Date: March 02, 2023

GEOTECHNICAL INVESTIGATIONS FOR PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT (SINDH)

Invitation of Bids for Geotechnical Investigations (Field and Laboratory Works)

Dear Sir,

Sealed bids (**Technical and Financial in separate sealed envelopes**) are invited in accordance with the attached **Technical specifications**, **BOQs** and **qualification criteria** from drilling Contractors / companies for carrying out the geotechnical investigations for the subject project.

The companies capable of carrying out subject work are requested to provide their Company's Profile and the following documents along with their sealed bids:

1. Valid PEC Registration Certificate
2. FBR & PRA Registration Certificates with proof of active tax payer
3. List of Similar Projects completed during last three years
4. Financial Capability
5. Equipment Capability
6. Personnel Capability
7. Litigation History
8. HSE Policies

The work comprises; execution of **fifty seven (57)** boreholes up to a maximum depth of 50 ft and **twenty one (21)** boreholes up to a maximum depth of 100 ft below natural surface level (NSL) by using straight rotary drilling method, excavation of **hundred (100)** testpits (10ft x10ft) up to a maximum depth of 10.0 ft**,** performance of SPTs & field permeability tests in boreholes, installation of **twenty five (25)** stand pipe piezometers, performance of field density tests in testpits, collection of disturbed/undisturbed soil samples, collection of water samples and laboratory testing of selected soil/water samples. The field and laboratory work shall have to be completed according to the following time schedule:

Minimum No. of Straight Rotary Drilling Rigs/ Percussion Boring Sets Required	Total Time for Completion of Field Investigations	Total Time for Completion of Field & Laboratory Investigations
02	60 Days	80 Days

Your bid shall be valid for a time period of ninety (90) days after the bid opening. **The work shall be executed under the instructions and full-time supervision of Consultant's Representative / geologists and the successful bidder shall mobilize to the site on three (03) days' notice after issuance of Letter of Award/Acceptance.**

The coordinates and ground elevations of all the boreholes and testpits by total station / differential GPS shall have to be provided to Thar Canal Consultants before completion of investigation at site by the Contractor.

The approved laboratory, where testing is to be carried out, shall be pursued by the successful bidder for timely completion of the assigned laboratory testing. The successful bidder shall be responsible for providing the interpretative geotechnical investigation report (including final borehole & testpits logs, sub surface profiles, summary of laboratory test results and detailed laboratory test result sheets, approach and methodology, interpretation of results, design criteria, design parameters, foundation design calculations, conclusions and recommendations etc.) to Consultants within the contract period.

The bidders shall submit a bid security amounting to Rs. 400,000/- at the time of submission of bids in separate envelope in the form of pay order or bank draft in favor of M/s. NESPAK.

Your **most competitive** sealed bids (**inclusive of all taxes**) in accordance with the attached specifications, BOQs and qualification criteria, should reach the office of the undersigned by 11:00 hours on date as mentioned in advertisement. Technical bids would be opened on the same day at 12:00 hours after their receipt in the presence of those bidders who wish to be present.

Financial bids would be opened after evaluation of Technical bids, at a time, date and venue announced and communicated to the technically responsive bidders in advance. However, the final decision to accept/reject any or all the bids as per PPRA rules solely lies with the undersigned. **Payment of the entire work shall be made by Consultants as per the terms and conditions mentioned in the specifications.**

Chairman BOM Thar Canal Project / General Manager / Head
Water & Agriculture Engineering Division
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QUALIFICATION CRITERIA OF BIDDING CONTRACTORS
FOR
GEOTECHNICAL INVESTIGATIONS
FOR
PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT
(SINDH)

1. Qualification Criteria

Qualification will be based on the criteria given in the following paras regarding the Applicant's experience, personnel and equipment capabilities, financial position and litigation history, as demonstrated by the Applicant's responses in the Forms attached as Annex-A to this Document. The Employer (Consultants) reserves the right to waive minor deviations, if these do not materially affect the capability of an Applicant to perform the contract by the Applicant.

Experience and resources of the Company intended to be employed as sub-contractor shall not be taken into account in determining the Applicant's compliance with the qualifying criteria. However, for joint venture, collective experience, resources and financial soundness of all partners shall be considered.

1.1 General Information

The Applicant shall provide general information of his / her firm as per the format specified in the Application Form A-1 attached in Annex-A.

1.2 Experience of the Firm

The Applicant shall meet the following minimum criteria:

1) Successful experience as Contractor in the execution of at least five (5) projects involving bulk of geotechnical investigations within the last three (03) years. This experience should specifically be of geotechnical investigations of similar nature. The Applicant will supply information as per the format specified in the Application Form A-2 attached in Annex-A.

1.3 Personnel Capabilities

The Applicant must have in his employment, suitably qualified and experience personnel to fulfill the positions tabulated below. The Applicant will supply information as per the format specified in the Application Form A-3 attached in Annex-A.

Sr. No.	Position	Qualification*	Minimum No. Required	Minimum Experience (Years)
1	Technical Manager	B.Sc. Civil Engg.	1	5
2	Site Geologist/ Supervisor / Engineer	M. Sc. Geology/ B.Sc. Civil Engg. / B.Sc. Geological Engg.	3	3
3	HSE Supervisor	HSE Certification course	1	1
4	Driller	Literate	4	3
5	Skilled Labor	-	As required	-

1.4 Equipment Capabilities

The Applicant should own, or have assured access to the following key items of equipment in full working order, and must demonstrate that, based on known commitments, these will be available for deployment on the proposed works.

Sr. No.	Equipment Type & Characteristics	Minimum Number Required
1	Straight Rotary Drilling rigs complete in all respects including drilling rods, bits, mud pumps etc. along with at least one stand-by rig.	2
2	Percussion boring set (≥ 250 mm diameter) complete in all respects including tripod, chisel/bit etc.	1
3	Casing set having various diameters for all types of boring at least 15 m in length with casing bits.	3
4	Core barrels (single tube & double tube) including coring and casing bits	3 each
5	Standard penetration test equipment complete in all respects (i.e. as per ASTM requirements) including all rods, split spoon sampler, hammer and containers etc.	4
6	Denison/Pitcher/Shelby samplers and tubes	10 each
7	Hydraulic jacks with all accessories for the extraction of casings	1
8	Electrically operated sounder for groundwater level measurement	1
9	Test pit excavation equipment, complete in all respects	4
10	Field density test (FDT) apparatus complete in all respect as per ASTM requirements.	5
11	Field permeability / water pressure test apparatus complete in all respects including hand auger apparatus for drilling.	2
12	Wooden box for the preservation of undisturbed soil samples	As required
13	Transport for mobilization of equipment	As required

The Applicant will supply information as per the format specified in the Application Form A-4 attached in Annex-A.

1.5 Financial Capabilities

The Applicant shall meet the following minimum criteria:

1) Annual turnover which is also termed as income from contracting for procurement of geotechnical investigations and is defined as billing for works completed during the last three (3) years of at least **Rs. 20.0 million** or the said figure has been achieved in any year during the last three (3) years.

The Applicant shall also provide evidence of financial health such as bank account statements, available line of credits, etc., to show the soundness of the Applicant's financial position for procurement of geotechnical investigations works. The Applicant will provide annual turnover of the geotechnical investigation works carried out by him during the last three years. The Applicant will supply annual turnover information as per the format specified in the Application Form A-5 attached in Annex-A.

1.6 Litigation History

The Applicant should provide accurate information on any litigation or arbitration resulting from Contracts completed or under execution over the last three (03) years. The Applicant will supply information as per the format specified in the Application Form A-6 attached in Annex-A. A consistent/ overwhelming history of award against the Applicant may result in rejection of the application. In case an Applicant claims Nil litigation, he shall submit the same statement on the letter head of his company.

1.7 Application of Health, Safety and Environmental Standards

The Applicant should provide the HSE Policies and supporting documentary evidence for the following:

i) First Aid Box
ii) Personnel Protective Equipments (PPEs)
iii) Standard Operating Procedures (SOPs)
iv) Health, Safety and Environmental (HSE) Policies
v) HSE staff

Annex-A

Application Form A-1 **Page___ of ____Pages**

General Information

All individual Applicants applying for qualification are requested to complete the information in this form. Nationality information (if applicable) is also to be provided for foreign owners as required under the PEC Bye-Laws as a Partnership.

1.	Name of Firm	
2.	Head Office Address	
3.	Telephone	Contact Person: Name: Title: Cell No.
4.	Fax	E-mail
5.	Place of Incorporation/Registration Certificates of the firm*	Year of incorporation/registration

*** Registration certificates must include:**

- Valid registration with Pakistan Engineering Council (PEC)
- Valid registration with Federal Board of Revenue (FBR)
- Valid registration with concerned Provincial Revenue Authority (PRA)
- Proof of active taxpayer of FBR
- Proof of active taxpayer of Punjab & Sindh Provincial Revenue Authority (PRA)

Application Form A-2 **Page___ of ____Pages**

Experience of the Firm

Name of Applicant: _____

Sr. No.	Name of Project	Value of Geotechnical Contract* (Pak Rs.)	Contract Duration

Attach copy of Letter of Awards / Project Completion Certificates for any five (5) latest projects.

Application Form A-3 **Page___ of ____Pages**

Personnel Capabilities

Name of Applicant: _____

Sr. No.	Name of Person	Qualification	Designation/ Position*	Total Experience

Attach CVs of the Key Staff Members.

Application Form A-4 **Page___ of ____Pages**

Equipment Capabilities

Name of Applicant: _____

Sr. No.	Equipment Description	Capacity	Number of Equipment	Working Condition a) Very good b) Good c) Satisfactory	Current Location

Application Form A-5 **Page___ of ____Pages**

Financial Capabilities

Name of Applicant: _____

Year	Annual Turnover (in PKR)
2021 - 2022	
2020 - 2021	
2019 - 2020	

Note: Financial soundness certificate from the bank(s) as specified in section 1.5 must be provided by the Applicant

Application Form A-6 **Page___ of ____Pages**

Litigation History

Name of Applicant: _____

Year	Award for or against Applicant	Name of Client, cause of litigation, and matter in dispute	Disputed amount (current value Pak Rs. or equivalent)

Health, Safety and Environmental (HSE) Policies Personal Protective Equipment (PPE) and Standard Operating Procedures (SOP) of the Contractor

Name of Applicant: _____

The Applicant should provide the following policies/supporting documentary evidence as required in Para 1.7.

A. HSE Policies

Please attach HSE Policies

B. Details of PPE Available with the Contractor

Sr. No.	Type of PPE	Total Number

C. Details of SOPs of the Contractor

Please attach the copies of SOPs

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS
FOR
GEOTECHNICAL INVESTIGATIONS FOR PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT (SINDH)

1. INTRODUCTION

1.1 General

The geotechnical investigations are to be carried out as part of Preparation of Feasibility Study of Thar Canal Project.

1.2 Scope of the contract

The purpose of the work specified herein is to determine the type, nature, thickness, arrangement, structure and texture of the various subsurface strata, conditions and engineering characteristics of the subsurface materials (soil / rock) as they exist to the depth and at locations specified. This is to be accomplished by drilling of boreholes, excavation of test pits, rock coring, in-situ testing, SPT and collection of disturbed / undisturbed samples from the project sites. The selected samples of soil, rock and water shall be tested in the approved laboratory for their physical, chemical and engineering properties. The Bill of Quantities (BOQ) for geotechnical investigations is attached with this bidding document. Moreover, the number of boreholes, their locations and respective depths, and the other quantities in BOQ may be varied as per site conditions and as directed by Site Engineer/Geologist. Such variations shall not affect the respective rates quoted by the Contractor in BOQ.

1.3 Work under instructions of Employer (Consultants)

The contractor shall carry out the specified works under the supervision of the Employer, his Representative or the Representative's assistants.

1.4 Mobilization

Within three (03) days of receiving a written order to commence the works, the Contractor shall mobilize to site for the execution of work as per agreed schedule. Mobilization shall consist of the delivery at the site of all plant, equipment, accessories, spares, materials, and supplies to be furnished by the Contractor; the complete assembly of all such plant and equipment in a satisfactory working order and satisfactory storage at site of all materials and supplies.

1.5 Permission to start the works

The Contractor shall not be allowed to commence the works until he has mobilized all the equipment mentioned in Qualification Criteria and any delay caused thereby shall not be allowed as a basis of a claim for additional expenditure or an extension of the time for completion of the Contract.

1.6 List of equipment which must be included but not limited to in items mobilized by the Contractor.

Sr. No.	Equipment Type & Characteristics	Minimum Number Required
1	Straight Rotary Drilling rigs complete in all respects including drilling rods, bits, mud pumps etc. along with at least one stand-by rig.	2
2	Percussion boring set (≥ 250 mm diameter) complete in all respects including tripod, chisel/bit etc.	1
3	Casing set having various diameters for all types of boring at least 15 m in length with casing bits.	3
4	Core barrels (single tube & double tube) including coring and casing bits	3 each
5	Standard penetration test equipment complete in all respects (i.e. as per ASTM requirements) including all rods, split spoon sampler, hammer and containers etc.	4
6	Denison/Pitcher/Shelby samplers and tubes	10 each
7	Hydraulic jacks with all accessories for the extraction of casings	1
8	Electrically operated sounder for groundwater level measurement	1
9	Test pit excavation equipment, complete in all respects	4
10	Field density test (FDT) apparatus complete in all respect as per ASTM requirements.	5
11	Field permeability / water pressure test apparatus complete in all respects including hand auger apparatus for drilling.	2
12	Wooden box for the preservation of undisturbed soil samples	As required
13	Transport for mobilization of equipment	As required

Note: All soil and water samples must be labelled and transported as per ASTM D 4220.

1.7 Demobilization

Demobilization shall consist of the removal from the site of all plant and equipment after completion of the work and leaving the site clear, clean and tidy to the satisfaction of the Employer. Employers' permission shall be sorted before demobilization from the site.

1.8 Plant and equipment

The Contractor shall keep on the site sufficient plant to meet the requirements of the work. The plant and equipment shall be in good operating condition and capable of efficiently performing the work as set forth.

1.9 Drillers and supervisory staff

The Contractor shall have on site, at all times, qualified, experienced, orderly and thoroughly competent persons including geotechnical engineers or engineering geologists who shall conduct and supervise drilling/boring operations, coring, sampling, logging and in situ testing. The Contractor shall remove from the site any of his employees that, in the opinion of the Employer do not meet these requirements.

1.10 Setting up at each hole

The Contractor shall make all the necessary arrangements for setting up at the location of each hole, everything necessary for carrying out the work specified at that hole, and for the preparation and reinstatement of the work areas, improvement to access routes and all other temporary works.

1.11 Housing and storage

The Contractor shall make his own arrangements for housing of his personnel and storage of the equipment and supplies at the site. However, the Contractor shall provide a temporary site office established in a tent and properly furnished for the Employer or Employer's Representative.

1.11 Health, Safety and Environmental (HSE) Measures

a) The Contractor shall ensure that all necessary measures are undertaken to maintain good health of its staff and hygienic conditions at the job site.

b) The Contractor shall ensure the safety of all the personnel engaged in the work including the Employer and his supervising staff, and shall take necessary precautions and preventive measures to that end including the use of personal protective equipment (PPE) and safe working procedures.

c) The Contractor shall take effective steps to assure that during the work no air, water or soil pollution is generated.

1.12 Interference with others

It is possible that the Employer may engage some other agency for the execution of other investigations at the Project sites, which will start within the period of this contract. The Contractor shall ensure that neither he nor his staff cause any interference with, as well as delays to any other agency working on or near the site and that his plant, equipment or supplies shall not prevent or hinder the movement of personnel or of plant, equipment or supplies belonging to others who are lawfully in the area. If the Contractor receives any complaint either verbally or in writing that his operations have caused or are causing delays or hindrance to others, he shall inform the Employer immediately and pass on the original or a copy of any written complaint received. Likewise, the Employer shall inform the Contractor of such complaint which he has received concerning the Contractor's operations.

1.13 Measurement of Quantities

The quantities shown in the BOQ are approximate. The payment shall be made on the basis of actual work performed in accordance with the specifications.

1.14 Submission of Field Data

The Contractor shall supply field investigation data from time to time as investigations progresses and complete data to the Employer within two (02) weeks after the completion of field work. This data shall include copies of all approved final logs, summary of laboratory test results, test result sheets, foundation design criteria, design recommendations etc. any relevant records prepared during the course of the contract including any alterations or amendments required by the Employer. Moreover, two (02) copies of interpretative geotechnical investigation report, prepared in ***FPS System***, shall be provided to the Employer in hard binding and one (01) in the form of digital file (editable format) saved on a compact disc. No separate payment shall be made for this work.

Order of work

The order of the execution of the work will be specified by the Employer.

2 DEFINITIONS

2.1 Holes

Any borehole or drill hole is referred to generally as a hole.

2.2 Boring

Boring shall mean advancing a hole using machine-driven bailer, drill-bit, chisel or clay-cutter. The rig used shall be called a boring rig and the hole formed shall be called a drilled/ augured/ percussion hole.

2.3 Rock Coring

A 'rock core' is true representative of rock mass retrieved after drilling activity on a specific depth vertical/ inclined/ horizontal of the shape of core recovery barrel.

2.4 Sample Tube

A 'sample tube' shall mean the container into which undisturbed soil is forced during sampling and in which the soil is extracted from the ground and stored, after sealing, against loss of moisture.

2.5 Sampler

A 'sampler' shall mean the sample tube and all the accessories that are required to obtain the disturbed or undisturbed sample of soil.

3 MATERIALS AND EQUIPMENT'S

3.1 General

The Contractor shall keep on the site sufficient plant to meet the requirements of the Works. The plant and equipment shall be in good operating condition and capable of efficiently performing the work specified. Site investigation work shall be carried out in accordance with the recommendations of the Employer.

3.2 Drilling Equipment

Rotary and percussion equipment capable of drilling to depths of 150 ft shall be supplied for drilling exploratory holes in overburden/gravely strata. Percussion equipment shall be of the cable-tool type except where otherwise approved by the Employer. Water jet equipment shall not be used. A sufficient number of rotary and percussion boring rigs shall be available for bore through overburden, or in lieu of this, the Contractor may provide rigs capable of drilling by both rotary and percussion methods. Sampling equipment to be provided shall include undisturbed samplers (like Pitcher, Denison and Shelby tubes), piston sampler, rock core recovery assembly and equipment for performing Standard Penetration Tests (SPTs).

4 WORKMANSHIP

4.1 General

Any quantities, patterns, spacing, types and depths of drilling given in these Specifications are tentative and may be altered or omitted as a result of the conditions revealed as work progresses.

4.2 Contractor's Experience

Unless the Contractor has satisfied the Employer that he is skilled and experienced at drilling and has successfully completed drilling work of a similar nature and extent, the Contractor shall employ an approved specialist subcontractor to undertake the drilling.

The experience and qualifications of the drilling supervisors shall be subjected to the prior approval of the Employer. The Contractor shall have on site, at all times, experienced graduate engineers or geologists who shall conduct and supervise the drilling, sampling, logging and in-situ testing.

4.3 Location of Holes

The Employer (Site Engineer/Geologist) will specify the exact location and reference number of all holes, but locating the holes accurately in the field shall be the Contractor's responsibility. Before work is started in connection with each hole, the Contractor shall confirm its position and required depth with the Employer. These details shall be recorded either in the form of a written instruction from the Employer to the Contractor, or if this is not received, by written confirmation from the Contractor to the Employer before work commences.

The Contractor shall measure and record the ground level at every borehole position so as to establish the point from which depth measurements are taken.

The Employer will indicate the type and maximum depth likely for each hole before it is started, and the Contractor shall use the equipment necessary for continuing the hole to that depth.

4.4 Drilling

4.4.1 General

Drill holes may be vertical, inclined or horizontal as directed by the Employer. All reasonable care, including the use of stabilizers fitted to the drill-string in rotary drill holes, shall be exercised to ensure that deviations from the specified inclination are kept to minimum. When required by the Employer, the verticality or inclination of any hole shall be checked by an approved method.

No lubricants shall be used in drill holes other than an adequate supply of clean water, unless specifically approved by the Employer. The use of drilling mud may be required by the Employer for drilling in certain holes, but shall not be used unless specifically approved by the Employer.

Water shall not be added or removed from a hole when, in the opinion of the Employer, such action might adversely affect undisturbed sampling and the results of in situ tests.

When drilling is carried out in any material which is not sufficiently cohesive to stand firmly without a casing, casing shall be used. Casing shall of a suitable size and shall be inserted in

such a manner as to be recoverable. Casing shall not be removed from any hole nor any filling introduced into a hole until permission is given by the Employer. This permission will normally be given as soon as work in the hole is completed and the groundwater level has been measured as specified herein. Casing shall be gradually withdrawn keeping the level of the backfill or grout above the bottom of the casing during withdrawal. The Contractor shall, as much as possible, avoid leaving a hole overnight after he has begun to withdraw the casing and before he has finished.

Any hole which becomes clogged or obstructed by caving or for any other reason before completion of the operation shall be cleaned out to the satisfaction of the Employer, or an additional hole shall be drilled. Blasting shall not be allowed for breaking up material encountered in a hole except with the written permission of the Employer.

Any hole that is abandoned before work on it is completed and any hole from which unsatisfactory samples have been obtained or in which unsatisfactory field tests have been performed shall be rejected and replaced by another hole adjacent to the original location. The exact location of any such replacement hole will be specified by the Employer. Penetration of a replacement hole to depth to which the rejected hole was satisfactory completed may be made by any method selected by the Contractor which, in the opinion of the Employer, will permit satisfactory completion of the replacement hole and any testing or sampling below that depth.

Logs of holes shall be provided on forms supplied by the Contractor in accordance with examples which will be provided by the Employer. They shall include descriptions of all strata and details of samples taken, and an account of all observations and field tests.

All logs shall be subject to the approval of the Employer, and two draft copies shall be submitted to the Employer not more than 5 days after the hole is backfilled. Soil descriptions shall conform to the recommendations given in BS 5930. All depths and thickness shall be recorded in metres and all reduced levels shall be recorded in metres and to the datum established by the Employer's representative on Site.

The presence of the Employer, who may keep separate drilling records, shall not relieve the Contractor of any of his responsibilities for keeping records.

4.4.2 Rotary Drilling of Exploratory Holes

The Contractor may be required to carry out drilling under the direction of the Employer to obtain cores to investigate subsurface conditions. Where core recovery is required, the minimum size shall be 4 inch in soft soil and rock.

Drilling shall be carried out in such a manner that the maximum amount of core is recovered. To achieve this, close surveillance shall be given to drilling fluid, drilling pressures, lengths of runs and all other factors relevant to the nature of the material being drilled. The drilled material shall be withdrawn and the core barrel removed as often as may be necessary to recover the maximum possible amount of core. Coring runs shall normally be limited to 5 ft. when core recovery is less than 80%, coring runs shall be limited to 1.65 ft. unless otherwise directed by the Employer. The core barrel shall be removed from the drill hole immediately if blocking of the bit or grinding of the core is apparent, regardless of the length of run which has been made.

Where required or ordered by the Employer, the casing shall be advanced in sequence with each coring run, and the casing shoe shall be kept within 3 ft. of the core bit face.

4.4.3 Percussion Drilling of Holes

Where exploratory holes are drilled by percussion method, the Contractor shall avoid any unnecessary disturbance to the material and shall ensure that:

- The water level in the hole shall be maintained slightly above the water table in the permeable stratum.
- During percussion drilling, the casing shall be kept at least 6 inch ahead of the bottom of the hole, except where, in the opinion of the Employer, it is impossible to advance the casing so far. The bottom of the casing shall never be higher than 6 inch above the bottom of the hole except where the Employer has ordered a borehole to be depended without lowering casing to form a greater length of open hole for preliminary testing.
- Close – fitting tools shall be withdrawn slowly to avoid suction pressures.
- If any obstruction such as timber, brickwork, concrete, boulder or other material is encountered in any hole and such obstruction cannot be removed unless if first be broken up by the repeated use of a heavy chisel or other similar tool, the Contractor shall immediately inform the Employer and either await the Employer's instruction before proceeding any further; or endeavour to break up and remove the obstruction immediately. The Employer will instruct the Contractor as to which course is to be followed at beginning of each hole or set of holes. A small sample shall be taken of the material forming the obstructions.

The casing shall never be in advance of the bottom of hole by more than 150 mm (6 inches) during undisturbed sampling or standard penetration tests. When instructed by the Employer, it shall be withdrawn so that the bottom of the casing is less than 150 mm (6 inches) below or level with the base of the hole at the time of sampling or testing.

Two sizes of bailer shall be available to work with each size of casing. The smaller bailer, which shall generally be used, shall have an outside diameter between 175 mm (7 inch) and 125 mm (5 inch) smaller than the internal diameter of the casing. The larger (close fitting) bailer, which shall only be used when in the opinion of the Employer, it is impossible to advance the hole with the smaller bailer, shall have an outside diameter not more than 50 mm (2 inch) smaller than the internal diameter of the casing. The area of aperture through which the soil must enter at the base of the bailers shall be not less than 50 per cent of the overall cross sectional area of the bailers.

When directed by the Employer, the Contractor shall suspend percussion drilling, clear the hole of any obstacles and set up a stand-by rotary rig to drill in advance of the bottom of the percussion drill hole. 5 inch diameter casing shall be lowered to the bottom of the hole before the start of rotary drilling and shall be kept as close as practicable to the bottom of rotary drill-hole. While rotary drilling, the Contractor shall install a T-piece on the top of the 5 inch diameter casing so that returning flush water is discharged outside the large diameter casing and may be sampled easily to determine the nature of the cuttings. The Contractor shall carry out Standard Penetration Tests through the 5 inch diameter casing when instructed by the Employer. After the completion of rotary drilling and any tests ordered to be carried out through the 5 inch diameter casing, that casing shall be pulled out of the hole, the rotary rig shall be removed and shifted to its stand-by position, and the hole shall be cleared of any obstacle which may hinder the resumption of percussion drilling to advance the hole.

The material removed from all percussion drill-holes, except for disturbed samples in their containers and undisturbed samples in their samplers shall be laid out in sequence on a clean dry board for examination by the Employer. The material shall be displayed in such a manner that, when required by the Employer, further disturbed samples can be taken unmixed with other material. No material shall be removed from the board until authorised by the Employer.

All the material displayed shall be protected from adverse effects of the weather including sun and rain.

4.5 Sampling

4.5.1 General

The Contractor shall take samples from any drill hole when ordered to do so by the Employer. This shall include the provision of all necessary sampling equipment, tubes, containers, crates and boxes, core boxes, as well as handling and transport to the laboratory or store.

The contractor shall be responsible for the safe keeping of samples of all kinds until they have been handed over to the Employer or disposed of at the Employer's instructions, as the case may be. Any sample lost, damaged or showing signs of deterioration while in the Contractor's care shall be replaced by the Contractor. All samples shall be transported to the Contractor's laboratory or store at the Site the day the samples are collected. Samples in tubes shall be transported with the tubes in a horizontal or vertical position as instructed by the Employer.

4.5.2 Labelling of Samples

The Contractor shall assign a reference number to each soil and water sample taken from a hole. The number shall be unique for that and shall be in order of depth below ground level.

All samples taken from drill holes shall be clearly labelled. Each label shall include the following information:

- Name of Contract
- Reference number of the hole
- Reference number of sample
- Date of sampling
- Brief description of the sample (e.g. sandy gravel)
- Depth of the top and bottom of the sample below ground level
- Number of the sample tube (if relevant).

Tubes and crates for undisturbed samples shall be labelled 'Do not jar or vibrate' in English and translated in Urdu.

4.5.3 Disturbed Samples

All large disturbed samples shall be sealed into heavy duty plastic bags of at least 500 micron thickness immediately after they are taken. The sealed bag shall then be placed inside another similar plastic bag. Each outer bag shall be labelled as specified and a second label giving the same information shall be placed inside the outer bag.

Small disturbed samples shall be taken from the split spoon samplers used for Standard Penetration Tests. When the samples have been taken they shall be placed without delay in airtight glass jars of not less than 1.1 lb nominal sample size, and each sample shall fill the jar as nearly as possible.

4.5.4 Field Moisture Content Samples

Samples for field moisture content shall be taken with (and separate from) each small disturbed sample or as otherwise instructed by the Employer. The samples shall be placed in air tight containers immediately after sampling and shall fill the containers. The containers shall be kept wrapped in damp cloths in boxes and delivered to the site laboratory within four

hours of sampling.

4.5.5 Open Drive Undisturbed Samples

Undisturbed samples up to 100 mm (4 inches) diameter shall be taken in sands and fine-grained soils, at changes of strata, and at intervals of 2 m in any stratum thicker than 2 m or otherwise as directed by the Employer. Continuous undisturbed sampling may be required in some holes when directed by the Employer.

The use of oil inside the sampler shall be limited to the minimum practical. The end of the sample tube marked 'TOP' shall be driven uppermost. Care shall be taken to ensure that the sample is not compressed by overdriving. The dimensions, construction and condition of each sample tube, cutting shoe and adaptor head shall be subject to the approval of the Employer.

The Contractor shall make every effort to avoid disturbance of the material to be sampled. The debris in the bottom of the hole shall be cleaned out as much as possible before sampling by careful use of the clay-cutter or bailer. The Contractor may try two or three different types of samples such as Denison, Pitcher or Shelby as directed by the Employer, to improve the quality of sampling.

Before withdrawal of the sampler, the sampler shall (if practicable) be rotated through one complete revolution to shear the soil horizontal at the bottom of the sampler. The sampler shall then be withdrawn smoothly so as to cause the minimum disturbance to the sample. The total length of the sample shall be measured and recorded and, if any of the soil has fallen out of the bottom of the tube, this fact shall also be recorded.

4.5.6 Preserving Undisturbed Samples

After removing the cutting shoes and the adaptor head with the disturbed material which they contain, the visible ends of the sample shall be trimmed of any wet disturbed soil and then immediately coated with not less than four layers of just molten microcrystalline wax or other similar material approved by the Employer. A material foil disc with diameter 0.4 inch greater than the diameter of the tube shall then be added and followed by more layers of molten wax to give a total thickness of not less than 1 inch. Any space remaining in the ends of sample tube shall be completely filled with damp sawdust or other material approved by the Employer and the ends of sample tube shall be covered with tight fitting screw caps.

The sample tube shall immediately be labelled as specified. A second label giving the same information shall be placed inside the sample tube at the top end.

Every precaution shall be taken to avoid damage to the undisturbed samples during transportation. Samples shall be transported in wooden boxes made from 0.5 inch or thicker timber, and with a capacity of six samples. The samples shall be well packed in suitable material to protect the samples against vibration. The Contractor shall not expose packed samples to direct sunlight or extreme temperatures. The samples shall be stored in the sheds.

4.5.7 Core Handling

The cores obtained from drill holes shall be carefully removed from the core barrel by means of a hydraulic or pneumatic core extruder onto half-round channel or split pipe of similar diameter to the core. The core shall then be lifted off that channel and placed without delay onto the plastic wrapping sheets in the core boxes. The plastic sheets shall be wrapped around the core so to overlap at the top of the core and shall be sealed at the ends and along the side with adhesive tape, in order to preserve the original moisture content. The depth at the top and bottom of each run of core shall be indelibly marked on the wrapping and 'TOP'

marked at the upper end. Field moisture content samples shall be taken as directed by the Employer.

Where the core is contained in an expendable triple tube liner, the ends of the tube shall be sealed and waxed as described for undisturbed open drive samples. Field moisture samples shall be taken from the part of the core remaining in the bit.

The Contractor shall place the cores in core boxes in correct sequence and with each run segregated accurately be labelled wooden blocks 25 mm thick according to the measured depth in the drill holes. Cores of different size shall not be stored in the same box. No box shall weigh more than 112 lb when full. The depth of the bottom of all runs shall be neatly marked on the partitions with paint.

Pieces of rock shall be carefully fitted together as close as possible to their relative positions in the ground. Core losses shall be shown as wooden blocks each of a length equal to that of the core lost; these should be inserted immediately after the core is placed in the core box.

4.5.8 Marking and Storage of Core Boxes

The core boxes shall be marked prominently and clearly on the top, sides and ends or as directed by the Employer using waterproof black paint. The markings shall include the name by the Contract, the working area, the drilling number, box number and the total number of boxes for the drill hole. The same markings shall be painted inside the lid. The marking shall be sufficiently large and clear to be legible in the photographs taken in accordance with the Specifications.

Until the boxes containing the cores are transported from the working areas, they shall be neatly stored under weatherproof cover at the drill hole locations in such a manner that inspection of the cores can easily be made.

At intervals throughout the contract period, or at the end of the contract period, the Employer will direct the Contractor either to dispose of the cores and boxes or to move them to a permanent storage site.

4.5.9 Core Photography

The Contractor shall take colour photographs of cores in core boxes. Each photograph shall be taken from vertically above and shall be of two core boxes containing adjacent core runs. Plastic wrapping shall be folded back to expose the core and shall be folded over and resealed with adhesive tape immediately after the photographs have been taken. Similar colour photographs of triple-tube cores shall be required on their exposure in the laboratory and the cores shall be resealed on completion of the photography.

Within one month after core recovery, the Contractor shall submit to the Employer 3 colour prints not less than 4 inch x 6 inch. The prints shall remain the property of the Employer.

4.5.10 Core Samples

Cores recovered from drill holes shall be taken for use as samples for laboratory testing when directed by the Employer. Such samples shall be cut from the core as ordered by the Employer, either after it has been extruded onto the channel or split pipe from the core barrel, or after the core has been placed in the core box. A spacer bearing the sample number shall be placed in the core box to fill the space which would have been occupied by the core sample.

Immediately after they are taken, samples shall be coated with microcrystalline wax and cheese cloth or other similar material approved by the Employer. The coating shall be built up in layers to a total thickness of not less than 0.2 inch in order to seal the samples against loss of moisture by evaporation. The samples shall then the packed with straw or sawdust against loss of moisture by evaporation. The samples shall then be packed with straw or sawdust boxes for transport to the Contractor's laboratory. The wooden boxes shall become the property of the Employer. The samples shall be stored in the manner prescribed for undisturbed samples. The top of the sample shall be clearly marked before it is waxed and on the outside of the wax. Labels in accordance with the Specifications shall be placed inside the wax, outside the wax and on the wooden box.

4.5.11 Core Boxes

Core boxes shall be made of 0.75 inch thick timber with 0.75 inch thick partitions, and shall be safe against attack by termites. The bottoms shall be screwed on and the covers shall be hinged and securely padlocked at the end of each working period. Carrying handles shall be provided at each end of the box. No box shall contain more than 16.5 ft of core from 4 inch diameter holes and not more than 10 ft of core from holes larger than 4 inch diameter.

A separate continuous plastic sheet shall be provided to wrap all the cores placed in each channel formed by the partitions in the core boxes. The sheet shall be wide enough to wrap around the core with an overlap of 2 to 3 inch. Adhesive tape, to seal the edges and ends of the plastic wrapping, shall be suitable for damp as well as dry conditions and shall be suitable for unsealing without tearing the plastic wrapping.

The core boxes shall become the property of the Employer after the core has been permanently placed therein.

4.5.12 Temporary Core Shed

The Contractor shall provide a temporary lockable core shed or sheds large enough to contain all the boxes of core and allow easy inspection of the core while protected from the weather.

4.5.13 Water Samples

The Contractor shall take water samples from drill holes before the addition of water to the hole unless this is impossible. If necessary, the hole shall be bailed out before taking the sample to ensure that any potential contaminant is removed. No fuel or other potential contaminant shall be allowed to enter the drill hole. Samples shall be stored in approved air-tight and clean containers, and shall not be less than one litre in volume, labelled in accordance with the Specifications.

4.5.14 Water Level Reading in Holes

Reading of water levels in holes shall be taken with an electrically-operated sounder and recorded in the daily field records and logs at the following times:

- Before work commences in the morning.
- After work has finished in the evening, both before and after water (if any) is added to stabilize the hole.
- When a hole has been completed.
- Immediately prior to backfilling a hole.
- At the time of undisturbed sampling and standard penetration and other in situ tests.
- When the Employer requires.

An electrically operated sounder in good working order shall be maintained at each drill hole where work is in progress, whether or not water has previously been observed in that borehole. The level of the bottom of the drill hole and the bottom of the casing, if any, shall be measured and recorded at the same time as each water level reading. The times when water levels are measured shall also be recorded.

If, at any time, the level of the water in a drill hole fluctuates, a record shall be kept of the fluctuation. If the hole 'makes' or 'loses' water, the Employer shall be informed immediately, and any extraordinary smell or colour of the water and any other unusual circumstances shall be reported. Any addition of water to assist the advance of a drill hole shall be recorded.

The groundwater level in drill holes shall be determined after completion of the hole as follows. Clear water shall be added, or the hole shall be bailed out as necessary, to bring the water level to the expected groundwater level as directed by the Employer, and the water level shall be recorded. The water level within the casing at the start of normal working hours on the morning of the next working day shall be recorded.

5 TESTING

5.1 Standard Penetration Tests (SPTs)

When directed by the Employer, the Contractor shall carry out Standard Penetration Tests (SPTs) in any type of material. The penetration will be performed using a 140 lbs hammer, dropping freely from a height of 0.750 m (30 inches) to force the standard split barrel sampler 0.45 m (18 inches) into the soil. The penetration resistance 'N' shall be expressed as the number of blows of the number required to force the sampler the last 0.3 m (12 inches) into the soil.

The bevelled edge of the drive shoe shall be maintained in good condition and if worn, shall be re-sharpened to the satisfaction of the Employer. A damaged or bent drive shoe shall not be used. It shall be replaced if damaged in such a manner as to cause projections within the interior surface of the shoe. No liner shall be fitted in the split barrel sampler. When directed by the Employer, a core-ended adapter with a 30 degree half angle shall replace the open ended drive shoe for use in gravelly soils.

Standard Penetration Tests shall be carried out in holes when directed by the Employer during the progress of the work. If the Employer or Contractor has reason to believe that the hole has entered a layer which consists predominantly of sand or finer soil, percussion drilling shall be stopped after cleaning the bottom of the hole, taking care to bail out all the loosened material which could have remained in the hole above the test level. Then a rotary drilling machine shall be installed for drilling 100mm (4 inch) diameter holes, and 100mm (4 inch) external diameter casing fitted with a casing bit at the bottom should be lowered to the bottom of the percussion hole. The hole should then be drilled 200mm (8 inches) below the bottom of the percussion hole using mud and tricone bit. The 4 inch casing also should then be advanced by 200mm (8 inches) by rotating with wrenches. If, in the opinion of the Employer it is impossible to advance the casing with wrenches it may be advanced using the rotary drilling machine but in no case may the 100mm (4 inch) casing be driven by hammering. The depth of the hole shall be checked by sounding and the hole should be drilled again, if necessary, using a tricone bit with mud flush, to ensure the hole is open to the base of the casing but no deeper. The 100mm (4 inch) dia casing shall remain filled to the top with mud slurry all the time. During the process of boring, washing or cleaning the hole, care shall be exercised to ensure that the material to be tested and sampled in not disturbed by these operations. The 100mm (4 inch) diameter casing shall not be in advance of the bottom of the hole where the test is to be conducted.
If the number of blows required to the drive the sampler including the seating drive exceeds

seventy five, the test shall be terminated even if the required penetration of the sampler has not been obtained. In such cases the number of blows and the penetration attained shall be recorded.

Immediately after each test, the sampler shall be carefully taken apart and any soil sample collected shall be classified. The most representative portion of the soil sample from the bottom of the sampler shall be placed in an airtight container. This soil sample shall be considered as a disturbed sample. After performing the first test in this way, the hole shall be drilled with the tricone bit and mud flush, and soundings shall be taken to ensure that the hole is clean to the bottom of the previous test. Then a second SPT shall be performed in the same manner as described above. The 4 inch diameter hole shall then be advanced to the bottom of the second test using the tricone bit and mud flush, and then the 100mm (4 inch) diameter casing also shall be advanced to the bottom of the hole as previously specified. The 125 mm (5 inch) diameter hole shall be cleaned to the level of the bottom of the casing using the tricone bit and mud flush taking precaution to avoid disturbance. Soundings shall then be taken to ensure that the hole is clean to the bottom. Then an undisturbed sample shall be taken with a sampler in accordance with the provisions of Contract. The sampler shall be withdrawn and dismantled carefully to avoid disturbance, and the sample shall be waxed properly in the field. Subsequently, undisturbed sampling and SPTs shall be performed alternately until the Employer directs otherwise.

During the performance of SPTs including the seating drives, an accurate free fall of the hammer shall be attained. The rod above the hole collar shall be held in a vertical position to prevent energy loss due to rod whip or buckling. The hammer shall be pulled up and held exactly 30 inch above the anvil with the help of only one free-running pulley and without any turn of the rope around any other pulley or cathead, and then shall be dropped. Uniformity shall be obtained in all SPTs to be done.

The rate of application of hammer blows shall be between 10 and 20 blows/minutes. The Contractor shall ensure that the persons engaged for pulling the hoist rope synchronise their timing for releasing the rope to avoid drag which could prevent a free fall condition. A foreman, if necessary, shall call the time and ensure synchronised timing.

The test data obtained shall be recorded in the field and shall include the following:

- No. of borehole, test number and depth.
- Description of soil.
- Thickness of layer.
- Depth of water surface at the time at which test conducted.
- Size of casing, depth of cased hole.
- Number of turns of rope around the cathead.
- Type and weight of anvil, and size of rods.
- Number of blows for each 3 inch penetration and total length of penetration.
- Penetration resistance ‘N’ value.
- Whether open-ended drive shoe or core-ended adaptor was used.

Two copies of the field data for each test recorded on forms to be supplied by the Contractor in accordance with examples which will be provided by the Employer shall be submitted to the Employer within 24 hours of completing the test.

5.2 Excavation of Test Pits

5.2.1 Areas to be investigated

The Employer will specify from time to time during the contract period the exact location and reference number of all test pits in project area, but locating the test pits accurately in the field shall be the Contractor's responsibility. In addition, the Contractor will provide the exact co-ordinates of test-pits to Site Engineer/Geologist and in its final report.

5.2.2 Excavation

5.3.2.1 Excavation method

The Contractor shall perform excavation in test pits to final dimensions, lines and depths as specified or approved by the Employer. The Contractor will be free to choose any method of excavation with prior approval of the Employer. The Contractor shall be entirely responsible for the success of the method of excavation used regardless of approval by the Employer. The Contractor shall carry out his excavation operations in a manner so as to cause least disturbance to the in situ material outside the lines of excavation.

5.3.2.2 Excavation Extent

The test-pits shall be up to a maximum of 3.0 m depth or as specified in BOQ at least 3.0 m x 3.0 m throughout their depth or as directed by the Employer. The Contractor shall excavate test-pit so as not to have any protrusions inside the clear section. Excess excavation performed by the Contractor for any purpose or reason, except that ordered in writing by the Employer, shall be at the expense of the Contractor. The Contractor shall keep the walls and floor of the test pits accessible and clean for inspection by the Employer. The Contractor will prepare a detailed test-pit log of the strata encountered as directed by the Employer.

5.3.2.3 Removal and Disposal of Excavated Materials

The Contractor shall remove all excavated materials and any caved in debris from the test-pits and shall be responsible for disposal of such excavated material away from top of the test pits as directed by the Employer.

5.2.3 Supports of Test-pits Excavation

The Contractor shall properly support the test-pit excavation as and when instructed by the Employer in writing. The Contractor alone shall be responsible for the adequacy of the supports regardless of the approval by the Employer. Timber supports shall be used and left in place after completion of test pits for sampling and logging. The Contractor shall be free to use his own system of timber supports with the approval of Employer. However, nothing contained in this clause shall relieve the contractor of his responsibilities in respect of adequacy of supports of the excavations. If necessary, the Employer shall direct the Contractor to install additional supports or to abandon an unsafe pit without any payment to the Contractor. The support system shall be removed before backfilling of Test pits.

5.2.4 Rain and Surface Water

Surface water shall be prevented from entering the test pit. For this purpose, suitable earth dykes or interceptor ditches shall be constructed by the Contractor around the test pit at suitable locations with the approval of the Employer. The Contractor shall also remove any accumulated water from within the pits.

5.3 Hoisting Arrangements

5.3.1 Hoisting equipment

The Contractor shall provide, install, operate and maintain hoisting equipment wherever required as approved by the Employer and operate such equipment for removal of excavated material and all other related purposes.

5.3.2 Mucking buckets

The Contractor shall provide, install, maintain and operate mucking buckets. The buckets shall be of suitable size and sound construction as approved by the Employer. In addition, the Contractor will provide such other equipment, as he may deem necessary for efficient handling and disposal of excavated material.

5.3.3 Blasting in Test-pit

Blasting shall not be allowed for breaking up material encountered in a test pit except with the written permission of the Employer. Such permission shall only be given if a boulder with diameter larger than half the width of the pit is encountered.

5.3.4 Supplementary Test-pit

Test pits that are abandoned due to fault of the Contractor shall be supplemented by other test pits adjacent to the original location. The exact location of such supplementary test pits shall be specified by the Employer in the field.

No payment will be made for the portion of supplementary test pit above the depths paid for the unacceptable test pit.

5.3.5 Daily Field Records

Each day during the work on the Site, the Contractor shall hand over to the Employer the original and a legible copy of the records of the previous day's work containing the following information in respect of each test pit where work was in progress.

a. Name of Contract.
b. Number, and size of the test-pit.
c. Date and hours worked on the site.
d. Brief description of the weather.
e. Total depth of test-pit at the beginning and end of each shift.
f. Reference number, depths and other details of all small and large disturbed samples.
g. Description of material encountered.
h. Details of backfilling if any.
i. Details of reasons of delays.
j. Any other relevant information and details of any other operation.

5.3.6 Backfilling Test-pits

When instructed by the Employer, the Contractor shall backfill the Test pits. The materials for backfilling shall come from material excavated and the procedures shall be approved by the Employer.

5.3.7 Logging, Collection of Samples and In-situ Testing

The Employer or his staff shall inspect strata exposed by the excavation to prepare test-pit logs on approved forms and direct the contractor to collect disturbed and undisturbed samples during the progress of excavation. Whenever the Employer or his staff enters a test pit the Contractor shall temporarily suspend his operations inside the test pit and shall provide to Employer or his staff all facilities including labor and access through ladders into and out of the pit.

5.3.8 Contractor's Responsibility for Records

The presence of the Employer or any of his staff and their keeping separate test pit excavation records shall not relieve the Contractor of any of his responsibilities for keeping records.

5.3.9 Sampling

a) Disturbed samples

Disturbed samples shall be collected for carrying out classification test at the depth and location to be specified by the Employer at the site.

b) Composite samples

Composite samples shall generally be collected in those horizons where field density tests are carried out. The quantity of each sample shall be enough to allow carrying out classification and laboratory compaction test.

c) Borrow Samples

Borrow samples shall be collected from the existing potential borrow sources (along the alignment), for sand/sandy non cohesive soil (A-3)/A-4 materials and for gravely material.

6 LABORATORY TESTING

6.1 Approved Laboratory

The soil, rock and water samples shall be tested at local approved laboratories mentioned at the end of this document. The Employer shall have access to the laboratories to supervise and check the laboratory testing of the samples. The testing shall be carried out in accordance with ASTM, ISRM, BS or AASHTO Standards or as directed by the Employer.

6.2 Testing Program

The Contractor shall arrange to carry out the following laboratory tests on the specified samples of the subsoil materials and water. The Employer shall issue particular instructions for any tests, if required. The samples to be tested and the tests to be carried out for each sample shall be specified by the Employer.

6.3 Type of Tests on Soil Samples

The testing in the laboratory shall comprise, but not limited to, the following tests:

1. Grain size Analysis including Hydrometer.
2. Atterberg Limits (LL, PL).
3. Natural Moisture Content, Bulk Density and Dry Density.

4. Direct Shear Test.
5. Tri-axial Compression Test.
6. Sulphate and Chloride Contents of soil.
7. Complete chemical analysis of water.

6.4 Type of Tests on Rock Samples/Cores

The testing in the laboratory shall comprise of, but not limited to, the following tests:

1. Specific Gravity Determination.
2. Slake Durability Test.
3. Uniaxial Compression Test.
4. Petrographic Analysis.
5. Los Angeles Abrasion Test.
6. Modulus of Elasticity.

6.5 Type of Tests on Construction Material Samples

1. Grain Size Analysis
2. Atterberg Limit
3. Standard proctor Compaction
4. Hydrometer Analysis
5. Direct Shear Test
6. Tri-Axial Compression Test
7. Odometer Test
8. Permeability Test
9. Elastic Modulus

7 REPORTS AND RECORDS

7.1 Introduction

The Contractor shall prepare and submit to the Employer the final comprehensive Geotechnical Investigation Report (02 copies in good binding form and 01 saved on compact disc) final borehole & testpits logs, sub surface profiles, summary of laboratory test results and detailed laboratory test result sheets, approach and methodology, interpretation of results, design criteria, design parameters, foundation design calculations, conclusions and recommendations etc. and other details as required by the Employer.

7.2 Daily Report

The Contractor shall prepare a Daily Report signed by the Contractor's agent or representative on site for each borehole, which shall be submitted to the Employer within 24 hours of the completion of the exploration to which they refer and contain the following information where relevant.

i. General

   (a) Job name, location and coordinates.
   (b) Foreman's name.
   (c) Exploratory borehole reference number and level.
   (d) Name of Supervisory Staff.

7.3 Submission of complete field and laboratory data

The results of each borehole, test pit and field tests carried out shall be communicated to the

Employer as follows:

i. Oral reports as the work proceeds.
ii. Two sets of complete data of the work in the form of a bound document, which shall contain but not limited to:
    a. A site plan showing the position of holes and giving their map reference.
    b. The borehole logs.
    c. Complete results of field tests.
    d. Complete results of Laboratory tests.
    e. Summary of Laboratory tests results
    f. Comments on any point, which the Employer has put to the contractor for inquiry and investigation during the works.

7.4 Payment for Reports

No separate payment shall be made for this work.

8 MEASUREMENT AND PAYMENT

8.1 BOQ Field Work - Mobilization and Demobilization (Item No. A1)

a) Measurement

No quantity measurement will be made of the work under this item and payment shall be based on the completion of work as specified herein.

b) Payment

The payment shall constitute full compensation for all costs for mobilization and demobilization. The contract rates shall be deemed to include all costs for providing, transporting, operating and maintaining all the equipment and plant necessary for site investigation work along with providing water, power, providing all insurance covers, providing any other expense not covered in the item rates of the BOQ and shifting and setting up at each borehole location.

8.2 BOQ Field Work - Drilling of Boreholes (Item No. A2)

a) Measurement

The actual quantity shall consist of the full depth of acceptable vertical drill hole as measured along the line of the hole.

b) Payment

All the necessary operations done to accomplish drilling as specified shall be deemed to be part of this item. The casing of the boreholes, taking and recording of water levels in holes, supply of daily field record and borehole logs and all associated costs shall be deemed to be included in the contract rate. No separate payment shall be made for backfilling of holes and drilling of angle holes.

8.3 BOQ Field Work - Collection of Disturbed / Undisturbed Soil / Rock Core Samples from Boreholes (Item No. A3, A4, and A5)

a) Measurement

Measurement shall be made as number of acceptable undisturbed samples separately and actually recovered on the instructions of the Employer.

b) Payment

Payment shall be made as a unit for each undisturbed sample successfully recovered. The contract rate for these items shall be deemed to include the cost of any incidental delay of standing time of labor and plant, for the cost of taking, sealing, labeling, transporting samples and the cost of supply of all approved tubes, containers, crates and boxes which shall become the property of the Employer after delivery to the approved laboratory.

8.4 BOQ Field Work - Collection and Preservation of Groundwater Samples From Boreholes (Item No. A10)

a) Measurement

Measurement shall be made as number of water samples actually taken on the instructions of the Employer.

b) Payment

Payment shall be made as a unit for each water sample. All costs incurred for providing equipment, material, and labor and bailing out of the hole, if necessary and taking sealing, labeling, transporting the water samples as well as the cost of the containers shall be deemed to be included in the contract rate for water sampling.

8.5 BOQ Field Work - Excavation of Test-pits (Item No. A8)

a) Measurement

Measurement under this item will be computed by actual measurement methods and will be made of number of test pits actually excavated below ground surface (according to a specified size and depth). Measurement will be correct to a centimeter. This also includes backfilling after logging.

b) Payment

Payment shall be made at the Contract unit price for this item and shall constitute full compensation for the tools, plant, labour etc. required to excavate and perform mentioned testing in the test pit and to backfill the test-pit later on.

8.6 BOQ Field Work - Collection of composite bulk/borrow soil samples from Test Pits (Item No. A9)

a) Measurement

Measurement shall be made as number of bulk samples actually taken on the instructions of the Employer.

b) Payment

Payment shall be made as a unit for each bulk sample. All the costs incurred on providing equipment material and labour etc. for collection labeling, storage and transportation as well as the cost of bags, containers and boxes shall be deemed to be included in the contract value.

8.7 BOQ Field Work - Installation of twenty five (25) stand pipe piezometers in the boreholes (Item No. A6)

a) Measurement

Measurement shall be made as number of stand pipe piezometers actually installed on the instructions of the Employer.

b) Payment

Payment shall be made as a unit for each stand pipe piezometers. All the costs incurred on providing equipment material and labour etc. for collection, labeling, storage and transportation as well as the cost of bags and installation shall be deemed to be included in the contract value.

8.8 BOQ Field Work - Performance of Permeability Test in boreholes (Item No. A7)

a) Measurement

Measurement shall be made as number of Permeability Test actually performed in the boreholes on the instructions of the Employer.

b) Payment

Payment shall be made as a unit for each Permeability Test performed. All the costs incurred on providing equipment material and labour etc. shall be deemed to be included in the contract value.

8.9 BOQ Items Laboratory Testing (Item No. B1 to B17)

a) Measurement

Measurement under the item “Laboratory Testing” shall be made as per actual number of laboratory tests performed according to ASTM, AASHTO or the equivalent British Standards, or as directed by the Employer.

b) Payment

Payment shall be made for number of laboratory test actually performed in the laboratories approved by the Employer according to the price bid by the Contractor in the Bill of Quantities as a lump sum for each test. The lump sum shall be deemed to include complete laboratory testing for the specified test according to ASTM, ISRM, AASHTO or British Standards and presentation of reports in standard form as directed by the Employer.

LIST OF APPROVED LABORATORIES

Engineer's approved laboratories have been listed hereunder:

1. SOILCON Geotechnical Testing Laboratories, 18- Km, Multan Road Lahore.

(Tel # 042-7510942, Fax # 042-7510944)

2. CENTRAL MATERIALS TESTING LABORATORIES (CMTL) WAPDA, Near Muhammad Pura Village P.O Thokar Niaz Baig, Lahore.

(Tel # 042-5300922, Fax # 042-5302921)

3. SOIL MECHANICS LABORATORY CIVIL ENGINEERING DEPARTMENT, UET, Lahore.

(Tel # 042-9029273, Fax # 042-9029202)

4. DECON, 159-P, Model Town Extension, Lahore.

(Tel # 042-8428699, Fax # 042-5840662)

5. BERKELEY ASSOCIATE, 316-D, OPF Housing Colony, Raiwind Road, Lahore.

(Tel # 042-8452273, Fax # 042-5323316)

6. NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY, ISLAMABAD.

- If the Contractor intends to acquire the services of any testing laboratory other than the laboratories mentioned above, he shall obtain approval of the Employer and will be responsible for arranging to provide all relevant data required by the Employer for the approval of the Employer.

FORM OF QUOTATION

_____

(Date)

To: **THAR CANAL CONSULTANTS** (Employer's / Consultant's Name)

W&A Division, NESPAK House, Block-N, Model Town Extension, Lahore (Employer's Address)

We offer to execute the_____(name and number of Contract) in accordance with the Conditions of Contract (in the Form of Contract) accompanying this Quotation for the Contract Price of _____ (amount in words and numbers) (_____) (name of currency)_____. We propose to complete the Works described in the Contract within a period of ……days from the Date of Signing of the Contract.

This Quotation and your written acceptance will constitute a binding Contract between us. We understand that you are not bound to accept the lowest or any Quotation you receive.

We hereby confirm that this Quotation complies with the Validity of the Offer required by the proposal documents.

We have not been associated with the firm that prepared the design and specifications of the contract that is subject of this request for quotation.

Authorized Signature: _____

Name and Title of Signatory : _____

_____

Name of Contractor: _____

Address _____

_____

Phone Number : _____

Fax Number, if any: _____

Email address (optional) _____

FORM OF CONTRACT

Name of Country: Pakistan

Project Name: PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT (SINDH)

Name of Contract: Geotechnical Investigations for Feasibility Study for Thar Canal Project (Sindh)

Contract Number _____

This Contract is made this _____ day of _____2023 between **Thar Canal Consultants** on the one part (hereinafter called the Employer) and _____ (hereinafter called the Contractor) on the other part.

Whereas the Employer has called for quotations for (Geotechnical Investigations for Feasibility Study for Thar Canal Project and the Contractor has submitted a quotation for the above work and the Employer has accepted the Contractor's Quotation dated _____ for the execution and completion of such works and the remedying of any defects therein.

Now this Contract witnesses as follows:

1. The Contractor hereby covenants to execute the works fully described in the Bill of Quantities included in the Contractor's Quotation which constitute an integral part of this Contract (as Annex 1) in a professional and workmanship like manner in accordance with the following Conditions of Contract:

(a) Remedy all defects within 30 days of notification by the Consultant's Representatives during the period of execution of the contract and thereafter defects notified within the defect liability period;

(b) The Employer reserves the right to terminate the contract due to unsatisfactory performance 14 days after giving a written notice. If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor, the Consultant's Representatives shall certify that the contract has been frustrated. In such an event, both the Employer and Contractor will have a right to terminate the contract by giving 21 days notice to the other party without any financial repercussions on either side. Payments after termination or frustration shall consider the value of work completed and materials delivered by the Contractor, and the advance payment made by Employer;

(c) All material and construction equipment on site, temporary works, and Works shall be deemed to be the property of the Employer if the contract is terminated due to fault of the Contractor;

(d) The Contractor will in all cases abide by the directions of the Consultant's Representatives.

(e) The Contractor shall submit to the Consultant's Representatives, a program within three (3) days after signing the contract describing general methods and schedule to complete the works;

(f) Contract completion period 80 days after signing of the contract.

(g) No part of the works shall be subcontracted without prior approval of the Employer.

(h) New items of work performed as ordered by the Consultant's Representatives will be paid at the mutually agreed rate and in case of any disagreement between the Contractor and the Consultant's Representatives the latter will fix the unit rates that will be binding on the Contractor;

(i) The Law governing the contract shall be applicable laws of Pakistan;

(j) The Contractor shall be responsible for the safety of all the activities on the Site.

(k) During execution of works the Consultant's Representative will carry out inspection of works at site to verify that works are executed by the Contractor in accordance with the specifications and required quality as per specifications. Consultant's Representatives will reject works not performed to the required specifications and the Contractor shall take immediate actions to rectify all defects in accordance with subparagraph (a) above;

(l) Either party may terminate the Contract by giving a 21 days notice to the other for unforeseen events such as wars and acts of Gods such as earthquake, floods fires etc. In such case the payments will be made to the date of termination of contract;

(m) The Contractor is responsible for all taxes, duties. levies, etc. in accordance with the laws of the Pakistan; and

(n) The disputes between the Employer and the Contractor arising between them under or in connection with the Contract shall be resolved amicably. In the event the dispute remains unresolved either party may refer the dispute to Chairman BOM and the decision of Chairman BOM will be binding on both the parties.

2. In consideration thereof the Employer covenants to pay the Contractor the contract price of _____(in words and figures) in the following manner and installments:

(i) An advance payment of 20 percent of the Contract sum will be paid against bank guarantee and upon the Contractor bringing at the work site the following items and Consultant's Representatives certifying it i.e. all equipment required for the work as per BOQ and Specifications.

(ii) The Employer shall pay the balance amount to the Contractor as per the following schedule, after deduction of all applicable taxes. Each installment payment will be due for payment within 28 days of submission of invoice when the value of the work actually performed, calculated on the basis of unit prices and quantities, duly certified by the Consultant's Representatives.

- 50% of the amount for the field work physically done, after deduction of mobilization advance payment subsequent to satisfactory completion of field work and submission of field borehole logs/ data.
- Remaining amount of field work subsequent to submission of satisfactory laboratory test results.
- Another 30% of laboratory work amount subsequent to submission of interpretative Geotechnical Investigation Report
- Balance payment will be disbursed upon satisfactory completion of the whole works certified by the Consultant's Representatives.

3. The defect liability period will be One (01) (months) after taking over of completed works by the Employer.

In witness whereof the parties thereto have caused this Contract to be executed the day and year first before written.

Signature and seal of the Employer: FOR AND BEHALF OF	Signature and seal of the Contractor: FOR AND BEHALF OF
_____ Name of Authorized Representative	_____ Name of Authorized Representative

FORM of LETTER OF ACCEPTANCE

Date: _____

To: _____ *[Name and address of the Contractor]*

Dear Sir or Madam,

This is to notify you that your Quotation dated _____for execution of the *[name and number of the Contract]* for the Contract price of _____ *[amount in words and figures]*, as corrected and modified in accordance with the Request for Quotation has been accepted by us.

You are also requested to sign the attached contract form and commence construction of the Works not later than _____, and ensure the completion of the Works within the construction period specified in the contract.

For and on behalf of the Employer:

Authorized Signature: _____

Name of Signatory : _____

Title : _____

CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT

GEOTECHNICAL INVESTIGATIONS

BILL OF QUANTITIES

Sr. No.	Description	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
A1	Mobilization and demobilization of at least Two(02) straight rotary and One (01) heavy percussion drilling rigs at site including setting and shifting of equipment from one investigation point to another. The equipment should be sufficient, as per technical specifications, to meet the time schedule.	L.S.	Job		
A2	Execution of Fifty Seven (57) boreholes up to a maximum depth of 50.0 ft at major canal structures **(cross regulators)** and Execution of Twenty One (21) boreholes up to a maximum depth of 100.0 ft at **proposed bridge/water crossing/cross drainage structures** in overburden soils or upto rock strike level, which ever is met earlier below NSL by straight rotary / percussion drilling method including backfilling of boreholes to their original position with cement sand and bentonite mix.	ft.	4500		
A3	Continuous core drilling (NX size in general) in bedrock up to a maximum depth of 10.0 ft. m below rock strike level including preservation of core samples in core boxes, waxing of core samples, photography of rock cores and transportation of core samples to the laboratory.	ft.	450		
A4	Performance of Standard Penetration Tests (SPTs) in boreholes along with collection of SPT samples at 3.0 ft interval in general, or as necessary, including their labelling, packing, storage & transportation to an approved testing laboratory.	No.	1260		
A5	Collection of undisturbed soil samples from boreholes through Shelby/Denison/ Pitcher samplers, including their waxing, labelling, packing, storage & transportation to an approved testing laboratory.	No.	100		
A6	Installation of twenty five (25) stand pipe piezometers (PVC pipe of dia 1.5") in bore properly washed holes executed for geotechnical investigations and monitoring of water levels on daily basis for first seven (07) days and on weekly basis for two (02) months.	No.	25		
A7	*Performance of Permeability Test in boreholes at various depths using constant head for soil column/flush bottoms conditions, as appropriate or as directred by the Engineer in Charge.	No.	25		
A8	**Excavation of Hundred (100) testpits (10 ft x 10 ftm) up to a maximum depth of 10.0 ft at main canal and borrow locations in the vicinity of project area, and performance of Field Density Tests at different horizons (2 at each test pit), as specifiec by the Engineer in charge, below top of ground including backfilling of pits to its original condition.	No.	100		
A9	**Collection of composite bulk/borrow soil samples from testpits/quarry sites including their labelling, packing, storage & transportation to an approved laboratory.	No.	200		
A10	Collection of water samples (if encountered) from boreholes including their labelling, packing, storage & transportation to an approved testing laboratory.	No.	30		
	Sub-Total A - Filed Work	**Rs.**			

Establishment of coordinates and ground elevations of all the boreholes & testpits using **TOTAL STATION** are included in the scope of work. The coordinates should be provided with reference to a permanent local bench mark.

All the undisturbed soil samples shall be stored and transported as per ASTM standards. The area and clearance ratios of the sampling tubes should be as per ASTM Standards.

The Contractor is sole responsible for access to the site, security and safety of his own staff and equipment.

CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY STUDY OF THAR CANAL PROJECT

GEOTECHNICAL INVESTIGATIONS

BILL OF QUANTITIES

Sr. No.	Description	Unit	Qty.	Rate	Amount
B.	**LABORATORY TESTING**			(Rs.)	(Rs.)
B1	Sieve analysis	No.	600		
B2	Hydrometer analysis	No.	250		
B3	Liquid and plastic limits	No.	250		
B4	Bulk density & dry density	No.	100		
B5	Consolidation with Swell Potential Measurements	No.	50		
B6	Direct Shear	No.	200		
B7	Unconfined Compression (Soil)	No.	100		
B8	UU Triaxil Compression Test	No.	20		
B9	Unconfined Compression Strength (Rock)	No.	50		
B10	Point Load Strength Index (Rock)	No.	50		
B11	Modified AASHTO Compaction	No.	100		
B12	Knight Collapse Potential Test	No.	25		
B13	Lab Permeability Test (Constant/Falling Head)	No.	50		
B14	Sulphate content of soil	No.	50		
B15	Chloride content of soil	No.	50		
B16	Organic matter content of soil	No.	50		
B17	Complete chemical analysis of water samples i/c TDS, Cl, SO4 & pH	No.	30		
	Sub- Total B			**Rs.**	**-**

Total (A+B)=	**Rs.**	
Say	**Rs.**	

Name of Testing Laboratory: _____