THE GEOLOGICAL SOCIETY

TRAINING GUIDE FOR

ENGINEERING GEOLOGISTS

This document has been produced by a Working Group under the auspices of the Education and Training Committee of the Engineering Group of the Geological Society of London.

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THE GEOLOGICAL SOCIETY OF LONDON

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Second Edition

EXECUTIVE SUMMARY

The Geological Society is responsible for awarding the title of Chartered Geologist to those of its Fellows it considers have sufficient education, training and experience to meet the requirements laid down by the Society. A primary aim of this Training Guide is to provide guidance to graduate earth scientists in obtaining the necessary experience and knowledge to attain chartership status. To this end the tables provided in the Guide are designed to provide a comprehensive list of achieved skills that, in their project context, may serve as the basis of a submission for charter status. It is further intended that the Training Guide will continue to be used by Chartered Geologists for whole career training and a record of Continual Professional Development

There are many specialisations within the geological profession and therefore one training guide cannot apply to them all. This Training Guide has been produced for Engineering Geologists, although in doing so it is recognised that the sphere of employment of the Engineering Geologist is very broad and so a range of subjects have been included, some of which would rightly be considered to belong in other geological specialisations such as hydrogeology, geophysics and extractive industries. While it is considered necessary that the Engineering Geologist should gain some experience in these fields in-depth knowledge would not be expected unless required by the Trainee's main fields of employment.

A working knowledge of geology to graduate level is required of all Trainees starting their training and most will have a first degree in the earth sciences. Those without an education majoring in geology should contact the Geological Society for advice on what further education may be needed to achieve Chartered status

This Training Guide sets out a number of objectives which are worded in general terms so that a wide range of different experience can meet these objectives. A company may wish (and is encouraged) to write its own more specific training guide which must include the core objectives. Much of the Training Guide is appropriate for Engineering Geologists working outside the fields of civil engineering and construction, however, modifications may be necessary to suite some specific areas of activity.

The guide covers seven broad sections including a section of Core Skills, which are expected to be obtained to the required level of attainment before applying for Chartership. It is likely though that during the trainees career objectives in other sections are likely to be fulfilled. Completion of every objective is not required. A detailed description of the use of the Guide is in Part 1 with detailed objectives being placed in Part 2. Instructions to Employers who wish to make use of the Training Scheme are in the Appendix.

PART 1 – THE TRAINING GUIDE

1 INTRODUCTION

The Geological Society of London (GSL) is the Chartered body recognised by the Department of Trade and Industry as the designated authority for Geology in the United Kingdom (UK) under the terms of the European Community Directive on the Recognition of Professional Qualifications. As such it is responsible for scrutinising the qualifications of candidates for Fellowship (FGS) and for validating as Chartered Geologists (CGeol) those Fellows it considers meet its standards of qualifications and experience. In common with other such bodies the Geological Society is responsible for facilitating the practising of geology in the UK to the highest possible technical and professional standards. In this professional role, the Society has an obligation to guide the development of young geologists in their careers and, in particular, to ensure that those who wish to qualify for chartered status receive the best possible training.

This Training Guide is provided for the use of geologists and other related earth scientists who would be classed as Engineering Geologists. It provides guidance on the level of experience that they should attain to support their applications to the Geological Society (GSL) for Fellowship with Validation (CGeol) status and is further designed to serve as a whole career record of achievement of skills through continued professional development (CPD).

Engineering Geologists use their geological skills in such fields as site investigation, slope stability analysis, mapping of geological and geotechnical hazards, foundation and earthworks design and the identification and remediation of contaminated sites. They may also be involved in the related disciplines of engineering geophysics, hydrogeology and mineral exploration. They are critical to, and should be considered as the principal developer of, the conceptual ground model for a given site. Whatever their speciality, all Engineering Geologists require good training if they are to become competent professionals and it is with this aim in mind that the Geological Society has produced this Training Guide for Engineering Geologists.

The Training Guide was prepared jointly by the GSL's Professional Standing Committee and the Engineering Group of the Society (EGGS). It is the Second Edition of the Guide, and as such supersedes the Guide prepared by a working group chaired by Mr. AJ Bowden (October 1994). This Second Edition was prepared by a working group chaired by Mr Simon Wheeler, whose brief was to update the 1994 Guide in the light of:

- changes in technical requirements and professional practice of Engineering Geologists,
- revisions to the GSL's requirements and procedures for the granting of CGeol status
- introduction of the GSL's CPD scheme, which is available as an on-line record through the GSL web-site.
- the proposed introduction of a Registration for Ground Specialists.

1.1 Stages in the Process

An application for CGeol status should be seen as part of a career-long commitment to (CPD), which the GSL divides into two phases:

Phase 1 – from graduation with a first degree to being awarded CGeol.

Phase 2 – from award of CGeol through to Registration and beyond**.**

A flow chart explaining the route to CGeol (i.e. Phase 1) can be downloaded from the GSL's website. The following notes provides some further guidance, explanations and requirements of the CPD process during Phase 1:

1. The Trainee should apply for, obtain and maintain Fellowship of the Geological Society.

2. The GSL strongly advises that Fellows working towards CGeol status should have a Training Supervisor from within their work organisation. Training Supervisors should be Chartered Geologists. The GSL maintains a list of CGeols who have indicated that they would be willing to act as Training Supervisors for aspirant CGeols and can suggest names of suitable Training Supervisors.

3. The Trainee should work towards and attain the training objectives listed below, recognising that they are part of the wider range of CPD activities that a Fellow is encouraged to undertake. The GSL has an on-line system for recording and submitting CPD records.

4. The Trainee should maintain a work diary and submit it, on a quarterly basis, to the Training Supervisor. A print-out of the on-line CPD record should be included in the work diary as supporting information.

5. Periodically the Trainee should review his/her progress in achieving the required training objectives, including an annual review meeting with the Training Supervisor.

6. On completion of the training objectives and attainment of the required experience (minimum of five years) the Trainee will need to:

    - prepare a report (1500-2000 words) on professional experience, demonstrating how the seven requirements for CGeol listed in section 2 have been met;

    - assemble professional documents to support the experience described in the report and work diary.

7. Review the professional report and documents with the Training Supervisor and obtain the required signatures from the relevant project managers and supervisors.

8. Submit the application and supporting documents to the GSL.

9. Prepare for and attend the professional interview during which the candidate is required to make a 15-minute presentation to the Scrutineers.

A formal statement of the requirements is provided in the GSL's 'Rules for Admission and Guidance Notes for Fellowship', which can be obtained from the Fellowship Manager at Burlington House.

2 AN OVERVIEW OF THE TRAINING OBJECTIVES

The objective of the Training Guide is to encourage Engineering Geologists to expand their experience throughout their professional career and also to structure their early training so as to gain sufficient and relevant experience to meet the requirements for Chartered Status as applied to the discipline of Engineering Geology. It is anticipated that the Guide will form the basis for a formal structured training scheme within an organisation.

GSL Regulation R/FP/2 requires that Fellows seeking validation as a CGeol demonstrate seven components of relevant experience(October 2006). At the time of writing they are:

(i). An ability to understand the complexities of geology and of geological processes in space and time in relation to his/her speciality.

(ii). An ability to use geoscience information to develop predictive models.

(iii). An ability to communicate clearly verbally and in writing.

(iv). A clear understanding of the meaning and needs of professionalism

(v). An awareness of Health and Safety issues and other statutory obligations applicable to his/her discipline or area of work (that is, including appropriate industry standards).

(vi). A knowledge and understanding of the Code of Conduct.

(vii). An appreciation of the role of Continuing Professional Development during training and after validation (that is, once Chartered).

Trainees should check that they are using the current version of the Regulations. The requirements are for all Fellows applying for validation as a Chartered Geologist. It is intended that in fulfilling these requirements the exercise of the above should form at least 50% of the usual working hours over the period of experience claimed. For those where it is less the length of experience required will be commensurably longer. (Paper 13/1 of the Fellowship and Validation Committee).

The Training Guide is written with the intention that those complying with the Training Guide should meet these criteria.

The Training Guide is not intended as a substitute for postgraduate education and the Engineering Geologist is encouraged to undertake an MSc in Engineering Geology, Geotechnical Engineering, Foundation Engineering, Hydrogeology, Soil Mechanics, Rock Mechanics or other related subject during his/her early career. It should be stressed however, that classroom teaching is not a substitute for practical on the job training and experience which are essential for achieving Chartered status. Due to the advanced technical aspects of a MSc, it is included in the experience for Chartered status.

2.1 Admission to the Scheme

The Training Scheme is administered by the GSL and is open to all Fellow Members of the Society who are practising geology and who have a realistic prospect of satisfying the requirements for Chartered status as set out in the Rules for Admission and the guidelines above. Those without a formal qualification in geology will be accepted providing they are employed (or are otherwise active) in Engineering Geology. The Training Guide assumes a sound knowledge of geology and of geological processes; anyone joining the scheme without this knowledge should seek advice from the Society on what further geological education will be required.

The booklet entitled "Rules for Admission and Guidance Notes for Fellowship" is printed by the GSL and sets out the requirements for joining the Society and for the granting of Fellow and Chartered Status.

3 THE STRUCTURE OF THE TRAINING GUIDE

This Training Guide lists the topics that are likely to be included in the work experience of an Engineering Geologist. The sphere of employment of Engineering Geologists is very wide and it is not intended that all of the topics should be covered by any Trainee. The core skills are considered to be essential parts of the training of all Engineering Geologists, while achievement in the topics covered in the subsequent sections will depend on the work experience of the individual Trainee. The key skills in each section are indicated and the Trainee working in these areas should ensure the target level is achieved in these areas. The details may be varied to suite individual Trainees whose experience is in some way out of the ordinary. Employers and Training Supervisors should consider producing their own training scheme based on this document. Where an employer's sphere of activity is particularly specialised, or lacking in the area of some key skills, consideration should be given to obtaining an appropriate secondment for the Trainee to obtain the necessary experience.

The training objectives are sub-divided into sections:

C Core skills

S Site Investigation

A Interpretation, analysis and design

P Professional and general

M Business management and commercial

L Legislation and Contracts

H Health and safety

Each section starts with guidance on the applicability of the subjects, followed by a description of the level of training and achievement that is required.

The relevant table for the section is included in Appendix A, on which the experience gained can be recorded. The experience gained should be endorsed by the Training Supervisor who will date and initial the relevant column as each standard is achieved.

Trainees should score their current experience and competencies against each objective and use this (with their Training Supervisor) to monitor their progress and professional development.

The following levels of attainment have been used:

A Appreciation; a general understanding of a subject or an appreciation as to how to undertake an activity

K Knowledge; observation and recall of information or knowing how to undertake an activity

E Experience; ; a depth of knowledge of a subject or activity actually undertaken by a Fellow (generally under supervision)

C Competence; a sound knowledge of a subject or activity actually undertaken by a Fellow without supervision; the Fellow can successfully direct others in the activity

In addition, where a particular item is regarded as being a necessary component of an Engineering Geologist's capability this is indicated as follows

- ● an essential objective
- ○ a recommended objective.

The objectives marked by ● are the core objectives and it is expected that experience will be gained in these subjects. In exceptional circumstances a good working knowledge may suffice but the omission of a number of these core objectives would bring into question the adequacy and breadth of the training obtained. These symbols have been used sparingly and the requirements of each section have been drafted so that a wide variety of training and experience should be able to satisfy the broad objectives of each section. Additional notes on any other relevant experience and training received may be included at the end of any section.

An example is given below of the completion of the record of attaining training targets:-

Training Objectives	Date of Assessment, Level of Attainment and Training Supervisors Initials				Comment
	A	K	E	C	
Core Logging	5.7.06 AJB	5.9.06 AJB	5.7. 07 AJB	5.7.08 AJB	AJB 5.7.08 Supervising a team of 3 geologists

When assessing their attainment level Trainees should consider what evidence they need to submit in support of their application for chartership, noting that an item of evidence could cover more than one objective. In addition objectives and abilities recorded under other schemes such as the industry-wide Construction Skills Certification Scheme (CSCS) and individual company schemes for Investors in People (IIP) may be used.

In using this Training Guide and preparing a chartership submission, Trainees should also bear in mind the categories under which CPD is recorded (see the GSL web-site):

1. Acquiring knowledge and skills by deployment (that is during one's day-today work):
    - Professional practice
2. Enhancing and maintaining skills and knowledge:
    - Formal learning (tested)
    - Formal learning (untested)
    - Informal learning/training
    - Self-directed study

3. Participating in the geoscience community:
    - Non-work activities
    - Contributing to knowledge

3.1 Training Supervisors

All Engineering Geologists participating in this training scheme will have a Training Supervisor, for purposes of attaining Chartership. The Geological Society should be informed of the name and title of the training supervisor within the company. Such a person must be a Chartered Geologist, usually with significant experience. Wherever practicable, the Training Supervisor will be a practising Engineering Geologist who is in the same organisation as the Trainee and who is fully committed to the aims of the Training Guide.

Once the Training Supervisor has been identified the Supervisor and the Trainee are jointly responsible for the implementation of the scheme and the Geological Society will not be involved further unless problems arise. If it becomes necessary for the Training Supervisor to be changed during the training period, the Geological Society should be informed of the change.

Where the Training Supervisor is not in the same organisation as the Trainee it is recognised that there may be problems of confidentiality. Whilst the Supervisor is bound by his code of conduct not to disclose any information obtained, it is recognised that the Trainee may not be permitted to disclose any such confidential information and the Supervisor must make any necessary allowances for this.

The training period leading to chartership shall be a minimum of 5 years and during that time the Training Supervisor should have formal contact with the Trainee on a quarterly basis. These meetings should preferably be face to face, but telephone and mail contact is acceptable provided direct contact is made at least annually. These contacts should be used to discuss the training and experience that the Trainee is receiving and to make any recommendations to the employing organisation which are thought necessary, either directly or through the Geological Society. In exceptional circumstances, such as either the Supervisor or the Trainee working in remote locations/overseas, it may be necessary for this contact to be achieved entirely by correspondence, but this very limited supervision is considered undesirable and must be approved by the Geological Society in advance.

The Training Supervisor shall inspect the record of training on a quarterly basis and authenticate the grades of training achieved by dating and initialling the record. The tables in the Training Guide are designed to serve as the training record. As part of the requirements for attaining chartership, the Trainee should record these quarterly meetings and any objectives set for the purposes of producing an annual report of 1500 – 2000 words. Any lectures or training courses attended during the period are to be reported separately as a brief summary with an emphasis on the content and value to the Trainee of the lecture/course attended and recorded on the online CPD record. Attendance at the course is to be authenticated by the employer, Supervisor or course organiser.

The Training Supervisor will also assist in arranging any secondments and will monitor their progress.

3.2 The Training and CPD Record

Maintenance of a Training and CPD record is an essential part of the training of any professional geologist. It is a requirement for attaining Chartered Status and it is recommended that the record should be maintained throughout the Engineering Geologist's professional career. The Training and CPD Record should record the type of work carried out, illustrating the experience gained and responsibilities held. It should therefore be sufficiently detailed to allow correlation with the experience recorded in the Training Guide, but should not contain confidential information, nor need it include details regarding the client, administrative information or site locations that might be of a sensitive nature. The training and CPD record should contain details of all formal and informal training received.

As mentioned in earlier sections the GSL have produced an online CPD record, which it is recommended is utilised at the earliest opportunity. This can be found on the GSL website at:

www.geolsoc.org.uk

PART 2 – TRAINING OBJECTIVES

4 CORE SKILLS (C)

4.1 Introduction

The Training Objectives identified as Core Skills are considered fundamental requirements for anyone employed as a professional Engineering Geologist. Attainment of these skills at the Competence level is a mandatory requirement for becoming a Chartered Geologist within the Engineering Geology discipline.

Most of the Core Skills will have been learnt as part of an undergraduate degree programme prior to the Trainee embarking on a professional career and it is important that they should be maintained either as part of their work or, for example, by attending workshops and fieldtrips that are arranged by the Geological Society through its various Regional and Specialist Groups (including the Engineering Group) and by a number of other organisations.

5 SITE INVESTIGATION (S)

5.1 Collection and Collation of Existing Data (The Desk Study)

5.1.1 Introduction

Collection and collation of existing data is the essential first stage in any site investigation. It is necessary for the establishment of the conceptual ground model which can then be used to scope and plan appropriate field investigations to develop the model through to design stage. These activities are often called the 'desk study' even though site reconnaissance ('walkover survey') and possibly some more detailed mapping may be, and ideally should be, included in this stage of an investigation. The Trainee should develop the necessary skills for this work which often requires the evaluation of data from different sources and the assessment of confidence levels where there is an absence of information or conflicting evidence.

Training in this area should ensure that a methodical approach is taken to data collection, that it is collated appropriately and used in a logical manner to develop a fully supported conceptual ground model, which can be used to plan the subsequent stages of the investigation and developed as further information becomes available.

5.1.2 Retrieval of Information

Existing data arises from a variety of sources including, but not limited to, the Ordnance Survey, the British Geological Survey, public libraries and the libraries of learned and professional bodies, university and copyright libraries, the Environment Agency, Local Planning Authorities and records held by the client.

5.1.3 Collation, Synthesis, Interpretation and Presentation of Results

The best way to present data summaries will depend on the details of the site and the project. In many cases it will be best to present the desk study results as a report including a series of plans and cross sections. The Trainee should gain experience in producing output of this type and of other useful techniques such as graphs, histograms, annotated photographs, sketches and block diagrams and learn to select the best method of presenting information.

All the training objectives listed can be achieved on paper, it is expected that the Trainee will develop and use basic computer skills, specifically the use of word processors, spreadsheets and data bases in the storage and manipulation of data and the presentation of results.

5.1.4 Conceptual Ground Model

As mentioned in previous sections once the data has been gathered a conceptual ground model and assessment of the associated risks can be produced. Ideally this should relate to both geotechnical and geoenvironmental risks so that the planned investigation can address all potential issues associated with the site, but this is generally dependent on the project brief which the trainee should be aware of before commencing the work.

5.2 Site Reconnaissance and Mapping

Site reconnaissance and mapping can form part of the desk study or may be carried out as a separate phase of the investigation. The purpose of site reconnaissance is to confirm information obtained from the desk study and to note any relevant features that may not be evident from the documentary records. Mapping may be used to obtain a basis for the conceptual model, or it may be of a more specialist nature aimed at a particular feature of the site, such as the extent of soft or waterlogged ground, a contamination association such as a spoil tip, the morphology of an old or active landslide, or other geohazard.

Specialist mapping may be carried out at any stage of a project and might consist of one of the following:

- Geomorphological mapping for geotechnical/asset management purposes
- Resource maps for extractive industries and hydrogeological purposes
- Contamination delimitation for geo-environmental purposes.

5.2.1 Field Work

Field experience is one of the most important aspects of an Engineering Geologist's training and it is the specialist skills in this area that often distinguish the Engineering Geologist from other ground specialists. Accurate and detailed field observations and the recognition of the geological and 'man-made' processes which affect the site are often crucial to the effectiveness and the safety of the final design.

5.2.2 Mapping and its Interpretation

It is essential that an Engineering Geologist demonstrates an ability to record and transmit data in the form of plans and sections derived from systematic engineering geological mapping. The mapping may be factual or interpretative, with the difference clearly indicated, and should always include a key to symbols, north point and scale. Experience should be gained at working at a variety of scales depending on the size of the site and the degree of detail required. An ability to think in three dimensions and to recognise the effects of natural and man-made processes is an essential part of the science of the Engineering Geologist.

The Trainee should become familiar with the use of remote sensing data in field operations.

5.3 Ground Investigation

5.3.1 Introduction

This section deals with ground investigations as they are most commonly used in the following industries:

- Geotechnical
- Geo-environmental
- Hydrogeological
- Extractive Industries

An Engineering Geologist must regard a site investigation as an evolving process and not attempt to follow a predetermined plan. The results must therefore be continually re-evaluated as work progresses, particularly if subsurface conditions are complex, or not as anticipated.

All Engineering Geologists must have a detailed knowledge of the more commonly used site investigation methods and be able to supervise and control the works and carry out a progressive interpretation of the data.

5.3.2 Planning the Ground Investigation

A ground investigation is generally required to provide much of the information that forms the conceptual ground model on which any future design work will be based and to provide the parameters required for the design. The Trainee will require a knowledge of the project as well as an understanding of the ground model derived from the earlier studies in order to plan a successful and cost effective investigation.

Planning the investigation should address three fundamental questions:-

- What is already known about the site?
- What is the proposed development (nature, size and effect on the ground)?
- What further information is required at this stage of the design (feasibility, preliminary, detailed design)?

Ideally the investigation should be carried out in stages, with the results of each stage being used to plan the subsequent work. Each stage of the investigation must be planned so as to be as flexible as possible to allow for any reasonable changes arising from unexpected ground conditions or changes in scheme proposals.

Investigation should be planned with the above objectives in mind and the Trainee should have a clear understanding of the reason, whether specific or general, for the location of each exploratory hole, and of the ways in which the necessary information will be obtained from each hole.

5.3.3 Geotechnical Parameters Required

In order to plan an effective investigation, the Trainee will be required to have some knowledge of the type of geotechnical parameters that are to be used in design, how the parameters are related to the predicted ground conditions and how they can be obtained from insitu testing and sampling for laboratory testing. Implicit in this is an appreciation of any shortcomings of the chosen methods, of the quality of samples that can be obtained by various methods and the likely effects of sample disturbance on the testing.

5.3.4 Geoenvironmental Parameters Required

As for the geotechnical parameters the Trainee is required to have knowledge of the previous industrial land uses of the site so that an appropriate and targeted investigation can be carried out. It is important that the Trainee understands how sampling strategies, chains of custody, sample size and storage can effect the results obtained and know how to limit the loss in reliability of the results obtained from the laboratories.

5.3.5 Groundwater Observations

The Trainee must learn to appreciate the role of groundwater in the conceptual ground model and its effect on the project requirements. He/she must also understand the ways in which groundwater information can be obtained during and investigation and the benefit of long term monitoring and sampling to obtain information that is representative of the equilibrium conditions at the site. The aim of the groundwater investigation should be an understanding of the groundwater table, hydraulic gradients, nature of flow and the ground permeabilities.

5.3.6 Ground Gas Observations

Ground gas as with water can be an issue particularly on sites close to landfills, contaminated site, marshes and carbonate rocks and will need to be incorporated into the conceptual ground model. Therefore the Trainee should be aware of these potential issues and be able to design an appropriate monitoring and if required sampling regime so that the risks associated with ground gas can be designed out.

5.3.7 Evaluation of Possible Techniques

Once it has been decided where investigation is required and what parameters are needed, decisions can be taken on the most appropriate techniques for obtaining the data. These will all have limitations, for example depending on the ground conditions, quality of samples required, depth of investigation, working area and cost. The Trainee will require a knowledge of these in order to determine which techniques to use.

5.3.8 Description and Classification

An Engineering Geologist must be able to use standard descriptive terminology for soils and rocks to draw detailed and consistent trial pit and borehole logs to recognised standards.

The Trainee should develop an understanding of the various systems that are available for classifying engineering characteristics of particular rock types and become familiar with the use of some of those used in his/her area of work.

5.3.9 Laboratory Testing

An Engineering Geologist will frequently be asked to schedule the laboratory testing for a site investigation. In order to do this effectively he/she should have knowledge of the soil properties that are required, how they can be obtained and the way in which they will be used in characterising the soil and in design. In acquiring these skills the Trainee should appreciate the effects of sample disturbance, how representative the sample is likely to be, and the probable rate of deterioration of the sample.

For geotechnical testing an understanding is also required of the stress changes that will occur during construction and any relevant details regarding the method of construction and/or proposed use of the site.

For contamination testing an understanding of the type of contaminants likely to be encountered based on the previous industrial uses, construction methods likely to be used, the requirement to remove waste material and the proposed end use need to be taken into account.

An understanding of laboratory test scheduling can be gained by attending specialist courses or by studying previous reports, but work place training leading to experience of scheduling tests and the subsequent application of the test data often constitutes the best training. It is particularly beneficial if the Trainee can also obtain ‘hands on’ experience of testing in a laboratory.

6 INTERPRETATION, ANALYSIS AND DESIGN (A)

6.1 Geotechnical

6.1.1 Interpretation and Analysis

Data will arise from a variety of sources and at several stages of an investigation. This data needs to be recorded, manipulated as necessary, and analysed to extract the required information and parametric values. Data analysis may be used to reappraise and refine some aspect of the engineering geological model for further analysis or be used directly in engineering design.

Training in this area should give an appreciation of the sufficiency and reliability of the data, an understanding of the most appropriate method of analysis and the meaning of the results as they relate to the project requirements and the site conditions. Data to be analysed can be presented in a variety of ways and come from a variety of sources such as these listed below:-

- Information on geological surfaces as point data sections or contours
- Laboratory or field test results in tabular or graphical form
- Geophysical information in plan and section
- Groundwater or porewater pressure monitoring information as time sequence graphs
- Remote sensing imagery as annotated maps

Key skills required in data analysis are listed below and the Trainee should be able to demonstrate competence in a variety of techniques. Typically these processes provide the basis for detailed geotechnical design.

The Trainee should develop a critical consideration of the approach to be adopted for a specific project and data set, for example whether to analyse data in relation to ground level, reduced level or depth below a marker horizon, rather than working to a formula. The Trainee should develop an appreciation of the distribution of data and the extent of natural variation and hence be able to identify the effects of sample disturbance and the presence of rogue results and to differentiate real and meaningless statistical relationships.

When using computer programmes it is particularly important that the Engineering Geologist has a clear appreciation of the assumptions implicit in a particular programme and an understanding of the way in which the programme works. Software should always be used with understanding of the principles and appreciation of the sensitivity to the input variables. Results should be critically appraised to ensure that the model and analysis are appropriate and the results are correct, and relevant. The Trainee should be in the habit of systematically or spot checking the input data and results as appropriate.

6.1.2 Geotechnical Design

Geotechnical design is the end product of much of the work that an Engineering Geologist employed in the construction industry will undertake. However, the extent to which he/she will be involved can vary considerably, depending on the organisation they work for, the extent of their own engineering capability and on the nature of individual projects. Engineering Geologists are more likely to obtain design experience in relation to shallow foundations, excavations, small retaining walls, slope stabilisation, soil nails, rock bolts and dewatering systems than in more complex aspects of mathematical modelling and soil structure interaction. In all aspects of geology, but particularly in design, it is important that the Trainee understands and acknowledges the limits of his/her expertise and is mindful of the Code of Conduct of the Geological Society.

6.2 Contamination

6.2.1 Interpretation and Analysis

A contamination assessment comprises the assessment of a site in terms of the likely presence of, and potential risk posed by, any likely contaminants in the soil or groundwater, the possible effects of those contaminants and the way in which the nature of the contamination may affect, or be affected by, the proposed development of the site. Contamination assessments are increasingly forming part of site investigations either as a routine measure to safeguard the health of site workers, or as part of the overall assessment of a site for planning permission for a change of land use.

From an engineering geological point of view the basic skills required for a contamination assessment are very similar to those required for a geotechnical assessment, investigation and design. Both operations require the gaining of an understanding of the nature of the site, its geology and its history both natural and man-made. This understanding is then used to develop a conceptual ground model which in turn permits the Engineering Geologist to identify contaminant sources and to determine the processes affecting migration of contamination which are the prime considerations in assessing the risk and remediating a site.

The Trainee needs to become familiar with the various soil guideline values and their derivation together with the more sophisticated assessment techniques, including programmes such as CLEA, RBCA, CONSIM and BP.RISC which can be used to predict the effects of contaminant concentrations within the framework of the conceptual ground model on the current or proposed end land use and any construction activities. Such an assessment is then used as the basis for recommendations for mitigating risks during each of these phases, possibly including remediation measures.

6.2.2 Remediation Design

The Trainee should be familiar with the techniques of soil remediation including:

- Bioremediation (insitu and exsitu)
- Soil stabilisation and solidification
- Soil washing
- Permeable reactive barriers
- Insitu groundwater remediation techniques
- Monitoring natural attenuation

Design of a remediation strategy should include provision of a validation methodology with target values and clearly defined steps to be taken if the values are not achieved. The aim of the validation programme should be to ensure that the site has been remediated to the required extent and that this has been demonstrated. The remediation strategy may also include long term monitoring programmes.

6.3 Hydrogeological Design

6.4 Extractive Industries

6.5 Construction Experience (E)

It is essential that the Engineering Geologist gains some experience of construction processes in order better to understand the practicalities of design options. Not all firms can provide site experience as part of a Trainee's normal employment and time may have to be specifically set aside for site observation, or an opportunity sought for secondment to a a firm involved in a suitable construction project. In the pre-chartership training period a minimum of 6 months site experience in a 5 year training period is recommended.

6.6 Risk Assessment

In most industries today risk assessment is a common tool to ensure that design risks associated with a projected are reviewed and managed appropriately. An understanding of the conceptual ground model provides the Engineering Geologist with an appreciation of both the geotechnical and geoenvironmental risks associated with a particular project, or one or the other depending if the Engineering Geologist is specialising in a particular field. The Trainee should be able to identify key geotechnical and/or geoenvironmental risks associated with design, construction and maintenance phases of a project, including risks that might affect safety, cost and programme.

The risk assessment should be carried out at the earliest opportunity and is generally started as part of the desk study phase; this is then reviewed as each stage of the site investigation process is undertaken.

The Trainee should be able to carry out a quantitative risk assess in which the level of risk is quantified, mitigation measures are defined and a assessment is made of the extent to which such measures will reduce the risk. Typical mitigation measures may include additional or specific desk studies or ground investigation, monitoring before, during and after construction and, defining contingency measures which can be prepared and ready for deployment when required. The Trainee should be able to manage the mitigation of risks for aspects of work for which he/she is responsible.

The Trainee should gain experience in drafting and maintaining a geotechnical/geoenvironmental risk register as a live document throughout the life of a project.

7 PROFESSIONAL AND GENERAL (P)

The Geological Society offers geologists continuity through every stage of their scientific and professional life. Engineering Geologists applying for chartership should recognise the role, purpose and functions of the Geological Society and serve the profession through participation in the activities of the Engineering Group of the Geological Society.

Trainees are encouraged to maintain and improve their competency as an Engineering Geologist through training, presentations, attendance at conferences and seminars, reading and preparation of papers for publication. Formal recording and monitoring of Continual Professional Development (CPD) acknowledges the responsibility of chartered geologists, and those intending to become Chartered, to maintain and develop standards of technical and professional competence inherent in the designation of CGeol. Development of personal qualities is necessary for the execution of professional and technical duties throughout a practitioner's working life.

Fellows who provide advice to others, whether to clients and employers in a professional capacity, through membership of committees or to the general public directly or via the media, are required, under the Code of Conduct, to restrict such advice to their own areas of expertise. The trainee is required to demonstrate an awareness and application of the Geological Society Code of Conduct.

8 BUSINESS MANAGEMENT AND COMMERCIAL (M)

The Trainee should understand his/her employer's business strategy and objectives and carry out his/her work in accordance with these stated principles.

Commercial awareness and an understanding of their employer's quality management system, project and resource management and financial organisation are becoming increasingly important and these aspects should be addressed in training together with the development of technical capabilities. This section contains the main business and commercial issues that are likely to be encountered during the career of an Engineering Geologist. These skills may be of limited relevance in the early stages of the Trainee's career, but they will inevitably become more important as his/her career develops.

Over the period of training a Trainee should demonstrate increasing involvement with management of both finances and resources within a project and develop an awareness of the need to meet a programme of deliverables to an appropriate standard and within the target profit margins.

The Trainee should understand the procedures set out in his/her Employer's Quality Assurance System and ensure that his/her work is carried out in accordance with the requirements of the system. This will include rigorous attention to the procedures for recording instructions, checking and approving work and for registering issue and receipt of drawings and documents.

Whilst in the formative years of the Trainees career technical experience is likely to dominate, the requirement to manage people, resources and finances will increase and further training in these aspects may be required to support this growing aspect of the trainees career.

9 LEGISLATION AND CONTRACTS (L)

Contracts and Legislation form the framework for all operations within the construction industry and its associated industries.

The Trainee should be aware of current legislation, the most common conditions of contract and specifications and be able to apply these to both design and construction contracts. The Trainee should understand the duties and responsibilities of the defined roles under a contract, such as the Employer/Owner, Engineer, Resident Engineer, Engineer's Representative, Contractor, Site Agent, and sub-contractors.

The trainee should be able to prepare contract documentation including technical specifications and bills of quantities, for many this is likely to initially be for ground investigations, although construction operations which are related to engineering geology, such as earthworks, slope stabilisation, ground treatment, remediation and drainage may also require this documentation. He/She should able to monitor the contract during site works in terms of technical adherence to the specification and measure the works against a bill of quantities.

10 HEALTH AND SAFETY (H)

In most countries employers and employees are required to satisfy legal obligations set by the Government of the land and statutory bodies associated with the relevant legislation. Therefore the Trainee is required to have an understanding from early on in their career of the safety management systems of their company and safety requirements specific to their sector(s) of work. The trainee may also be required to hold specific Health and Safety qualifications to work in specific sectors e.g. railways. More broadly, they should appreciate their statutory and professional responsibilities to employers, the workforce and to the public.

The Trainee should be able to manage and apply safe systems of work with reference to the Safety Management Systems. The Trainee should be able to recognise potential health and safety hazards in design and on a construction site and make appropriate changes in order to reduce the risk of accidents during construction and the life of the project. They should be aware of the current acts, regulations and codes of practice and be able to apply them to both design and construction.

REFERENCES

Geological Society (1991) Rules of Admission and Guidance notes for Fellowship

Geological Society (1992) Guidelines for the assessment of relevant professional experience, Fellowship and Validation Committee Paper 13/1

APPENDICES

APPENDIX A – Objective Tables

APPENDIX B

GUIDE TO EMPLOYERS

OBJECTIVE OF THE GUIDE

The objective of the Training Guide for Engineering Geologists is set out in full in the Introduction to the Guide. In brief, it has been produced to outline the type of experience and training desirable for an Engineering Geologist in his/her formative years and to provide a whole career record of training and skills achievement.

The aim of the training is to assist the Trainee to develop the appropriate skills and adherence to good practice that will make him/her an Engineering Geologist who is a competent professional of wide experience and a credit to him/herself, his/her employer and the profession.

The implementation of the Training Guide need not entail significant cost or loss of income to an employer since it should be possible to provide most of the training within the framework of project work. Any costs that are incurred should be more than offset by the value to the company of an increasingly competent, well motivated, Engineering Geologist.

The Employer's Role

The Training Guide sets out a framework of desirable experience. It is written in terms of general objectives so that it can apply to a wide variety of organisations and individuals with a range of relevant experience. The training and experience is to be provided by the employer with direction from the Geological Society and the appointed Training Supervisor based on the outline of objectives given in the Training Guide.

Ideally the Training Supervisor will be in the same company as the Trainee, in which case the Training Supervisor is expected to negotiate with line managers to ensure that the Trainee is given appropriate experience to facilitate his/her training, if not, the Trainee will need to negotiate assignment to appropriate projects directly with his/her manager. The manager will then ensure that the Trainee is given appropriate instruction and supervision. It is appreciated that the Trainee may be the only Engineering Geologist in the company, in which case the Training Supervisor may have to discuss the training requirements with the employer in order to ensure that the employer has a full understanding of the objectives of the training programme as set out in this Guide.

The employer will need to be familiar with the basic requirements of the Guide. He will then need either to plan in advance how the various topics can be covered in, say, a 5 year period, or take the opportunities as they arise on individual projects to assign the Trainee to work on aspects not so far addressed.

The Training Guide is written in general terms to cover the very wide range of types of organisation in which Engineering Geologists are employed and the wide range of areas in they are active. An individual employer may wish (and is encouraged) to produce his own company specific training guide. The Geological Society is prepared to review any such document and give formal approval to signify that it meets the requirements set out

in this guide. A company specific guide should be written in the format of this Training Guide but with more specific objectives replacing general ones.

A company's Training Scheme should include

i) A description of the company's objectives and organisation

ii) The training policy of the company and the specific commitment to training.

iii) The Training Objectives, both general and company specific should be clearly defined and must include all the Core Skills as listed in this Training Guide. There is, however, wide scope for specifying exactly how these should be achieved within the operating environment of any one company. Other company specific objectives may replace non-core objectives in the Training Guide but in every case the objectives should be clearly stated together with a clear pathway as to how they are to be achieved. The company may either carry out its own assessment of the level of achievement or it may rely on the quarterly review by the Training Supervisor.

iv) Procedures for the trainee to obtain continuing education and training both taught and in the workplace.

v) Review procedures and the Trainee's probable internal movement within the company, including any secondments.

vi) The role and authority of the line managers and Training Supervisor in terms of planning and managing the training programme.

The employer is expected to provide opportunities for the Trainee to attend conferences and courses and to pay any necessary fees or expenses. Many companies, universities and institutions run evening lectures, workshops of half day to 2 or 3 days or longer conferences.

The Trainee should take advantage of training courses such as those run by the Geological Society on various geological formations, on report writing and expert witness. The ICE covers subjects such as Contract Law, Health and Safety and Computational Methods. The Trainee is also expected to engage in background reading in his/her own time. To this end the employer should produce a reading list. This is not expected to be exhaustive but should supply reference material and indexes to more specific papers that may be researched for specific projects.

The aim of this Guide is to give broad experience that will provide an appreciation of the many facets of the Engineering Geology and ensure a suitable standard in the Core Skills. In writing the Guide in general terms, it is hoped that an individual will not have undue difficulty meeting the requirements whilst remaining in one company. However, it may be that the work of a company is so specialised that whole sections of the Guide cannot be covered. In this case it will be necessary to arrange secondment to another company for the Trainee to gain the necessary experience.

Any questions concerning how to apply the Training Guide should be addressed initially to the Training Supervisor.

APPENDIX C

SUMMARY OF REQUIREMENTS FOR CHARTERED STATUS

The requirements for Chartered Status are set out in the Geological Society's booklet:

"Rules of Admission and Guidance Notes for Applicants"

At the time of printing these are, in summary:-

i) provide evidence (log book or report) of at least five or seven years' relevant postgraduate experience, depending on qualifying degree

ii) have, attended a professional interview

iii) have, if required, undertaken written examinations set by the Society (only required in exceptional circumstances)

Years of experience required under item (i):-

5 years for "geological" degrees:

CATEGORIES OF RECOGNISED "GEOLOGICAL" DEGREES

BSc/BA (Honours)

Applied Geology	Geophysics
Earth Science	Mining Geology
Engineering Geology	Mineral Exploration
Environmental Geology	Natural Sciences (specialising in geology)
Geochemistry	Petroleum Geology
Geological Sciences	Physical Geology
Geology	

(or a combination of the above)
Combined (joint) honours in geology with another scientific subject (including geography with an appropriate bias)

Honours degrees in environmental science in which geology forms at least half of the course.

Science-based honours degrees of the Open University where all the credits obtained have been in science and technology subjects and at least 40% in the earth sciences. (Candidates must also be able to show that they have obtained suitable geological field experience, including geological mapping).

Postgraduate degrees

Most taught MSc courses and post graduate degrees by thesis which are carried out mainly in geology and earth science departments are eligible.

7 years for "cognate" degrees:

CATEGORIES OF RECOGNISED "COGNATE" SUBJECTS

BSc/BA (Honours)

Subject	Geological Sub-discipline
Biology	Palaeontology, Biostratigraphy
Chemistry	Geochemistry
Civil Engineering (with geology as subsidiary)	Engineering Geology, Geotechnics
Mining or Mining Engineering (with geology as subsidiary)	Mining Geology
Petroleum Engineering (with geology as subsidiary)	Petroleum Geology
Environmental Science	Environmental Geology
Oceanography/Marine Science	Marine Geology
Physics	Quaternary Geology
Combined honours degrees in geology and non-scientific subject	(Various)
Science based degrees of the Open University with a geological content	(Various)

Fellows without a degree can be validated individually on the basis of their experience as practising geologists. As a guideline it is anticipated that individuals would not qualify by this route with less than 10 years' relevant experience.

Note: The qualifying degrees are under review and the applicant should make enquiries before applying