GUIDELINES FOR

GEOTECHNICAL

ENGINEERING SERVICES

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PUBLISHED BY:

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GUIDELINES FOR

GEOTECHNICAL ENGINEERING SERVICES

1.0 INTRODUCTION

1.1 PURPOSE OF GUIDELINES

The "Guidelines for Geotechnical Engineering Services" have been prepared by a sub committee of Professional Engineers and Geoscientists of Newfoundland & Labrador and have been adopted by the Council of PEGNL.

The Guidelines have been prepared to set out the standards of practice which *Members* should meet and follow in providing professional engineering services. PEGNL and its Council have a commitment to maintain the quality of the services *Members* provide to *Clients* and the public, and have published these Guidelines for that purpose.

It is anticipated that variations in the application of these Guidelines may be required. A *Member* must always exercise professional judgement in providing services. It is not intended that the Guidelines be used as a legal document or to alter contracts between *Members* and *Clients*.

However, a variation that detracts from the overall purpose of the Guidelines should never be made. The Guidelines are intended to establish minimum standards of practice which *Members* must meet to fulfil the *Member's* professional obligations, especially in regard to the primary duty to protect the public. The Council of PEGNL intends that failure to meet these standards may give rise to disciplinary proceedings.

PEGNL supports the proposition that *Members* should receive fair and adequate compensation for services rendered and that this principle applies to the services provided to comply with these Guidelines. In no event will low fees be justification for services which do not meet the minimum standards set out by these Guidelines. *Members* may wish to discuss these Guidelines with their *Clients* when receiving instructions for assignments and reaching agreement regarding compensation.

1.2 SCOPE OF GUIDELINES

These Guidelines apply to the practice of Geotechnical Engineering.

The *Professional Engineer* who is in responsible charge of geotechnical engineering works in either an investigative or a regulatory capacity, should fulfill the requirements of this guideline.

This guideline outlines the extent of the services to be provided and the general method to be followed, the types of reports and the normal range of the recommendations which may be included by the *Professional Engineer* who originates the work. *Professional Engineers* operating in a regulatory capacity should be familiar with these procedures in initiating a Geotechncial investigation and in making an objective appraisal of submitted reports.

These Guidelines also take into account the commitments which municipalities may require from geotechnical engineers while conducting field work.

1.3 GEOTECHNICAL ENGINEERING

Geotechnical engineering embraces the knowledge of soil, rock, and other earth materials as applied to foundations, the behaviour of engineering structures, the assessment of natural land forms and the stability of natural and man-made slopes. It includes aspects of soil mechanics, rock mechanics, groundwater conditions, foundation engineering, and construction techniques as applied to building foundations, excavation methods, earth dams, and embankments, foundations for pavements, floor slabs and other relevant aspects of construction works.

1.4 QUALIFICATION

Notwithstanding the purpose and scope of the Guidelines in section 1 through 4, the decision by the *GER* not to use one or more of these Guidelines does not mean that the *GER* is legally negligent or unprofessional in the performance of professional services, if *Due Care* has been exercised.

2.0 DEFINITIONS

Additional Services:

Services, as set out in Section 4.4, which the *GER* may provide in addition to the *Basic Services*.

Association:

Professional Engineers and Geoscientists of Newfoundland & Labrador.

Authority Having Jurisdiction:

The governmental body with authority to administer and enforce the applicable codes or the local by-laws.

Basic Services:

The services provided by the *GER* as set out in section 4.3.

Client:

The party who engages the *GER* to provide professional geotechnical engineering services.

Contract Documents:

All documents including the engineering and architectural drawings and Specifications as defined in the construction contract(s) for the project or structures.

***Due Care*:**

The level of care which would be found by reasonable and knowledgeable people to be adequate in the specific circumstances in which the term was used.

Field Services:

The services provided by the *GER* as set out in Section 4.3.3 to ascertain if the geotechnical work is generally in accordance with the Geotechnical Contract Documents.

General Contractor:

The contractor who has a contract with the *Owner* for the construction of all or a portion of the project.

Geotechnical Engineer of Record:

The member with general responsibility for the geotechnical integrity of the project as provided by Section 3.0 of the guidelines.

Geotechnical Report:

The geotechnical report outlines the terms of reference of the investigation, summarizes the findings of the field investigation and the laboratory testing and then presents the conclusions and recommendations based on these findings.

GER:

The *Geotechnical Engineer of Record*.

Member:

A *Member* in good standing with PEGNL.

Owner:

The person, company or other entity who controls the property under consideration and has the authority of ownership.

Prime Consultant:

The individual who or firm which is registered with the *Association* or the Newfoundland Association of Architects, and who or which has the responsibility to coordinate the design and field reviews of the various design professionals (such as electrical, structural, mechanical, geotechnical, architectural) for the project.

Professional Engineer:

A person who holds a certificate of registration to engage in the practice of engineering under the Engineers and Geoscientists Act.

Subcontractor:

The person, company or other entity who contracts with the *General Contractor* to perform a specified part of the *General Contractor's* work.

***Submittal(s)*:**

Items required by the *Contract Documents* to be submitted such as requests for payment, progress reports, shop drawings and manufacturer's literature. *Submittals* are normally used by the *GER* to aid in determining if the work and work products conform with the intent of the *Contract Documents*.

Tests/Testing:

Tests/Testing refers to field and laboratory procedures carried out on construction materials, as per the applicable standards, to determine conformance with the project specifications.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 COMMON FORMS OF PROJECT ORGANIZATION

Project organizations vary according to the needs of the project and the parties. The following organizational charts are included in the Appendix:

1. *Geotechnical Engineer of Record* (*GER*)/*Prime Consultants* Contract
2. *Geotechnical Engineer of Record* (*GER*)/*Owner* Contract
3. Design/Build Contract

3.2 RESPONSIBILITIES OF ORGANIZATION PARTICIPANTS

3.2.1 OWNER

It is not the mandate of this guideline to stipulate the responsibilities of the owner, however, in order that the design and construction of the project may be carried out in a manner that meets appropriate standards of public safety and the requirements of applicable regulations, the *Owner* should:

3.2.1.1 Retain or cause to be retained qualified *Professional Engineers* including a *Prime Consultant* and a *GER* with responsibility for providing the necessary geotechnical design parameters used in foundation design and construction;

3.2.1.2 Cooperate with the *GER* to set out a written description of the scope of the *GER's* services as referred to in paragraph 3.2.3.3, and an adequate written description of the project;

3.2.1.3 Before the commencement of the *GER's* services, finalize or cause to be finalized a written agreement with the *GER* (directly with the *Owner* or with the *Prime Consultant* or with another appropriate party);

3.2.1.4 Cooperate with the *Prime Consultant* and the *GER* in establishing a realistic schedule for the provision of design services;

3.2.1.5 Authorize in writing any *Additional Services* that may be required beyond the scope of the *GER's* contract;

3.2.1.6 Ensure that all required approvals, licences and permits from the *Authorities Having Jurisdiction* are obtained prior to proceeding with construction;

3.2.1.7 Recognize that drawings, Specifications and other documents prepared by the *GER* are for the project and that such documents shall not be used or copied for other projects without the agreement of the *GER* and without advice from a

qualified design professional;

3.2.1.8 Recognize that geotechnical investigations probe the subsurface and that unanticipated conditions may be encountered and that, accordingly, a reasonable contingency should be included in the *Owner's* budget.

3.2.2 PRIME CONSULTANT

To enable the *GER* to perform his duties properly, the *Prime Consultant* should:

3.2.2.1 Interpret and define the needs of the *Owner* and in so doing define the *Owner's* intended functions and needs. The *Prime Consultant* should identify any special design criteria such as equipment and other requirements and should advise the *GER* accordingly;

3.2.2.2 Outline the scope of assignment to each design professional for design, preparation of *Contract Documents*, review of work during construction and contract administration;

3.2.2.3 Negotiate a fee with the *Owner* that is in accordance with the APEGN fee schedules and shall input from each design professional before finalizing same;

3.2.2.4 Provide timely information in sufficient detail as required by the *GER* to adequately perform his/her duties;

3.2.2.5 Coordinate and review the designs, drawings and other *Contract Documents* produced by all participants of the design team;

3.2.2.6 Coordinate communication of information between the *Owner*, the contractor and the design professionals, including the *GER*, so that the work proceeds in a manner that complies with applicable codes and regulations and meets the *Owner's* needs.

3.2.3 GEOTECHNICAL ENGINEER OF RECORD

3.2.3.1 The *Geotechnical Engineer of Record (GER)* is responsible for provision of geotechnical design parameters to allow for the safe design of foundation and related components by the design team.

3.2.3.2 The *GER* may rely on other *Members* to be responsible for the design of elements of the project but the *GER* has the overall responsibility to see that all design is undertaken as is necessary to achieve a project that meets acceptable engineering standards. In this event the *GER* must require the other *Members* to sign and seal the documents for such elements.

3.2.3.3 The *GER* together with the *Client* is responsible for setting out a written description of the scope of the *GER's* services to enable and permit the *GER* to meet the design and field review requirements of these Guidelines and applicable codes and regulations. These *Members* are responsible for the integrity of their design.

3.2.3.4 If the *Owner* or *Prime Consultant* fails or refuses to carry out the obligations as set out in Section 3.2.1. and 3.2.2, the *GER* should:

(a) consider giving written notice to the *Owner* advising the *Owner* of the *GER's* recommendations;

(b) consider whether the *GER* can continue with the project,

because in any event the *GER* must comply with the minimum requirements of these Guidelines.

3.2.4. GENERAL CONTRACTOR

It is not the mandate of this guideline to stipulate the responsibilities of the *General Contractor*, however, the *GER* shall ensure that the *Contract Documents* clearly state that:

3.2.4.1 The *General Contractor* is responsible for all labour, materials, equipment, and plant required to complete the work.

3.2.4.2 The *General Contractor* is responsible for the construction methods, techniques, sequences, procedures, safety precautions and programs associated with the construction work, all as set out in the *Contract Documents*.

3.2.4.3 The *General Contractor* is responsible for coordinating the work of the *Sub-Contractors* and for checking the *Sub-Contractor's* work.

3.2.4.4 The *General Contractor* is responsible for providing reasonable notice to the *GER* when the work is ready for field inspection and *Testing*.

3.2.4.5 The *GER's* field inspection and *Testing* does not relieve the *General Contractor* from his responsibilities to complete the work in conformance with the *Contract Documents.*

3.3 SELECTION OF CONSULTANTS

The recommended procedures for selecting a consultant are as described in the "Selection by Ability" booklet published by PEGNL.

4.0 GUIDELINES FOR PROFESSIONAL PRACTICE

The following are guidelines for the services which the *GER* should consider providing as part of good practice. They may assist the *GER* in explaining his services to a *Client*. These guidelines deal in an advisory way with matters of practice and procedure rather than with matters of substantive engineering. The limitations imposed upon the geotechnical consultant by practical considerations in the determination of subsurface conditions should be recognized by the *Owner*, the *Client* and other members of the design team.

4.1 SOLE USE OF DOCUMENTS

The following clause should appear on all drawings and specifications.

"These design documents are prepared solely for the use of the party with whom the *GER* has entered into a contract. There are no representations of any kind made by the *GER* to any other party".

4.2 SCOPE OF SERVICES

Before commencement of design services, the *GER* shall meet with the *Client* to:

4.2.1 Determine the terms of reference and the scope of work of *Basic Services* and *Additional Services*;

4.2.2 Reach agreement on fees, payment schedule and professional liability insurance coverage;

4.2.3 Reach agreement on a contract.

4.3 BASIC GEOTECHNICAL ENGINEERING SERVICES

The usual stages of the *Basic Services*, as discussed below, are generally organized in an agreement according to the sequential stages of a typical project.

4.3.1 PRELIMINARY INVESTIGATION STAGE

During the conceptual planning of a project, a preliminary geotechnical investigation may be carried out. The *GER* may attend, as required, periodic meetings with the *Client* and design team to obtain the *Client's* instructions regarding project requirements. In the preliminary investigation stage, the *GER* may provide the following:

4.3.1.1 Air Photo Interpretation

Where air photographs are available, the site and surrounding area terrain may be mapped to

indicate some or all of the following:

a) general drainage patterns
b) general slopes and ranges of gradient
c) bedrock outcrops, where present
d) general surficial soil types
e) poorly drained or bog areas (peat or muskeg)
f) erosion features
g) old or potential slope failure areas;

4.3.1.2 Literature Search

The geology of the area may be reviewed from known data, either to supplement the air photo interpretation, or to replace it where air photos are not available.

All available physiographical data may be searched and previous site investigation data reviewed along with any available well water records;

4.3.1.3 Site Reconnaissance

Following air photo interpretation and/or literature search, a preliminary site reconnaissance may be made to physically examine land forms, drainage, erosion features, etc. In addition, hand auger holes or rod soundings may be put down, or shallow test pits excavated to confirm the general surficial soil, bedrock and groundwater conditions;

4.3.1.4 Preliminary Investigation Report

The findings of the work will be presented in the preliminary investigation report. The data should be presented in a form that enables the *Client* to assess the economic effect which the soil, bedrock and groundwater may have on the viability of the project.

4.3.2 DETAILED GEOTECHNICAL INVESTIGATION

Upon completion of the preliminary investigation the *GER* may attend, if required, meetings with the *Client* and design team to review other relevant planning information. The detailed geotechnical investigation shall include;

4.3.2.1 Field Exploration

The pattern of borehole drilling and/or test pit excavation should be agreed between the *GER* and the *Client* or *Client's* consulting design engineer. The nature of the project to be designed and the known subsurface conditions of the area usually dictate the location, spacing and depth of the test holes.

The drilling of boreholes should be carried out by an experienced drill crew using the type of

equipment best suited for the terrain and anticipated soil conditions. Boreholes may be advanced by wash boring, with or without driven casing, solid stem augers or hollow stem augers. Test pits may be hand or mechanically excavated. In all cases, the method by which the test hole has been made must be clearly stated as part of the field procedure. Such work should be performed under the direction of the *GER*;

4.3.2.2 Field Sampling

Exploration and field sampling work must be carried out in accordance with recognized practice, such as recommended in the Canadian Foundation Engineering Manual and by A.S.T.M.

The frequency and type of sampling may be varied by the requirements of the project, but should be under the control of the *GER*. Normally, standard sampling is carried out at 0.75 m intervals initially, with a spacing often increased to 1.5 m intervals below the 4.5 m or 6 m depth if conditions warrant such increase. Types of samples normally used include split spoons and thin wall Shelby tubes. Other types of samplers which may be required in certain types of soil are piston and Oesterberg samplers and foil samplers.

In test pit excavations, representative bulk samples may be recovered from the different stratigraphic units as necessary;

4.3.2.3 Field *Testing*

Field *Testing* must be carried out in accordance with recognized practice such as recommended in the Canadian Foundation Engineering Manual and by A.S.T.M. or in accordance with special instructions set out by the equipment manufacturers. Types of *Tests* normally done include in-situ vane, standard penetration, dynamic cone penetration, pressure meter and pumping *Tests*. Other *Tests* depending on soil conditions may include static cone penetrometer, flat dilatometer, plate load *Tests*, etc.

Such *Tests* must be utilized correctly and at the appropriate place in order to define the in-situ soils or bedrock parameters;

4.3.2.4 Groundwater Records

Fluctuations in the elevation of the groundwater occur over a period of time. It is considered good practice that the existing groundwater level should be monitored by piezometers or other methods as a routine part of any investigation. The installation of such equipment should be in accordance with recognized standards and as directed by the qualified *GER*. Such installations usually require additional visits to the site to make field observations until conditions have reached equilibrium.

It is also essential that all observations of the encountering of seepage water or initial water percolation into test pits be recorded as part of the field records. Further, the rate of inflow and rise of water levels should be recorded at the time of the initial observations in order to assess correctly the apparent influence which the water condition may have on the design project as well as on construction procedures;

4.3.2.5 Laboratory *Testing* of samples

It is normally a requirement that representative samples from the detailed site investigation be tested in the laboratory for the determination of soil properties essential to the preparation of the geotechnical report. It is normally essential that the natural moisture content of samples be determined at the time of the investigation as a routine measure. Subsequent to the completion of the laboratory *Testing* program, the report and recommendations should be made based on the results obtained;

4.3.2.5.1 Classification *Tests*

Classification *Testing* of samples is frequently carried out to identify soil type. Such classification *Tests* include grain size analysis, Atterberg limits, moisture content determinations and must be carried out in accordance with recognized practice such as recommended by A.S.T.M.;

4.3.2.5.2 Strength *Tests*

Strength and consolidation *Tests* should be carried out on undisturbed samples if conditions warrant such *Testing*. Such *Tests* may be carried out in a variety of ways, depending upon the parameters required and the soil type being examined, but all such *Tests* must be carried out in accordance with recognized practice, such as recommended in Canadian Standards, the National Building Code of Canada, and by A.S.T.M. Laboratory *Testing* will be performed by trained and qualified technicians working under the control of an experienced *GER*.

Only such *Testing* as is required to provide the data for proper analysis of the geotechnical problem should be carried out;

4.3.2.6 Report and Recommendations

The *Geotechnical Report* should outline the terms of reference of the investigation, should summarize the findings of the field investigation and the supplementary laboratory *Testing* and should then present the conclusions and recommendations based on these findings. When construction proceeds, it is recommended that the *GER* be retained to provide services during construction;

4.3.2.6.1 Factual Data

The factual data comprises the terms of reference, the details of the field investigation procedures, the results of the field investigation, the results of the field *Testing*, records of groundwater observations, laboratory *Test* results, site plan and inferred soil stratigraphy, etc.

This portion of the report should not include any conclusions derived from the factual data;

4.3.2.6.2 Report Recommendations

The report recommendations and geotechnical conclusions should be presented separately, so that these recommendations may be excluded from the tendering documents if the user so desires.

Such recommendations may cover a variety of activities, such as alternative founding depths/elevations with recommended design bearing values, pile design considerations, estimates of potential settlements, recommended safe slopes of banks or excavation walls, earth pressures for shoring design, dewatering requirements, soil stabilization, etc.

The recommendation should be made with due consideration to the construction proposed by the user, in order to provide the most economic viable alternatives available for consideration. Only in this way can the user obtain the true benefits available from a competently performed geotechnical report.

The report embodying the findings of the *GER* should be a necessary tool for the planner, designer and for those contractors who specialize in dewatering, excavating and foundations. It is thus recommended that the part of the report containing factual information be incorporated in the tendering documents.

4.3.3 SERVICES DURING CONSTRUCTION

Further to the carrying out of a geotechnical investigation and report, various supplementary activities can be provided as part of the *GER's* work during the construction phase. The supplementary services which should be arranged include the following:

4.3.3.1 Foundation Subgrade Inspection

Site inspection of the foundation bearing material during construction should be carried out under the supervision and control of the *GER* who prepared the original site investigation report.

The geotechnical engineer should be given the opportunity to verify the conditions at the bottom of the excavated site as were anticipated and that no part of the excavation shows soil conditions which are substantially different than those which were anticipated.

It is normally a requirement by the foundation designer or structural engineer that such inspection verify that the specified bearing values have been achieved at the foundation level.

4.3.3.2 Pile Driving Inspection

During the driving of piles for the foundations, it is normally a requirement that an independent inspection be carried out by an inspector or technician under the supervision of the *GER* who carried out the site investigation report to ensure that the piles have been driven to adequate penetration and set, as required for the load design capacity of the pile. The pile driving records should include the final set, the founding elevation of the tip of the pile and the length of the pile in place, as well as the cut-off elevation of the pile. Geotechnical supervision should also be provided in the case of compacted concrete piles, drilled caissons and vibroflotation and dynamic compaction operations to ensure installations, are in accordance with specifications.

4.3.3.3 Load *Test* Supervision

It is occasionally necessary that load *tests* of piles or foundations must be carried out as decided by the *GER* and the Structural Engineer of Record. Such load *testing* should be carried out under the supervision of a technician working for the *GER*. The details of the load application and settlement under each increment of load must be recorded as the work proceeds. All such load *tests* should be carried out in accordance with recognized practice such as recommended by A.S.T.M. Details of the *tests* should be presented in graphical form representing the Load/Time/Settlement curves for the pile or footing tested; a report should be submitted providing details of the work and the results obtained.

4.3.3.4 Fill Compaction *Testing*

Where fill placement is a requirement of the contract, inspection and *testing* for approval of soils (site borrow material or granular fills) should be carried out by a qualified experienced soils technician under supervision of the *GER*. Where standards of compaction are a requirement for these fills, the physical *testing* of the fill material should be carried out also by a qualified and experienced soils technician under the supervision of the *GER*. As such *testing* is carried out, a report should be submitted to the user indicating acceptance or rejection of the work as it is performed.

4.3.3.5 Pavement Subgrade *Testing*

Road subgrades should be tested for design recommendations for the eventual pavement design, which should be based upon the nature and condition of the subgrade at the time of construction of the roadway.

Such *tests* may involve laboratory *testing* of samples recovered from the site or may involve in-situ *testing* of the subgrade in its prepared condition.

4.3.3.6 Slope Stability Monitoring

The installation of, and the monitoring of, slope indicators prior to, during and following construction of civil engineering works may be essential to the safety of the facility. Such work should only be carried out by qualified and experienced engineering technicians under the supervision of a *GER*.

4.3.3.7 Field Instrumentation-Settlement

The monitoring of instrumentation established during construction to determine settlement and stress changes is frequently a requirement of the *GER* services. Such work should only be carried out by qualified experienced technicians acting under the supervision of a *GER*.

4.4 ADDITIONAL GEOTECHNICAL ENGINEERING SERVICES

In addition to the *Basic Services*, the *GER* may provide the following *Additional Services* if the *GER* and the *Client* reach appropriate mutual agreements. They are not considered intrinsic parts of the basic geotechnical design services as discussed in Section 4.3, and are not part of the minimum services which the *GER* should provide under these guidelines.

Examples of *Additional Services* are:

4.4.1 Geotechnical engineering work resulting from changes to the project as originally described and agreed to under the contract between the *GER* and *Client*, such as changes in scope, complexity, diversity or magnitude of the project;

4.4.2 Work connected with the preparation of documents for tendering segregated contracts, pre-tendered contracts, phased or fast-track construction;

4.4.3 Review of alternative designs or products after completion of the *Contract Documents*;

4.4.4 Review of design drawings or Specifications prepared by others to determine suitability;

4.4.5 Blast monitoring during excavation and/or seismic risk analysis;

4.4.6 Special dynamic analysis beyond that required by codes such as ground-foundation response;

4.4.7 Special physical soil model analysis such as centrifuge *testing*;

4.4.8 Field investigation of existing buildings and structures including surveys of existing construction;

4.4.9 Design review or field observations of shoring or bracing for excavations and building or underpinning of adjacent structures;

4.4.10 Review of the contractor's methods, procedures and construction equipment with respect to the effect on the project;

4.4.11 Work resulting from corrections or revisions required because of errors or omissions in construction by the contractor;

4.4.12 Extra work arising from disputes due to problems outside the control of the *GER*;

4.4.13 Work due to extended time schedules for design or construction, beyond the control of the *Prime Consultant* or *GER*;

4.4.14 Services as an expert witness in connection with any public hearing, arbitration, or court proceedings concerning the project, including attendant preparation for same;

4.4.15 Work resulting from damage as the result of fires, man-made disasters, or natural disasters;

4.4.16 Overtime work requiring premium pay when authorized;

4.4.17 Travelling time outside of normal requirements;

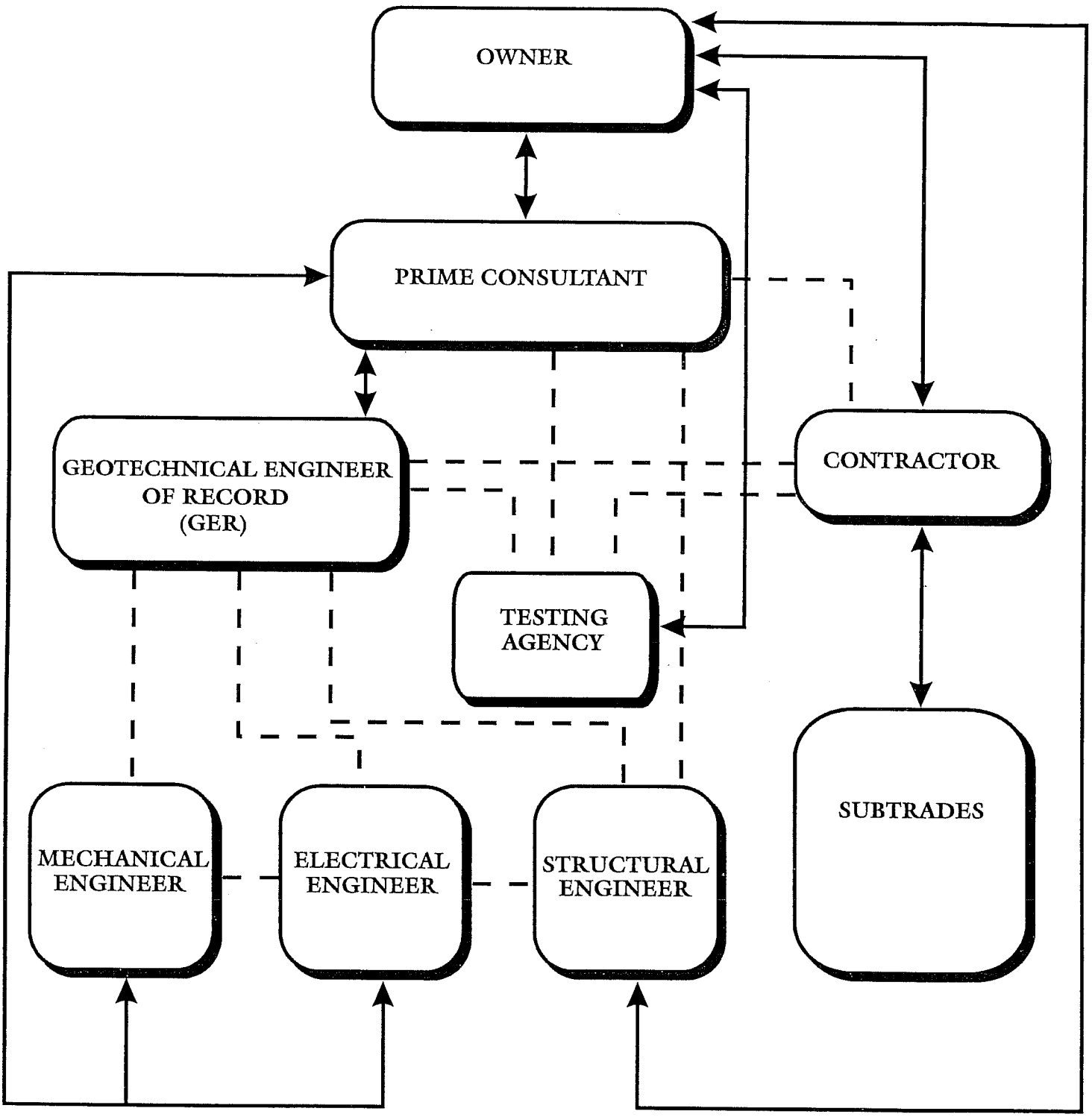
4.4.18 Provision of special clauses to be included in the specifications where unusual soil, bedrock or groundwater conditions exist and where special expertise is required;

4.4.19 Provision of special sketches for drainage, special foundation measures, safe slopes and shoring requirements;

4.4.20 Attendance at special site meetings to review problems of an unforeseen nature that have arisen during foundation or earthworks construction.

Common Organizational Charts

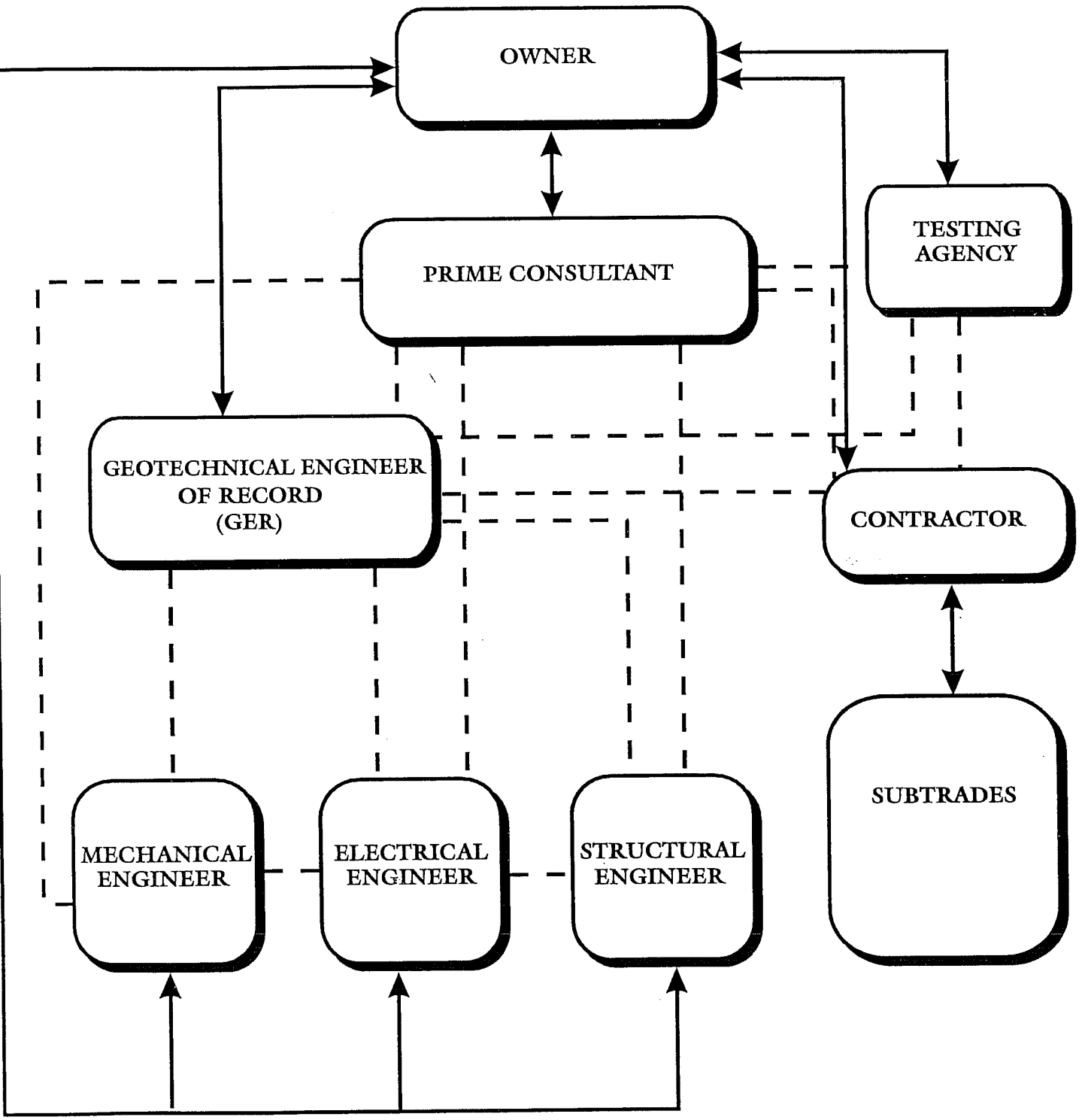
1. Geotechnical Engineer of Record (GER)/Prime Consultant Contract



Note: The *Prime Consultant* shall be responsible for coordination of the Subconsultants even though they are hired by the *Owner.*

Common Organizational Charts

2. Geotechnical Engineer of Record (GER)/Owner Contract



Contractural Relationship

Functional Interface

Note: The *Prime Consultant* shall be responsible for coordination of the subconsultants even though they are hired by the *Owner.*

Common Organizational Charts

3. Design/Build Contract