal affected population, collection of recommendation/suggesting from all concerned stakeholders.
   - Publication of notices regarding public consultation in local/national daily and dissemination of information via various media as guided by EPR 2077.
   - Layout map for proposal components, labor camp site, stock piling sites, batching plants site.
   - Depiction of forest area, cultural and archeologically significant site in map if it falls under ZoI.
   - Collection of complete information regarding land acquisition by the project. Preparation of cadastral map if necessary.

c. Preparation of ToR should be based on information gathered and assessed during field survey and review of other pertinent documents and as per Rule 5 (1-a) of EPR 2077, and the report should be prepared as prescribed in Annex 6 of EPR 2077.

d. After the approval of ToR by concerned ministry, based on approved ToR the consultant is required to "prepare a BES report The process of BES study should follow

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as per Rule 5, 6 and 7 of EPR 2077,and the report should be prepared as prescribed in Annex 10 of EPR 2077.

(Note: Depending upon the nature and type of proposal the above scope of work can be modified accordingly)

6.20.1.1.1.1.3. SCOPE OF WORK FOR IEE

a. General: To prepare scoping document (SD), terms of reference (ToR) and Environmental Impact Assessment Report and present the report at concerned ministry/authority on behalf of the proponent as per Environment Protection Act (2076) and Environment Protection Rules (2077) and other guiding document(s), manual(s) published by authorized entity in the context.

b. Specific

- Review all the existing documents such as Detailed Feasibility Study Report (DFSR), Detailed Project Report (DPR), Master Plan (MP), Geotechnical Investigation Report, Environmental and Social reports published by Central, Provincial and Local Governments, Seismic Reports, Climate Change and Natural Disaster Reports pertaining to proposal impact zone.
- Briefing and Debriefing meeting with the proponent regarding proposal.
- Area delineation, categorization of Zone of Influence (ZoI), Indirect Impact Zone(IIZ), Direct impact Zone (DIZ), depiction of Area Delineation on map indicating all the impact zones.
- Preparation of map using cadastral map and digitization of area occupied by proposal components permanently and temporarily.
- Analysis of land use, geology and seismicity by preparing/depicting appropriate map.
- Acquisition of air quality (PM_{10}, $PM_{2.5}$, CO,TSP, Wind Speed and Direction), water quality (TDS, DO, Conductivity, Total Nitrogen, pH, E.coli, Arsenic), Equivalent Noise Level and soil quality data (NPK) relevant to proposal.
- Complete primary information regarding demography, economy and culture of all the affected people of the direct impact zone. Information from secondary source for denizens of zone of influence.
- Public Consultation with proposal affected population, collection of recommendation/ suggesting from all concerned stakeholders. Publication of notices regarding public consultation in local/national daily and dissemination of information via various media as guided by EPR 2076.
- Layout map for proposal components, labor camp site, stock piling sites, batching plants site
- Depiction of forest area, cultural and archeologically significant site in map if it falls under ZoI.
- Information regarding other infrastructure such as Strategic Road Network, Dams, Transmission Lines, Major Irrigation Canal, Special Economic Zones, International Boundary if it falls under ZoI.
- Collection of complete information regarding land acquisition by the project using government issued cadastral maps.

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c. Preparation of ToR should be based on information gathered anti assessed during field investigation and review of related documents and as per Rule 5 (1-b) of EPR 2077, and the report should be prepared as prescribed in Annex 7 of EPR 2077.
d. After the approval of ToR by concerned ministry, based on approved ToR the consultant is required to prepare an IEE report. The process of IEE study should follow as per Rule 7 (5-b) of EPR 2077, and the report should be prepared as prescribed in Annex 11 of EPR 2077.

(Note: Depending upon the nature and type of proposal the above scope of work can be modified accordingly)

6.20.1.1.1.1.4. SCOPE OF WORK FOR EIA

a. General: To prepare scoping document (SD), terms of reference (ToR) and Environmental Impact Assessment Report and present the report at concerned ministry/authority on behalf of the proponent as per Environment Protection Act (2076) and Environment Protection Rules (2077) and other guiding document(s), manual(s) published by authorized entity in the context.
b. Specific:
   - Review all the existing documents such as Detailed Feasibility Study Report (DFSR), Detailed Project Report (DPR), Master Plan (MP), Geotechnical Investigation Report, Environmental and Social reports published by Central, Provincial and Local Governments, Seismic Reports, Climate Change and Natural Disaster Reports pertaining to proposal impact zone.
   - Briefing and Debriefing meeting with the proponent regarding proposal.
   - Area delineation, categorization of Zone of Influence (ZoI), Indirect Impact Zone(IIZ), Direct Impact Zone (DIZ), depiction of Area Delineation on map indicating all the impact zones.
   - Preparation of map using cadastral map and digitization of area occupied by proposal components permanently and temporarily.
   - Analysis of land use, geology and seismicity by preparing/depicting appropriate map.
   - Acquisition of air quality (PM_{10}, $PM_{2.5}$, CO,TSP, Wind Speed and Direction), water quality (TDS, DO, Conductivity, Total Nitrogen, pH, E.coli, Arsenic), Equivalent Noise Level and soil quality data (NPK) relevant to proposal.
   - Complete primary information regarding demography, economy and culture of all the affected people of the direct impact zone. Information from secondary source for denizens of zone of influence.
   - Public Consultation with proposal affected population, collection of recommendation/suggesting from all concerned stakeholders. Publication of notices regarding public consultation in local/national daily and dissemination of information via various media as guided by EPR 2076.
   - Layout map for proposal components, labor camp site, stock piling sites, batching plants site.
   - Depiction of forest area, cultural and archeologically significant site in map if it falls under ZoI.

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- Information regarding other infrastructure such as Strategic Road Network, Dams, Transmission Lines, Major Irrigation Canal, Special Economic Zones, International Boundary if it falls under ZoI.
- Collection of complete information regarding land acquisition by the project using government issued cadastral maps.

c. Scoping Document

The Scoping is an essential step of determining the range of issues to be analyzed during the EIA study of the proposal. It helps to know the issues and the scope of the works to be dealt with during the EIA report preparation. The Scoping process involves the following tasks:

- Involvement of the interested parties and the affected population;
- Identification of significant and/ or priority issues to be examined/ assessed during the EIA report preparation;
- Identification and selection of alternatives; and
- Providing input for the determination of the ToR for further study.
- Identification of other pertinent issues
- Area delineation, ZoI, IIZ and DIZ

The process of scoping should follow as per Rule 5 (1) of EPA 2076; Rule 4 of EPR 2077, and the report should be prepared as prescribed in Annex 5 of EPR 2077.

d. Preparation of Terms of Reference (ToR)

Preparation of ToR should be based on information gathered and assessed during scoping and as per Rule 5 (1) of EPA 2076; Rule 5 (1-c) of EPR 2077, and the report should be prepared as prescribed in Annex 8 of EPR 2077.

e. Preparation of EIA Report

After the approval of SD and ToR by MoFE, based on approved ToR the consultant is required to prepare an EIA report. The process of EIA study should follow as per Rule 5 of EPA 2076; Rule 7 (5-c) of EPR 2077, and the report should be prepared as prescribed in Annex 12 of EPR 2077.

(Note: Depending upon the nature and type of proposal the above scope of work can be modified accordingly)

6.20.1.1.1.1.5. SCOPE OF WORK FOR HH SURVEY

- Preparation and approval of data collection checklist by the proponent.
- Complete count of the total population under question and collection of information according to approved checklist.
- Consolidation and analysis of data.
- Preparation and presentation of report.
- Approval of report by the proponent.

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6.20.1.1.1.1.6. SCOPE OF WORK FOR FOREST SURVEY/INVENTORY

- Preparation and approval of forest survey and inventory checklist by the proponent.
- Complete count and enumeration of total species of the proposal area as per the methodology approved by authorized entity of government of Nepal.
- Consolidation and analysis of data.
- Preparation and presentation of report.
- Approval of report by the proponent.

6.20.1.1.1.1.7. SCOPE OF WORK FOR GENERAL ENVIRONMENTAL SURVEY/ MONITORING/AUDITING

- Review all the existing documents such as Detailed Feasibility Study Report (DFSR),Detailed Project Report (DPR), Master Plan (MP),Geotechnical Investigation Report, Environmental and Social reports published by Central, Provincial and Local Governments, Seismic Reports, Climate Change and Natural Disaster Reports, approved BES/IEE/EIA reports pertaining to proposal area.
- Selection of indicators/parameters for Environmental Survey/Monitoring/Auditing.
- Discussion with proponent and finalization of indicators/parameters for study.
- Approval of checklist and methodology by the proponent.
- Field visit, data collection, discussion with local stakeholders.
- Discussion with proponent regarding findings.
- Consolidation of data acquired and preparation of reports.
- Presentation and approval of report by the proponent.

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SECTION 5: RIVER MORPHOLOGY STUDY

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Government of Nepal
Ministry of Energy, Water Resources and Irrigation
Singh Durbar, Kathmandu, Nepal

5.3 RIVER STUDIES

5.1.A. FOR CLASS ONE RIVERS

DESK STUDY

i- Human Resource Required

Team Leader	0.25
River Engineer	0.25
Hydrologist	0.25
Geologist	0.125
RS/GIS Expert	0.06
Surveyor	0.06
Socio-economist	0.06
Sub-engineer	1.00
Computer Operator	0.25
Supporting Staff	0.50

ii- Performance Criteria

All Class One Rivers	5 days/km

FIELD WORK

A.1.1 L-section, X-section Survey

i- Human Resource Required

Surveyor	1.00
Tape man	2.00
Supporting Staff	2.00
Labor	4.00
Team Leader	0.10

ii- Performance Criteria

All Class One Rivers	5 days/km

A.1.2 Satellite Imagery

i- Human Resource Required

RS/GIS Expert	0.50
Computer Operator	0.50
Supporting Staff	0.50
Team Leader	0.05

ii- Performance Criteria

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All Class One Rivers	5 days/km

A.1.3 *Hydrological Study*

i- Human Resource Required

Hydrologist	1.00
River Engineer	1.00
Sub-engineer	2.00
Supporting Staff	2.00
Team Leader	0.10

ii- Performance Criteria

All Class One Rivers	5 days/km

A.1.4 *Geological Study*

i- Human Resource Required

Geologist	0.25
Supporting Staff	0.25
Labor	0.50
Team Leader	0.025

ii- Performance Criteria

All Class One Rivers	5 days/km

A.1.5 *Socio-economical Study*

i- Human Resource Required

Socio-economist	0.25
Supporting Staff	0.25
Team Leader	0.025

ii- Performance Criteria

All Class One Rivers	5 days/km

OFFICE WORKS

A.1.6 *Detailed Design*

i- Human Resource Required

Team Leader	1.00
River Engineer	1.00

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Hydrologist	0.50
Geologist	0.25
RS/GIS Expert	0.25
Surveyor	1.00
Socio-economist	0.25
Sub-engineer	2.00
Computer Operator	1.00
Supporting Staff	2.00

ii- Performance Criteria

All Class One Rivers	5 days/km

A.1.7 Report Preparation

i- Human Resource Required

Team Leader	0.50
River Engineer	0.50
Hydrologist	0.25
Geologist	0.125
RS/GIS Expert	0.125
Surveyor	0.125
Socio-economist	0.125
Sub-engineer	0.50
Computer Operator	0.50
Supporting Staff	1.00

ii- Performance Criteria

All Class One Rivers	5 days/km

NOTE:

i. The class one rivers are those rivers that are perennial in nature being snow fed from the Himalayas that traverse through Mountain, Hill and Terai geographical regions and a part of any four major catchments i.e., Mahakali, Karnali, Gandaki and Koshi. Any main tributary of the above-mentioned rivers will automatically fall under a class one river. For example, the Bheri of Karnali or Marsyangdi of Gandaki or Sunkoshi of Koshi etc. would also be considered a class one river. These rivers have relatively narrow waterways while flowing in the mountains and hills as compared to the Terai. However, the accessibility in the mountains and hills is difficult due to the rugged topography and requires more effort in conducting research and studies. Whereas the river will be easier to access in the Terai but work area will be large due

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to the increased flow area after the river enters the flood plains. Due to this dual liability and benefit in the upper reaches and Terai region of these rivers, the overall work required for both reaches will remain the same as it is assumed that the harder accessibility will compensate for the large work area.

ii. Human Resource requirement for field work (A.2.1) such as Surveyor, Tape man, Supporting Staff, Labor, and Team Leader shall be multiplied by a factor 1+((width above 2 km)/8) for rivers having width greater than 2km.

iii. The amount for transportation shall be added as per requirement.

iv. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

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5.1.B. FOR CLASS TWO RIVERS

DESK STUDY

i- Human Resource Required

Team Leader	0.175
River Engineer	0.175
Hydrologist	0.175
Geologist	0.0875
RS/GIS Expert	0.042
Surveyor	0.042
Socio-economist	0.042
Sub-engineer	0.70
Computer Operator	0.175
Supporting Staff	0.35

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

FIELD WORK

B.1.1. L-section, X-section Survey

i- Human Resource Required

Surveyor	0.70
Tape man	1.40
Supporting Staff	1.40
Labor	2.80
Team Leader	0.07

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

B.1.2. Satellite Imagery

i- Human Resource Required

RS/GIS Expert	0.35
Computer Operator	0.35
Supporting Staff	0.35

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Team Leader	0.035

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

B.1.3. *Hydrological Study*

i- Human Resource Required

Hydrologist	0.70
River Engineer	0.70
Sub-engineer	1.40
Supporting Staff	1.40
Team Leader	0.07

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

B.1.4. *Geological Study*

i- Human Resource Required

Geologist	0.175
Supporting Staff	0.175
Labor	0.35
Team Leader	0.0175

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

B.1.5. *Socio-economical Study*

i- Human Resource Required

Socio-economist	0.175
Supporting Staff	0.175
Team Leader	0.0175

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

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Singh Durbar, Kathmandu, Nepal

OFFICE WORKS

B.1.6. Detailed Design

i- Human Resource Required

Team Leader	0.70
River Engineer	0.70
Hydrologist	0.35
Geologist	0.175
RS/GIS Expert	0.175
Surveyor	0.70
Socio-economist	0.175
Sub-engineer	1.40
Computer Operator	0.70
Supporting Staff	1.40

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

B.1.7. Report Preparation

i- Human Resource Required

Team Leader	0.35
River Engineer	0.35
Hydrologist	0.175
Geologist	0.0875
RS/GIS Expert	0.0875
Surveyor	0.0875
Socio-economist	0.0875
Sub-engineer	0.35
Computer Operator	0.35
Supporting Staff	0.70

ii- Performance Criteria (each activities) :

All Class Two Rivers	5 days/km

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Singh Durbar, Kathmandu, Nepal

NOTE:

i. The class two rivers are those rivers originating from the Mahabharata mountain range or further north but not snow fed as in the case of class one rivers. Such class two rivers are perennial in nature and traverse the Hills and Terai geographical regions. For convenience of classification and to avoid any confusion, these rivers are stated as here under:
Mechi, Kankai, Kamala, Bagmati, Tinau, Rapti and Babai.

The major tributaries of the above mentioned rivers will also be classified as a class two river. For example, the Marin Khola of Bagmati would also be considered a class two river. Further criteria for this category would be major rivers originating in the hills but being a tributary of a class one river. For example, the East Rapti River, being a tributary of Narayani will also be a class two river. As stated in the class one river, such class two rivers will have narrow water ways in the mountains and hills but difficult accessibility whereas the water way will be large after it enters the flood plains of the Terai, but the accessibility will be easy. Due to this dual liability and benefit in the upper reaches and Terai of these rivers, there will be no difference in work estimation whatever the geographical location.

ii. Human Resource requirement for field work (B.2.1) such as Surveyor, Tape man, Supporting Staff, Labor, and Team Leader shall be multiplied by a factor 1+((width above 1.5 km)/5) for rivers having width greater than 1.5km.

iii. The amount for transportation shall be added as per requirement.

iv. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

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5.1.C. FOR CLASS THREE RIVERS

DESK STUDY

i- Human Resource Required

Team Leader	0.125
River Engineer	0.125
Hydrologist	0.125
Geologist	0.0625
RS/GIS Expert	0.03
Surveyor	0.03
Socio-economist	0.03
Sub-engineer	0.50
Computer Operator	0.125
Supporting Staff	0.25

ii- Performance Criteria

All Class Three Rivers	3 days/km

FIELD WORK

C.1.1 L-section, X-section Survey

i- Human Resource Required

Surveyor	0.50
Supporting Staff	1.00
Labor	3.00
Team Leader	0.05

ii- Performance Criteria

All Class Three Rivers	**3** days/km

C.1.2 Satellite Imagery

i- Human Resource Required

RS/GIS Expert	0.25
Computer Operator	0.25
Supporting Staff	0.25
Team Leader	0.025

ii- Performance Criteria

All Class Three Rivers	3 days/km

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C.1.3 Hydrological Study

i- Human Resource Required

Hydrologist	0.50
River Engineer	0.50
Sub-engineer	1.00
Supporting Staff	1.00
Team Leader	0.05

ii- Performance Criteria

All Class Three Rivers	3 days/km

C.1.4 Geological Study

i- Human Resource Required

Geologist	0.125
Supporting Staff	0.125
Labor	0.25
Team Leader	0.0125

ii- Performance Criteria

All Class Three Rivers	3 days/km

C.1.5 Socio-economical Study

i- Human Resource Required

Socio-economist	0.125
Supporting Staff	0.125
Team Leader	0.0125

ii- Performance Criteria

All Class Three Rivers	3 days/km

OFFICE WORKS

C.1.6 Detailed Design

i- Human Resource Required

Team Leader	0.50
River Engineer	0.50
Hydrologist	0.25

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Geologist	0.125
RS/GIS Expert	0.125
Surveyor	0.50
Socio-economist	0.125
Sub-engineer	1.00
Computer Operator	0.50
Supporting Staff	1.00

ii- Performance Criteria

All Class Three Rivers	3 days/km

C.1.7 Report Preparation

i- Human Resource Required

Team Leader	0.25
River Engineer	0.25
Hydrologist	0.125
Geologist	0.0625
RS/GIS Expert	0.0625
Surveyor	0.0625
Socio-economist	0.0625
Sub-engineer	0.25
Computer Operator	0.25
Supporting Staff	0.50

ii- Performance Criteria

All Class Three Rivers	3 days/km

NOTE:

i. The class three rivers are those rivers originating within the Terai, Bhabar zone or from the Siwalik (Churiya) hill formation. Such rivers may not necessarily be perennial in nature but more prone to flash floods during heavy precipitation mostly during the monsoon. An example of such a river would be the Khando of Saptari district. However, minor rivers in the mountains and hills may also be classified as a class three rivers depending on their peak discharge regardless of whether they are tributaries of class one or class two rivers. As stated in the previous two classes of rivers, class three rivers also will have narrow water ways in the mountains and hills but difficult accessibility whereas the water way will be large after it enters the flood plains of the Terai, but the accessibility will be easy. Due to this dual liability and

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benefit in the upper reaches and Terai of these rivers, there will be no difference in work estimation whatever the geographical location.

ii. Human Resource requirement for field work (C.2.1) such as Surveyor, Tape man, Supporting Staff, Labor, and Team Leader shall be multiplied by a factor 1+((width above 1.0 km)/3) for rivers having width greater than 1km.

iii. The amount for transportation shall be added as per requirement.

iv. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

v. Other remaining small rivers geographically located in any region of Nepal are also included in class three category for survey field work. They may be a tributary of any class of river. The definition may also be extended to large drains with significant discharge. Typical examples of such class of rivers would be Nakkhu Khola of Lalitpur and Dhobi Khola of Kathmandu.

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5.4 LANDSLIDE STUDY

5.2.A. PRELIMINARY STUDY OF LANDSLIDE

A.1.1 DESK STUDY / INCEPTION

i- Human Resource Required

Team Leader	1
Civil Engineer/Geotech. Engg.	0.7
Engg. Geologist	1
Hydrologist	0.3
Bio Engineering Expert	0.3

ii- Performance Criteria

Landslide Category	Performance Criteria
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	3 days
Medium (toe width=50-100m, Length 100-200m and Area 0.5-2 ha	5 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	7 days

A.1.2 FIELD WORK

i- Human Resource Required

Team Leader	1.00
Civil Engineer/Geotech. Engg.	0.8
Engg. Geologist	1.00
Hydrologist	0.4
Bio Engineering Expert	0.4
Surveyor	0.4
Sub- engineer	0.4
Supporting Staff	0.4
Labors	1.6

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ii- Performance Criteria

Landslide Category	Performance Criteria < 30 degree terrain	Performance Criteria >30 degree terrain
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	8 days	12 days
Medium (toe width=50-100m, Length 100-200m and Area 0.5-2 ha)	12 days	18 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	16 days	24 days

A.1.3 OFFICE WORK / REPORT PREPARATION

i- Human Resource Required

Team Leader	1.00
Civil Engineer/Geotech. Engg.	0.6
Engg. Geologist	0.8
Hydrologist	0.3
Bio Engineering Expert	0.2
Surveyor	0.5
Sub- engineer	0.5
Supporting Staff	0.5

ii- Performance Criteria

Landslide Category	Performance Criteria
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	12 days
Medium (toe width=50-100m, Length 100-200m and Area 0.5-2 ha)	20 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	25 days

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NOTE:

i. The amount for transportation shall be added as per requirement.

ii. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

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5.2.B. DETAIL STUDY OF LANDSLIDE

B.1.1 DESK STUDY / INCEPTION

i- Human Resource Required

Team Leader	1.00
Civil Engineer/Geotech. Engg.	0.5
Engg. Geologist	1.00
Hydrologist	0.25
Bio Engineering Expert	0.25
Surveyor	0.00
Socioeconomics	0.15
Sub- engineer	0.00
Supporting Staff	0.00

ii- Performance Criteria

Landslide Category	Performance Criteria
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	4 days
Medium (toe width=50-100m. , Length 100-200m and Area 0.5-2 ha)	6 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	10 days

g. B.1.2. FIELD WORK

i- Human Resource Required

Team Leader	1.00
Civil Engineer/Geotech. Engg.	0.8
Engg. Geologist	1.00
Hydrologist	0.2
Bio Engineering Expert	0.2
Surveyor	0.4
Sub- engineer	0.4
Supporting Staff	0.4
Labors	1.6

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ii- Performance Criteria

Landslide Category	Performance Criteria < 30 degree terrain	Performance Criteria >30 degree terrain
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	13 days	20 days
Medium (toe width=50-100m, , Length 100-200m and Area 0.5-2 ha)	19 days	28 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	24 days	36 days

B.1.3 OFFICE WORK / REPORT PREPARATION

i- Human Resource Required

Team Leader	1.00
Civil Engineer/Geotech. Engg.	0.60
Engg. Geologist	0.85
Hydrologist	0.20
Bio Engineering Expert	0.2
Surveyor	0.4
Sub- engineer	0.4
Supporting Staff	0.4
Labors	0.00

ii- Performance Criteria

Landslide Category	Performance Criteria
Small (toe width ≤ 50m, length ≤ 500 m and area ≤0.5 ha	24 days
Medium (toe width=50-100m, , Length 100-200m and Area 0.5-2 ha)	32 days
Large (Toe Width ≥ 100 m, Length ≥ above 200m and Area ≥2 ha	40 days

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NOTE:

i. The amount for transportation shall be added as per requirement.

ii. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

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5.2.C. TERMS OF REFERENCE FOR LANDSLIDE STUDY

➢ ***BACKGROUND:***

- **LANDSLIDE:**

Landslide is one of the insightful hazards frequently occurring in mountainous region having fragile and unstable geology and refers to the potential for the movement of rock, soil, and debris down a slope due to various triggering factors. Landslide may be shallow-seated and deep-seated. A shallow-seated landslide, often referred to simply as a "shallow landslide," is a type of mass movement that involves the downslope movement of soil, debris, or rock over a relatively short distance. Unlike deep-seated landslides that involve larger volumes of material moving through deeper geological layers, shallow landslides typically occur in the uppermost layer of soil or weathered rock. Landslide poses a threat to life, property, infrastructure, and the environment. Landslides can be triggered by natural processes, such as heavy rainfall, earthquakes, volcanic activity, or they can be human-induced through activities like construction, deforestation, or mining.

Landslides can occur in various forms, each with distinct characteristics. Some common types of landslides include Rockfall, Rockslide, Debris flow, Mud slide, Earthflow, Landslide complex etc. Landslides can result in various risks and impacts, including Loss of Life and Injury, Property Damage, Infrastructure disruption, Environmental damage and Economic loss; and hence its timely assessment to take meaningful preventive or mitigation measures is inevitable.

➢ ***OBJECTIVES OF LANDSLIDE STUDY:***

The primary goal of the LANDSLIDE STUDY is to evaluate landslide-prone areas to identify potential risks. This assessment aims to provide valuable information to decision-makers and the public, enabling the creation of response strategies to minimize impact in the civil structures and settlements in the vicinity and recommend appropriate mitigation measures and installation of landslide early warning system (LEWS).

➢ ***SCOPE OF WORK:***

The study of landslide shall be divided into two stages. Stage I will be the preliminary study of landslide where investigation/study will be carried out to see the general outline and general characteristics/mechanism/cause of the landslide. On the other hand, Stage II will be the detailed study of landslide where detailed investigation/study will be carried out based on preliminary study to see the detailed outline of the landslide, detail characteristics/mechanism/cause of failure. Each stage shall be classified into three categories namely small, medium and large on the basis of following features of landslide:

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Category	Toe width (m)	Length (m)	Area (sq.m)	Area (ha)
Small	Upto 50	Upto 100	Upto 5000	Upto 0.50
Medium	50-100	100-200	5000-20000	0.50-2.0
Large	Above 100	Above 200	Above 20000	Above 2.0

The general scope of works of the landslide study shall include:

1. Data Collection and Review

- Gather existing geological, hydrological, and meteorological data.
- Review historical landslide occurrences and their impacts.

2. Field Investigations

- Conduct site visits to observe and document current conditions.
- Perform soil and rock sampling for laboratory analysis.
- Map the topography and geomorphology of the area.

3. Hazard Assessment

- Identify and map landslide-prone areas using geological and topographical data.
- Analyze the potential triggers of landslides, such as rainfall, seismic activity, and human activities.
- Use remote sensing and GIS technologies to enhance hazard assessment.

4. Risk Analysis

- Evaluate the potential impact of landslides on communities, infrastructure, and the environment.
- Quantify the probability and magnitude of potential landslides.
- Assess vulnerabilities and exposure of at-risk areas.

5. Mitigation Measures

- Develop and recommend engineering and non-engineering measures to reduce landslide risks.
- Design drainage systems, retaining structures, and other stabilization techniques.
- Propose land use planning and zoning regulations to prevent development in high-risk areas.

6. Response Strategies

- Formulate emergency response plans and protocols for landslide events.
- Create early warning systems and public awareness programs.

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- Develop evacuation routes and safe zones for affected communities.

7. Reporting and Documentation

- Prepare detailed reports outlining findings, risk assessments, and recommendations.

- Provide maps, charts, and visual aids to support the study's conclusions.

- Present findings to stakeholders, including government agencies, planners, and the public.

8. Monitoring and Follow-Up

- Establish monitoring systems to track changes in landslide-prone areas.

- Conduct periodic reviews and updates of the landslide study based on new data and observations.

- Engage in ongoing communication with stakeholders to ensure effective implementation of mitigation and response strategies.

The scope of landslide study includes, but is not limited to, the following activities:

- **DESK STUDY:**
  - **Planning of Field Work:** Team selection, Task assignment and preparation of plan for field mobilization.
  - **Literature Review:** Review /Research existing studies, reports, and papers related to the specific area and type of shallow-seated landslides to understand the geological, geomorphological, and climatic conditions that might contribute to landslides.
  - **Data Compilation:** Gather available maps, satellite images, topographic data, geological maps, and any previous landslide inventories. This information provides a baseline understanding of the study area.
  - **Historical Study:** Investigate historical records of landslides, if available, to identify trends and patterns of previous events.
  - **Geomorphological Study:** Study and analyze the terrain features, slope angles, and land cover using remote sensing data to identify potential landslide-prone areas.
  - **Rainfall and Climate Data Study:** Study local rainfall patterns and climatic conditions that could trigger landslides after collecting historical precipitation data and analyzing meteorological patterns.
  - **Geotechnical Study:** Examine soil properties, geological formations, and bedrock conditions to understand the stability of the area

- **FIELD WORK:**
  - **Community Consultation:** Engage with local communities and experts through interviews and focus group discussions to gather their knowledge and experiences of shallow-seated /deep seated landslides.
  - **Site Visit:** Conduct on-site visit of the study area to gain firsthand

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knowledge of the terrain, vegetation, land use, and other relevant factors.

- **Geomorphological Mapping:** Conduct detailed field mapping of terrain features, slope angles, soil types, and vegetation cover to identify potential landslide sources and runout zones.
- **Landslide Identification:** Locate and document existing landslides or evidence of past events, such as scarps, debris, or tilted trees.
- **Soil Sampling:** Collect soil samples at various depths (depth upto 3m for shallow seated and more than 3 m for deep seated landslides) to assess their properties, including moisture content, density, shear strength, and particle size distribution. SPT/CPT test.
- **Instrumentation Installation:** Set up monitoring instruments like inclinometers, piezometers, and rain gauges to continuously measure factors affecting landslide activity.
- **Photographic Documentation:** Capture photographs and videos to record the current state of the study area and any ongoing landslide activity.

- **DATA ANALYSIS AND MODELING:**

The Data Analysis and Modeling Phase shall be initiated immediately after the completion of Field work. The data analysis and modeling shall involve the following activities:

- **Data Analysis:** Process and analyze the collected field data / information, including topographic measurements, soil samples, and instrument readings.
- **GIS and Remote Sensing:** Use Geographic Information Systems (GIS) and remote sensing software to create maps, overlay data layers, and identify high-risk zones.
- **Modeling and Simulation:** Develop numerical models or simulations to predict potential landslide scenarios under various conditions. This could involve slope stability analysis and rainfall-induced slope failure simulations.
- **Runout Zonation:** In case of debris flow, the runout analysis and zonation shall perform.

- **REPORT PRODUCTION AND COMMUNICATION:**

Report Production: The Report Production work shall be initiated after the completion of data analysis. The following reports in specified numbers shall be prepared and submitted in due course of time:

- Inception Report
- Field Report
- Draft Final Report
- Final Report comprising required contents after editing all comments and suggestions given during presentation of draft report

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The Final Report shall be a comprehensive report compiling all the findings, issues, methodologies, maps, and analyses. This will include detailed explanations of landslide assessments, field observations, and recommendations for mitigation and preparedness.

Communication: Present findings of the study shall be communicated through presentation to stakeholders, such as local authorities, community members, and relevant agencies, to raise awareness and aid decision-making.

- ***THE HUMAN RESOURCES:***

The working team for field and office work of landslide study and their input shall be as per the approved norms for study for related work; and shall be listed here accordingly. The tasks of each key expert, their qualification and general and specific experience shall be determined based on the nature and volume of the work desired and shall be depicted accordingly.

- ***DELIVERABLES / REPORTINGS:***

The following four deliverables shall be produced as part of the landslide study assignment:

- Inception Report comprising required contents.
- Field Report comprising required contents
- Draft Report comprising required contents and presentation.
- Final Report comprising required contents after editing all comments and suggestions given during presentation of draft report.

Number of copies of each report shall be as specified.

- ***TIME SCHEDULE:***

The timeline for the landslide study shall be determined based on the stages of the study, volume of work and data processing requirements. Duration of assignment for the consultant performing the task shall be the number of calculated months from the date of signing the contract.

- ***MODE OF PAYMENT:***

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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5.5 STUDY OF DEBRIS FLOW (Along the stream, gullies, and valleys)

DESK STUDY / INCEPTION

i- Human Resource Required

Team Leader	1
Civil Engineer/Geotech. Engg.	0.7
Engg. Geologist	1
Hydrologist	0.3
Bio Engineering Expert	0.3

ii- Performance Criteria

Debris Flow Category	Performance Criteria
Small (Flow Length upto 500 m)	3 days
Medium (Flow Length upto 500 -1000m)	5 days
Large (Flow Length >1000m)	7 days

FIELD WORK

i- Human Resource Required

Team Leader	1
Civil Engineer/Geotech. Engg.	0.8
Engg. Geologist	1
Hydrologist	0.4
Bio Engineering Expert	0.2
Surveyor	0.4
Sub- engineer	0.4
Supporting Staff	0.4
Labors	1.6

ii- Performance Criteria

Debris Flow Category	Performance Criteria < 30 degree terrain	Performance Criteria >30 degree terrain
Small (Flow Length upto 500 m)	5 days	8
Medium (Flow Length upto 500 -	7 days	10

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1000m)		
Large (Flow Length >1000m)	12 days	18

OFFICE WORK / REPORT PREPARATION

i- Human Resource Required

Team Leader	1
Civil Engineer/Geotech. Engg.	0.6
Engg. Geologist	0.8
Hydrologist	0.3
Bio Engineering Expert	0.2
Surveyor	0.5
Sub- engineer	0.5
Supporting Staff	0.5

ii- Performance Criteria

Debris Flow Category	Performance Criteria
Small (Flow Length upto 500 m)	12 days
Medium (Flow Length upto 500 -1000m)	20 days
Large (Flow Length >1000m)	25 days

NOTE:

i. The amount for transportation shall be added as per requirement.

ii. The amount for other secondary items (stationary, communication and hire charge of equipment) shall be taken as 15 % of the amount of all activities of the research and study works.

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5.6 PREPARATION OF WATER INDUCED HAZARD MAPS

5.4.A. PRELIMINARY HAZARD MAP PREPARATION OF INCEPTION PHASE

DESK STUDY

i- Human Resource Required

River Engineer Expert	1.00
Geotechnical Expert	1.00
Remote Sensing Specialist	2.00
GIS Specialist	2.00
Socio-economist	0.50
Natural Resource/Environmental Manager	0.50
Computer Operator/Assistants	4.00

ii- Performance Criteria

	River Basin Type	River Basin Size	No. of Days per Km^2	Remarks
i)	Very small river basin	Less than 500 km2	0.05	
ii)	Small river basin	500 km2 - 1000 km2	(500*0.05 + (x- 500) *0.006)/x	'x' is any area in km2 between 500 km2 to 1000 km2
iii)	Medium river basin	1000 km2 - 5000 km2	(500*0.05 + 500 *0.006 + (y-1000) *0.003)/y	'y' is any area in km2 between 1000 km2 to 5000 km2
iv)	Large river basin	5000 km2 - 10000 km2	(500*0.05 + 500 *0.006 + 4000*.003+ (z-5000) *0.001)/z	'z' is any area in km2 between 5000 km2 to 10000 km2
v)	Very large river basin	Greater than 10000 km2	(500*0.05 + 500 *0.006 + 4000*.003+5000*0.001+(a-10000) *0.0005)/a	'a' is any area in km2 greater than 10000 km2

NOTE:

i. Scope of Works comprises of:
- Secondary data collection.
- Satellite Image, Aerial Photo and GIS analysis for the preparation of Preliminary Hazard Maps.
- Secondary data analysis for hazard and vulnerability analysis of infrastructures, natural resources, and socio-economic elements.

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ii. Add 20% in the number of RS and GIS experts for mountain and hill digital map analysis to allow heavy contour map.

FIELD SURVEY WORKS

i- Human Resource Required

River Engineer Expert	1.00
Geotechnical Expert	1.00
Remote Sensing Specialist	0.20
Socio-economist	0.50
Natural Resource/Environmental Manager	0.50
Civil Engineer	1.00
Hydrologist	0.20
Assistants	6.00

ii- Performance Criteria

River Basin Type		River Basin Size	No. of Days per Km2	Remarks
i)	Very small river basin	Less than 500 km2	0.04	
ii)	Small river basin	500 km2 - 1000 km2	(500*0.04 + (x- 500) *0.004)/x	'x' is any area in km2 between 500 km2 to 1000 km2
iii)	Medium river basin	1000 km2 - 5000 km2	(500*0.04 + 500 *0.004 + (y-1000) *0.001)/y	'y' is any area in km2 between 1000 km2 to 5000 km2
iv)	Large river basin	5000 km2 - 10000 km2	(500*0.04 + 500 *0.004 + 4000*.001+ (z-5000) *0.0008)/z	'z' is any area in km2 between 5000 km2 to 10000 km2
v)	Very large river basin	Greater than 10000 km2	(500*0.04 + 500 *0.004 + 4000*.001+5000*0.0008+(a-10000) *0.0002)/a	'a' is any area in km2 greater than 10000 km2

NOTE:

i. Scope of Works comprises of:
- Fixing of Control points and training area survey.
- L-section and X-section survey of River.
- Landslide, Debris flow and Bank erosion mapping and survey for mitigation works.

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- Survey for preliminary hazard map validation.
- Infrastructure, socio-economic and natural resource survey for assessing vulnerability.

ii. Add 30% in the Hill and Mountain Terrain Survey.

iii. Calculate Human Resources required for L-section and X-section survey as per River Survey Norms.

iv. Add travel days from the central office to the study site in each of the Human Resources.

FINAL HAZARD MAP PREPARATION

i- Human Resource Required

River Engineer Expert	1.00
Geotechnical Expert	1.00
Remote Sensing Specialist	2.00
GIS Specialist	2.00
Socio-economist	0.50
Natural Resource/Environmental Manager	0.50
Hydrologist	0.50
Civil Engineer	1.00
Assistants	6.00

ii- Performance Criteria

River Basin Type		River Basin Size	No. of Days per Km2	Remarks
i)	Very small river basin	Less than 500 km2	0.04	
ii)	Small river basin	500 km2 - 1000 km2	(500*0.04 + (x- 500) *0.004)/x	'x' is any area in km2 between 500 km2 to 1000 km2
iii)	Medium river basin	1000 km2 - 5000 km2	(500*0.04 + 500 *0.004 + (y-1000) *0.001)/y	'y' is any area in km2 between 1000 km2 to 5000 km2
iv)	Large river basin	5000 km2 - 10000 km2	(500*0.04 + 500 *0.004 + 4000*.001+ (z-5000) *0.0008)/z	'z' is any area in km2 between 5000 km2 to 10000 km2
v)	Very large river	Greater than	(500*0.04 + 500 *0.004 +	'a' is any area

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	basin	10000 km2	4000*.001+5000*0.0008+(a-10000) *0.0002)/a	in km2 greater than 10000 km2

NOTE:

i. Scope of Works comprises of:
   - Modification of Preliminary liaison Maps (1:25000 scales) using field data for verification
   - Preparation of 1:10000 (depending upon the base map) scale hazard map with mitigation plan and cost estimations for the most vulnerable location of the river basin.
   - Validation of hazard maps.
   - Vulnerability analysis of infrastructures, natural resources, and socio-economic elements.
   - Hydrological Analysis.

ii. Add 20% in the number of RS and GIS experts for mountain and hill digital map analysis to allow heavy contour map

REPROT PREPARATION

i- Human Resource Required

River Engineer Expert	1.00
Geotechnical Expert	1.00
Socio-economist	0.50
Natural Resource/Environmental Manager	0.50
Assistants	4.00

ii- Performance Criteria

River Basin Type		River Basin Size	No. of Days per Km2	Remarks
i)	Very small river basin	Less than 500 km2	0.05	
ii)	Small river basin	500 km2 - 1000 km2	(500*0.05 + (x- 500) *0.006)/x	'x' is any area in km2 between 500 km2 to 1000 km2
iii)	Medium river basin	1000 km2 - 5000 km2	(500*0.05 + 500 *0.006 + (y-1000) *0.003)/y	'y' is any area in km2 between 1000 km2 to 5000 km2
iv)	Large river basin	5000 km2 - 10000 km2	(500*0.05 + 500 *0.006 + 4000*.003+ (z-5000) *0.001)/z	'z' is any area in km2 between 5000 km2 to 10000 km2

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v)	Very large river basin	Greater than 10000 km2	(500*0.05 + 500 *0.006 + 4000*.003+5000*0.001+(a-10000) *0.0005)/a	'a' is any area in km2 greater than 10000 km2

NOTE:

i. Scope of Works comprises of:
- Preparation of Inception Report
- Preparation of Field Report
- Preparation of Draft Report
- Preparation of Final Report

MISCELLANEOUS WORKS

Scope of Works:

- **Purchase of satellite images** - **As per necessary**
- **Hire charge of computers and plotters** - 5 % of items (I+II+III+IV)
- **Hire charge of Survey equipment** - 3 % of items (I+II+III+IV)
- **Transportation charge** - As per necessary
- **Stationery, photocopy, reports. map production and binding** - Lump sum
- **Presentation at site** - Lump sum
- **Presentation at Office** - Lump sum
- **Purchase of Digital maps** - As per necessary
- **Departmental supervision** - As per GON Norms

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5.4.B. TERMS OF REFERENCE FOR HAZARD MAPPING

➢ ***BACKGROUND:***

- **HAZARD MAPPING:**

Water-induced hazard mapping involves identifying and assessing areas prone to hazards caused by water-related events, such as flooding, landslides, and erosion in a specific geographical area. It aims at providing valuable information to individuals, communities, governments, and other stakeholders about the potential risks they may face from natural or human-made hazards. By mapping out these hazards, decision-makers can make informed choices about land use planning, emergency response strategies, and disaster preparedness measures.

Hazard mapping is thus, a vital component of disaster risk reduction and plays a significant role in minimizing the impact of hazards on communities and the environment.

- **SEQUENTIAL STEPS OF HAZARD MAPPING:**

HAZARD MAPPING shall include the following sequential steps:

- **Hazard Identification:**
  Involving identifying the types of hazards (commonly earthquakes, floods, hurricanes, landslides, wildfires, industrial accidents, and more) that could affect a given area;
- **Vulnerability Assessment:**
  Assessing the vulnerabilities of the area's population, infrastructure, and environment to each identified hazard (physical; quantitative and/or semi-quantitative and socio-economic vulnerability). This helps determine the potential impacts of different hazard scenarios;
- **Data Collection:**
  Gathering data from various sources, such as satellite imagery (open access is preferable), historical records, geological surveys, and meteorological data, to build a comprehensive understanding of the area's conditions;
- **Hazard Zoning:**
  Dividing the area into different hazard zones based on the likelihood and potential impact of each hazard (expertise judgments in case of data scars and data driven in case of data available). These zones can be used for land use planning, building codes, and emergency response strategies;
- **Visualization and Mapping:**
  Creating maps that display hazard zones, vulnerable areas, critical infrastructure, and potential evacuation routes. These maps provide valuable information to decision-makers and the public;
- **Public Awareness and Preparedness**
  Sharing the hazard maps and information with the public, community leaders, and relevant authorities. This promotes awareness, education, and preparedness efforts;
- **Continuous Monitoring and Updating:**

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Regularly updating to reflect changing environmental conditions, new data, and evolving hazard scenarios;

- ***OBJECTIVES OF HAZARD MAPPING:***

The main objective of the **HAZARD MAPPING** is to create maps that will display hazard zones, vulnerable areas, critical infrastructure, and potential evacuation routes in order to assess the potential risks to provide valuable information to decision-makers and the public; and create response strategies to minimize the impact of disasters.

- ***SCOPE OF WORK:***

The tools required to be used for **Hazard Mapping** shall be GIS, RS, GPS, Modeling software, Field survey equipment, etc. based on the type of hazard mapping sought to be prepared.

The scope of hazard mapping includes, but is not limited to, the following activities:

- **DESK STUDY:**
  - **Data Collection:** Gathering existing data such as geological surveys, meteorological data, historical records, satellite imagery, topographic maps, land use data, and previous hazard assessments from various sources;
  - **Literature Review:** Review of scientific studies, reports, and documents related to the specific hazard such as earthquakes, floods, landslides or tsunamis to be mapped in order to understand the historical context, trends, and patterns of hazards in the area;
  - **Preliminary GIS Analysis:** Analyze spatial data using Geographic Information Systems (GIS) software to create preliminary hazard maps showing factors like fault lines, flood zones, and landslide susceptibility based on existing data;
  - **Work planning:** Plan field work including management of competent and experienced working team, well-functioning equipment and their transportation to work site and again back from the work site;
  - **Risk Assessment:** Evaluate the potential impact of hazards on various elements, including population, infrastructure, economy, and the environment. Estimate potential losses and vulnerabilities to inform mitigation strategies;

- **FIELD WORK:**
  - **Site Visit:** Conduct on-site visits to collect ground truth data and validate the accuracy of existing information including Identification of local conditions, landforms, drainage patterns, soil types, and other factors that influence hazard susceptibility;
  - **Data Collection:** Collect field data using methods such as soil sampling, geological surveys, GPS measurements, and visual assessments. Field data collected shall be used to refine hazard maps and assess the actual risk in different areas;

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- **Interviews and Surveys:** Interact with local residents, experts, and authorities to gather qualitative information about hazards, historical events, community awareness, and preparedness measures. This will provide valuable context for hazard assessment;
- **Photographic Documentation:** Capture photographs and videos of the study area to document specific conditions, potential hazards, and vulnerable areas;

➢ ***DATA ANALYSIS AND MODELING:***

The Data Analysis and Modeling Phase shall be initiated immediately after the completion of Field work. The data analysis and modeling shall involve the following activities:

- **Data Integration:** Combine and synthesize the data collected during the desk study and field work stages involving merging GIS data, field measurements, and other relevant information;
- **Analysis and Modeling:** Use specialized software to model potential hazard scenarios, as earthquake simulations can estimate ground shaking intensity whereas flood models can predict water flow and inundation patterns;
- **Risk Assessment and Zonation:** Utilize the collected data and analyses to create risk zones or vulnerability assessments, categorizing areas based on their susceptibility to hazards. This information shall be useful to guide land use planning and disaster preparedness efforts;
- **Map Production:** Develop hazard map that depict the distribution and intensity of the related hazard in the study area;

➢ ***REPORT:***

The Report writing work shall be initiated after the completion of data analysis and modeling work. The following reports in specified numbers shall be prepared and submitted in due course of time:

- Inception Report
- Field Report
- Draft Final Report
- Final Report comprising required contents after editing all comments and suggestions given during presentation of draft report

The Final Report shall be a comprehensive report compiling all the findings, methodologies, maps, and analyses. This will include detailed explanations of hazard assessments, field observations, and recommendations for mitigation and preparedness.

➢ ***THE HUMAN RESOURCES INPUT:***

The working team for field and office work of Hazard Mapping shall be as per the approved norms for study for related work; and shall be listed here accordingly. The tasks of each key expert, their qualification and general and specific experience shall be determined based on the nature and volume of the work desired and shall be depicted accordingly.

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➢ ***DELIVERABLES / REPORTINGS:***

The following four deliverables shall be produced as part of the hazard mapping assignment:

- Inception Report comprising required contents.
- Field Report comprising required contents
- Draft Report comprising required contents and presentation.
- Final Report comprising required contents after editing all comments and suggestions given during presentation of draft report.

Number of copies of each report shall be as specified.

➢ ***TIME SCHEDULE:***

The timeline for the hazard mapping shall be determined based on the volume of work and data processing requirements. Duration of assignment for the consultant performing the task shall be the number of calculated months from the date of signing the contract.

➢ ***MODE OF PAYMENT:***

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

➢ ***QUALIFICATION AND EXPERIENCE REQUIRED FOR KEY HUMAN RESOURCES FOR THE PREPARATION OF WATER INDUCED HAZARD MAPS:***

- **River Engineering Expert:**

  At least master's degree in civil engineering with specialization in river engineering or masters/post-graduate in river engineering/hydro informatics/water resource engineering/engineering hydrology with one academic course on hydraulic modeling or 1 month training on hydraulic modeling and 5 years relevant experience among which 1 job shall be water induced disaster mitigation work/study.

- **Geotechnical Expert:**

  At least master's degree in geotechnical engineering/engineering geology/geo-hydrology/landslides with 5 years relevant experience among which 1 job shall be water induced disaster mitigation work/study.

- **Natural Resource/Environmental Manager:**

  At least master's degree in natural resource management/environmental management/agriculture engineering/watershed management with 5 years' experience in land/natural resource/water resource watershed management/study.

- **Socio-economist:**

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At least master's degree in sociology/economy with 5 years' experience in socio-economic data analysis.

- **Remote Sensing (RS) Expert:**
  At least master's degree in any of the disciplines (River Engineering expert/geotechnical expert/natural resource environmental manager/socio-economist) with 1 academic course on RS or 3 months training on RS with 5 years relevant experience.

- **Geographic Information System (GIS) Expert:**
  At least master's degree in any of the disciplines river engineering expert/geotechnical expert/natural resource/environmental manager/socio-economist) with 1 academic course on GIS or 3 months training on GIS with 5 years relevant experience.

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SECTION 6: WATER MANAGEMENT STUDY

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6.1. WALKTHROUGH SURVEY

6.1.1. FIELD WORK

i- Human Resources required:

Engineer (Er.)	1
Sub. Engineer (SE)	1
Assistant/Labor	3
WUA member	2

ii- Performance criteria:

All projects (Hill/Terai)	6 km/day

6.1.2. OFFICE WORK

i- Human Resources required:

Engineer	1
Sub. Engineer (SE)	1
Assistant	1

ii- Performance criteria:

Small/Medium Projects	5 days
For Large/Mega Projects	7 days

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6.2. PREPARATION OF PARCELLARY MAP

6.2.1. FIELD WORK

6.2.1.1.1. CADASTRAL MAP COLLECTION

i- Human Resources required:

Sub. Engineer(SE)/Amin	1

ii- Performance criteria:

All Projects (Hill/Terai)	2-days

6.2.1.1.2. Field Verification

i- Human Resources required:

Sub. Engineer(SE)/Amin	1
Association Organizer	1
WUA member/Farmer	2 (One from Main committee and one from respective lower order canals)

ii- Performance criteria:

Command area <= 5000 ha (Terai)	60 ha/day
Command area > 5000 ha (Terai)	120 ha/day
All Projects (Hill)	60 ha/day

6.2.2. OFFICE WORKS (MAP PREPARATION)

6.2.2.1. COMPILATION OF CADASTRAL MAP OVERLAPPING & DETAILING

i- Human Resources required:

Engineer(Er.)	1
GIS Expert	1
Assistant	1

ii- Performance criteria:

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All Projects (Hill/Terai), if digital map is not available	500 ha/day

6.2.2.1.1. *MAP PREPARATION*

i- Human Resources required:

Engineer (Er.)/GIS Expert	1
Sub. Engineer (SE)	1
Assistant	1

ii- Performance criteria:

All Projects (Hill/Terai)	500ha/day

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Government of Nepal Ministry of Energy Water Resources and Irrigation 2074

6.3. CALIBRATION WORKS FOR IRRIGATION CANALS

FOR CANAL WITH FOLLOWING DISCHARGE

6.3.1. FIELD WORK

i- Human Resources required

Hydrologist/ Engineer	1
Sub. Engineer (SE)	1
Labour	6

ii- Tools required(days) : As Per Performance Criteria

Cut-Throat Flume/Current meter/Acoustic Doppler Current Profiler	1
Measuring Tape	1
Stopwatch	1
Gauge Scale	1

iii- Performance criteria:

Discharge on the Canal (cumecs)	No. of Locations/day
<1	4
1-5	3
>5	0.5

Note: No. of Structures will be counted according to number of Gate opening at respective locations.

6.3.2. OFFICE WORK

i- Human Resources required:

Engineer/ Hydrologist	1
ii- p Sub. Engineer (SE)	1
c Assistant	1

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Government of Nepal
Ministry of Energy
Water Resources and Irrigation
2074

ii- Performance criteria:

Discharge on the Canal (cumecs)	No. of Structures/day
0-1	4
1-5	3
>5	1

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6.4. WATER MEASUREMENT WORKS

6.4.1. FIELD WORK

i- Human Resources required:

Engineer	1
Sub. Engineer (SE)	1
Labour	2

ii- Performance criteria:

All Projects (Hill/Terai)	4 locations/day

6.4.2. OFFICE WORK

i- Human Resources required:

Engineer	1
Sub. Engineer (SE)	1
Assistant	1

ii- Performance criteria:

All Projects (Hill/Terai)	4 locations/day

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6.5.CALIBRATION WORKS FOR IRRIGATION STRUCTURES

6.5.1. FIELD WORK

i- Human Resources required:

Hydrologist/ Engineer	1
Sub. Engineer (SE)	1
Labour	6

ii- Tools required(days):

Cut-Throat Flume/Current meter/Acoustic Doppler Current Profiler	1
Measuring Tape	1
Stopwatch	1
Gauge Scale	1

iii-

iii. Performance criteria:

Discharge on the Canal (cumecs)	No. of Structures/day
<1	2
1-5	1
>5	0.5

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Note: No. of Structures will be counted according to number of Gate opening at respective locations.

6.5.2. OFFICE WORK

i- Human Resources required:

Engineer/ Hydrologist	1
Sub. Engineer (SE)	1
Assistant	1

ii- Performance criteria:

Discharge on the Canal (cumecs)	No. of Structures/day
0-1	1
1-5	1
>5	1

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6.6. ASSETS MANAGEMENT PLAN

6.6.1. ASSETS INVENTORY PREPARATION

6.6.1.1. FIELD WORK

6.6.1.1.1. Irrigation System/Infrastructure Inventory:

i- Human Resources required:

Engineer	1
Sub. Engineer (SE)	1
Labour	4

ii- Performance criteria:

iii-

All Projects (Hill/Terai)	3 km/ day

6.6.1.1.2. Others Assets Inventory (Canal Land, Office Building, Quarters, Vehicles and Equipments)

i- Human Resources required:

Engineer	1
Sub. Engineer (SE)/AO	1
Labour	2

ii- Performance criteria:

All Projects (Hill/Terai) Small/Minor Projects	2 days
All Projects (Hill/Terai) Large/Major Projects	5 days

6.6.1.2.OFFICE WORK

i- Human Resources required:

Water Resources/ Irrigation Er.	1
GIS Expert	1

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Sub Engineer/Auto Cad Expert	1
Assistant	1

ii- Human Resources Performance criteria:

For A.1.1 Irrigation System/ Infrastructure Inventory

All Projects (Hill/Terai) Small/Minor Projects	7 days
All Projects (Hill/Terai) Large/Major Projects	15 days

For A.1.2 Others Assets Inventory (Canal Land, Office Building, Quarters, Vehicles and Equipments)

Small/Medium (Hill/Terai)	5 days
Large/Mega (Hill/Terai)	10 days

6.6.2. CANAL MAINTENANCE PLAN PREPARATION

6.6.2.1.OFFICE WORK

i- Human Resources required:

Water Resources/ Irr. Er.	1
Sub Engineer	1
Assistant	1

ii- Human Resources Performance criteria:

Small/Medium (Hill/Terai)	7 days
Large/Mega (Hill/Terai)	15 days

Note: Survey, Design, estimation of Canal Maintenance Works should be done before Canal Maintenance Plan preparation. These works are not included in this part. It should be done according to detail design estimate of Details Study part.

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6.6.3. *ASSETS MANAGEMENT PLAN PREPARATION*

6.6.3.1. FIELD WORK

6.6.3.1.1. Asset Inventory Survey

Same as in Asset Inventory Survey in Section 6.2A

6.6.3.1.2. Agricultural Survey

Same as in Detail Feasibility Study

6.6.3.1.3. Socio-economic Survey

i- Human Resources required:

Sociologist	1
Economist	1
Assistant	1
Labour	2

ii- Performance criteria:

All Projects (Hill/Terai)	500 ha/day

6.6.3.2. OFFICE WORK

6.6.3.2.1. Data Analysis and Report Preparation

i- Human Resources required:

Irrigation Engineer	1
Agronomist	1
Sociologist	1
Economist	1
Sub. Engineer (SE)	1
Assistant	4

ii- Performance criteria:

Small/Medium (Hill/Terai)	15 days
Large/Major (Hill/Terai)	21 days

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6.7. PREPARATION OF CANAL OPERATION PLAN (COP)

6.7.1. FIELD WORK

6.7.1.1. HYDROLOGICAL ASSESSMENT

Same as in Detail Feasibility Study

6.7.1.2. AGRICULTURAL SURVEY

Same as in Detail Feasibility Study

6.7.1.3. PREAPARTION WATER BALANCE (SUPPLY AND DEMAND SIDE)

6.7.1.4. WATER DISTRIBUTION SCHEDULE

i- Human Resources required:

Irrigation Engineer	1
Agronomist	1
Sub. Engineer (SE)	1
Assistant/Labour	1

ii- Performance criteria:

CA up to 1000 ha of an Irrigation System (IS)	7 days

Note: Add 1 day for each additional 1000 ha of CA.

6.7.2. OFFICE WORK

6.7.2.1. DESK WORK

6.7.2.1.1. Data Collection and Compilation

i. Human Resources required:

Engineer	1
Sub-Engineer	1
Office assistant	1

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Performance criteria:

Minor	5 days
Major	7 days

Notes: Project Type	Hills	Terai
I Minor	Width < =5 m	Width < =10 m
	Area < = 3 Ha	Area < = 5 Ha
II Major	Width > 5 m	Width > 10 m
	Area > 3 Ha	Area > 5 Ha

6.7.2.1.2. HYDROLOGICAL ASSESSMENT

Same as in Detail Feasibility Study

6.7.2.1.3. AGRICULTURAL SURVEY

Same as in Detail Feasibility Study

6.7.2.2.REPORT PREPARATION (CROP/WATER SCHEDULING)

i. Human Resources required:

Engineer	1
Sub-Engineer	1
Office assistant	1

ii. Performance criteria:

Minor	20 days
Major	25 days

Notes: Project Type	Hills	Terai
I Minor	C.A. < =100 Ha	C.A. < =500 Ha
II Major	C.A. >100 Ha	C.A. >500 Ha

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6.8. PERFORMANCE ASSESSMENT OF IRRIGATION SYSTEM

6.8.1. FIELD WORK

Assessment of Service delivery in service provider point of view and service recipient's point of view. Achievements with respect to project target.

i- Human Resources required:

Irrigation Engineer Expert	1
Sub-Engineer (SE)	1
Economist	1
Labour	3

ii- Performance criteria:

All Projects (Hill/Terai) ≤ 5000 ha	10 days

Note: Add 1 day for each additional 1000 ha.

6.8.2. OFFICE WORK

i- H

Irrigation Engineer Expert	1
Engineer (SE)	1
Economist	1
Assistant	1

Resources required:

ii- Performance criteria:

All Projects (Hill/Terai) ≤ 5000 ha	7 days

Note: Add 1 day for each additional 1000 ha.

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6.9. BENCHMARKING OF IRRIGATION SYSTEM

Bench Marking can be done in selected representative sub systems of an irrigation project and that can be projected to obtain the idea of the whole project under consideration.

6.9.1. IDENTIFICATION AND PLANNING

i- Human Resources required:

Team Leader/ Irrigation Expert	1
Irrigation Engineer	1
Sociologist	1
Economist	1
Agriculturist	1

ii- Performance criteria:

All projects	2 days

6.9.2. DATA COLLECTION (FIELD WORK)

i- Human Resources required:

Team Leader/ Irrigation Expert	1
Irrigation Engineer	1
Socio-economist	1
Agriculturist	1
Sub Engineer/Association Organizer	2

ii- Performance criteria:

Canal system/s covering 100 ha irrigated command area	1 day

6.9.3. DATA PROCESSING AND ANALYSIS

i- Human Resources required

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Team Leader/Irrigation Expert	1
Irrigation Engineer	1
Sociologist	1
Economist	1
Agriculturist	1
Statistician	1

ii- Performance Criteria

Canal system/s covering 200 ha irrigated command area	200 ha/ day

6.9.4. REPORT PREPARATION

i- Human Resources required:

Team Leader/Irrigation Expert	1
Irrigation Engineer	2
Sociologist	1
Economist	1
Agriculturist	1

ii- Performance criteria:

Canal system/s covering 400 ha irrigated command area	1 day

1. ASSISTANCE TO CLIENT FOR ACTION (Part II)

i- Human Resources required:

Team Leader/ Irrigation Expert	1
Irrigation Engineer	1
Statistician	1
Computer operator	1

ii- Performance criteria:

All Projects	2 days

6.10. CROP CUT SURVEY

6.10.1. FIELD WORK

i. Human Resources required:

Manpower	Paddy	Wheat	Maize	Sugarcane	Vegetable
Team Leader (S. Sociologist)/Engineer	1	1	1	1	1
Sociologist	1		1	1	1
Senior Association Organizer	1	1	1	1	1
Data Collector	2		2	2	2
Labour (Crop cutting, threshing & Cleaning)	5	5	6	6	6
Labour (Crop Coverage Area Survey)	2		1	1	1

ii. Tools required(days):

Weighing Balance	As per requirement
Stationary (Measuring Tape, White Paper, Pen etc.)	As per requirement
Rope	As per requirement
Plastic Bags, Sickles etc.	As per requirement

iii. Performance Criteria:

One group (1 Team leader + 2 General Labour)	Five crop cut sample per day/group
For Crop Area Survey (1 General Labour)	(1000 ha/day/200 ha/day) for Paddy in Terai/Hill
	(500 ha/day/100 ha/day) for Wheat in Terai/Hill
	(250 ha/day/100 ha/day) for Maize in Terai/Hill
No. of Crop cut sample (Terai /Hill)	As per cropcut guideline

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6.11. MISCELLANEOUS

A. Transportation

Travel Expenses for the departmental employee shall be provided as per GON Rules. Above that extra amount NRs. 1 x district rate for labour per day x input of Engineer/Sub-Engineer shall be provided for accommodation, the carrying baggage & other equipment required for survey. If the assignment is to be performed through the consultant, estimate for travel expenses shall be made based on means of transportation, market rate of transportation means, and days required for travelling (to reach the field (work site) and return back).

B. Office Space, Office Equipment and Field Equipment and consumables

Field equipment & consumables (GPS, Current meter, note book etc) and Office equipment and consumables (Computer, Scanner, Photocopy, Printer, Plotter, Toner, Cartridge, Binder, Stationary etc)	15% of Total Cost of Human Resources (Field and Office)

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SAMPLE TERMS OF REFERENCES

1. Sample ToR for Parcellary Map

Rationale:

The crop yield for a given cropping season is affected by the actual service area of the irrigation system and thus, a very important economic data requiring acceptable level of precision and accuracy. The actual service area planted and harvested are essential data needed in the efficient planning and delivery of agricultural services to farmers.

Following procedures is formulated to set a uniformity by which the actual service area of irrigation projects are determined. It also identifies the concerned agencies that will perform the activities pertaining to the determination, reporting and updating of data on service area.

Procedure in Parcellary Mapping of the Actual Service Area

1. The boundaries or areal extent of the service area as well as the individual landholding of farmer beneficiary shall be determined through parcellary mapping with the use of global positioning system (GPS) or surveying instrument.

2. If the parcellary mapping will be conducted using a GPS or GPS enabled device, the following shall be observed:
   - Initialize the GPS/GPS enabled device and ensure that it has acquired cadastral map and got a fixed position;
   - Initialize the device outdoor in a location that has an unobstructed view of the sky;
   - After successful initialization of the GPS, set the device to map view;
   - Choose a starting point along the boundary of the farm and let the farm owner or his/her representative occupy that point;
   - Set the GPS/mobile phone to start recording the track and let the farmer or his/her representative traverse the boundary of the service area. The starting point will also be the end point of the traverse.
   - After finishing the traverse, ensure that the track has been recorded, labeled and saved in the GPS.

3. On the other hand, if the parcellary mapping will be conducted using a surveying instrument, the following shall be observed:

   - Assign the farm owner or his/her representative as the rodman/prism man. Train the farm owner or his/her representative on how to properly use the levelling rod during a survey;
   - Establish a benchmark that will serve as a reference for the succeeding stations or points;
   - Let the farm owner or his/her representative occupy the corner or inflection points on the boundary of the service area;
   - Obtain the reading of the levelling rod at the points occupied by the farmer or his/her

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representative on the boundary of the service area.

- End the traverse by asking the farmer or his/her representative to occupy the starting point. Obtain the reading of the levelling rod.
- Ensure that all data have been recorded or saved.

4. Please note to include the tracks of the headworks/dam, main and lateral canals and other structures

5. Plot the boundaries of parcel per landowner using the track obtained from the GPS or points from the surveying instrument in cadastral map. If digital cadastral map is not available, for further verification and editing, the tracks can be imported to Google Earth in *.kml* file format.

6. Calculate the area of each parcel (Closed polygon) of individual farmer.

7. The edited digital map or the edited *.kml* file will be imported to CAD Earth Software to facilitate downloading/plotting of the individual parcel following the format to be provided by the office.

8. The Parcellary map shall contain the following information:
   - The name and location of the project
   - Location of the headworks/dam relative to the service area;
   - Location and type of the main and lateral canals;
   - Area of individual parcels (hectares);
   - Name of landowner or tenant per parcel;
   - The date/season the Parcellary mapping was conducted;
   - The orientation (northing) and the scale of the parcellary map; and
   - The legend of the map.

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2. Sample ToR for Calibration of Structures:

Objectives of Work

The overall objective of this study is to evaluate the hydraulic performance of the flow control structures.

The specific objectives of the study are as follows:

- To measure the discharge through canal structures such as H/R , C/R, drop structures etc at different strategic locations at different depth of flow and gate openings (if gated);
- To prepare calibration chart of water delivery through above mentioned flow control structures of canals under consideration.

Scope of Work

- To review the reports and drawings of the control structures as built in;
- To identify the locations of measuring structures (points) in canals;
- To measure the discharge at minimum four different depths of flow at each location;
- To prepare the calibration chart for different flow conditions, gate openings (if gated) and degree of submergence (if submerged flow).

Methodology and Approach

A. Discharge Measurement

Measurement of Discharge Measurement works shall be carried out by following standard practices adopted in hydrology and the DHM.

Area-Velocity Method using appropriate current meter shall be used to measure the velocity at a point on a selected vertical of a cross section, selected vertical section shall be downstream of the control structure where flow is uniform and the canal section is in proper shape as per design (deposit free bed and side) as far as possible.

Following procedures shall be adopted for discharge measurement:

- Divide the measuring section into required verticals of equal width such that
- Each vertical will not pass more than 10% of total discharge.
- The difference of velocities in the adjacent segments shall not be more than 20%.
- Measure the distance from the initial point and the water depth for each vertical
- Measure the velocity using three-point method at 0.8 depth (V0.8d), 0.4 depth (V0.4d) and 0.2 depth (V0.2d) or using two-point method at 0.8 depth (V0.8d), and 0.2 depth (V0.2d) depending upon the water depth and discharge of the canal in each vertical.
- Measure the velocity, at 0.6 depth (V0.6d) near the bank where the depth is shallow.
- Compute velocity using the current meter-rating table provided by the manufacturer. Continue for all the partial sections.
- Compute the partial discharge for all partial sections using appropriate equation.
- Compute the total discharge.
- Record the data observed, i.e. discharge, head over the crest at control structure, gate openings (if any), the difference between upstream and downstream water level (head loss)

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in case of submergence.

- Repeat the process for different head over the crest, different gate openings (if any) and different head loss (if the flow is submerged) till the sufficient data are obtained for calibration development.

B. Development of Calibration Charts and Equations.

Rating Curve (Stage Discharge Relation or Calibration of the station)

Measured discharges shall be plotted against concurrent stages, different gate openings (if gated) and different head loss (if submergence occurred) on graph paper to define the rating curve. The stage discharge relation at control station is defined by the complex interaction of the channel characteristics including cross-sectional areas, shape, slope and roughness. The combination of these effects is called control. A control is said to be permanent control if the stage discharge relationship which is defined does not change with time. If there are discharge measurements covering the entire range of stage experienced during a period of time, there will not be any problem in defining the stage-discharge relation. On the other hand, if the discharge measurements are lacking to define the upper end of the rating, the defined lower part of the rating curve must be extrapolated to the highest stage experienced. Such extrapolations are always subject to error, but the error may be reduced if the analyst has knowledge of the principles that govern the shape of the rating curves. Stage-discharge relations are usually developed from a graphical analysis of the discharge measurements plotted on either rectangular co-ordinate or logarithmic plotting paper.

In a preliminary step, the discharge measurements available for analysis shall be tabulated and summarized on a form by numbering consecutively in chronological order. Discharge shall then be plotted as the abscissa, corresponding gauge height that shall be plotted as the ordinate for different gate openings (if gated) and different head loss (if submerged), and a curve or line is fitted to the plotted points. The use of logarithmic plotting paper shall be preferred for graphical analysis of the rating because in the usual situation of compound controls, changes in the slope of the logarithmically plotted rating identify the range in stage for which the individual controls are effective. Furthermore, the portion of the rating curve that is applicable to any particular control may be linearized for rational extrapolation or interpolation.

Now thus plotted rating curve shall be fitted into the appropriate/standard equation as per the case (Free flow, Submerged flow, Gated flow etc) to obtained constant values/ co-efficients. The process shall be repeated for different gate openings (if gated) and different head loss (if submerged).

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3. Sample ToR for Asset Management Plan:

Asset Management Plan Generally, Asset Management Plan (AMP) has its origin in finance and business sector and is now applied to the irrigation drainage sector. Traditionally, the investment made in irrigation and drainage infrastructure by the government was focused primarily on the cost planning and construction the infrastructure with little attention to the consumption of assets during their economic life. However, the management of infrastructure comprises several other types of events including maintenance, rehabilitation (replacement), modernization or implementation of the new technology, retirement and disposal of assets. All these events have specific costs, which form part of the overall cost of providing a sustainable service.

"The AMP can be defined as a process for planning investment in infrastructure in a sustainable manner, to provide users with a reliable and affordable service."

Objective

The objective is to develop Canal Asset Management Plan (CAMP) for the Canal Network under consideration. This is a decision support tool for Canal System envisaged to be developed with the objective of :

- Monitoring of water flow to be released from canal as per the demand assessed for irrigation in the command area
- Finding, identifying and maintaining the infrastructure asset
- Updating and distributing information mapped
- Recording & retrieving maintenance information of the system
- Identifying &issuing notification for future maintenance needs.

The CAMP will support irrigation management functions such as:

- maintenance and strengthening of existing canal;
- generation of alerts for anticipated irrigation related hazards;
- planning of new control structures and irrigation management works;
- development of community participation for canal surveillance for discharge of water as per demand in the canal system;
- Assessment of irrigated land in the command area and updating canal safety information in the CAMP.

The information database in CAMP will also help in collection of revenue from the farmers on the basis of irrigated land.

In future CAMP will be integrated and provide all the relevant information needed on Canal System under consideration for efficient irrigation monitoring through canal operation and maintenance. It will support development of a Canal Safety Programme by periodically monitoring physical status of canal. It will integrate operational use of past and current canal data whenever required. It will assist identifying vulnerable reaches from hydraulic and structural aspects and store relevant data for subsequent detailed design at field level.

Scope of the Consulting Services

The expected output from the consulting services will be as follows:

- Preparation of the detail status of the assets of canal network, structures, equipment, building and others its physical conditions, operational status and needs to rehabilitate for its functionality;
- Supply of essential data to create integrated data base in future for all the relevant

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information;

- Defining the valuation of the assets and the liabilities like operation and maintenance cost light rehabilitation and mainly differed maintenance and replacement requirements;
- Review of the project and WUA organizational setup, functions, procedures including human and financial status;
- Preparation of financial management plan of the canal under consideration;
- Analysis on the potential irrigation service fee collection and other funding resources available for the operation and maintenance of the system;
- Assess the operation and maintenance cost for essential structures and WUA office management cost, deferred maintenance cost for DWRI with actual requirements, feasible irrigation service fee for the cost recovery;
- Preparation of essential structures implementation action plan for implementation of the construction activities showing involvement of WUA and agency for different time frame.
-

Methodology

- Review of Current Practices, Data Availability & User Need Survey
  - Study of International practices and review of current practices used for maintaining database of main canal & assets and identify possible approach for integration in CAMP
  - Review current practices of canal operation & maintenance and recommend appropriate approach for integration in CAMP. The consultant will review samples of various field reports and suggest modalities for integration in CAMP.
  - Prepare inventory of existing and expected future data of canal & assets to design the database (in future).
  - Conduct "User Need" survey to define functional requirement of Canal Asset Management Plan.

Data for Database, Management Functional Modules and Integration in CAMP

Database:
To create database (in future) the indicative list of spatial and non-spatial data to be collected from respective field offices, other departments and field visit are:

a) Administrative Data:

- Name of the irrigation system under consideration,
- Section wise Start and end point of Canal,
- Name of Canals and its origin at Parent Canal
- Name of the village, VDC.
- Name and location of offices under whom the different Canals System is maintained.
- Location and inventory of stores and mechanical divisions.

b) Engineering Data:

- Cross Section of the Canals at different locations,

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- Longitudinal Section of the Canals,
- Bed Level, Full Supply Level (FSL), and Freeboard etc.
- Structural Information – Structures existing along canals, such as
  - aqueducts, syphon, head regulator, gates, cross regulator and bridges etc. and their condition,
  - Current physical status of canal and structures
  - Maintenance history – Past and current data on inspection, certification and maintenance of all works on or along the canal
  - Breach/cut history – for last ten years
  - Inspection report generated at offices

c) Spatial Data:

- Location and alignment of all the canals, structures etc.
- Canals with road-crossings, details of junctions
- Photographs of vulnerable locations taken at different time.

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4. Sample ToR for Bench Marking of Irrigation Projects:

Definition:

Benchmarking can be defined as "A systematic process for securing continual improvement through comparison with relevant and achievable internal or external norms and standards".

The overall aim of benchmarking of irrigation system is to improve the performance of the system as measured against its mission and objectives. Benchmarking is about change, moving from one position to a better position.

Irrigation and drainage are essentially services to irrigated agriculture – providing and removing water to suit the crops' needs. Thus in the irrigation and drainage sector we are interested in improving the level of service provision to water users, thereby enabling them to maintain or increase levels of agricultural production. That's why this benchmarking works has been initiated.

In approaching benchmarking for the irrigation and drainage sector there are three characteristics that need to be borne in mind:

- Irrigation and drainage service providers operate in a natural monopoly environment
- Irrigation and drainage entails complex and interacting physical, social, economic, political, technical and environmental processes
- Performance of irrigation and drainage schemes is site specific.

What should be benchmarked?

The scope of the benchmarking activity is determined by the objectives and scale pursued in finding "best management practices". In any system, such as an irrigation network, there are:

- Inputs
- Processes
- Outputs, and
- Impacts

There are a variety of irrigation domains (or systems). Main three domains that are of primary interest are:

- Service delivery: This domain includes two areas of service provision: (a) the adequacy with which the organization manages the operation of the irrigation delivery system to satisfy the water required by users (system operation), and (b) the efficiency with which the organization uses resources to provide this service (financial performance).
- Productive efficiency: Measures the efficiency with which irrigated agriculture uses water resources in the production of crops.
- Environmental performance: Measures the impacts of irrigated agriculture on land and water resources.

SCOPE OF THE WORKS

Following tasks shall be carried out by the consultant/s:

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1. Carry out full works under part I (Finding out) as mentioned below:
2. Stage 1 Identification and Planning
3. Stage 2 Data Collection
4. Stage 3 Analysis
5. Conclusion and Recommendation

2. Consultant/s shall assist to the client to carry out works under part II (Taking Action) as mentioned below:

6. Stage 4 Integration
7. Stage 5 Taking Action (to formulate action plan)
8. Stage 6 Monitoring and Evaluation (to formulate M & E plan and its indicators)

BENCHMARKING PROCESS

The process of benchmarking has six stages, namely, identification and planning; data collection; analysis; integration; action; and monitoring and evaluation. These six ~~stages can~~ be divided into two parts – Part - I Finding Out and Part II – Taking Action.

Part I – Finding out

Stage 1 Identification and planning

In Stage 1 the following are decided:

- The purpose, drivers and desired outputs of the benchmarking process ·
- The "customers" – both within and outside the organization ·
- What areas of the organization's activities are to be benchmarked ·
- Against whom or what performance is to be benchmarked ·
- Indicators of performance

The planning phase, like that of many other processes, is one that will to a large extent determine the success of the benchmarking activity. The extent and specifications of data needed for benchmarking is defined at this stage. Consistency in the definition of the performance indicators used for benchmarking is of critical importance to ensure that all the data collected are comparable. To facilitate integration and action following the analysis phase it is important to involve key players in the benchmarking process at the outset. This reduces the resistance to change and makes use of the expertise at a variety of levels within the organization to facilitate change.

Stage 2 Data collection

The core of any benchmarking exercise is data collection. In order to enable comparison between irrigation and drainage schemes data used for benchmarking needs to be consistent and comparable. This is a crucial aspect that requires adequate provisions during the identification and planning phase of the programme. There are three types of data collection:

1. Data collected for day-to-day management, operation and maintenance of the irrigation and drainage systems

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2. Data collected for benchmarking and comparison with other systems.
3. Data collected as part of the diagnostic process within the benchmarking exercise to identify causes of performance.

This section is primarily concerned with the data collection for the benchmarking activity. However, it must be recognized that data collected for the day-today operation of the system play a critical role in achieving high performance of service delivery and in helping to interpret the outcomes of the benchmarking comparison. A key issue within the irrigation and drainage sector is the uniqueness of each irrigation and drainage scheme. There are many variables that influence the performance of irrigation and drainage schemes, making comparative performance difficult.

To be able to group similar types of system for benchmarking purposes it is necessary to collect background descriptive data on each scheme, including information of the drainage system separately. This information includes information such as the location, climate, water source, type of crops grown, irrigated area, average farm size, irrigation method, type of management, type of drainage. Details of the data requirements describing the irrigation and drainage schemes are given below:

Code	Descriptor	Possible options
	Location	
D1	Country	
D2	Continent	
D3	Scheme name	
D4	Latitude	
D5	Longitude	
	Climate and soils	
D6	Climate (*select one option)*	• Arid • Semi-arid • Humid • Humid tropics
D7	Average annual rainfall (mm)	
D8	Average annual reference crop potential evapotranspiration, Eto (mm)	
D9	Peak daily reference crop potential evapotranspiration, Eto (mm/day)	
D10	Predominant soil type(s) and percentage of total area of each type (*select one option)*	• Clay • Clay loam • Loam • Silty clay loam • Sand
	Institutional	
D11	Year first operational	

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D12	Type of management (*Select one option)*	• Government agency • Private company • Joint government/local organization/private • Water Users Association/Federation of WUAs
D13	Agency functions (*Select one option)*	• Irrigation and drainage service • Water resources management • Reservoir management • Flood control • Domestic water supply • Fisheries • Other
D14	Type of revenue collection (*Select one option)*	• Tax on irrigated area • Charge on crop type and area • Charge on volume of water delivered charge per irrigation
D15	Land ownership *(select one option)*	• Government • Private
Socio-economic		
D16	(National) Gross Domestic Product (GDP)	
D17	Farming system (*select one option)*	• Cash crop • Subsistence cropping • Mixed cash/subsistence
D18	Marketing (*Select one option)*	• Government marketing board • Private traders • Local market • Regional/national market
D19	Pricing (*Select one option)*	• Government controlled prices • Local market prices • International prices
Water source and availability		
D20	Water source (*select one option)*	• Storage on river • Groundwater • Run-of-the river • Conjunctive use of surface and groundwater
D21	Water availability (*Select one option)*	• Abundant • Sufficient • Water scarcity
D22	Number and duration of irrigation season(s)	Number of seasons Number of months per season: • Season 1: • Season 2: • Season 3:

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Code	Descriptor	Possible options
	Size	
D23	Commanded (irrigation) area (ha)	
D24	Total number of water users supplied	
D25	Average farm size (ha)	
D26	Average annual irrigated area (ha)	
D27	Average annual cropping intensity (%)	
	Infrastructure – Irrigation	
D28	Method of water abstraction (*Select one option)*	· Pumped diversion · Gravity diversion · Groundwater
D29	Water delivery infrastructure (length and %)	· Open channel · Pipelines · Lined · Unlined
D30	Type and location of water control equipment (*Selectone option)*	Type: · None · Fixed proportional division · Gated - manual operation · Gated - automatic local control · Gated – automatic central control Location: · Control structure at main intake only · Control structures at primary and secondary level · Control structures at primary, secondary and tertiary level.
D31	Discharge measurement facilities location and type(*Select one option)*	Location: · None · Primary canal level · Secondary canal level · Tertiary canal level · Field level Type: · Flow meter · Fixed weir or flume · Calibrated sections · Calibrated gates
	Infrastructure – Drainage	
D32	Area service by surface drains (ha)	

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D33	Type of surface drain (*Select one option)*	· Constructed · Natural
D34	Length of surface drain (km)	· Natural · Constructed · Open · Closed
D35	Area serviced by sub-surface drainage (ha)	
D36	Number of groundwater level measurement sites	
Water allocation and distribution		
D37	Type of water distribution (*Select one option)*	· On-demand · Arranged-demand · Supply orientated
D38	Frequency of irrigation scheduling at main canal level *(Select one option)*	· Daily · Weekly · Twice monthly · Monthly · Seasonally · None
D39	Predominant on-farm irrigation practice (*Select one option)*	· Surface – furrow, basin, border, flood, furrow-in-basin; · Overhead – raingun, lateral move, centre pivot · Drip/trickle · Sub-surface
Cropping		
D40	Main crops each season with percentages of total command area	· Crop 1: · Crop 2: · Crop 3: · Crop 4: · Crop 5:

Stage 3 Analysis

The analysis stage identifies the performance gap between the organization and the organization(s), norms or standards with which the organization is compared. From the analysis comes the understanding of: the performance gap. The causes of the performance gap · Actions required to close the performance gap. Thus benchmarking is not just a comparative performance assessment exercise, it also incorporates diagnostic analysis that is finding out about the causes of identified levels of performance. Once the causes are understood then solutions can be identified and action taken to apply the solutions. It is at this stage that the desired performance targets are formulated. The final target values are established during the integration stage when the feasibility of achieving these values are discussed and agreed with key stakeholders. It is important to note that these stakeholders will include all those affected by irrigated agriculture within the area, including farmers, villagers, fishers, urban dwellers, etc.

Performance indicators used in irrigation and drainage systems shall be used and can be had from "GUIDELINES FOR BENCHMARKING PERFORMANCE IN THE IRRIGATION AND DRAINAGE SECTOR "published by IPTRID Secretariat, Food and Agriculture Organization of the United Nations, Rome, 2001. Similarly, Formulation details for each benchmarking indicator are provided in Appendix A1 of the above mentioned document.

DATA CAPTURE

To ensure consistency in the comparison of results, organizations joining the benchmarking programme will need to collect the data required for the calculation of the benchmarking indicators according to the specifications and protocols provided in Appendix A2 of the above mentioned document.

Partner organizations will carry out the primary data processing to convert raw data into the format required for input into the benchmarking spreadsheet. This task must be carried out according to the instruction provided.

The spreadsheet workbook provided to benchmarking partners consists of six worksheets containing data in the following categories;

- Summary of benchmarking indicators
- System descriptors
- Irrigation service delivery
- Financial performance
- Productive efficiency
- Environmental performance

Indicator values in the summary worksheet are calculated automatically after the basic data are entered into the appropriate worksheet without user intervention.

Appendix A2 of the above mentioned document provides for each indicator the definition, measurement specification, processing needs and an example of the data entry spreadsheet.

Two types of indicators shall be considered according to the type of data required:

a. Indicators based on primary data

b.SECIndicators based on secondary data

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Some indicators are based on primary data that the organization must collect either as a normal part of its operation or for the specific purpose of benchmarking. Variables such as inflow volumes, revenues collected from water users, and total operation expenditure fall into this category.

Some other indicators rely on the use of secondary data for their calculation. For example, the calculation of evapotranspiration (Etc) relies on climatic data for the location of the irrigation scheme that must be provided in the format specified by the methodology for calculating Etc. This type of data may be collected either by the partner organization itself or an external organization. Wherever data are procured from an external organization special attention must be paid to the data processing methodology. This is particularly important when data auditing is necessary to trace possible calculation errors.

DATA PROCESSING AND ANALYSIS

Partner benchmarking analysis

Much of the data analysis involves compiling ratios of the data collected to produce the value of the required performance indicator. This task will be performed by the spreadsheet template provided. Partner organizations will be responsible for processing the raw data collected in conformance with the protocols outlined in Appendix A2 of the above mentioned document. It is recognized that past data collected by partner organizations may have been collected in a variety of formats that may not necessarily comply with these specifications. In such cases, special attention shall be paid to ensure that data are processed in a comparable manner.

Partner internal analysis

Data analysis by using statistical methods to analyse internal trends shall be adopted. This type of analysis may be especially useful in trying to explain causative factors of low performance. This might be the case, for example, with data on Delivery Performance Ratios (DPR) taken at tertiary off take points throughout the irrigation network, where the weekly average DPR values might be statistically analysed to obtain seasonal trends or variability (coefficient of variation). This analysis can be of considerable (internal) value to the partner organization.

COMPARATIVE ANALYSIS

The essence of the benchmarking process is to provide organizations with the ability to compare their performance in relation to similar organizations or similar processes. The comparative analysis will consist primarily of ranking performance levels for individual indicators both numerically and graphically. Table 3 and Figures 4, 5, 6, and 7 of the above said document provide an example of comparative analysis carried out by the Australian benchmarking programme. A similar type of analysis will be carried out in this programme.

The main desired outputs of this service are partner benchmarking analysis, partner internal analysis and comparative analysis and recommendation to the organisation for taking action.

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Part II – Taking action

Stage 4 Integration

The action plan developed from the analysis phase must be integrated into the operational processes and procedures of the organization in order to bring about the desired change. It is crucial that those responsible for benchmarking have the power within the organization to bring about change. Benchmarking programmes often fail at this stage, leaving those involved disillusioned with the process, and with the performance of the organization. The process of gaining adoption of the new processes and procedures is often termed "internal marketing", and leads to the development of a sense of ownership and support by key personnel for the benchmarking process. Training is a key element of this process.

Stage 5 Action

Once acceptance of the new processes and procedures has been gained, they can be put into place to bring about the desired change.

Stage 6 Monitoring and evaluation

Monitoring and evaluation of the process is required to ensure that desired targets are being achieved, and that corrective action, where necessary, is taken in time. The success of benchmarking is marked by the continuing measurement of the organization's performance against the target norms and standards established during the analysis and integration stages. These targets are, however, changing over time, and continual updating and revision of the targets is necessary to maintain best practices and relative performance.

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SECTION 7: VIDEOGRAPHY

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Making Video / Documentary on Irrigation System Construction or Irrigation System Operation or Workshop or Training etc

Making Video / Documentary on Irrigation System Construction or Irrigation System Operation or Workshop or Training etc involving 3 days field (Pre-production) works except travelling duration all complete as per the direction of Office / Project Chief.

1. *Pre-Production Works*

i- Resources required:

1	**Direction Works including Study, Research, and Conceptualization etc all complete.**	**1 Job**	Highly skilled (Director)	m-day	7				
2	**Videography Works**	**1 Job**	Highly Skilled (Camera person)	m-day	5	Camera	m-day	5	
			Highly skilled (Drone Operator)	m-day	3	Drone Camera	m-day	3	If Drone shoot required
			Skilled (Light Operator)	m-day	3	Light	m-day	3	
						Microphone	m-day	5	

2. Production Works

1	**Script writing**	**1 Job**	Cost of Script writing all complete = 13% of Pre-production Cost in (A)		
2	**Voice Over**	**1 Job**	Cost of Voice over all complete = 2% of Pre-production Cost in (A)		
3	**Studio for Voice over**	**1 Job**	Cost of Studio for voice over all complete = 1% of Pre-production Cost in (A)		
4	**Visual (Video) Editing Works**	**1 Job**	Highly Skilled (Editor)	m-day	3.9

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5	**Graphic design (if required)**	**1 Job**	Cost of Graphic Design all complete = 13% of Pre-production Cost in (A)		
6	**Direction during editing etc.**	**1 Job**	Highly Skilled (Director)	m-day	3.9
7	**English Sub-title works**	**1 Job**	English sub-title	Page	3

3. Post-Production Works

1	**Telecasting Works**	**1 Job**	Cost of Telecast agency (production house) for telecasting arrangement all complete = 15% of Telecasting cost.		
2	**Electronic copy submission including data transformation to computer / Web site etc as directed by the client.**	**1 Job**	Pen-drive / Hard drive as required	No.	1

4. Transportation for mobilization, field works (Pre-production works) and demobilization etc.

1	**Transportation for mobilization, field works (Pre-production works) and demobilization etc.**	**1 Job**	4-WD with fuel & Driver	day	5

NOTES:

1. *Duration of Field Work is assumed to be 3 days.*
2. *Wages of highly skilled and skilled Human Resources shall include per Diem too for Pre-production works.*
3. *Vehicle day (V-day) here for transportation is taken to be 5 v-days considering 3 days for field work and 2 days for going to field and returning back.*
4. *Input of Editor for editing and that of Director for direction during editing process in Production phase shall be 130% of duration of Field works.*

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Singh Durbar, Kathmandu, Nepal

Terms of Reference for Videography

➢ ***BACKGROUND:***

- **VIDEOGRAPHY:**

Videography is the art and process of capturing moving images on electronic media, typically using a video camera. It involves the process of planning, shooting, editing, and producing videos for various purposes such as films, documentaries, communication, education, advertising, events, and more. Videographers are responsible for capturing high-quality footage, ensuring proper framing, lighting, and audio, and creating visually appealing videos through the use of different techniques and equipment. They work in collaboration with directors, producers, editors and other team members to bring a vision and convey a story or message through the medium of video. Videography has evolved significantly with the advancement of technology as modern digital cameras and editing software have made it more accessible for individuals too.

Overall, videography encompasses the technical and creative aspects of producing videos for various platforms and purposes. Videos are very effective media to convey message of developmental, operational and incidental activities more clearly and precisely.

- **SEQUENTIAL STEPS OF VIDEOGRAPHY:**

VIDEOGRAPHY shall include the following sequential steps to perform the desired tasks:

- **Transportation works:**
  - Transportation of the videography equipment and videography team to and from the work place ensuring safety, reliability and compliance with local regulations.
- **Pre-production works:**
  - Direction of works including study, research and conceptualization works to be performed;
  - Videography by skilled videographer with the help of drone operator (if applicable), light operator using digital camera, drone camera (if applicable), light and microphone.
- **Production works:**
  - Involves script writing, voice over in the studio, sound design, visual editing with direction during editing, graphic design (if required), adding effects and sub-title works in selected language/s;
- **Post-production works:**
  - Involves telecasting, electronic copy submission including data transformation to computer, web site etc. as directed.

➢ ***OBJECTIVES OF VIDEOGRAPHY:***

The main objective of the VIDEOGRAPHY is to produce a video of the desired activity to communicate message/information about the activity more clearly and accurately to the public to ensure transparency of the activity performed using public fund.

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➢ ***SCOPE OF WORK:***

The scope of Videography includes, but is not limited to, the following activities:

- **DESK STUDY:**
  - Review of available documents, data, information, maps etc. related with the work;
  - Locate the project location (work site) on Topographic Map / Google Map / GIS Map;
  - Obtain necessary permits and permissions for videography operations, if required, in compliance with local regulations;
  - Plan field work including management of competent and experienced videography team, well-functioning equipment and their transportation to work site and again back from the work site;

- **FIELD WORK:**

Transportation Management:

Efficient transportation of videography team and equipment is essential for the successful execution of videography work. The following aspects should be taken into consideration during transportation management:

- Arranging a suitable and efficient transportation for the videography team and equipment to the work site and back from the work site including local transportation as required;
- Ensuring the safety of the work team, the cameras, lights and associated equipment during transportation;
- Considering any logistical challenges related to remoteness / site locations.

Videography Work:

Shooting works to produce videos by skilled videographer with the help of drone camera operator, light operator using digital camera, drone camera, light and microphone being a crucial aspect of the videography, every care should be taken by the videographer to capture high-quality footage. Key considerations to be taken during this work include:

- Proper conceptualization and direction of work by experienced director;
- Use of skilled, experienced and responsible Human Resources and modern equipment (camera, light, microphone etc.) to the extent available;
- Coordination among team members;
- Capturing high-quality footage, ensuring proper framing, lighting, and audio;
- Ensuring adherence to safety guidelines;
- Maintaining backup copies of all recorded footage.

- **PRODUCTION WORKS:**

The production work shall be initiated after the completion of Pre-production Works (Field work). The production phase shall involve the following activities:

- Script writing;

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- Voice over in the studio after selection of appropriate studio;
- Sound Design;
- Visual editing with proper direction by director during editing;
- Graphic design (if required);
- Adding effects and
- Sub-title works in selected language/s.

- **POST-PRODUCTION WORKS:**

The post-production work shall be initiated after the completion of Production Works. The post-production phase shall involve the following activities:

- Telecasting as specified;
- Electronic copy submission in specified numbers;
- Data transformation to computer, web site etc. as directed.

- **DELIVERABLES / REPORTINGS:**

The following four deliverables shall be produced as part of the videography assignment:

- Inception Report comprising required contents.
- Field Report comprising required contents
- Draft Report comprising required contents and presentation.
- Final Report comprising required contents after editing all comments and suggestions given during presentation of draft report.

Number of copies of each report shall be as specified.

- **TIME SCHEDULE:**

The timeline for the videography shall be determined based on the volume of work and data processing requirements. Duration of assignment for the consultant performing the task shall be the number of calculated days/months from the date of signing the agreement.

- **MODE OF PAYMENT:**

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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SECTION 8: DRONE SURVEY

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Topographic survey

For planning and design of irrigation system / River Training Work / Road Work using Drone including data processing, Map Preparation and Report

For 2 Km^2,

1. Ground Monumentation Work

   i- Human Resources required:

Highly Skilled (Sr. Surveyor)	3 m-days
Skilled (Surveyor)	3 m-days
Unskilled (Labour)	9 m-days

   ii- Equipment and tools required:

Cost of Pillar, Flex, Spray paint and other accessories	15% of Labour cost for A (Ground Monumentation Work)
Cost of DGPS with accessories	3 m-c days

2. Drone Survey Work

   i- Human Resources required:

Highly Skilled (Operator)	3 m-days
Skilled (Assistant)	3 m-days
Unskilled (Helper)	1 m-days

   ii- Equipment and tools required:

Drone	3 mc-day

3. Data Processing

   i- Human Resources required:

Highly Skilled (Data Processing Expert)	2 m-days
Highly Skilled (GIS Expert)	1 m-days
iiSkilled (Computer Operator)	1 m-days
qUnskilled (Assistant)	1 m-days

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Equipment and tools required:

Cost of soft wares, computers etc	25% of cost for item (C) work

4. Transportation

4-WD vehicle with fuel and Driver	3 V-day

5. Map and Report Production

Map and Report production	25% of cost of Total Human Resources

NOTES:

1. *Wages of highly skilled and skilled Human Resources shall include per diem too.*
2. *Cost of Topographic survey using Drone per ha = Total cost (A+B+C+D+E) / 200*
3. *Cost of Topographic survey using Drone for smaller area (area equal or less than 1 sq. km) shall be 20% more.*

Conditions:

1: Flight ht 100m, Total progress by one flight is 20 ha with 75 % overlap and 65 % side overlap
*2: For good analysis one control point is needed over 300*300m Grid. So minimum 7 to 8 GCP is required with some additional check points.*

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TERMS OF REFERENCE FOR DRONE SURVEY

➢ BACKGROUND:

- **DRONE SURVEY:**

A drone survey, which uses unmanned aerial vehicles (UAVs), commonly, known as drones is a modern survey technique other than the traditional surveying methods to conduct various types of surveys and data collection tasks. Drones equipped with cameras, sensors, and GPS technology offer an efficient and cost-effective solution for capturing aerial imagery, collecting geospatial data, and creating detailed maps and models. Drone surveys are widely used in various industries, including engineering and land surveying. They provide a range of benefits such as improved safety, faster data acquisition, higher accuracy, and the ability to access remote or hazardous areas. Drone survey is very effective to prepare detailed topographical map of an area for planning an irrigation system precisely and accurately.

- **SEQUENTIAL STEPS OF DRONE SURVEY:**

Drone surveying shall include the following sequential steps to perform the desired tasks:

- **Transportation** of the drone equipment and survey team to and from the survey site;
- **Selection of Control Points** on the site, well-defined and easily identifiable physical features spread out across the survey area to provide good coverage;
- **Surveying Control Points** by surveyors using high-precision GNSS (Global Navigation Satellite System) equipment like GPS (Global Positioning System) receivers to accurately measure the coordinates (latitude, longitude, and elevation) of each control point, usually in a geodetic coordinate system;
- **Marking Control Points** on the ground using physical markers like metal or concrete monuments, wooden stakes, or even temporary markings like painted crosses or flags to make the control points easily identifiable during the drone survey and any subsequent fieldwork;
- **Drone Survey** with the marked control points in place and flying of drone over the survey area, capturing high-resolution images or LiDAR data, depending on the survey's purpose;
- **Identification of Ground Control Points's (GCPs')** coordinates in the drone-captured data after completing the drone survey;
- **Georeferencing and Data Alignment** of the entire drone dataset with the real-world coordinate system by comparing the known coordinates of the control points to their positions in the drone data, correcting any distortions and errors in the drone data caused by factors like camera lens distortion, drone flight inaccuracies, and atmospheric conditions;
- **Data Processing** of the survey data, creating accurate orthomosaics, digital surface models (DSMs), point clouds, contour maps, or other required deliverables after

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the drone data are georeferenced and aligned properly.

➢ *OBJECTIVES OF DRONE SURVEYING:*

The main objective of the Drone Surveying is to capture high-resolution aerial imagery, including ortho-photos and 3D point clouds, of the survey area, and process the collected data to generate accurate and reliable topographic maps with accurate elevation data and create a detailed digital terrain model for planning of an irrigation project; and prepare a complete survey report.

➢ SCOPE OF WORK:

The scope of Drone Surveying Work includes, but is not limited to, the following activities:

• DESK STUDY:

- Review of available documents, data, information, maps etc. related with the study area;
- Locate the project area (survey area) on Topographic Map / Google Map / GIS Map;
- Conduct a site assessment to identify potential risks and obstacles;
- Develop a flight plan, including the selection of flight paths and altitudes;
- Obtain necessary permits and permissions for drone operations in compliance with local regulations;
- Plan survey work including management of survey team, equipment and their transportation to site and again back from the survey site;

• FIELD WORK:

Transportation Management:

Efficient transportation of survey team and equipment is essential for the successful execution of the drone survey work. The following aspects should be taken into consideration during transportation management:

- Arranging a suitable and efficient transportation for the survey team and equipment to the survey site and back from the survey site;
- Ensuring the safety of the survey team, the drone and associated equipment during transportation;
- Considering any logistical challenges related to remoteness / survey locations..

Ground Monumentation Work:

Ground Monumentation is a crucial aspect of the drone surveying to establish reference points and markers on the ground to facilitate accurate geospatial data collection and correlation. Key considerations to be taken during this work include:

- Selection of suitable locations for the placement of reference points (control

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points) spread over the survey area;

- Survey of Control Points by surveyors using GPS (Global Positioning System) receivers to accurately measure the coordinates (latitude, longitude, and elevation) of each control point in a geodetic coordinate system;
- Marking Control Points on the ground using physical markers like metal or concrete monuments etc. to make the control points easily identifiable during the drone survey;
- Ensuring proper installation and secure anchoring of the markers to maintain their stability and longevity
- Adhering to established geodetic standards and practices.

Drone Survey Work:

The drone survey work involves the operation of drone over the survey area, with the marked control points in place, to capture the high resolution aerial imagery and collect data required for the purpose for which the drone survey is proposed. Due attention should be given to the following factors:

- Planning / designing flight paths and altitudes to cover the entire survey area effectively;
- Conducting drone flights using high-resolution cameras;
- Ensuring the safety and security of the drone operations, including implementing emergency protocols and following best practices; and
- Capturing the high resolution aerial imagery and collection of required data.

Topographic Survey by Drone is the main component of the drone survey. This survey component of the drone survey aims at obtaining the accurate and detailed elevation data of the survey area. The following activities are minutely taken into consideration while performing this survey:

- Capturing the high resolution aerial imagery, collecting data on elevation for contours and other topographic relevant features;
- Ensuring the accuracy and reliability of the collected data.

- **<u>DATA PROCESSING:</u>**

The data processing shall be initiated after the completion of Drone Survey Work of the survey area. The data processing phase involves the analysis and transformation of the collected aerial imagery and point cloud data into usable information. The following considerations should be addressed during this processing:

- Conducting quality checks to ensure the desired standards of data.
- Utilizing appropriate software tools to process and analyze the collected data.
- Validating the processed data for accuracy and reliability.
- Generating accurate digital terrain model (DTM), digital surface model (DSM), orthophotos, contour maps, volumetric calculation and other required outputs based on the collected data / information.

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- **PREPARATION OF MAPS AND REPORTS:**

The maps and reports production phase shall come into play after the completion of data processing phase. It involves the generation of comprehensive deliverables (maps and reports) summarizing the findings of data processing of survey data/information. The following key considerations shall be taken during this phase:

- Creating detailed topographic maps with contour lines, features, and annotations.
- Generating reports comprising the survey findings, analysis, and recommendations clearly and concisely.
- Ensuring the accuracy and completeness of the maps and reports.

- **STAKEHOLDERS / HUMAN RESOURCES AND THEIR HEALTH, SAFETY AND ENVIRONMENTAL CONSIDERATIONS:**

The stakeholders shall include the survey team, drone operator, data processing specialists, transportation coordinator, and survey management head. The responsibilities of the various stakeholders involved in the drone survey work shall be clearly defined and assigned before the execution of actual survey work.

The entire drone survey squad shall adhere to all applicable health, safety, and environmental regulations and guidelines. Proper risk assessments should be conducted, and safety measures should be implemented to ensure the well-being of the entire survey team, the public, and the environment throughout the survey duration.

- **DELIVERABLES / REPORTINGS:**

Communication channels shall be established to keep all stakeholders informed about the survey status, challenges, and key milestones. Clear lines of communication should be established to address any concerns or issues that may arise during the survey operation.

The following deliverables shall be produced as part of the drone survey assignment:

- Detailed topographic maps with contour lines, features, and annotations.
- Digital terrain models (DTMs) and digital surface models (DSMs).
- Orthophotos with high-resolution imagery of the survey area.
- Survey reports summarizing the survey findings, analysis, and recommendations.
- Regular progress reports.

Four Reports namely Inception Report, Field Report, Draft Report and Final Report shall be prepared comprising required contents and submitted in due course of time.

- **TIME SCHEDULE:**

The timeline for the drone survey shall be determined based on the size of the survey area, complexity of the terrain, and data processing requirements. A detailed survey

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schedule shall be developed and communicated to all stakeholders prior to the commencement of the actual survey work. Duration of assignment for the consultant performing the task shall be the number of calculated months from the date of signing the agreement.

- **MODE OF PAYMENT:**

Mode of Payment for consulting services shall be decided by the Client based on the duration of services, stage of reporting, prevailing procurement rules and regulations, donor agencies' guidelines, if any, and availability of funds.

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SECTION 9: LiDAR TECHNIQUE

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Topographic survey

For planning and design of irrigation system / River Training Work using Drone including data processing, Map Preparation and Report

Unit: For 100 Km^2

1.1.Human Resources required:

Human Resources	Duration	Remarks
Team leader	6 m-months	Equal to contract duration
Lidar Operator	1 m-month	Equal to Lidar Sensor duration
LiDAR data Processing Expert	6 m-months	1 expert can process 100 km^2 in 6 months
Senior Surveor/Geomatics Engineer	4 m-months	4 months require for1 expert to control site DGPS and verify the final output in 100 km^2
GIS and Remote Sensing Engineer	4 m-months	1 expert's 4 months input requires for 100 km^2
DGPS operator/Surveyor	4x4=16 m-months	4x DGPS Reciever
Support Staff	2x6=12 m-months	2x contract duaration

1.2.***Equipment and tools required:***

Equipment	Duration	Remarks
LiDAR Sensor and aerial camera		
i.One time cost	1 job	For transportation and other liabilities
ii Hire charge	7 m-c days	Round up (helicopter hours / 3 hrs,0) days+ n days
DGPS Receiver	40 m-c days	40 m-c days require for 100 km^2
Helicopter	10 hours	10 hours require for 100 km^2
4 WD -Vehicles with fuel and driver	40 V days	Equal to DGPS Receiver

In LiDAR Sensor and aerial camera hire charge "n" stands for number of days provisioned for flight disturbance days due to weather and other reasons, if any, and shall be taken as follows:

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Flying hours	"n" in days
Upto 12 hours	3
More than 12 hours and upto 24 hours	4
More than 24 hours and upto 36 hours	5
More than 36 hours and upto 60 hours	6
More than 60 hours and upto 100 hours	7
For more than 100 hours add 1 days for each additional 40 flying hours.	

1.3.Miscellaneous

Item	Input	Remarks
Communication costs	4 months	Equal to input of Geomatic Engineer
Personal Insurance (No. of field crew + TL)	6 persons	Equal to Nos of field crew +Team Leader
Professional Liability Insurance	0.5% of total cost	
Consumables items such as Stationeries, maps, sample/zipper bag, boxes, batteries, pegs etc.	1% of total cost	

1.4.Map and Report Production

Map and Report production	2% of total cost

Note: (1)Rates of human resources, equipment and related item shall be obtained from approved Government entity, if any, and / or from competitive market price.

(2) For very large area work can be divided into groups to optimize the contract duration.

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Technical Specifications for Topographical Survey using Lidar Technique:

S.N.	Description	Specification	Remarks
1	**LiDAR Point Density**	At least 10 points/m^2 point density will be captured considering the nature of the topography and accuracy requirements.	
2	**Ground sample distance (GSD) and focal length of lens**	Medium frame camera with 100MP will be used to capture digital image, and GSD will be maintained at 10 cm.	Camera specification shall be approved by the client
3	**Photographic Coverage**	1. The forward overlap (fore lap) between successive exposures in each run will be kept at a minimum 45 percentage. 2. The lateral overlap (side lap) between adjacent strips will be kept at a minimum 45 percentage.	
4	**Fundamental Spatial Accuracy**	1. Fundamental vertical accuracy: Root Mean Square Error <= +/- 0.15 m. Or better on clear or vegetated ground. 2. Fundamental horizontal accuracy of ortho photo will be maintained at <= +/- 0.10 m.	
5	**Coordinate Datum's**	1. WGS 84 with UTM 45N coordinate system 2. MUTM with Everest Spheroid system	
6	**Vertical Datum**	Elevation data will be adjusted to local height datum with the BM established by the Consultant. The vertical control of the BMs will be established using precise Level Machine.	
7	**Ground Control System**	1. The Ground Control Points will be established within the grid of size 1km*1km, but in close proximity of the proposed networks as provided by the client. 2. Maximum distance between the Reference GPS station on the ground and airborne GPS units will not exceed 10 kilometers during the flight. 3. All survey control data used or derived will be supplied to ensure independent Quality Assurance (QA) of the survey operations. All primary ground stations will be visible in photographs after the orthophoto is generated 4. The primary ground control and check point	

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		surveys will be referenced to survey control marks with geodetic control points (in terms of coordinates and height) demarcated by survey department. 5. Elevation data will be validated and corrected for systematic errors to ensure accuracy specifications are met.	
8	**LiDAR Data acquisition details**	1. A Draft Pre-Flight Agreement will be made to ensure that no LiDAR data over the Study Area will be collected during any period where extent of LiDAR ground returns in any part of the Study Area is likely to be significantly compromised e.g. flood, adverse weather etc. 2. The Draft Pre-Flight Agreement will include provision whereby the Project is notified of each proposed LiDAR collection flight with sufficient notice to enable consultation between the Project and the Consultant to determine if data capture by the Consultant should proceed. 3. Flight line overlap will be 45% or greater, as required to ensure there are no data gaps between the lines. 4. The spatial distribution of geometrically usable points will be maintained uniform and free from clustering in order to ensure consistent data densities throughout the project area. 5. Environmental conditions – during the data capture cloud and fog free condition between the helicopter and the ground will be ensured. 6. Details of the helicopter, navigation and mission planning activities for LIDAR and digital photography acquisition will include details of whether the photography and LIDAR will be acquired during the same mission (i.e. from the same helicopter) or from separate missions. If separate missions are required to satisfy the respective resolution requirements for LIDAR and photography (eg. Due to flying height constraints) then specify alternative mission	

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		scenarios based on a sensor type and platform.	
9	**Intensity Image**	1. 0.3 m grid intensity image or better to preserve required accuracy. 2. Mosaic will be generated using average laser intensity values from "first return" LiDAR points. 3. Tiled delivery, following the sheet numbering and extent as provided by the Project.	
10	**Digital Surface Model (DSM) (Orthometric)**	1. 0.3m grid Digital Surface Model (DSM) will be generated from the "first return" LiDAR mass point data. This will include ground and non-ground points such as vegetation and buildings. 2. The DSM generation will employ a Point to TIN and TIN to Raster process with Natural Nearest Neighbor interpolation. 3. Void areas (i.e., areas outside the project boundary but within any tiling scheme) will be coded using a unique "NODATA" value.	
11	**Digital Terrain Model (DTM) (Orthometric)**	1. 0.3m grid bare earth Digital Elevation Model (DEM) will be generated from the LiDAR mass point data classified as "Ground" only, so that it defines the "bare earth" ground surface. 2. The DEM generation will employ a Point to TIN and TIN to Raster process with Natural Nearest Neighbor interpolation. 3. Void areas (i.e., areas outside the project boundary but within any tiling scheme) will be coded using a unique "NODATA" value	
	DGPS Data collection	1. GPS data for all base station occupations in excess of 4 hours or more will be provided in RINEX format (Receiver Independent Exchange Format). 2. GNSS observation log sheets which include the following details: (a.) Survey mark ID (b.) Occupation time & date (c.) Antenna height measurements (d.) Instrument /antenna types & serial numbers The GPS observation log sheets will be provided in pdf format or Excel spreadsheet if data is captured digitally. Where appropriate, some jurisdictions may	

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		find it useful to also request GPS data for any static primary control surveys.	
12	**Metadata**	1. For each supplied data product, a complete metadata Statement will be in consistent with the ISO Standard. 2. Metadata will be provided with every delivery including interim, partial and final deliveries.	
13	**Spatial Accuracy Validation**	1. The fundamental vertical accuracy of the point cloud data set will be determined with check points located only in open, relatively flat terrain, where there is a very high probability that the sensor will have detected the ground surface. 2. The vertical accuracy of the point cloud dataset will be tested using a TIN surface constructed from bare- earth LiDAR points compared against ground survey check points. 3. Check points will be surveyed independently of any LiDAR GPS operations. 4. The number of check points (locations) is dependent on the extent of the survey. The following strategy will be used as a guide: a. Check points will be established to adequately cover the full extent of the survey area and be representative of the project area landscape. b. A minimum of 10 check points (locations), with 1 point per 1 km^2 in 1 km * 1 km grid in different vegetation types. The checked result will have to lie within 90 percent confidence interval. 5. The proposed check point survey design will be submitted and approved by the Client prior to implementation. Acceptance of the post-survey spatial accuracy report discussed above is dependent on the quality, number and distribution of these check points. In the above circumstances a "compiled to meet" statement of horizontal accuracy at 95 percent confidence will be reported.	
14	**Data Processing**	Consultants will process all the acquired data (LiDAR and Ortho photo) in Data Processing LAB (Software and Hardware) inside Nepal.	
15	**Facilitation**	The Project will facilitate in administrative	

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		procedure (inter and intra governmental organizations).	

Human Resource Qualifications

1. Team Leader

Qualification

Master's Degree in Geomatic engineering / Geoinformatics or GIS and Remote sensing or Geography with focus on GIS and Remote Sensing, Photogrammetric, LiDAR, Preferable Ph.D.in one of the above-mentioned subjects.

Work experience

Minimum 5 Years work experience in Remote Sensing, GIS and aerial LiDAR Survey and Mapping work. Has successfully completed 3 or more LiDAR projects in Nepal or abroad

2. LiDAR operator

Qualification

Bachelor in Geomatics with at least 3-year experience in operation of LiDAR flight via Helicopter

Experience

Minimum 3 years' experience in operation of Lidar flight via Helicopter and airplane and had successfully completed at least 3 projects in Nepal.

3. LiDAR Data processing Expert

Qualification

Master's Degree in Geoinformatics/IT/Computer Science/Engineering

Experience

Minimum 3 years' experience in LiDAR Data Processing of the data captured by Helicopter.

4. Geomatics Engineer/Senior Surveyor

Qualification and Experience

B.E. in Geomatics Engineering/Survey engineering or Senior Surveying Course (or equivalent to senior surveying Course). At least 3 years' experience in Surveying work including establishment of Ground Control Marks for LiDAR Survey and have worked in minimum 2 LiDAR Projects

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Ministry of Energy, Water Resources and Irrigation, Nepal

5. **GIS and Remote Sensing Engineer**

Qualification and Experience

BE in geomatic engineering preferable master's Degree with GIS/RS included and studied in course or having PG diploma in GIS/RS after the completion of Bachelor's Degree. At least 3 years' experience with minimum 2 LiDAR projects completed.

6. **DGPS operators/Surveyors**

One-year Junior Surveyor Course or Diploma in Geomatics with experience in operation of DGPS

<u>Equipment's and Software</u>

1. **LiDAR Sensor**

- Riegl Vux-240 or equivalent sensor that can be mounted in Helicopter and airplane.
- Minimum Laser Pulse Repetition Rate (PRR) of 1000 KHZ or higher
- Minimum Relative Accuracy of 15 mm or lower
- Minimum Absolute Accuracy of 15 mm or lower
- Minimum number of Target per pulse should be 5 or higher

2. **Aerial Camera**

- At least 50MP RGB Aerial Camera

3. **Software**

- Terra solid or equivalent LiDAR processing software

4. **DGPS**

- Multi band GNSS receiver (DGPS) with minimum 180 channel
- Duel frequency (L1, L2, L5) GNSS receiver must be used with capable of multi constellation (GPS, GLONASS, BAIDEAU, QZZ)

5. **High processing Computer**

- Computer with minimum 64 GB RAM, 16GB Graphics, 2 TB Hard drive with i9 Processor

Director General

Secretary