TERMS OF REFERENCE

CONSULTANCY SERVICE FOR THE CONDUCT OF GEOTECHNICAL INVESTIGATION OF VARIOUS FLOOD CONTROL PROJECTS IN LA UNION

I. PROJECT SUMMARY

PROJECT NAME	DEPTH	BH
1.) Construction/ Rehabilitation of Flood Mitigation Facilities within Major River Basins and Principal Rivers, Construction of Flood Control Structure Along Aringay River, Barangay Anduyan, Tubao, La Union	15 meters	3
2.) Basic Infrastructure Program (BIP), Construction of Flood Control Structure, Aringay River Basin, Barangay Leones East, Tubao, La Union	15 meters	1
3.) Basic Infrastructure Program (BIP), Construction of Flood Control Structure, Aringay River Basin, Barangay Rizal, Tubao, La Union	15 meters	3
4.) Basic Infrastructure Program (BIP), Rehabilitation of Flood Control Structure, Aringay River Basin, Barangay San Antonio, Aringay, La Union	15 meters	2
5.) Sustainable Infrastructure Projects Alleviating Gaps (SIPAG), Construction of Breakwater along Shoreline of Barangays Paringao and Pagdalagan Sur, Bauang, La Union	15 meters	2
6.) Sustainable Infrastructure Projects Alleviating Gaps (SIPAG), Construction of Flood Control Structure, Barangay Concepcion-Tabtabungao, Rosario, La Union	15 meters	2
Location: La Union		
Boreholes: 13 Boreholes		
Total depth: 195 linear meter		
Duration: 14 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 subsurface exploration herein required, viz:

A. Subsurface Exploration
B. Laboratory Testing
C. Geotechnical Investigation Report (GIR)

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. SUBSURFACE EXPLORATION

1. Borehole Location

The borehole location was based on the guidelines stipulated on D.O. 75 s. 2024. Exact location of boreholes shall be upon the instruction of the geologist/geotechnical engineer of the DPWH Regional Office I and shall be identified during joint field reconnaissance survey.

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

2. Borehole Depth

The borehole depth for each project was based on the guidelines stipulated on D.O. 75 s. 2024. The depth shall be twice the height of the structure or extend until 3 successive N-values (>40) when soft soil layers are encountered.

The minimum depth shall be 15 meters in ordinary. In case bearing layer is not encountered within 15m, drilling shall be continued until preferred layer is encountered and/or upon the instruction of the geotechnical engineer with approval of the DPWH Regional Office I.

3. Procedure

a. The Geotechnical Investigation (GI) shall only be based under this Terms of Reference. A coordination meeting shall be scheduled between the Consultant and the DPWH Regional Office GI Team to discuss the GI plan and methodology report, and shall conduct site inspection together to define the scope of the project.

b. The conduct of field and laboratory tests for the project shall be witnessed and certified by the duly designated representative from the GI team. During the conduct of the GI activities, photos shall be taken and geotagged accordingly and shall be attached as annexes or shall be part of appendices of the GIR.

c. The consultant shall perform analyses and testing (refer to Laboratory Testing) in accordance with AASHTO and ASTM standards. They shall utilize the standard format for Final Borehole Log provided in D.O. 75 s. 2024 and legends for soils/ rocks shall be in accordance with DPWH DGCS Volume 2C 2015 Edition and/or its latest edition.

d. The GIR shall include design recommendations, foundation condition scheme, bearing capacity and settlement, groundwater table, hydrological influences, excavation stability, seismic design consideration and liquefaction assessment.

e. The GIR shall be duly signed by the Geotechnical Engineer on-record of the Consultant, subject for review of the GI team and approval of the DPWH Regional Office I. Once the GIR has been finalized and approved, the Consultant shall prepare the Geotechnical Plan in accordance with D.O. 75 s. 2024 regarding the preparation of the DEAD plan.

4. Handling of Core Samples

The Consultant 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 labeled 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 purposes. 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 relationships 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 (%)
Senior Geotechnical Engineer	• 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	14 man-days	50	50
Junior 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	10 man-days	30	30
Junior 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	1	4 man-days	20	20

Detailed Tasks and Responsibilities of Key Personnel

A. Senior Geotechnical Engineer

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

B. 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.

C. Senior Soils/ Materials Engineer

- Investigate and supervise the testing of Physical Properties of sample materials from areas of concern and prepare reports after performing calculations
- Collects necessary data and information in carrying out detailed soil tests and investigations including Atterberg Limits, moisture content, grading analysis, 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 and interim report ten (10) 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. Draft Final Report

The Consultant is required to submit the draft final report and a soft copy saved in a CD twelve (12) calendar days from the commencement of work for the approval and evaluation of corrections prior to the printing and submission of the final report.

3. Final Report

The Consultant is required to submit the final GIR fourteen (14) 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 GIR 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 (CRS:PRS92/ Philippines Zone 3- EPSG:3123)

e. Idealized Soil Profile (Correlated cross section of all boring logs)
f. Final Boring Logs with SPT graph (Standard format in accordance to D.O. 74 s.2024)
g. Methodology (Field Investigation, Soil Boring Exploration, and Laboratory Testing)
h. Geology and Geohazards Aspect (components enumerated in section 3)
i. Geotechnical Aspect (components enumerated in section 4)
j. Final Laboratory Tests Results
k. Appendices, Photographs, and References

4. 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. Topographic Map
e. Discussion on Regional Geology, Local Geology and Geomorphology
f. Field photographs of geologic fieldwork
g. Rock Mass Rating
h. Brief Discussion about the Geohazard maps
   -Degree of susceptibility of each geohazard relative to the location of the project:

   - Flood hazard and discussion on Fluvial hazards with supporting map
   - Liquefaction hazard (as per PHIVOLCS map)
   - Rainfall-induced Landslide
   - Earthquake-induced Landslide
   - Storm Surge
   - Tsunami
   - Volcanic hazard (Lahars, volcanic mudflows, debris flows)
   - Karst Hazard

i. Discussion on Problematic Soils
   - Expansive soils
   - Poorly compacted soils
   - Highly Compressible soils
   - Contaminated soils
   - Collapsible soils
j. Peak Ground Acceleration (PGA)
k. Spectral Acceleration Coefficient at 0.20 sec (S_{DS})
l. Spectral Acceleration Coefficient at 1.0 sec (S_{D1})
m. Liquefaction Assessment
   - As per BSDS 2013
   - Fukushima and Tanaka Equation as per DGCS Volume 2A

n. Preliminary screening analysis (based on grain size analysis & atterberg limit test, and water table as per BSDS 2013)
o. Calculation of Cyclic Resistance Ratio and Cyclic Stress Ratio (based on geotechnical parameters of soils).

5. 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 applicable:
        - 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)
f. Geotechnical Investigation Plan (hard copy and soft copy) in accordance with the latest Department issuance/s for the preparation of Detailed Engineering Design (DED) plans (refer to D.O. 75 s. 2024).

6. 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 as RQD, percent core recovery, angle of friction etc.

B. Photographs

Photographs at each borehole site and laboratory testing shall be taken by the Consultant 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. Laboratory Testing procedure and samples
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 subsurface exploration works including laboratory tests shall be fourteen (14) Calendar Days and the Consultant shall commence work after receipt of Notice to Proceed.

Prepared by:

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