FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
MINISTRY OF WATER AND ENERGY

Terms of Reference for

Groundwater Potential Assessment, Detail Reconnaissance Hydrogeological Study, GW Feasibility Study, Contract Administration & Supervision of Drilling of Test Wells in Weito Area, South Ethiopia Region

July 2024
Addis Ababa

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1. Introduction

1.1 Background

Groundwater is able to create drought resilience, improve the welfare of the population, to utilize the land resources and for sustainable agricultural production. In this regard, the use of groundwater for water supply and/or irrigation practices is expected to result in far reaching implication in ensuring food security for urban and the rural community. The Project is part of a regional HoA initiative that aims to strengthen the resilience of targeted communities through the management and collaborative use of the groundwater resources and is funded by the World Bank.

Water insecurity is a growing concern globally, especially in developing countries, where a combination of population growth, urbanization, changing consumption patterns along with improved living standards, and climate change variability put increasing pressure on water supply systems. Development of groundwater scheme has received considerable attention in recent years. However, in many such instances, the expansion of groundwater development has not been preceded or accompanied by systematic studies to evaluate the resource potentials of the respective aquifers.

Exploration of groundwater potential has been undertaking with a very good results in different parts of Ethiopia. So far, many groundwater resource assessment and evaluation projects covering broad areas were completed mainly by the Ministry of Water and Energy, UNICEF and ATA. These include Raya-Kobo-Girana (Northern), Teru-Chifra (North Eastern), Allaidege (Main Ethiopian Rift), Meskan-Mareko-Silte, Lower Bilate (Rift Valley), Adaa-Becho-Addis Ababa (Central), Fafem-Jerer (Eastern) and Ambo-Welkite (Western) areas groundwater resource assessment and evaluation projects are the major ones completed in the past. Of these, the water supply source of Addis Ababa City and its surrounding towns is mainly from groundwater (about 60 to 70%).

Therefore, in order to derive the optimum benefit from a groundwater scheme, a proper resource study has to be carried out. However, unlike surface water processes, most of the groundwater activity is invisible in the strata that lie below the ground surface. Measurement and monitoring of groundwater flow are therefore extremely difficult. Therefore, in order to minimize most of the simplifying assumptions in groundwater assessment programs, several integrated exploration approaches should be applied. As part of the integrated approach to groundwater exploration, combination of geological, hydrological, hydrogeological and geophysical exploration tools needs to be implemented. Groundwater recharge is an essential component of such investigation and therefore must be estimated before attempting to develop the groundwater model of an area. Hence, the core and ultimate goal regarding this project shall be to estimate the quantity and investigate the quality of the groundwater available in an area for water supply and/or irrigation development.

The proposed studies shall be carried out in five stages. The First Stage (Stage-I) of the investigation is the Inception Stage composed of review of previous works, overlay analysis to determine groundwater prospective areas, develop conceptual hydrogeological model, preliminary field visit and submission of Inception report. The Second Stage (Stage-II) comprises field hydro-geophysical surveys in specified target areas to select sites for test and/or pilot production wells, drilling and testing. During the Third Stage (Stage-III), detail hydrogeological investigation shall be conducted at a specific target area with the aid of test and/or pilot production wells that shall be drilled and tested to assess the groundwater resource; evaluation and management activities that includes determination

of aquifer parameters and estimation of total exploitable groundwater resource together with analytical and/or numerical groundwater modelling used for groundwater management shall be carried out. The final activities are preparation of Groundwater Database in Stage-IV, and information dissemination and capacity building in Stage-V.

1.2 The Project Area

The proposed study area is situated in South Regional State and areas surrounding of Weito Area, SNNP Region that comprises of 2 Woredas namely Gamo Gofa and Konso Special. Its extent is about 13,558.8 km^2 that lies between 5.16^o to 6.71^o Latitude and 36.39^o to 37.83^o Longitude geographic coordinate. Its elevation is approximately in the range of 708 m a.s.l in the valleys and 3381 m a.s.l in the mountains of Gamo Gofa while it ranges from 554 m to 1842 m a.s.l. in Konso Special. The study area is situated entirely within the Omo-Gibe Basin.

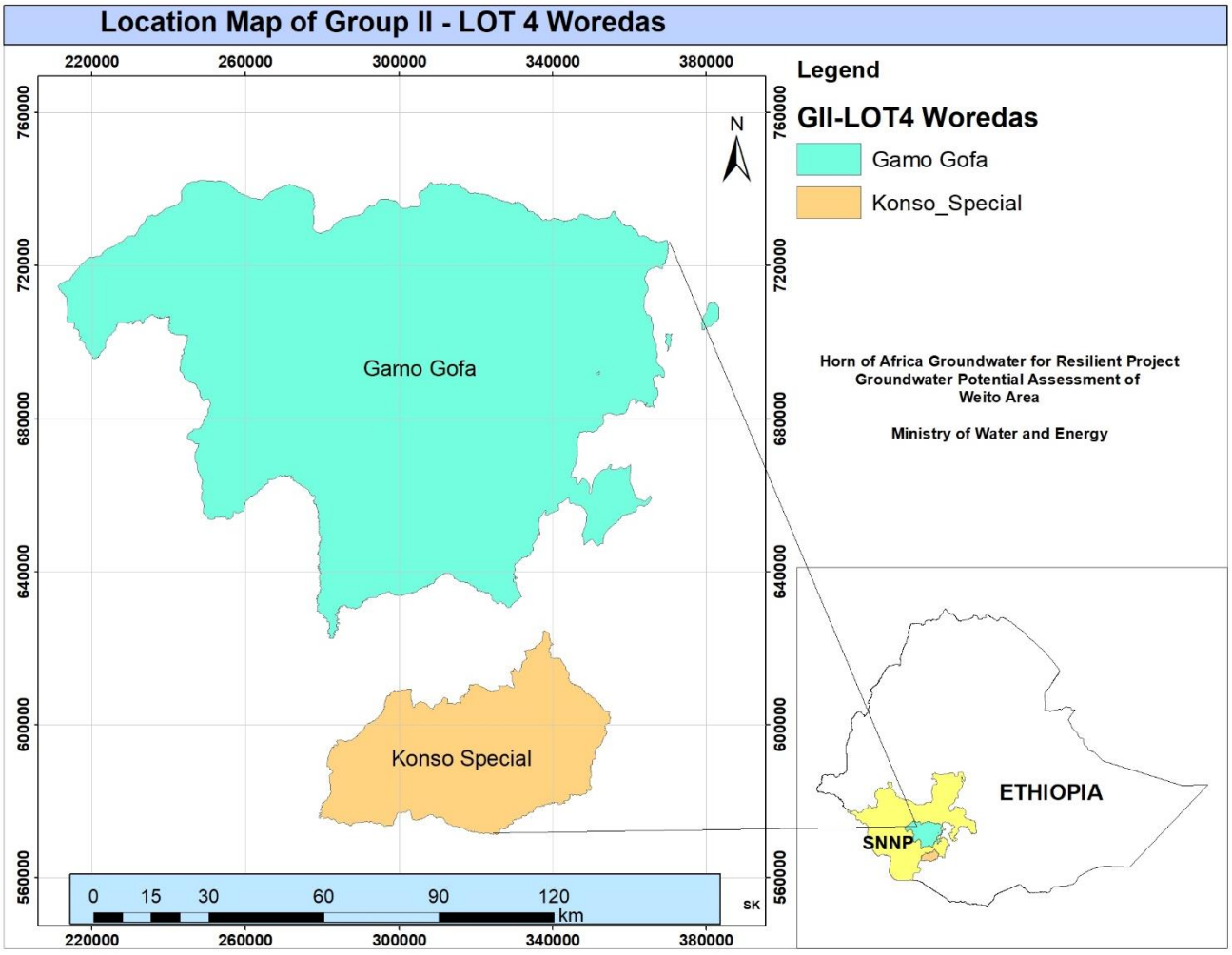

Figure 1: Project area location

2. Objective

The general objective of the investigation is to determine the potential (prospective) groundwater sites for groundwater development for intervention of the current and future water demand under consideration of the climate change impacts.

The specific objectives of the study are summarized as follows:

- Undertake water demand assessment for multipurpose utilization.
- Determine the hydrogeological condition of the area: identify sites, evaluate recharge and discharge conditions, delineate spatial distribution of different aquifers, determine hydraulic parameters, analyse water quality of the aquifers and assess impacts of future exploitation of the potential aquifers.
- Qualitative and quantitative evaluation of the groundwater resources on selected potential sites or prospective areas
- Bidding document preparation for drilling and testing of test/pilot production wells
- Supervision of test and/or pilot production wells drilling and testing
- Carry out analytical and/or numerical model of the main aquifer of the area to recommend appropriate groundwater exploitation and management
- Evaluate the groundwater resources and develop strategy of groundwater resources development with their cost estimates.
- Create detailed groundwater resource potential maps
- Identify promising areas for groundwater development
- Conduct enhancement of the national groundwater database and carry out massive processing and uploading of existing data collected from all over the country

Build the capacity of MoWE and Regional Water Bureaus by providing on-the-job training and short courses in groundwater exploration, development and management.

3. Scope of the Service, Tasks and Expected Deliverables

The assignment has two major components, and it is a mixture of LUMP SUM and TIME-BASED CONTRACT:

- **Groundwater Study and Design and**
- **Drilling Supervision of ten (10) Test Wells**

In addition, groundwater data preparation and capacity building and information dissemination will be carried out. Thus, the scope of the assignment is:

Phase I: Lump-Sum - Groundwater and Design – 6 months

Stage-I: Inception – 2 months

Stage II: Field Survey of Target Areas – the deliverable from this Stage is selection of test well drilling sites which will be carried out in 3 months. In this Stage, the consultant is expected to prepare drilling specifications and tender documents for tendering of the drilling contractors by the client – 2½ months

Stage-III: Drilling and Groundwater Resources Evaluation – the consultant uses the drilling result for ***evaluation*** of the groundwater potential (final study and design report) – (Note: 1½ months for final report of study and design and 8 months for drilling supervision)

Stage-IV: Groundwater Database Preparation

Stage-V: Capacity Building and Information Dissemination

Phase II: Time-Based - Supervision of Drilling of Test Wells – this activity will be conducted in Stage III of the Lump-Sum Period, and after supervision of borehole drilling and pumping test, the data will be used as input Stage III for finalization of the study and design - 8 months.

Environmental and Social (ES) Obligation for Test Well Drilling Supervision

The consultant should ensure that the Contractor delivers its ES obligations under its contract. This includes:

1) review the Contractor's Environment and Social Management Plan (C-ESMP), including all updates and revisions at frequencies specified in the Contractor's contract (at least once in the contract period);
2) review all other applicable contractor's documents related to ES aspects including the health and safety manual, security management plan and Sexual Exploitation and Abuse (SEA) prevention and response action plan;
3) review and consider the ES risks and impacts of any design change proposals and advise if there are implications for compliance with ESIA, ESMP, consent/permits and other relevant project requirements;
4) undertake, as required, audits, supervisions and/or inspections of any sites where the Contractor is undertaking activities under its contract, to verify the Contractor's compliance with ES requirements (including relevant requirements on SEA/SH);
5) undertake audits and inspections of Contractor's accident logs, community liaison records, monitoring findings and other ES related documentation, as necessary, to confirm the Contractor's compliance with ES requirements (including relevant requirements on SEA/SH);
6) determine remedial action/s and their timeframe for implementation in the event of a noncompliance with the Contractor's ES obligations;
7) ensure appropriate representation at relevant meetings including site meetings, and progress meetings to discuss and agree appropriate actions to ensure compliance with ES obligations;
8) ensure that the Contractor's actual reporting (content and timeliness) is in accordance with the Contractor's contractual obligations;
9) review and critique, in a timely manner, the Contractor's ES documentation (including regular reports and incident reports) regarding the accuracy and efficacy of the documentation;
10) undertake liaison, from time to time and as necessary, with project stakeholders to identify and discuss any actual or potential ES issues;
11) establish and maintain a grievance redress mechanism including types of grievances to be recorded and how to protect confidentiality e.g., of those reporting allegations of SEA and/or SH.
12) carry-out the following activities consistent with the Works contract to be supervised, including but not limited to the following:
    1. support the Works employer to organize an SEA/SH conference, ensure appropriate representation in the conference and follow-up on any agreed actions by the attendees;
    2. monitor contractor's compliance with its SEA/SH Prevention and Response Obligations in the Works contract, and take appropriate contractual actions if non-compliance is identified, including upon identification of potential non-compliance by a dispute board;
    3. ensure that any allegation of SEA and/or SH that are received by the Consultant are documented, maintaining appropriate confidentiality, and promptly submitted to the Employer and the Contractor;

4. prior to its engagement for the Works, verify that, any proposed subcontractor not named in the contract, is qualified in accordance with the provisions of the SEA/ SH performance declaration for sub-contractors;
5. provide appropriate support and relevant documents that a dispute board may need in reviewing SEA/SH contractual compliance;

In addition, the consultant reviews and approves SEA/SH submitted by the contractor and submits to the client for final review and approval.

4. Methodology

The proposed methodology for the groundwater resources investigation is an integrated approach set up for data collection, review, field survey, identification, selection and evaluation of prospective sites/well fields. The proposed study should focus on evaluation of the groundwater potential through detailed, comprehensive and integrated methods and will be completed in five stages:

Stage-I: Inception

Stage II- Field Survey of Target Areas

Stage -III: Drilling and Groundwater Resources Evaluation

Stage IV: Groundwater Database Preparation

Stage V: Capacity Building and Information Dissemination

4.1. Stage-I: Inception

Stage-I (Inception) includes preliminary collection and review of existing data from previous works of the area or at near vicinities such as geological (maps 1:250,000 and 1: 50,000 scales), Hydrogeological data (complete borehole data including pump test data), Hydro-metrological data such as (rainfall, Daily maximum and minimum temperature, Relative humidity, wind speed, Sunshine duration and etc.) and Geophysical data such as (VES, TDEM/TEM, MAGNETIC preceded by overlay analysis, preliminary conceptualize hydrogeological setup of the study area, preliminary site visit, preparation of draft Inception report, validation workshop and submission of final inception report shall be conducted.

Preliminary Data Collection and Review

Available geomorphological, geological, hydrogeological, and other maps together with study reports and data will be collected and studied; any available relevant satellite imagery interpretation will be carried out to conceptualize the hydrogeological setup of the area (scale 1:250,000) and finally preliminary conceptual groundwater map of the study area after overlay analysis will be prepared to facilitate the field visit.

Overlay Analysis

Due to large coverage of the area, an overlay analysis is very important to identify specific target locations for aquifer recharging sites (dam & ponds with accessory canals) and monitoring points. An overlay analysis is used also to determine recharge zones where recharge is very effective, environmentally vulnerable areas for land degradation where siltation is hazardous for future dams using weighted overlay analysis aggregate input layers under the GIS environment.

The general steps involve:

- Preparation of physical thematic layers required for multi criteria overlay analysis of study area.
- Determining the significant layers

- Reclassifying or transforming the data within a layer
- Weighting the input layers
- Adding or combining the layers
- Analyzing the result and delineation of the groundwater potential zones.

Preliminary Conceptualization of the Hydrogeology

Development of preliminary conceptual models (hydrogeological cross-sections) of the area for a better understanding of the regional groundwater system based on existing information and overlay analysis outputs will be carried out.

Field Visit

After having the analysis of previous data in combination with the overlay analysis, preliminary site visit should be carried out to ascertain what was interpreted at the office level. Accordingly, site visit will be organized for at least a week to familiarize with the study area, enhance and update the conceptual hydrogeological map. The main purpose of the field visit is to enhance the conceptual understanding of the groundwater system, to verify the geological setting of the prospective groundwater sites and its surrounding area, and to plan more appropriately the subsequent activities (such as site selection for carrying out geophysical survey). Besides, water demand assessment will be carried out in consultation with stakeholders (Regional as well as Zonal/Woreda and local officials/communities).

Inception Report and Workshop

Subsequently, all gathered hydrological, climatological, hydrogeological, geological information and data shall be reviewed and preliminary analysis shall be done integrated with the outcome of the field visit. The main outputs of the Inception will be but not limited to:

- Preliminarily reviewed and analysed previous studies and data
- Identified specific target areas for detail groundwater potential investigation using overlay analysis,
- Prepared different possible conceptual groundwater flow system models of the area,
- Enhanced existing groundwater database and uploaded data,
- Preliminary hydrogeological and groundwater potential maps at a scale of 1:250,000,
- Different formats prepared for collection of existing data and information, which includes format for existing water points inventory (water wells, springs, rivers, reservoirs, etc.)
- Identified data gaps and revised methodology and volume of work for the next stages.
- Present findings of the draft inception stage at a validation Workshop-1. All cost of the venue and client-side Participants of workshop shall be covered by the client and place of work shop shall be as appropriate. Numbers of participants may be till 30 but all fee of the participants from the consultant side (transportation and per diem will be covered by the Consultants)
- Prepare and submit Final Inception Report based on the outcome of Workshop-1.

4.2. Stage-II: Field Survey of Target Areas

At this stage, site specific investigations to be carried out includes geological and geomorphological, hydrological, geophysical survey and hydrogeological investigation with exploratory and or production wells drilling and testing to verify the groundwater potential of the area for further activities.

i) Environmental & Social Assessment and Socio-economic Situation of the Project Area

In this regard, the consultant is expected to undertake the following major activities: -

- During feasibility study of borehole sites, the feasibility of each specific site will be assessed from environmental and social aspects including possible options in case of any substantial environmental and social adverse impacts that can hamper the implementation and sustainability of the sub-project.
- Not as independent deliverable, but as one chapter of the study document, environmental social assessment of the project area expected to be prepared.
- Assess and prepare environmental, social and economic baseline data of the project area.
- With responsible project safeguard specialists undertake periodic public and stakeholders' consultation.
- Assess and briefly describe socio-economic situation of the woredas included in the project area.

ii) Geological and Geomorphological Survey

The geological mapping with a scale of 1:250,000 from Stage-I is the base map for this stage specific areas study to prepare a 1:100,000 scale maps. These maps will be the base map for the preparation of the hydrogeological map of the study area. Geological and geomorphological survey to be carried out with field geological assessment along different traverses to determine:

- Classification of all the rock types and establishment of the stratigraphic relations of litho-stratigraphic units at a scale of 1:100,000 for the selected specific prospective areas.
- Determination of the lateral and vertical extent of litho-stratigraphic units.
- Identification and mapping of all geological structures.
- Determination of the major structures (faults, lineaments, folds, dykes and etc.) having important hydrogeological implications.
- Preparation of geological sections along zones of likely high groundwater flow paths.
- Close observation on the texture, cementation, porosity and general lithostratigraphy of the geological formations at the local sites (geological characterization).
- Other activities which may be required for comprehensive geological investigations.

iii) Hydrological Study

The main objective of hydrological study is to characterize available rivers/streams within or adjacent to the detailed study areas and assessments on recharge possibilities, accounting of all factors influencing the catchment area, the existence of springs at regional and local scales, and their hydrogeological implications, surface, and groundwater relationships. Hydro-meteorological Studies shall be carried out using:

- Collection, checking of data consistency and analysis of the last 10-years hydro-meteorological data used to know the rainfall-runoff characteristics, to study the climate variability of the area.
- Analyses of hydrological data to determine surface water-groundwater interaction.
- Estimation of groundwater recharge using base flow separation, water balance, Wets pass approaches based on available data (Land Use-Land cover, soil, slope, drainage, groundwater level, permeability, etc.)

iv) Geophysical Investigation

The main objective of the geophysical investigation is to determine:

- Thickness of different geological formation
- Depth to the groundwater
- Qualitative and/or quantitative evaluation of degree of salinity of the groundwater
- To identify geological structures
- To identify depth to aquifer and determine aquifer thickness
- Spatial variation related to hydraulic properties of the different lithologic units.

- Preparation of Geophysical report with pseudo and geoelectric sections
- To recommend exploratory and/or production well sites for drilling and testing based on the geophysical analysis and interpretation.

It is proposed to carry out geophysical investigation of Vertical Electrical Sounding (VES) and magnetic survey over all of the specific areas along different profiles to obtain subsurface information. VES are recommended in order to identify the resistivity contrast between the different zones of aquifers. Besides this, magnetic survey shall be carried out to identify geological structures and the possible contact with the underling formations.

Although the quantity of VES and Magnetic survey may be increased or decreased based upon the Stage-I output, here in the Stage-II, it is recommended to carry out a total of about 120 VESs AB/2 >= 1000 meters at 2 kilometres interval along the traverse lines and magnetic survey at three of these traverse lines for a total length of 60 km.

v) Water Quality Survey

The water quality survey collected shall be conducted for hydro-geochemical characterization of the area and analyse the water samples for the suitability of the water source for domestic and irrigation use.

Water samples shall be collected systematically from surface water bodies (rivers, ponds, reservoirs), springs, dug wells and existing wells in the study area. The water sampling points shall be chosen on the basis of the study results from the regional hydrogeological, geological, structural and tectonic setup of the area. The main parameters to be determined are:

In-situ field measurement of electrical conductivity (EC), pH and water sampling from different water sources (boreholes, hand dug wells, springs, rivers and streams).

Physico-chemical analysis of water samples shall be analysed according to "Standard Methods for the examination of water and Wastewater" published by WPCF/AWWA/APHA 16th edition in laboratory.

A total of about 100 samples shall be collected from all available sources in order to:

- Characterize the chemical composition of the aquifers within and surroundings to determine the recharge and discharge areas
- Identify groundwater pollution sources using available spatial information and additional analysis, where required
- Determine the spatial distribution of groundwater quality maps (EC, TDS, SAR…)
- Characterize the groundwater of the study area, its suitability for domestic water supply based on Ethiopian Drinking Water and WHO standards and for irrigation based on Sodium Adsorption Ratio (SAR) and the United States Salinity Laboratory (USSL).

vi) Hydrogeological Study and Workshop

For further familiarization and visualization of the groundwater condition of the area, it is proposed to conduct detail hydrogeological surveys in the specific target areas. The hydrogeological surveys mainly include but not limited to the following:

- Inventory of springs, wells and all boreholes and records of their geographic locations (taken by GPS) with labelled codes.
- Identify major aquifers, define their possible extent based on the available data and field inspection combined with the geological data
- Hydrological/hydrogeological observations and measurements of water level (groundwater level observations) from boreholes with their discharge measurements where applicable.
- A field observation on the geomorphology, land use, vegetation, and geological structures

- Field observation and mapping of groundwater manifestation horizons like seepage zones, spring, etc, and groundwater flow directions.
- Assessment/evaluations of recharge conditions for the area for its sustainable utilization
- Regional view and understanding of the groundwater system of the specific target area/s
- Estimation of the hydraulic properties of the aquifers
- Other basic data/parameters that may be revealed during the study
- Make analysis of groundwater level data and geological setup to determine the groundwater flow direction and zones of aquifer-surface water interactions.
- Map and verify Hydrogeological boundaries and units (hydrogeological mapping at 1:100,000).
- Proposal (selection) of exploratory and/or pilot production well sites to be drilled and tested for Stage-III activities based on the updated overall information including geophysical analysis and interpretation result
- Bidding document preparation for test and/or pilot production wells drilling and testing.
- Present and discuss findings and prospective drilling sites to stakeholders of the Stage-II at a validation Workshop-2
- Prepare and submit the final Stage-II report based on the outcome of the workshop

4.3. Stage-III: Drilling and Groundwater Resources Evaluation

During this phase of the assignment, the consultant must understand that evaluating groundwater resources is the primary objective. To achieve this, it is essential to drill test wells at the sites chosen by the consultant and utilize the resulting data. Therefore, the consultant will supervise the drilling of these test wells according to appropriate methodologies and standards. This process will enable the consultant to gather critical data needed to assess the groundwater potential of the area and produce a comprehensive groundwater assessment report.

4.3.1. Test Well Drilling

Groundwater resource evaluation of specific target area shall be carried out by using supervision of test and/or pilot production wells drilling and testing. In this stage, ten (10) test and/or pilot production wells will be drilled and tested and used for groundwater resource evaluation. Such wells are also very important to generate site specific hydrogeological data (aquifer characterization) and they are also usable for water supply for the community domestic/ irrigation use (double importance). The Consultant should undertake the following tasks during the drilling and testing supervision activity;

- Contract administration (project duration, activity dependency, critical logistics)
- Supervise the drilling and testing activity of ten (10) test/pilot production wells from the very beginning up to the end as per the specification (Drilling, casing installation, well development, pumping test, etc.).
- Measure and collect important data during drilling of the test wells (EC, TDS, temperature of the gashing out water and/or drilling fluid), the rate of drilling, or any situations (caving, water loss, etc.) encountering while the drilling is in progress
- Supervise the borehole-geophysical logging work and analyse the result in correlation with lithological log, and prepare casing arrangement accordingly
- Check and certify payment certificates, manage the cost of the project
- Prepare borehole completion report, including Vertical section drawings of completed borehole together with geologic log, pumping test data and their analysis, water quality and their analysis, etc. and then submit to the Client.
- Prepare drilling site maps at 1:10,000.

4.3.2. Groundwater Resource Evaluation

The groundwater resource evaluation in this stage is mainly based on the outcome from the drilling and testing of the ten (10) test/pilot production wells with the following specific points to be achieved by carrying out detail Hydrogeological Investigation:

- Interpretation and calibration of the geophysical survey results using drilling results of the test and/or pilot production wells
- Detail investigation of the hydrogeological system
- Aquifer characterization and determination of aquifer parameters
- Delineation of the main aquifer
- Evaluation of the quantity and quality of groundwater
- Determination of rational technical and economical distribution of production wells for future drilling
- Analytical and/or numerical groundwater model
- Map and verify hydrogeological boundaries and units (hydrogeological mapping at 1:50,000 based on the extent of potential areas)
- Characterize the intra and inter annual groundwater recharge dynamics under the current and predicted effects of climate change
- Estimation of the total exploitable groundwater resources
- Assess the temporal changes in groundwater levels under current and future climate change scenarios (under the current and predicted effects of climate change).
- Present and discuss findings to stakeholders of the Stage-III at a validation Workshop-3
- Prepare and submit the final Stage-III report based on the outcome of the workshop.

4.4. Stage-IV: Groundwater Database Preparation

The existing groundwater database available at the Ministry of Water and Energy (ENGDA, ENGWIS and the recently completed web-based groundwater information system developed by Acacia Waters and Aquacon Engineering, which is currently hosted by Ministry of Innovation and Technology) and others if any shall be reviewed, updated and enhanced. All data generated during this study shall be uploaded into the new database system.

4.5. Stage V: Capacity Building and Information Dissemination

Five (5)-days training will be organized and provided by the Consultant for at least 20 participants from Ministry of Water Groundwater experts and Hydrogeologists from Regional Water Bureaus. All costs for the venue and participants will be covered by the consultants in at least three-star Hotel. The place shall be selected as appropriate by consent of client. The training participants will be from relevant stakeholders to explain the steps of groundwater resource assessment and evaluation to ensure that the hydrogeological investigation work can continue in this way in the country. This training will require the steps of groundwater mapping, the interpretation of the remote sensing overlays, the weighting process for the different layers and the final interpretation of the maps for targeting well prospects, integrating borehole and surface geophysical information. It will also cover basics of groundwater modelling, three-dimensional model setup, and analysis of the simulation results (groundwater recharge and groundwater level, current and future scenarios). The Consultant will provide all material and software for the training.

The main component of this stage is to train staffs of the Ministry of Water and Energy involved in groundwater resource assessment and management and Water Management Zones on concepts, techniques for assessment and management of groundwater resources.

Proposed Equipment and Software for the study

Item	Description	Unit	Quantity
Resistivity meter	An effective and the best tool for the exploration of underground water through application of current using electrodes and cables that are connected to voltage source	No.	1
Tomographic geophysical survey (Imaging)	A geophysical technique that investigates the subsurface of the earth and it is a non-invasive imaging technique with a high parametrical and spatio-temporal resolution that can be used to model object understudy in 2D or 3D as well as monitor changes.	No.	1
Measuring tape	Flexible hand tool to measure distance or size	No.	2
Magnifying lens	A convex lens that is used to produce a magnified image of an object	No.	1
CCTV	Borehole video recorder	No.	
Calliper	Tool used to measure the dimensions of an object	No.	1
Compass	A device that indicates direction (for navigation and geographic orientation)	No.	1
Clinometers	Angle measuring instrument	No.	1
GPS	Utility that provides users with positioning, navigation and timing	No.	2
Geologic Hammers	Rock hammer or rock pick used for splitting or breaking rocks to obtain a fresh surface of a rock to determine its composition, bedding orientation, nature, mineralogy, history and field estimate of rock strength	No.	1
Deep meter 200 and 300 m	Water level meters ideal for measuring the depth of water in wells and boreholes	No.	1
EC-meter	A device that is used to measure electrical conductivity of water	No.	2
Satellite imageries of the study area	Used to create detailed maps of the area of interest	No.	Different types (SPOT, Landsat)
First aid kit	A collection of supplies and equipment used to give immediate medical treatment for injuries	No.	2
Laptop	Computer usable at field for data input, visualization	No.	1

Computer Software

- Groundwater Modelling Software (3D Visual Mod flow 15.1 and/or Modflow pro, GMS)
- Software for Interpretation of Geophysical survey results
- AutoCAD
- GIS and Image processing software

N.B: For Equipment to be imported as listed above or any proposed equipment by the consultant relevant to the assignment, the client will issue tax-free or exemption letter to Ethiopian Revenues and Customs Authority (ERCA) up on the request of the consultant.

5. Organization of the Assignment

Ministry of Water and Energy coordinate and manage the overall activities and all deliverables shall be submitted to them. Project coordinators shall be appointed by the Ministry to supervise the implementation of the entire works and coordinate the day-to-day activities.

The Consultant is required to elaborate in his technical offer on the envisaged logistical set-up and deployment of appropriate skills for the execution of the assignment. The consultant should carefully review the scope of

works and propose a team of well-organized competent staff, adequately equipped with the necessary skills/facilities to execute the assignment, bearing in mind that a substantial amount of work in this assignment is field based.

6. Team Composition and Qualification of Key Experts

The Consulting Firm should provide a team of experts all of whom shall be qualified and experienced in their respective fields and be eligible for registration with the relevant professional bodies. The following is the minimum qualification and number of personnel for both steps of the assignment:

6.1. Team Composition

6.1.1. Team Composition and Task Assignment of Study and Design Team

In this section, the Consultant is required to identify the Team Composition it intends to deploy for the Study and Design based on his appreciation of the services. It should also identify and assign the Tasks involved in order to deliver satisfactorily on the study outputs. However, a minimum number and type of key personnel to be deployed for Study are given in the Table 1:

Table 1 Proposed positions of the Consultants staff with maximum man-month for the service

SN	Proposed Position	Person	Person-Month (PM)		Total Person-month	Remark
			Office	Field		
1	Project Manager/ Team Leader	1	4	2	6	**6 Months**
2	Senior Hydrogeologist	1	3	3	6	
3	Senior Geophysicist	2	2	2	8	
4	Senior Geologist	1	2	2	4	
5	Senior Hydrologist	1	2	2	4	
6	Senior RS & GIS Expert	1	5	1	6	
7	Senior Socio-Economist	2	1	2	6	
8	Senior Environmentalist	1	1	2	3	
	Total	**18**			**43**	

6.1.2. Team Composition of Supervision Team of Test Wells Drilling

A minimum number and type of key personnel to be deployed for the supervision of drilling of test wells is given below with the accompanying man months in Table 3.

Table 3: Proposed positions and maximum person-month of test well drilling supervisions

SN	Proposed Position	Person	Person-Month (PM)		Total Person-month	Remark
			Office	Field		
1	Project Manager/ Team Leader	1	6	2	8	**8 Months**
2	Senior Hydrogeologist/ Senior Groundwater Modeler	1	4	4	8	
3	Supervising Hydrogeologists	2	0	8	16	
4	Senior Social Safeguard Expert	1	0	3	3	
5	Senior Environmental	1	0	3	3	
	Total	**4**			**38**	

6.2. Qualification of Key Experts

The Consultant shall identify and deploy a team necessary to carry out the assignment and should describe clearly the functions of each team member. The Consultant is however expected to provide a team, composed of the following key staff. The Consultant has the right to propose additional staff/competencies/short-term specialists as deemed appropriate for the successful execution of the assignment.

Table 1: Professional Requirement

No	Job Title	#	Qualification & Education	Specific Experiences	General Experience	Time-Month
1	Project Manager/ Team Leader	1	MSc in Hydrogeology/ Water Resources Engineering	At least 10 years of specific experiences in hydrogeology and groundwater development management of which 3 years in management of drilling operation and contract administration works	At least 13 years of general experience in Infrastructure Construction, Study and Design of Water Supply in WaSH/WRM/ Irrigation or construction sectors	14
2	Senior Hydrogeologist/ Senior Groundwater Modeler	1	MSc in Hydrogeology	At least 10 years of specific experiences in hydrogeological investigation, groundwater mapping and development, groundwater modelling, interpretation of geophysical results, borehole design and groundwater development, drilling supervision, contract administration able to work with water resource software (ArcMAP, QGIS, Aquifer Test, Aquachem)	At least 13 years of general experience in groundwater source investigation, Study and Design of Water Supply in WaSH/WRM/ Irrigation or drilling sectors	14
3	Senior Geophysicist	2	MSc in Geophysics or related fields	At least 8 years experiences in geophysical application to water source mapping (groundwater investigation and borehole logging), analysis and interpretation, able to apply various geophysical exploration methods, experience in borehole geophysical logging	At least 10 years general experiences in geophysical investigation for groundwater exploration in WaSH/WRM/ Irrigation or construction sub sectors	8

No	Job Title	#	Qualification & Education	Specific Experiences	General Experience	Time-Month
4	Senior Geologist	1	MSc in Geology and related fields	At least 10 years of specific experience in geological and geomorphological investigations, mapping, able to use remote sensing images, to extract geological structures and mapping of geology, GIS skill, knowledge of stratigraphy and structural geology.	At least 13 years of general experiences in geological studies and mapping in WaSH/WRM/ Irrigation or construction sectors.	4
5	Senior Hydrologist	1	MSc in Hydrology/ Water Resources	At least 10 years of specific experience in hydrological studies and projects including fieldwork, data analysis and modelling, able to use various hydrological software (HEC-RAS, HEC-HMS, SWAT) to model surface water interaction with groundwater, skill in GIS and Remote sensing	At least 13 years of general experience in streamflow and river studies, watershed management, flood risk assessment, climate impact studies, adaptation strategies, integrated water resources management (IWRM)	4
6	Senior RS & GIS Expert	1	MSc in RS & GIS or related fields	At least 10 years of in GIS and Remote Sensing, experience in various GIS and Image analysis software, use and analysis of various satellite images	At least 12 years of general experience of GIS, Remote Sensing or relevant mapping experience in water supply works and resource mapping, WaSH/WRM/ Irrigation or construction sectors	6
7	Supervising Hydro-geologists	2	BSC/MSc in Geology/ Hydrogeology or related fields	At least 10/8 years specific experiences in geological and hydrogeological investigations and mapping for water supply and groundwater potential studies, experience in well design, drilling works, pumping test, borehole geophysical logging and interpretation, borehole construction design	At least 12/10 years general experiences general experiences in groundwater studies and drilling works, hydrogeological mapping in WaSH/WRM/ Irrigation or construction sectors.	16
8	Senior Socio-economist	2	MSc Degree in Sociology or relevant and related fields	At least 8-years of specific experiences in socio-economic study works in the water sector	At least 10-years of general experiences in socio-economic study and design of Water supply projects of WaSH/WRM/ Irrigation or construction sectors	6
9	Senior Environmentalist	1	MSc in Environmental Engineering or related fields	At least 8-years of specific experiences in Environmental study works in the water sector	At least 10-years of general experience in Environmental study	3

7. Reporting and Schedule of Deliverables

The consultancy service is expected to last for a maximum of 14-months. Of this, 6-months are allocated for drilling and testing supervision of ten (10) test and/or pilot production wells to evaluate the groundwater resource. The drilling and testing result will be used to realize the achievement of overall hydrogeological investigation and it has to be completed within the allocated time. It is, however, the responsibility of the Consultant to establish a detailed work program within the above time frame, taking into consideration the estimated man-month requirements. This should be guided by their professional judgment of the assignment's requirements and knowledge of the local conditions and needs.

SN	Deliverable (Report)	Deliverable Contents to be included but not limited to	No. of Hard Copies (soft copy)	Time frame from commencement date (C) (Month)	Payment Schedule
PHASE I – Study and Design					
1	Draft Inception report (Stage-I)	The report includes: Intensive review of available documents and collected data, different thematic layers for multi-criteria overlay analysis delineated groundwater potential zones preliminary conceptualized hydrogeological models (Cross-sections and hydrogeological maps 1:250,000), identified data gaps for further phase works and proposed methodology and final work plan for the next Stages	5 Hard Copy 1 Soft Copy	C+1	-
		Review the draft report and forward comments to the consultant (1 Week)		C+1.25	
2	Final Inception report (Stage-I)	Final inception report submission after incorporating comments/feedbacks of Workshop-1	5 Hard Copy 1 Soft Copy	C+2	30%
3	Draft field survey report for selected prospective area (s) (Stage-II)	Comprises; inventory water points data, identified aquifers, source, rate and mechanism of recharge, discharge condition, geological and hydrogeological maps (1:100,000) with Cross-sections, geophysical, geo-electrical & pseudo-sections, regional as well as local groundwater flow systems, estimated hydraulic properties of identified aquifers, surface-groundwater interaction conditions, maps showing selected sites for test and/or pilot production wells drilling and testing (groundwater resource potential maps), specification and borehole drilling bid documents	5 Hard Copy 1 Soft Copy A0, A1 and A3 maps	C+3.5	-
		Review the draft report and forward comments to the consultant (2 Weeks)		C+4	
4	Final field survey report (Stage-II)	Final field surveys report submission after incorporating comments/feedbacks from the Workshop-2	5 Hard Copy 1 Soft Copy	C+4.5	40%
Phase II - Supervision of Well Drilling of Test Wells (8 months)					
5.1	Quality Assurance manual	1 Month from commencement of Stage 3 for the **Draft** and within two weeks of receipt of client comments for the **Final**.	5 Hard Copy 1 Soft Copy	Draft C+5.5 Final C+6	

SN	Deliverable (Report)	Deliverable Contents to be included but not limited to	No. of Hard Copies (soft copy)	Time frame from commencement date (C) (Month)	Payment Schedule
5.2	Bi-Monthly Progress Report and Drilling Supervision Report	The 1st week of every two (2) month except the commencement, the Quarters and the End of Project	5 Hard Copy 1 Soft Copy	C+7, C+9, C+11	
5.3	Test Well Drilling Completion Report - Report on Provisional Acceptance of works complete with Defects Liability report	Two weeks prior to issuance of provisional Completion of Works	5 Hard Copy 1 Soft Copy	C+12	
5.4	Project Completion Report	Two weeks after commissioning of works	5 Hard Copy 1 Soft Copy	C+12.5	
6	• Draft groundwater resource evaluation report (Stage-III), • Developed Groundwater database (Stage-IV) and • Training manual (Stage-V)	• Draft detail hydrogeological investigation and analytical/numerical groundwater flow modelling for specific target sites/well fields comprises mainly; major aquifers, hydrogeological operational maps (1:50,000) & cross-sections, drilling site maps (1:10,000), estimated total exploitable groundwater resource, groundwater recharge and water level dynamics under current and predicted climate changes, drilling of selected production well sites for intended purpose, • Enhanced groundwater database, and • Training manuals and 20-trained and capacitated participants	5, 20-training manuals A0, A1 and A3 maps	C+13	-
		Review the draft report and forward comments to the consultant (2 Weeks)		C+13.5	
7	Final groundwater resource evaluation report (Stage-III)	Final groundwater resource evaluation report after incorporation of comments and suggestions from Workshop-3	5 Hard Copy 1 Soft Copy	C+14	30%
8	3-workshops	At the end of Stage-I, Stage-II and Stage-III	-	C+1.5, C+3.5 and C+13	

All reports shall be submitted in both soft (MS Word, PDF) and hard copies. The hard copies will be prepared in A4 format, except for plans and drawings which should be prepared in A3 format. In addition, maps have to be prepared with A0, A1 and A3 size paper in five (5) copies. The reports should be clearly labelled, i.e., title of the study indicated, for easy identification and documentation purposes. All reports shall be prepared in the English language. Please note that the Consultant will be expected within one (1) week of submission of draft reports (Stage-I, II, III) to make presentations to the respected stakeholders. At each workshop, the Consultant shall make PowerPoint presentations, provide concise background documents for discussion and prepare workshop reports to document the proceedings. All cost of the venue and Client-side participants of workshop

will be covered by the Client and place of the workshop shall be as appropriate. Numbers of participants may be till 30 but all fee of the participants from the Consultant side (transportation and perdiem) will be covered by the Consultan