Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REGIONAL OFFICE I
City of San Fernando, La Union

TERMS OF REFERENCE

GEOTECHNICAL AND GEOLOGICAL SURVEY (SOIL BORING EXPLORATION) OF VARIOUS FLOOD CONTROL STRUCTURES IN ILOCOS NORTE (PACKAGE 4)

I. PROJECT DESCRIPTION AND PURPOSE

PROJECT NAME	NO. OF HOLES
1.) Rehabilitation of Flood Control along Galpac Creek, Paoay, Ilocos Norte	1 hole
2.) Construction of Flood Mitigation Structure along Quiaoit River (Construction of Diversion Channel), Paoay, Ilocos Norte (Package B)	2 holes
3.) Construction of Quiaoit River Diversion Canal, Paoay, Ilocos Norte	1 hole
4.) Construction of Quiaoit River Diversion Canal, Paoay, Ilocos Norte, Phase 2	1 hole
5.) Construction of Flood Mitigation Structure along Quiaoit River (Construction of Diversion Channel), Batac, Ilocos Norte (Package B)	2 holes
6.) Construction of Quiaoit River Diversion Canal, Batac City, Ilocos Norte	1 hole
7.) Construction of Quiaoit River Diversion Canal, Batac City, Ilocos Norte, Phase 2	1 hole
8.) Construction of Flood Control Structure along Badoc River, Barangay Mabusag Sur, Badoc, Ilocos Norte	1 hole
9.) Construction of Flood Control Structure along Quiaoit River, Barangay Mabaleng, Batac City, Ilocos Norte	4 holes
10.) Rehabilitation of Marcos SWIP Dam, Marcos, Ilocos Norte	1 hole
11.) Construction of Flood Control Structure and Drainage Systems along Bongo River Barangay Peralta, Dingras, Ilocos Norte	1 hole
12.) Construction of Flood Control Structure along Bongo River, Barangay Medina, Dingras, Ilocos Norte (Phase IV)	1 hole
Location : Ilocos Norte	
Boreholes : 17 Boreholes; **15m** depth	
Duration : 22 Calendar Days	

II. SCOPE OF WORK

The Consultant shall provide all the labor, instrument/equipment materials and supplies, vehicles, bunkhouses, etc., necessary to perform satisfactorily the sub-surface exploration herein required, viz:

A. Field Works
B. Laboratory Testing
C. Soil Boring Exploration and Preparation of Report
D. Geotechnical and Geological Evaluation Report

The Consultant shall be held solely responsible for the result of this boring/drilling exploration and other activities under this Terms of Reference (TOR).

III. DETAILED EXPLORATION REQUIREMENTS/SPECIFICATIONS

A. FIELD WORKS

1. Borehole Location

Spacing shall be one (1) at each near both ends of the project and additional intermediate borehole shall be conducted every 250 meters increment or at identified critical section/s. Exact location of boreholes shall be upon the instruction of the geologist/geotechnical engineer.

For onshore boring, all locations shall have a marker (precast concrete) with description placed exactly where the drilling was conducted.

2. Borehole Depth

Depth of borehole below the riverbed shall be twice the height of the structure or until three (3) consecutive SPT N-Value > 40 is obtained, whichever is greater. In case bearing layer is not encountered within 15 m, boring shall be continued until preferred layer is encountered and/or upon the instruction of the geotechnical engineer with approval of the implementing office.

3. Procedure

a. Deep drilling with Standard Penetration Test (SPT) shall be conducted at the plotted borehole location. Minimum depth shall be determined based on confirmation of hard strata or bed rock. Drilling can end after six (6) meters minimum penetration into hard strata or bed rock, subject to the approval of the structural engineer.

b. The Consultant shall perform analysis and testing on disturbed and undisturbed soil samples. These analyses and testing shall be performed in accordance with AASHTO and ASTM standards.

c. The soil samples for foundation design shall be preserved for the testing and determination of the main characteristics (grain size distribution and classification, moisture content, atterberg limits, etc.)

d. Submit design recommendations, foundation condition scheme, bearing capacity and settlement, groundwater table, hydrological influences, excavation stability, seismic design consideration and liquefaction potential.

e. Geological structure, especially active faults which might traverse the area, should be delineated and potential mass movement areas should be identified. Analysis for liquefaction potential during earthquake and consolidation due to soft ground should be included.

4. Handling of Core Samples

The contractor shall provide all the materials, equipment and labor necessary for preserving the samples for 5 years. Rock core samples need to be handled such that their properties are not altered in a way due to mechanical damage or changes in ambient conditions of moisture and temperature or other environmental factors.

All soil and rock samples must be clearly, accurately, and properly labelled to show all pertinent information necessary in identifying the samples.

B. LABORATORY TESTING

The preparation of samples and procedure of testing shall be made in accordance with the standards of American Association of Highway and Transportation Officials (AASHTO) and/or American Society for Testing and Materials (ASTM). The following tests shall be made on samples obtained from drilling.

Bearing Capacity Test

The maximum load per unit area which the soil or rock can carry without yielding or displacement is termed the bearing capacity of soils. Various methods of computing the bearing capacity can be by presumptive analysis, analytical method, plate bearing test, penetration test, or centrifuge test. The SPT is widely used to get the bearing capacity of soil directly at a certain depth. The consistency of clayey soils can often be estimated from this test.

Standard Penetration Test

The test shall be carried out through ordinary soil encountered to the depths specified above. Standard penetration test shall be performed by dropping a hammer weighing 140 lbs. (63.6 kg) onto the drill rods from a height of 76.00 cm (30 inch) at 1.50 meter interval or closer if necessary. First blow count shall be ignored as it represents materials from the previous layers and hole collapse materials hence the N-value is the

sum of 2nd and 3rd blow counts. The procedure of SPT shall be conducted according to AASHTO T 99 or AASHTO T 180.

Soil Classification

The Unified Soil Classification System (USCS), adopted by ASTM D2487-98 and IS: 1498-1970 shall be followed for classification and identification of soils for general engineering purpose. This is to be used for identification of soils in the field, laboratory, or any other location where soil samples are inspected and described. There should be assigned group name and symbol(s) along with the descriptive information. Initial description can be made during on-site logging, and revised upon availability of laboratory tests.

Sieve Analysis

This is the determination of particle size distribution in soils by sieve, hydrometer, or combined analysis. The procedure covers sieve analysis in accordance with AASHTO T 27 and materials finer than No. 200 (75 µm) in accordance with AASHTO T 11. The procedure combines the two test methods.

Moisture Content

This test determines the relationship between the moisture content and the density of soils compacted in a mold. It is the ratio of the weight/mass of water in the soil to the weight/mass of the dry soil after it has been dried to a constant weight/mass at a temperature of 110 ± 5° C. This shall be conducted according to ASTM D2216 or AASHTO T 265.

Atterberg Limits

The procedure for the determination of Atterberg limit shall be in accordance with ASTM D4318. The Liquid limit (AASHTO T 89) is the lowest moisture content at which the soil will flow upon the application of a very small shearing force whereas the Plastic limit (AASHTO T 90) is the minimum moisture content at which the soil can be readily molded without breaking or crumbling.

Specific Gravity

This is defined as the ratio of the weight/mass in air of a given volume of a material to the weight/mass in air of an equal volume of water at a stated temperature. It is used in connection with gravimetric-volumetric relationship in soils and various laboratory tests. This procedure is in accordance with ASTM D854-14 or AASHTO T100.

C. KEY PERSONNEL'S DETAILED TASKS/RESPONSIBILITIES AND QUALIFICATION

Position	Qualification	No. of Person	Duration	Wt. per person (%)	Total Wt (%)
Team Leader (Project Manager)	▪ Must have at least **ten (10)** years experience related in Geotechnical/Soil Investigation, Test Borings, Sampling and Analysis of similar and/or related projects ▪ Must be a Registered Civil Engineer ▪ Doctorate degree is an advantage	1	22 man-days	25	25
Senior Geotechnical Engineer	▪ Must have at least **five (5)** years experience in the related field for which geotechnical subsurface exploration and assessment of geological condictions were undertaken ▪ Must be a Registered Civil Engineer with specialization in geotechnical engineering ▪ Masters degree is an advantage	1	22 man-days	25	25
Senior Geodetic Engineer	▪ Must have at least **five (5)** years experience in the field of surveying and should be familiar with the latest technologies in surveying and research ▪ Must be a Registered Geodetic Engineer ▪ Masters degree is an advantage	1	13 man-days	15	15
Senior Geologist	▪ Must have at least **five (5)** years experience in the field of engineering geology and geotechnics, should be familiar with the latest technologies in borehole drilling and research work ▪ Must be a Registered Geologist ▪ Masters degree is an advantage	1	13 man-days	15	15
Senior Soils/ Materials Engineer	▪ Must have at least **five (5)** years experience in carrying out laboratory testing/ sampling and analysis for Geotechnical / Soil Investigation and Test Borings ▪ Must be a Registered Civil Engineer ▪ Masters degree is an advantage	2	9 man-days	10	20

Detailed Tasks and Responsibilities of Key Personnel

A. Team Leader

- overall guidance, direction and coordination of members of the Team.
- prepares operation plan and supervises all aspects of the project to ensure compliance with the objectives and maintain progress in accordance with the contract time schedule.

B. Senior Geotechnical Engineer

- study and determine the method of soil investigation and laboratory tests to be conducted to cater the needed subsurface data for a specific infrastructure project
- responsible for supervising the conduct of geotechnical investigations; gathering information and reporting results of evaluations of areas of concern

- conducts desk study, reconnaissance field work, subsurface exploration operations, and final geotechnical report

C. Senior Geodetic Engineer

- provides the necessary topographic maps
- undertakes necessary engineering survey and determines the precise layout of borehole distribution

D. Senior Geologist

- investigate risk of geological hazards and making sure any factors affecting engineering works are identified and managed
- responsible for the conduct of geological mapping and assessment; gathering information and reporting results of evaluations of areas of concern
- conducts desk study, reconnaissance field work, subsurface exploration operations, and prepares geological assessment report needed for the geotechnical evaluation

E. Senior Soils/ Materials Engineer

- investigate and supervise the testing of Physical Properties of sample materials from areas of concern and prapare reports after performing calculations
- collects necessary data and information in carrying out detailed soil test and investigations inlcuding Atterberg Limits, moisture content, rrading analysis, and etc.
- responsible in maintaining and calibrating test equipment and other duties related to lab operations as assigned

D. REPORTS AND DELIVERABLES

The Consultant shall prepare the following reports and deliverables:

1. Progress Report

The Consultant is required to submit a progress report eleven (11) calendar days from the commencement of work briefly and concisely describing all activities and progress of the project. Problems encountered or problems anticipated shall be clearly stated, together with the steps taken or recommendations for their correction. It shall also indicate the works to be performed.

2. Final Report

The Consultant is required to submit the final report twenty two (22) calendar days from the commencement of work in four (4) bound copies and a soft copy saved in a CD to the DPWH Regional Office I, Aguila Rd., Sevilla, City of San Fernando, La Union. The final report shall not be limited to the following:

a. Introduction (Purpose and scope, Project Location, Project Description)
b. Climate Map covering the project site
c. Vicinity Maps in scale of 1:50,000
d. Borehole Location Plan in scale of 1:250
   - reflecting the coordinates of the boreholes (WGS and PRS)
e. Methodology (Field and Laboratory)
f. Geology and Geohazards Aspect
g. Geotechnical Aspect
h. Field Investigation and Soil Boring Exploration
i. Final Boring Logs (BL)
j. Soil Profile (Cross section) showing boring/drilling logs and structures
k. Final Laboratory Tests Results (FLTR)
l. Appendices and References

3. Geology and Geohazards Aspect

a. Seismic Sources within the vicinity of the project site, it is necessary to determine the distance of an active fault/trench relative to the project site.
b. Earthquake magnitude that a fault/trench can generate (based on historical data provided by PHIVOLCS or USGS)
c. Geologic Map and Geomorphologic Map covering the project site
   - showing the geologic formations and structures present within the proposed location of the project (i.e. faults, fold)
d. Discussion on Regional Geology and Geomorphology
e. Brief Discussion about the Geohazard maps
   -degree of susceptability of each geohazard relative to the location of the project (Flood, Rainfall-induced Landslide, Earthquake-induced Landslide, Storm Surge, Tsunami, Volcanic, Karst Hazard, etc.)
f. Discussion on Problematic Soils
g. Peak Ground Acceleration (PGA)
h. Spectral Acceleration Coefficient at 0.20 sec (S_{DS})
i. Spectral Acceleration Coefficient at 1.0 sec (S_{D1})
j. Soil Liquefaction Assessment

4. Geotechnical Aspect

a. Summary of Results from Field and Laboratory Tests
b. Geotechnical Parameters (Unit Weight, Angle of Friction, Cohesion, Soil Strength, Void Ratio, Swell Index, etc.)
c. Geotechnical Evaluation and Recommendation (such as type of proposed counter measures to address geological/geotechnical problems and foundation type)
d. Laboratory Test Performed (D.O.22, S. 2028)
   - Mechanical Sieve Analysis
   - Specific Gravity Test
   - Atterberg Limits Test
   - Natural Moisture Content
   - Soil Strength Test
   - Additional tests, when applicaple:

- Consolidation Test
- Permeability Test
- Compaction Test
- Swell Index Test

e. Preliminary Calculation and Analysis
   - Global Stability Analysis
   - Allowable Bearing Capacity (Shallow Foundation)
   - Allowable Bearing Capacity (Deep Foundation)

5. Other Data to be Submitted

A. Boring Logs

1. Job, boring, hole number, date, time, boring/drilling, foreman, supervisor
2. Weather condition
3. Elevation and Depth of boring
4. Water level in casing at start of day
5. Method of penetration and flushing system
6. Description of soil strata encountered
7. Depth of soil boundaries
8. Size, type and depth of samples and sample number
9. Type and depth of in-situ tests
10. Standard Penetration Tests Resistance, "N" Value
11. Recovery ratios of samples
12. Detailed notes on boring/drilling procedure, casing sizes and resistance to driving, description of wash water or spoil from boring/drilling tools
13. Other relevant information such RQD, percent core recovery, angle of friction etc.

B. Photographs

Photographs showing the borehole drilling and sampling at each proposed sites shall be taken by the Contractor and incorporated in the report. Photographs shall be taken at each borehole location depicting the following:

1. Equipment used
2. Core drilling operation
3. Water level measurements
4. Performance of SPT and Shelby tube sampling
5. All cores in the core boxes, SPT and Shelby tube samples
6. Geotagged photos (CRS:WGS)
7. Location or station, and markers

IV. PAYMENT

There should be no Advance Payment for Consultancy. The final payment shall be made only after the final report and a final statement, identified as such, shall have been submitted by the Consultant and approved as satisfactory by the Procuring Entity.

V. WORK SCHEDULE

The Consultant's contract period for undertaking the sub-surface exploration works including laboratory tests shall be Twenty Two (22) Calendar Days and the Consultant shall commence work after receipt of Notice to Proceed.

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