-TERMS OF REFERENCE-

GEOTECHNICAL SITE INVESTIGATIONS FOR FEASIBILITY STUDY OF BAWGATA LOWER HYDROPOWER PROJECT, MYANMAR

1. BACKGROUND

The Client is desirous to undertake a feasibility study to further develop the project identified and evaluated in the Bawgata HPP Pre-feasibility study (PFS). The proposed Bawgata Lower Hydropower (BLHP) is located approximately 14 kilometres east-southeast from Kyaukkyi town, Bago Division in Myanmar (Map reference- 94 B/ 15 46 4217).

Previously, a hydropower project in Bawgata River project has been identified and investigated by the Union Government. In February 2016, Thoolei Company Ltd., a company owned by Karen National Union (KNU), signed a MoU with the Ministry of Electricity and Energy, which gives Thoolei Company the right to conduct a feasibility study for Bawgata Hydropower Project.

The project has been identified on the desk level already in the 1950's, but only recently studied in more detail. The latest study is conducted by Norconsult AS for Thoolei in 2016-17. The findings and conclusions in this Pre-Feasibility Study (PFS) shall form the basis for the Feasibility Study to be undertaken. The PFS recommends proceeding with a 3-step cascade development in Bawgata River.

The Feasibility Study to be undertaken now is for only the Bawgata Lower Hydropower Development which was identified in the PFS as the most promising single project in the PFS.

The location and layout of the Bawgata Lower Hydropower Project are shown in the Drawings:

Drawing No.	Title
A200	Location Map
A201	Existing and Proposed Road Network Overview
A202	Power Transmission System Overview
A210	General Layout Plan 3 – Step Cascade Development

Note: Drawing A210 shows all three steps of the cascade development, only the lower stage is to be subject to investigation under these Terms of Reference.

2. OBJECTIVES

The Feasibility Study entails a comprehensive investigation program and an in-depth analysis with the aim to bring the project to a bankable standard with the aim to carry the project forward to detailed design and construction phase.

The geotechnical site investigation works detailed within these Terms of Reference are required in order to provide data and information for the Feasibility Study Consultants engaged separately by the Client.

The activities to be carried out under this assignment include investigation of geological and geotechnical conditions at the Bawgata Lower site including trial pits, core drilling, insitu testing in drillholes, seismic refraction profiling, and laboratory tests.

Activities under this assignment shall be undertaken under the technical direction of the Feasibility Study Consultants.

3. GEOLOGY, GEOTECHNICS AND SEISMICITY

Under the overall direction and supervision of the Feasibility Study Consultant prepare and carry out a detailed program for the geological and geotechnical investigation of the project area including the following:

- Trial pitting for construction material testing at relevant locations at the Bawgata Lower site
- Geophysical (seismic refraction) survey of ground in dam site, intake, adit/ surge tunnel, penstock and powerhouse sites
- Logged core drillings at dam site and other locations as per the plan proposed by the Consultant.
- Define ground water levels and rock mass permeability by permeability test at various intervals in rock and in overburden/gravel deposits in each drill hole.
- Survey of quarry sites and borrow area for construction materials.
- Conduct laboratory tests of rock and samples from joints/weakness zones fill material to verify relevant mechanical and chemical characteristics (e.g. compressive strength, abrasion, crushing value, swelling, alkali reaction) as directed by the Feasibility Study Consultant
- Laboratory soil testing to verify the soils characteristics as directed by the Feasibility Study Consultant.

The tentative Bill of Quantities for Geotechnical Site Investigation works is provided in Appendix A. This will be subject to review and possible amendment by the appointed Feasibility Study Consultant.

4 TIME SCHEDULE AND REPORTING

It is anticipated that the works shall be completed within 8 weeks.

Every month after commencement of work, the Contractor shall prepare a brief Progress Report in order to keep the Client and other relevant parties informed about the progress of the project. The necessary content of these Progress Reports shall be agreed with the Client at the outset of the study, but is envisaged to include project progress and staff inputs during the period, any issues which require attention and measures proposed to ensure the success of the contract.

The Contractor shall provide a Geotechnical Investigation Report to include:

- Location details and logs for all trial pits
- Location details and results for all seismic refraction profiles
- Location details and drill logs for all cored drillholes
- Photographs of all core boxes
- Results of all insitu permeability tests in drillholes
- Results of all observations of water levels in drillholes
- Results of all laboratory tests

All reports including appendices, drawings etc., shall be submitted both in paper copy and in electronic copy using internationally accepted software (eg. Excel or Word file). All reports/documents shall be prepared in English language and delivered to the Client.

5 RESPONSIBILITIES OF THE CLIENT

The Client will provide area permission for fieldwork upon 6 weeks written notice. The written notice must include the objective of the fieldwork, time schedule, list of involved personnel and their respective title and copy of passports.

The Client will brief the Contractor of potential safety aspects and measures prior to the field activities at the project site.

The Client may facilitate logistic support (food, transport and accommodation) at site if the Consultant requests this, but the Consultant at cost must cover the cost of this support.

The Client will appoint a contact person for the assignment who will be the main focal point for the Contractor. The Client will respond within two working days to all requests from the Contractor.

6 PARTICULAR CONDITIONS FOR THIS ASSIGNMENT

The Project is located in an area which for years has been a conflict area populated with different indigenous ethnic communities. It is important that the Contractor is updated on the conflict situation in the area and seeks input from necessary external experts with detailed insight in the conflict.

Respecting human rights and supporting and encouraging the peace-building process between the KNU and the GoM throughout all phases of the project will be of paramount importance.

It is not known that landmines have been placed in the project area. However, both sides of the conflict have presence near to the area, and there have been reports of landmines used in the conflict. The Contractor should be extremely cautious with respect to landmines. Before starting any fieldwork, he should check the issue with different well-informed sources. The Contractor is responsible for informing his field staff about the landmine risk and instruct them how to behave if any signs of landmines are identified. If any signs of landmines are identified, the fieldwork should be stopped and the Client informed immediately.

APPENDIX A: SPECIFICATION AND BILL OF QUANTITIES FOR GEOTECHNICAL INVESTIGATION WORKS

SECTION 1 GENERAL

SCOPE OF THE GEOTECHNICAL INVESTIGATION WORKS

The works to be carried out in this Contract comprise initial investigation at feasibility level of the geotechnical conditions at Bawgata Lower dam and power station sites in Myanmar. The Engineer has been commissioned to arrange and supervise this geotechnical investigation Contract.

The work at the Bawgata Lower site under this Contract is anticipated to comprise approximately:

50 No. Trial pits

10 No. vertical drillholes totalling 600 m length

2 No. raking drillholes totalling 200 m length

2000 m of seismic refraction profiling

In addition survey works are required to determine the position of the above-mentioned investigations.

BASIS OF THE BID

The Contractor shall make his own arrangements for communications and other equipment/items necessary for the completion of the Contract. An item is included in the Bill of Quantities to cover all the Contractor's costs in establishing and maintaining during the Contract period all the access tracks that he requires. The Contractor shall be deemed to have made his own investigations regarding his access requirements prior to submitting his tender.

CONDITIONS AT THE SITES

The Contractor shall be deemed to have satisfied himself as to the conditions at all work areas, particularly in relation to the access, topography and climate. He shall be deemed to have made his own enquiries and investigated all the factors likely to affect the work to be carried out in the fulfilment of his obligations under the Contract.

Photographs of the site taken during pre-feasibility studies are available for inspection by the Contractor.

USE OF THE SITE

General

The Contractor shall not use the Site for any purpose other than that of carrying out the Works. Disfigurement of the natural environment of the area during construction must be kept to a minimum and special care shall be taken to avoid permanent damage. Needless adverse effects on the local ecology and the habitat of the wildlife shall be avoided. Bushes and trees shall not be cut except where necessary for the execution of the Works. Throughout the duration of the Contract, the Contractor shall maintain the whole area of his operations in a clean, tidy and safe condition.

PROGRAMME OF WORK

Fieldwork is expected to be completed in 8 weeks.

SUPERVISION AND STAFFING

Feasibility Study Consultant's Personnel

The Feasibility Study Consultant (The Engineer) will have staff on Site. The Contractor shall satisfy the Engineer's Representative that the operations performed by the Contractor may be expected to provide the desired information.

Contractor's Personnel

The Contractor shall provide full-time on the Site a responsible and experienced drilling supervisor with authority to act upon instructions issued by the Engineer's staff. The drilling supervisor shall be trained and experienced in the description of soil and rock samples, shallow rotary drilling and deep diamond coring. The supervisor shall be provided with a copy of the Specification. The Contractor shall also provide other personnel as necessary to perform the drilling and testing satisfactorily.

METHODS OF WORKING AND APPLIANCES TO BE APPROVED

The work to be undertaken under this Contract is of a specialised nature. It is therefore essential that there should be technical discussions and full agreement between the Contractor and Engineer with regard to the working methods and techniques to be employed by the Contractor so that the results will satisfy the objectives.

STANDARDS

The definitions, equipment and procedures used in respect of rotary drilling, trial pitting, in situ testing, laboratory testing, sampling and recording of results shall conform with BS 5930, BS 1377 and BS 4019 or equivalent internationally recognized standards unless otherwise indicated or directed by the Engineer and shall be carried out using accepted standards of engineering practice.

SURVEYING

Under a separate contract the Topographic Survey Contractor shall establish survey monuments with permanent concrete markers at the site and shall establish the position of each monument using the GPS system (i.e. ‘X’, ‘Y’ and ‘Z’ coordinates).

Under this contract the Contractor shall carry out surveys to establish the collar elevations and positions of all drillholes, positions and surface elevations of the trial pits and positions of seismic refraction profiles.

Items are included in the Bill of Quantities for surveying the cross-sections of the dam for the seismic refraction profile, for survey of drillholes and trial pits and supplying to the Engineer a schedule of X', 'Y' and ‘Z’ coordinates (i.e. collar elevations for drillholes and surface elevations of trial pits) for all drillholes and pits.

CONTROL OF EMPLOYEES

The Contractor shall supervise and exercise proper control over all his employees on this Contract and take all responsibility for any damage caused by his employees to private or public property.

WATER SUPPLY

The Contractor shall make his own arrangements for all water required for the Works, including domestic potable water.

ELECTRIC POWER

Electric power is not available at site and the Contractor shall make his own arrangements.

SANITARY ACCOMMODATION

The Contractor shall establish, at his own expense, in the vicinity of the Site, proper and approved sanitary conveniences for the use of his employees and the Engineer's site employees. The Contractor shall keep the same in a thoroughly clean, sweet and orderly condition, and adopt all means necessary to prevent the sites from being polluted by such conveniences erected thereon.

HOUSING OF EMPLOYEES

The Contractor shall make his own arrangements for the temporary accommodation for his employees. At the completion of the Contract the Contractor shall remove all traces of temporary accommodation constructed by him at the exploration sites.

HEALTH AND SAFETY

The Contractor shall accept full responsibility for the health and safety of his personnel. In undertaking the Works, the Contractor shall comply with the provisions of any local statutory requirements relevant to health and safety on Construction Sites, including those where site investigation is undertaken. Attention is drawn to the fact that various tropical diseases are known to occur in the region of the site investigation work and proper precautions should be taken. The Contractor shall make his own arrangements regarding first aid services for his employees.

MATERIALS

The Contractor shall make his own arrangements for any materials required for the satisfactory completion of the Contract, with the provision that the Engineer shall approve the said materials.

The Contractor shall not use or remove any materials or objects found on the Site without the prior written approval or instruction of the Engineer.

WEIGHTS AND MEASURES

The metric system shall apply.

PROTECTION ON COMPLETION

Investigation holes shall be capped as directed by the Engineer. The area around each investigation site shall be left in a neat and tidy condition.

Trial pits shall be backfilled and compacted with spoil previously removed from the pit. Top soil shall be placed last.

EQUIPMENT

The Contractor shall supply a dip meter of suitable range for the maximum proposed length of drillhole for the period of the Contract.

SECTION 2 – GEOTECHNICAL INVESTIGATIONS

SEISMIC REFRACTION PROFILING

General

The Contractor shall carry out geophysical investigations by generating shock waves near the ground surface, either from a small explosive charge or from a mechanical source, and accurately measuring the time taken for the first seismic or compression wave to travel from the point of origin to vibration detectors (geophones) at varying distances away. Continuous seismic refraction profiling shall be used to obtain the depth/velocity variations along the traverse to indicate primarily changes in rock types and also to delineate fracture zones and other major discontinuities. The depth to velocity interfaces shall be determined accurately at each geophone location.

Where required, s-wave velocities shall also be determined.

Seismic refraction investigation shall be carried out at the locations indicated by the Engineer.

The Contractor shall be responsible for obtaining all necessary licences for the use and storage of explosives on site if required.

Instrumentation

Multi-channel seismic recording systems shall be used capable of recording p-wave arrivals at 24 No. locations simultaneously.

The equipment shall be provided with adjustable signal gain control, frequency filters and a cathode ray tube for visual inspection of the seismic records.

The instrumentation shall be suitable for the recording of the seismic records on hard copy or digital tape/computer disk.

Data Acquisition

The data acquisition shall be conducted in multiples of 24 geophone seismic "spreads" with geophones spaced at suitable intervals for the equipment to be used and the expected geology at the survey location.

A minimum of 6 No. Energy Source Points (ESP's) shall be used for the data acquisition of every 24 geophone seismic "spread". Two ESP's shall be located with the "spread", two ESP's at reciprocal ends of the "spread", and a minimum of two ESP's at such a distance from the respective ends of the "spread" as to provide continuous data coverage from the target or "bedrock" refractors.

Energy Source

The energy source used by the Contractor shall be approved and sufficient to generate distinct p-wave arrivals at all geophone locations from all ESP's for arrival times up to 1000 milliseconds.

Data Processing and Interpretation

The p-wave arrival times shall be plotted on graph paper at a time/distance scale of 1:250, 1:500 or 1:1000 depending on the geophone spacing.

The processing of the refraction data shall be according to the principles of the Reciprocal Method of seismic refraction interpretations.

The interpretations shall make allowance for the possible presence of weak "early arrivals" and of "blind" and "hidden" layers.

The interpretation of seismic refraction data shall result in continuous velocity/depth profiles related to the objectives of the investigation, borehole and geotechnical test data.

An explanatory legend should accompany the interpreted profiles.

Criteria to be Used

The data acquisition and processing shall conform to a standard such that p-wave arrival times will be determined and compiled with a minimum accuracy of 1 millisecond on over 90% of all seismic records for arrival times up to 100 milliseconds.

The accuracy of the determination of arrival times shall be verified by objective criteria including the "picking" of records by second interpreters, standard deviation of time/distance curves and deviation of ESP/ESP reciprocal times.

The "bedrock interface" should be interpreted on the basis of 50% data redundancy, i.e. the time/distance curves should contain at least 50% data overlap from different ESP's originating from the "bedrock refractor".

All work sheets and records of the data acquisition and interpretation shall be retained by the Contractor for a period of not less than 36 months after completion of the investigation. They shall be made available for review to the Engineer upon request. The Contractor shall advise the Engineer within one month of the end of the 36 month period of his intentions with regard to this documentation.

Report Preparation

A report shall be prepared on seismic investigations with such detail as may be required for a comprehensive review of the data acquisition, processing, interpretation and conclusions, commensurate with the scope of the study.

The report shall contain:-

- the terms of reference for the investigation;
- a description of the site, topography and observed geology supported by a locality map and survey data of the seismic traverses, if available;
- details of the data acquisition including geophone and ESP layout, energy source and data quality;
- description of instrumentation and specification of the seismic recording system;
- representative examples of recorded seismic data and time/distance curves;
- description of the interpretation methods and routine;
- interpreted seismic profiles;
- legend and explanation of symbols used in the seismic profiles;
- conclusions related to the objectives of the investigation.

The Contractor shall submit four copies of the report within 4 weeks of the completion of the fieldwork.

ROTARY CORE DRILLING

General

Drilling shall be carried out at the locations indicated by the Engineer. If there are local surface features or other operations which would otherwise interfere with the drilling operation, holes may be relocated as agreed with the Engineer.

Equipment for Drilling

The drilling machines shall be the hydraulic feed type with a rotary cutting tool using diamond or tungsten carbide bits and equipped to recover cores from both very strong and weak rock and unconsolidated materials. The drilling machines used shall be capable of drilling to a depth of 100 m.

Core recovery equipment shall normally be double tube ball-bearing swivel type core barrels with the core-lifter located in the lower end of the inner barrel. In soft, loose or friable formations core barrels with face discharge bits may be required. The Contractor should therefore provide details of equipment he proposes to use and a detailed method statement describing the equipment and methods that are proposed in soft, loose or friable ground.

Size of Holes

The Contractor will be required to produce cores of minimum diameter 47 mm in rock drilling and 75 mm minimum diameter in soil and weathered rock up to 15 m depth where directed by the Engineer. To this end, the Contractor shall commence drilling at a suitably larger diameter where ground conditions dictate.

Drilling Procedure and Core Removal

Drilling shall be carried out in such a manner and using such sizes and types of core barrel and bits that the maximum of core is recovered. This requires close surveillance of wash water, drilling pressures, lengths of runs and all other factors significant to the nature of the material drilled. The core barrel shall be withdrawn and the core removed as often as may be necessary to secure the maximum possible amount of core. Removal of core by any method liable to cause fracturing of the core shall not be permitted. Lengths of core shall be removed from double and triple core barrels by the application of steady hydraulic pressure to the inner tube using a core plug.

Sampling and in situ testing will be carried out at intervals during the drilling operation and shall be recorded as described in later clauses.

Permanent standpipe piezometers shall be installed in the drillholes as described later.

Length of Coring Runs

Coring runs shall be limited to a maximum length of 3.0 m unless otherwise agreed by the Engineer. When less than 80% of the core is recovered from a run, the Engineer shall be notified and the run length reduced by 50% down to a minimum length of 0.5 m.

Removal if Core Blocking

The core shall be removed from the hole immediately, regardless of the length of run drilled, if blocking of the bit or grinding of the core is indicated.

Casing to Drillholes

Where drilling is being carried out in any stratum which is not sufficiently cohesive to stand firmly without a casing, or when directed by the Engineer, the drillhole shall be cased or stabilised. The Contractor shall ensure that casings are of a suitable size and are inserted in such a manner as to render them recoverable. The Contractor shall ensure that casing is sufficiently sealed at the base as to prevent leakage around the cased section of the drillhole during permeability testing.

Water Levels

All water levels encountered in drillholes shall be recorded. Water levels shall also be recorded each day both before the start and after the completion of drilling and at other times requested by the Engineer.

The Contractor shall keep a careful record of the behaviour of the drilling water (if used) including an estimate of the percentage return. When required by the Engineer, the Contractor shall take soundings to establish water levels in current or completed drillholes.

Stabilisation of Drillholes by Grouting

As an alternative procedure to casing for stabilising holes, improve drill flush returns or to facilitate seating of the packers used in permeability tests, the Contractor may in certain circumstances drill and grout provided that prior approval is obtained in writing from the Engineer and that the drilling and grouting procedures for any hole are to the satisfaction of the Engineer. The tendered rates for drilling shall be deemed to include for any such approved alternative procedure.

Handling, Storage and Labelling of Cores

Core Boxes

Core boxes shall be provided at each drillhole location before drilling commences. The Contractor shall supply core boxes of an approved design, constructed from metal sheeting with timber partitions. All timber used shall be treated to prevent deterioration, weathering or insect attack.

Sheet metal core boxes shall have tracks of 1.10 m length for each 1.00 m of drilling depth. The width of the tracks will be variable according to the size of the cores. The width of the boxes shall be of maximum dimension 0.35 m and they shall be equipped with a cover and lock.

The name of the Site, drillhole number, box number and depth section shall be painted on the inside and the outside of the cover and on the end of each box. Wooden markers indicating depth of the core shall be inserted at convenient intervals throughout the core box. Where core recovery is less than 100%, wooden core spacer pieces of appropriate length clearly identifying the missing lengths shall be placed in the core run. All markers and labels shall be made visible so as to be readable from the subsequent photographs.

Soil and highly weathered core shall be extruded into plastic "sausage" bags and placed in the core box. The drillhole number and depth of sample shall be written on the outside of the bag and on a suitable label to be placed inside the bag.

All undisturbed and disturbed soil samples and cores from cored holes shall be kept and stored in the core boxes as specified above. The boxes and bags shall be accessible to the Engineer at all times. On completion of each drillhole, core boxes shall be transported by the Contractor to the core store on Site.

Storage of Cores

Arrangements shall be made for the storage of cores in a weatherproof location during the course of the work. Such accommodation shall be kept secure from interference and protected from weather, including floods. On completion he shall deliver the core boxes to the Employer's premises at a time to be directed by the Engineer which is expected to coincide with the Contractor's demobilization.

Drilling Media

The drilling fluid shall normally be clean water i.e. containing less than 80 ppm of suspended solids. Settling tanks shall be used as necessary to remove finer solids. With the agreement of the Engineer drilling additives may be used. Precautions shall be taken to avoid any risk of pollution as a result of using drilling additives.

When permeability tests are to be undertaken, clean water shall be flushed through the drillhole before the test is undertaken.

It should be noted that drilling fluid flush returns may decrease or be lost due to high permeability zones that can be encountered at any depth. Therefore the Contractor shall ensure that sufficient supplies of water are maintained at all drilling sites in order to sustain drilling and testing progress.

RECORDS

General

Complete records of the drilling, trial pits, sampling and in situ testing shall be kept and submitted to the Engineer. In particular the following information is to be supplied:

(a) Depths, dates and times of excavation and of the extraction of each sample.

(b) For each hole the exact location, collar level, ground level (if significantly different from collar level), final depth of hole below collar level, and the depth of the top of each sample and of each penetration test.

(c) For each hole daily records showing name and type of rig, hole diameter, size, lengths and depth of casing used, drill bit type, date of installation and any evidence of caving or collapse of the hole.

(d) For each hole the elevation of the water level when first encountered and at the beginning and end of each day. After the completion of each core or sample extraction and before the commencement of penetration tests, the water level in the hole is to be allowed to find its natural position and this is to be recorded. If the progress towards equilibrium is so slow as seriously to impede the progress of the boring then this periodic measurement of the water level may be omitted, and the fact recorded.

(e) A continuous log, with depth recorded, of material recovered, viz. classification, grading, colour, odour, etc., based on visual examination. This log should include details of all anomalies and points of interest in all the materials encountered and in drilling and boring operations.

Particular Additional Requirements for Drillholes

The Contractor shall keep accurate records of all drilling, sampling operations, water level and temperature measurements as they are carried out. The records shall be made on an approved form and shall comprise:-

(a) Hours spent drilling, length drilled, nature of formation, changes of formation, location of fissures, and points of observation made during drilling, in particular where wash water is lost, core loss position, blocking of core barrel, cored material removed, stability of hole, rod vibration, change of water returns, colour and cores abstracted, together with details of all drillhole orientations.

(b) Groundwater levels in drillholes using an electrical water level measuring device accurate to 10 mm. All records should contain depth, date and time of day when the measurement was made.

(c) Rate of penetration in hours per metre when drilling, rotary head speed, feed pressure, pump/flush rate, drill bit type, number and wear.

(d) The accurate layout in core boxes of all cores recovered in such a manner as to produce a faithful record of the formation drilled. Marker blocks shall be inserted to indicate and record the depth of the drillhole at the end of each core run. Similar markers shall be inserted to indicate the depths at which core loss occurred or where core has been accidentally broken during removal from the core barrel or in handling. The core boxes shall be filled at the drillholes and then transported to and stored in a suitable store. Core boxes awaiting transport to a core store shall be stored above ground in weatherproof temporary stores. Box number, drillhole number and depth shall be painted or otherwise permanently marked on external sides of the core boxes.

(e) Photographs of each core box with the cores, the colour code card (supplied by the Engineer), a clear scale and a title card indicating drillhole number and core depths. All rock cores shall be wetted immediately prior to being photographed unless dry core reproduces a more representative image on the photographs. The photographs shall be taken in a consistent manner, in colour, in natural daylight, perpendicular to the core box avoiding shadows such that the core box in each fills the frame, and within a month of recovery by the Contractor. Digital files on a CD shall be submitted of each photograph for the approval of the Engineer and for his retention. If the quality of the photograph is not accepted by the Engineer, the Contractor shall photograph the cores at his own expense and within two weeks shall present a print for the approval of the Engineer. Depth markers shall be clearly visible in the photographs and the orientation of the core boxes shall be the same in each photograph. The photographic files shall become the property of the Employer.

Flowmeters and pressure gauges - evidence of calibrations and copies of calibration charts shall be supplied to the Engineer prior to commencing work and when otherwise requested.

Friction loss curves for packer equipment, all drill rods and pipework are to be submitted to the Engineer prior to commencement of the Works.

(g) The maintenance of a record book on the Works to record, independently of the Contractor's own private records, all information which may be required by the Engineer. This book shall be kept up to date, shall register all the required information within 12 hours and shall be available at all times for inspection by the Engineer. On completion of the Contract, this book shall become the property of the Engineer.

Standpipe Piezometers

The Engineer will direct those holes in which standpipe piezometers are to be installed as part of the investigation. Installations shall be carried out in holes after completion of the drilling and prior to the withdrawal of the casing. Piezometers shall comprise a Casagrande porous plastic tip comprising a cylindrical element protected by perforated rigid plastic tube and fittings. The porous plastic element should be of the low air entry type (e.g. Soil Instruments type IW 1.6 Casagrande porous standpipe piezometer) attached to lengths of tubing in accordance with the manufacturer’s specification. Piezometer and tubing shall be approved by the Engineer. The Contractor shall submit details of the proposed piezometers to the Engineer for approval. These details shall include the location and dimensions of the response zone.

A record shall be kept of the installation date, tip level, piezometer collar level (and its height relative to the drillhole collar level) and the initial reading of the water level within the piezometer.

PREAMBLE TO BILL OF QUANTITIES

1 - GENERAL PRINCIPLES

101 This Preamble and the associated Method of Measurement which follows are deemed to form part of the Bill of Quantities.

102 The Bill of Quantities is to be read in conjunction with all the other documents comprising the Tender Documents at the tender stage and the Contract Documents after award of the Contract.

103 Appropriate provisions of this Preamble shall also apply to the measurement of completed work in conjunction with the relevant Notes on Measurement.

2 - DEFINITIONS

201 The following words and expressions have the meanings hereby assigned to them unless specifically stated otherwise.

202 "Conditions of Contract" shall be as defined elsewhere in the Documents.

203 "Work" includes work to be carried out, goods, materials and services to be supplied, and the liabilities, obligations and risks to be undertaken by the Contractor under the Contract.

204 "Expressly required" means work which is shown on the Drawings, described in the Specification or ordered by the Engineer as a specific requirement pursuant to the Contract.

205 "Bill of Quantities" means the list of items giving brief identifying descriptions and estimated quantities of the work comprising the Contract and shall include this Preamble and the associated Notes on Measurement.

206 Expressions such as "depth 2-4 m" in bill items shall apply to operations within a range of depths which includes all depths exceeding 2 m but not exceeding 4 m. Thus the smaller dimension is excluded but the larger dimension is included.

207 "Supply" shall be deemed to include delivery to the Site and unloading to store unless expressly stated otherwise.

3 - WORK CLASSIFICATIONS AVAILABLE

Items in the Bill of Quantities have been allocated to whichever of the following alphabetical Work Classifications is considered to be appropriate:

Class A: General Items

Class B: Ground Investigation

4 - ARRANGEMENT OF THE BILL OF QUANTITIES

Mode of Description

401 To avoid unnecessary length, item descriptions will generally identify the component of the Works and not the tasks to be carried out by the Contractor.

402 Where the work identified by an item is specifically limited, the limitation will be stated in the item description.

Itemization and Description

403 Descriptions will identify the work covered by the respective items, but the nature and extent of the work is to be ascertained from the other Tender Documents, which shall be read in conjunction with the Preamble and Notes on Measurement.

404 Full detail or description may be omitted from an item description provided that, if necessary to aid clarity, an equivalent reference to the Drawings or Specification is given in its place.

405 Where a normal item description seems insufficient to identify clearly the particular work covered by the item, additional description will have been given to identify the work by reference to its location or other physical features shown on the Drawings or described in the Specification.

Ranges of Dimensions

406 Where all the components of work included in an item are of one dimension within a range given in the Work Classification, that one dimension will be stated in the item description in place of the range of dimensions given.

407 Where within one operation material has to be removed from an increasing depth as the operation proceeds and the words "in range" or "in range(s) of depth" are included against dimensions in the item description, e.g. "in range 2-4 m" (or in range(s) of depth), this means that there are separate items for measurement and payment of other ranges of depth during the course of that operation. For the above example, work at depths of 2 m or less, at 2-4 m and at depths exceeding 4 m would be billed under separate items. If all the work had a final depth of 2-4 m there would be separate items for 2-4 m and for depths not exceeding 2 m. It is unlikely that this will be applied to items other than certain items in Class B.

Quantities

408 The Tenderer must recognise that the billed quantities represent estimated quantities subject to variations on each item, and no claim shall be made for deficiency or over-run therein, actual or relative. Accordingly, while the Tenderer must complete his Tender using the estimated quantities shown, he shall do so on the understanding that these estimated quantities are only intended to give general guidance to the Tenderer, and to enable tenders to be compared on a uniform basis.

Abbreviations

409 The following abbreviations are applicable to the Bill of Quantities:-

	Abbreviation
Metre	m
Kilometre	km
Cubic metre	m3
Kilogramme	kg
Tonne	t
Sum	sum
Numbernr	
Hour	h
Week	wk

Bill Summary

410 A Provisional Sum for a general contingency (the General Contingency Allowance) will, if required, be given in the Bill Summary following the Bill Total, usually computed as a percentage thereof.

411 The Tender Sum is the Bill Total plus the General Contingency Allowance, if any.

5 - COMPLETION AND PRICING OF THE BILL OF QUANTITIES BY THE TENDERER

Insertion of Rates and Prices

501 Rates and prices shall be inserted in the Rate column of the Bill of Quantities, and elsewhere as instructed, in the currency as directed in the Instructions to Tenderers.

502 In inserting tendered rates and prices in the Bill of Quantities, the Tenderer thereby offers to perform the relevant items of work at those rates and prices, and declares that every rate and price which he submits in his Tender

(a) has been derived in a reasonable fashion;

(b) properly reflects the cost of doing the portion of the work to which that price or unit price pertains; and

(c) is inclusive of everything necessary to perform and complete in accordance with the Tender Documents that portion of the Work to which the price or unit price pertains including, without limiting generality, all supervision, labour, maintenance, Equipment, supplies, materials, facilities, overhead, profit and contingent expenses of every kind except as otherwise specifically provided for in the Tender Documents.

503 Page or Part totals, as appropriate, shall be carried to the Bill Summary.

Relationship to Other Documents

504 Certain clauses in the Conditions of Contract or Specification may be mentioned in the item descriptions contained in the Bill of Quantities but where no clause is mentioned the Contractor shall not be relieved of any of his obligations under the Contract. In general, a specification reference will be the first clause principally relating to the item but not necessarily the only clause.

505 The various prices and rates to be inserted in the Bill of Quantities are together to be the full inclusive value of the work described, including all costs and expenses which may be required in and for the construction of the work described, together with all risks, liabilities and obligations set forth or implied in the Tender Documents.

General directions and descriptions of work and materials given elsewhere are not necessarily repeated in the Bill of Quantities and reference is to be made to the Tender Drawings, Specification and other relevant documents for this information.

Operations included in a billed rate are generally listed only where it is felt necessary to differentiate between the content of a number of items, each of which covers a different part of a whole process. The use of the word "including" may be taken to highlight a particular operation but shall not mean that no other operations need be included in the rate. It follows that no claim for additional payment will be considered if based merely on the proposition that not all necessary operations within any item are included in any description or discussion. Thus, all necessary operations listed in or implied by the Specification and Drawings including supply, handling and fixing will be deemed to be included in the rates irrespective of whether some, all or none are specifically mentioned in the Bill, except where the item description gives a limit.

Procedure during Assessment of Tenders

508 The tenderer shall not alter or otherwise qualify the printed text of the Bill of Quantities unless so instructed by a tender addendum etc. Any alterations or qualifications made without such authority will be ignored during evaluation and the text of the Bill as provided will be used.

509 If there are any arithmetic discrepancies between a tendered rate and the corresponding amount in the Bill, the rate shall always be taken as correct during the assessment of tenders.

510 Items contained in the Bill of Quantities against which no rate or price is entered by the tenderer will be deemed to be covered by other prices or rates in the Bill.

NOTES ON MEASUREMENT RELATING TO GROUND INVESTIGATION

B.0 General

B.0.A The various billed rates shall together include for:

clearing vegetation to allow the investigation work to proceed.

disposal of excavated material and reinstatement of surfaces.

B.1 Rotary Drillholes

B.1.A Measurement for the number of drillholes shall include for the transport of drilling machines and appurtenances to a specified location and for the preparation of platforms, anchoring, setting-up and dismantling.

B.1.B Rates for drilling shall include all activities necessary to progress the hole to the required depth and shall include for water, mud, fuel, bits and wear and tear of equipment.

B.1.C Rates for drilling shall be applicable for all material – rock and soil shall be measured in 0.1m increments.

B.1.D Installation of casing shall be measured per metre length of hole cased.

B.2 Samples

B.2.A The provision of core boxes shall be deemed to be included within the rates for drilling and shall remain the property of the Employer. Rates for drilling shall include for obtaining cores and providing, marking, handling, temporary core storage on Site and delivery of core boxes to an address in Yangon.

B.3 Site Tests and Observations

B.3.A The rates shall include for all necessary transport, operations, personnel, equipment, materials and rig standing time involved.

B.3.B The rates shall include for all drillhole records including groundwater observations as the hole advances.

B.4 Trial Pits

B.4.A Rates for trial pits shall include for all activities necessary to progress the pit to the required depth and shall include for all tools, materials, fencing, support and for backfilling on completion.

B.4.B Rates for trial pits shall be measured in 0.1 m increments.

BILL OF QUANTITIES

Item No.	Item Description	Unit	Quantity	Rate (Birr)	Amount (Birr)
	PART 1: GENERAL ITEMS				
1	Insurances				
1.1	Insurance of Contractor's Equipment including vehicles	Sum	1		
1.2	Third Party Insurance	Sum	1		
1.3	Workmen's Compensation Insurance	Sum	1		
1.4	Maintenance of camp at Bawgata Lower site for duration of site activities	Sum	1		
	TOTAL FOR PART 1				
	PART 2: BAWGATA LOWER SITE				
Item No.	Item Description	Unit	Quantity	Rate (Birr)	Amount (Birr)
2.1	Mobilisation and establishment at Bawgata Lower site and demobilisation	Sum	1		
	Drillholes				
2.2	Set up rig at drillholes using conventional coring from the surface	Nr	12		
	Coring at NX size or larger and double tube coring equipment in holes drilled to the downward vertical depth, drilled in ranges of depth				
2.3	Within depth range 0-10m	m	100		
2.4	Within depth range 10-30m	m	200		
2.5	Within depth range 30-60m	m	300		
	Coring at NX size or larger and double tube coring equipment in raking holes, drilled in ranges of depth				
2.6	Within depth range 0-20m	m	40		
2.7	Within depth range 20-40m	m	40		
2.8	Within depth range 40-100m	m	120		
	Install Casing				
2.9	To drillholes to the downward vertical	m	100		
2.10	To raking drillholes	m	60		

	Site Tests and Observations				
2.11	Setup for insitu permeability (packer) tests	nr.	60		
2.12	Insitu permeability tests	h	300		
2.11	Supply and install steel pipe in drillholes and concrete surround with cover	nr.	12		
2.12	Survey position of drillholes	nr.	12		
	Seismic Surveys				
2.13	Provision of seismic equipment, mobilisation of team for seismic refraction traverse and demobilisation	Sum	1		
2.14	Survey of dam cross-sections and position of seismic traverses	M	2000		
2.15	Fieldwork for seismic survey, processing of data and interpretation of results	m	2000		
2.16	Production of report	Sum	1		
	TOTAL FOR PART 2				