
**VOLUME 5 CONTRACT DOCUMENTS
FOR SPECIALIST
ACTIVITIES**

**SECTION 3 GROUND
INVESTIGATION**

PART 5

**NOTES FOR GUIDANCE ON THE
SPECIFICATION FOR GROUND
INVESTIGATION**

SUMMARY

This Notes for Guidance should be used in conjunction with Specification for Ground Investigation for Highway Works. The notes provide guidance on the preparation of the schedules to accompany the specification.

INSTRUCTIONS FOR USE

This is a new document to be inserted into the Manual.

1. Insert Notes for Guidance into Volume 5, Section 3.
2. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from the Stationery Office Ltd.



THE HIGHWAYS AGENCY



THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT



**THE WELSH OFFICE
Y SWYDDFA GYMREIG**



**THE DEPARTMENT OF THE ENVIRONMENT FOR
NORTHERN IRELAND**

Notes for Guidance on the Specification for Ground Investigation

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NG1. INFORMATION

The following notes provide guidance for the Design Organisation/Designer (depending on the method of procurement) on preparation of the Schedules to accompany the Specification. The clause numbers relate to the clauses used in the Specification and are prefixed by “NG”.

Schedules

NG 1.2.1 The Engineer should ensure that the requirements set out in the Schedules are reasonable and fully reflect the specific work required. The information set out in Clause 1.2 should be provided in Schedules 1 to 5.

Schedule 1.1 Scope and object of the Contract

Schedule 1.1 should provide a brief outline of the work to be done under the Contract, naming the route and stating the type of exploratory holes (eg borings, trial pits, probings). It should state whether sampling and testing (in situ and laboratory) are required and if both the Factual Report and the Interpretative Report are required by the Contract. The schedule should state if the purpose of the investigation is to provide preliminary information for route selection or if it is the main ground investigation for the design and construction of the road. Reference should be made to any earlier investigation, which may be made available at the discretion of the Employer.

Schedule 1.2 Description of the route

The length of the route, the likely standard, the start and finish points and a brief description of the topographical features along the line should be given. Where the development is to run on or alongside existing highways this should be noted. Locations and descriptions of proposed structures along the route should be given, together with type of foundations intended, if known.

Schedule 1.3 List of Drawings

The drawing number, title and scale of each Contract Drawing should be listed. Reference should be made to other relevant documents which may be inspected at the Engineer's office, eg previous site investigations, location of underground services, aerial photographs, etc.

Schedule 1.4 Site Operations and Ancillary Works

Schedule 1.4 should describe the Site Operations and any Ancillary Works required. It should specify any Section(s) of the Investigation which are to be completed before the Time of Completion of the whole of the Investigation as referred to in the Instructions for Tendering. Sections of work which cannot be undertaken early in the contract should also be stated.

Reference should be made to any work to be carried out over water, on live highways, or on potentially contaminated land.

Any features of engineering significance which are known or suspected to exist should have attention drawn to them. Any access problems and particular reinstatement requirements should be stated.

Schedule 1.5 Geology

A summarised description of the geology expected to exist on the route obtained from geological maps and memoirs should be given. Where appropriate, reference could be made to any previous investigation. Difficult ground or groundwater conditions, areas of potentially contaminated land, mine workings, etc. should also be noted. Reference should be made to maps, plans and drawings which may be inspected at the Engineer's office.

Schedule 1.6 Landowners

Schedule 1.6 should list all landowners, tenants and occupiers of all lands which will be entered, crossed or affected by the investigation together with their addresses and telephone numbers. A complete set of land plans (Scale 1:2500) showing the holdings of each landowner, tenants and occupier should also be included, together with the names and addresses (if known) of their land agents. The use of a schedule may be a more convenient method. Landowners sometimes give details of their holdings in confidence and this information must, therefore, remain confidential to the Department.

Any specific timings for land entry or delays in obtaining land entry permission should be noted here.

Schedule 1.7 Form of monthly statement

If the monthly statement is required in a specific format (Conditions of Contract Clause 60) then this should be set out.

Schedule 1.8 Particular general requirements

Schedule 1.8 should identify any requirements additional to or different to those specified in Section 3 of the Specification. In particular, it should describe:

- Professional attendance on site, including environmental scientist (clause 3.12.1), and any requirements for interpretative or advisory services to the Engineer (clause 3.12.2)
- Hygiene and wheel wash facility requirements (clause 2.14, 3.8.2)
- Datum for ground elevation of exploratory holes (clause 3.15)
- Traffic safety and management requirements (clause 3.22)
- Quality management requirements (clause 3.23)
- References to superseded Standards (Appendix VII)

It is recommended that the following form of wording be used in Schedule 1.8 to describe requirements for professional attendance (and for advisory or interpretative services):

“The engineer or engineering geologist specified by Clause 3.12.1 shall have had [X] years' post graduate experience of ground investigation work. He shall be of chartered status and have a degree in Civil Engineering, Engineering Geology or Geology, and have adequate knowledge and experience of the technical direction and output required for the Site Operations. This engineer or engineering geologist may be the person appointed to the Site by the Contractor's agent or representative under Clause 15(2) of the Conditions of Contract, or he may supplement that person should that person not have the preceding technical experience.

The description of soils and the logging of rock cores and trial pits shall be carried out by an engineer, engineering geologist or geologist with at least 3 years' post graduate experience in the examination and logging of soil and rock cores in accordance with BS 5930. That person shall have an appropriate degree.

Soil and water samples for contamination testing shall be taken under the direction of an environmental scientist with at least 3 years' post graduate experience of relevant contamination ground investigation site work. The environmental scientist shall also undertake, or supervise on a full-time basis, gas monitoring and sampling in gas standpipes and groundwater sampling in groundwater sampling standpipes and combined gas and groundwater sampling standpipes. The environmental scientist shall have a relevant degree.

There is no requirement in the contract for interpretative or advisory services to the Engineer,

or

The requirements in the Contract for interpretative and advisory services to the Engineer are ”

The Design Organisation/Designer should request CVs of the Contractor's proposed technical staff for the Investigation, and accreditation certificates for drillers.

The Design Organisation/Designer should examine the CVs and satisfy itself that the Contractor's proposed technical staff meet the relevant experience and qualification criteria set out in the Specification.

Schedule 1.9 Particular borehole requirements

Schedule 1.9 should describe any requirements additional to or different to those specified in Section 4 of the Specification including:

- Methods for borehole advancement (clause 4.1)
- Specification for hollow stem auger (clause 4.4.3)
- Specification for backfill other than cement/ bentonite grout (clause 4.7)

Schedule 1.10 Particular rotary drilling requirements

Schedule 1.10 should describe any requirements additional to or different to those specified in Section 5 of the Specification, including:

- Types of equipment for rotary drilling (clause 5.3.1)
- Core diameter specification (clause 5.3.2)

- Hole diameter (clause 5.4)
- Addresses for delivery of cores (clause 5.3.8) and samples (clause 7.16.1)
- Specification for retention of cores (clause 5.3.9)
- Define the meaning of report (ie Factual or Interpretative) (Clause 5.3.9)

Schedule 1.11 Particular pit and trench requirements

Schedule 1.11 should describe any requirements additional to or different to those specified in section 6 of the Specification, including:

- Pit and trench dimensions (clause 6.4)
- Photography specification (clause 6.9)

Schedule 1.12 Particular sampling requirements

Schedule 1.12 should describe any requirements additional to or different to those specified in Section 7 of the Specification, including:

- Diameter of open tube and piston samples (clause 7.3)
- Specific requirements for bulk disturbed samples to be taken or in-situ tests carried out in pits and trenches (clause 7.9)
- Any special sampling requirements (clause 7.10)
- Requirements for gas sampling (clause 7.12)
- Addresses for delivery of samples, if required (clause 7.15)
- Specification for retention of samples (clause 7.16)

Schedule 1.13 Particular in-situ testing requirements

Schedule 1.13 should provide a list of in situ tests that are likely to be required during the investigation. Depths shall be indicated where appropriate. The extent of testing will normally be given in the Bill of Quantities.

Particular requirements shall be given in Schedule 1.13 for the following tests, if such tests are to be carried out:

- Plate loading test (Clause 8.3.1.5). Diameter of plate, time intervals for readings.
- The type of in situ vane test equipment (Clause 8.3.1.7)
- The type of dynamic probing equipment (Clause 8.5.1.1)

Any unusual or special tests should be specified in Schedule 1.13, including:

- Geophysical tests (clause 8.6)
- Pressuremeter tests (clause 8.8)
- Special testing requirements (clause 8.7)
- Field tests on groundwater samples from surface water courses or exploratory holes (clause 8.12)

Schedule 1.14 Particular instrumentation and monitoring requirements

Schedule 1.14 should describe particular or additional requirements for Ancillary Works such as installation of instrumentation, provision of fencing to standpipes, monitoring etc. It should also provide details of any gas probe requiring a valve for subsequent gas analysis (clause 8.10.5); any piezometer requirements (clause 9.2.3); any instrumentation and monitoring referred to in clause 9.12; and should state frequency of readings required during the Investigation (clause 9.13).

Schedule 1.15 Particular laboratory testing requirements

The responsibility for scheduling of laboratory tests should be noted in Schedule 1.15 (clause 11.1).

Schedule 1.15 should provide a list of laboratory tests that are likely to be required during the investigation. The extent of testing will normally be given in the Bill of Quantities. Requirements additional or different to those specified should be described in Schedule 1.15, including:

- Rock testing (clause 11.4)
- Special testing, if required (clauses 11.2, 11.7)
- Dry density/moisture content test procedure (11.3.1.13)

- Equipment and procedures for shear box tests (11.3.1.31)

Schedule 1.16 Particular reporting requirements

Any particular requirements for the Factual Report should be given in Schedule 1.16. If an interpretative report is required, the Design Organisation/Designer must set out those aspects in Schedule 1.16 that will need to be covered by the Contractor. This will mean that the location of structures, cuttings, embankments and other special features will need to be identified along with the parameters required. Schedule 1.16 should also note any particular requirements including:

- Define the meaning of report (ie Factual or Interpretative) (Clause 7.16)
- Reporting on special in-situ testing and instrumentation (clause 10.3)
- Preliminary log proformas (clause 12.1)
- Digital data requirements (clause 12.4)
- Format for factual report, exploratory hole records and laboratory test results (clause 12.6)
- Requirements for cross sections to illustrate problems such as sidelong ground, dips in strata, etc. (Clause 12.6)
- Analysis and recommendations for the Interpretative report (Clause 12.7)

Schedule 1.17 Particular requirements relating to potentially contaminated land

Any particular requirements relating to potentially contaminated land and to the scope or performance of the contamination ground investigation should be given in Schedule 1.17. The schedule should provide a list of areas identified as potentially contaminated land (clause 3.19.1) together with all relevant available data on the possible hazards present at each site (for use by the Contractor in his assessment of appropriate safety measures). Requirements for liaison with authorities should be noted (clause 3.19.3). Other requirements which should be described include:

- Minimum safety requirements (clause 3.19.5)
- Sampling requirements for the contamination ground investigation (clause 7.11)

- List of tests for the contamination ground investigation (clause 7.11, 11.5.1)
- Fixing agents for samples for the contamination ground investigation
- Detection levels for contamination tests (clause 11.5.2, 11.5.3)
- Test methods, procedures and reporting requirements for contamination testing in addition to or different to those given in Appendix 4

NG 1.2.2**Schedule 2 List of exploratory holes**

Schedule 2 should give details of all the exploratory holes including type, probable depth, National Grid coordinates and location. Particular details of the survey control stations are also to be given.

The probable depths of exploratory holes must relate to the quantities billed in the Bill of Quantities.

The minimum diameter should be inserted for exploratory holes covered by Sections 4 and 5. See Specification Clause 4.1 and 5.1.

Features and special requirements of the exploratory holes should be given including:

- (i) Information on any special ground conditions known to exist
- (ii) Special requirements (if known) for backfilling etc. eg concrete or cement/bentonite grouting, trial pits to be left open for the Engineer's inspection, reinstatement of pits and trenches in paved areas (Clause 6.7)
- (iii) Special requirements for notice of entry
- (iv) Whether the hole is for cutting, embankment or structure (see Specification clause 7.9)
- (v) Requirements for in situ measurement of gas concentration during advancement, including depth range

NG 1.2.3

Schedule 3 Engineer's facilities

- 1 Accommodation** Where accommodation for the sole use of the Engineer is required, this shall be fully described and if necessary supplemented by drawings and/or schedules indicating the standards of artificial lighting intensity and the minimum room temperature to be maintained. The provision of office accommodation should comply with the Offices, Shops and Railway Premises Act 1963 and any amendment thereof.

Accommodation, etc required up to end of the maintenance period should be scheduled.

- 2 Furnishings** List all the required office furniture, fittings and supplies.
- 3 Services** List services, eg telephone including number of extensions (if any), radio, electricity required.
- 4 Equipment** Should any equipment be required by the Engineer for testing to be supplied for his sole use this should be fully described and scheduled.
- 5 Vehicles** If none are required write "NONE".

NG2. DEFINITIONS

The definitions are for the administration and measurement of a ground investigation contract only.

Geotechnical and environmental personnel NG 2.2

The list given in this Clause defines categories of personnel who may be required. The particular Contract requirements for professional attendance and for interpretative and advisory work must be listed in Schedule 1.8.

The Contractor is required to provide Professional Attendance on Site (Specification Clause 3.12.1). The Contractor's costs for these specified personnel, and for any additional technical staff that the Contractor may decide to use, are included in the rates and prices entered in the main Bill of Quantities.

The Contractor may also be required to provide technical staff for interpretative and advisory works (Specification Clause 3.12.2). These staff, if required by Schedule 1.8, shall be additional to those assigned to Professional Attendance or Factual Reporting. The Contractor's charges for these advisory staff shall be paid according to the Schedule of Rates for Professional and Technical Staff (See Item 8) Preambles to Bill of Quantities.

Schedule 1.8 should clearly state whether or not interpretative and advisory services are required.

Hard stratum and obstruction NG 2.5

For the excavation of pits and trenches only, the term 'hard material' has been introduced as a more appropriate and less problematic term than 'rock'. It is useful because:

- some materials may not be 'rock' in a geological sense (eg existing paved areas) yet require additional effort in excavation warranting separate itemisation and pricing. These would qualify as 'hard material';
- some materials may be 'rock' in geological terms (eg weak sandstones or hard marls) yet not require any additional effort in excavation. Those would not qualify as 'hard material';

- Clause 2.5.6 defines 'hard material' and clearly limits the application of this definition to "the excavation of pits and trenches".

Potentially contaminated land NG 2.14

The definition of potentially contaminated land enables the identification in the Contract of areas of the Site requiring a particular approach with respect to health and safety, waste disposal, sampling techniques etc. Such Site Operations must be separately identified in the Bill of Quantities in accordance with MMGI Part II 2(d)(i).

Contamination ground investigation NG 2.15

The definition of 'contamination ground investigation' is the same as in HA 73/95, Advice Note on Site Investigation for Highway Works on Contaminated Land. Both contamination ground investigation and geotechnical/engineering ground investigation may be required on potentially contaminated land and on samples taken from potentially contaminated land. Site Operations on potentially contaminated land and Laboratory Testing on samples taken from potentially contaminated land must each be separately identified in the Bill of Quantities in accordance with MMGI Part II 2(d).

NG3. GENERAL REQUIREMENTS

British Standards and equivalent

NG 3.1

The references in Appendix 7 of the Specification should be checked to ensure the latest BSs are given (see NG for Schedule 1.8).

Statutory undertakers, public authorities and privately owned services

NG 3.3

The Design Organisation/Designer will need to prepare sufficient and detailed drawings for the Contractor's use showing, where known, the routes of all Statutory Undertakers' and privatised utility operators' apparatus as accurately as possible.

If the positions of services are unknown, it is necessary to indicate on the Drawings that the Contractor should use location equipment and proceed with care.

Notice of entry and access routes

NG 3.4

Entry to land is arranged by the Highways authority or the Roads authority (in Scotland) who under the terms of the appropriate standard agreement, agrees to give each private land owner at least 7 days' notice of entry (21 days to Statutory Undertakers). In order to allow for Sundays, Public Holidays and delivery time, an additional period of 7 days is allowed. In the event of entry being refused, the powers of entry under the Highways Act, or in Scotland, the Roads (Scotland) Act can be invoked. To do this 7 days' notice must be given before entry can be legally achieved. An additional period of up to 7 days is again allowed for possible conciliation and the serving of the notice.

The Highways authority or the Roads authority (in Scotland) also undertakes to give details of plant and personnel entering the land to the owner. The Contractor is to notify the occupier 48 hours before actual entry.

The Design Organisation will in most cases carry out the entry negotiations for the Highways authority or the Roads authority (in Scotland) and he should ascertain at this time, the access routes to be used to each location. The boundaries of the site and these access routes should be clearly shown on the drawings together with fences etc. which have to be removed and replaced.

In some cases it may be necessary to let the Contract without full possession of the site, ie it has not been possible to get all the land owners' agreement to allow the Contractor to enter. Pressures in the overall scheme programme may dictate that the Contract must proceed and it is equitable to notify the Contractor where difficulties are expected. This should be done on Schedule 1.4. It may be necessary to introduce a Section of work which cannot be undertaken early in the contract to be stated in Schedule 1.4 (See Clause 42(i) of the Conditions of Contract).

Care in executing the Site Operations

NG 3.6

The attention of the Contractor is drawn to the potential for spread of contamination through exploration on contaminated land. The Design Organisation/Designer should ensure that the Contractor is not instructed to carry out works involving a significant risk of contamination spread. See also NG 3.19 and the Advice Note on Site Investigation for Highway Works on Contaminated Land.

Working areas

NG 3.8

The Contractor is responsible for making good damage in the vicinity of the hole and the approaches thereto and specific requirements should be detailed in Schedule 1.8. This may include removal and replacement of the top soil over the whole working area. Alternatively it may be preferable to restore the texture of the working area by using a rotovator or cultivator. Reinstatement requirements such as reseeding should be agreed with the land owner before the Tender is prepared and a relevant addition made in Schedule 1.8.

Reinstatement of paved areas should be agreed with the owner or maintaining authority and a complete description and/or specification included in Schedule 1.8 for each area.

Working on potentially contaminated land
NG 3.8.2

The Contractor's attention is drawn to waste disposal legislation and the Duty of Care which must be applied when dealing with arisings from potentially contaminated land. If a ground investigation results in significant arisings of potentially contaminated groundwater or wash water, a consent may be required for discharge of this to sewers.

In many instances timber boarding may be used instead of heavy gauge plastic sheeting.

Backfilling and reinstatement of exploratory holes
NG 3.9

The collapse of inadequately backfilled holes and settlement of backfilled trial pits is a potential source of conflict with the affected landowner. This avoidable shortcoming should be paid due attention in the course of supervision.

It is important that all exploratory holes are adequately backfilled and compacted.

It may at times be useful to leave holes open for some days to reveal and observe any seepage and fissuring (see Clause 6.8). It is the Engineer's responsibility to direct the Contractor to leave the hole open and to specify minimum safety precautions.

It is usual to have a higher concentration of exploratory holes at the site of a structure and hence particular attention should be given to backfilling. At these sites, as an alternative to concrete backfilling, a cement/bentonite grout may be advisable.

The Environment Agency (in England and Wales), the Scottish Environment Protection Agency (in Scotland) and local water company(s) should be consulted before inviting tenders, to ascertain if any present or future underground water supplies could be affected by the method of backfilling (see also NG 3.19). The Schedule of exploratory holes (Schedule 2) should give information on special backfill and/or surface reinstatement where required, in the "Special Requirements" columns.

Where exploratory holes are located in a highway the Highway Authority's agreement to the method of backfilling should be obtained. If alterations or additions are required to this clause then this should appear in Schedules 4 or 5. See also NG 1.2.2 (ii).

Compensation for unavoidable damage
NG 3.10

This is invariably an area for dispute and the Engineer is advised to take a set of photographs before and after the Contractor has been on site. Attention should be paid to tracks, roads, hedges, fences, etc. which are affected by the Investigation.

Engineers facilities'
NG 3.11

If it is anticipated that the Engineer's Office will not be required for the whole of the period of the Site Operations or will be required for a longer period, then the required period should be stated in Schedule 3. Should the Engineer wish to extend the period during the Contract, a Variation Order will be required.

Professional attendance on Site
NG 3.12

This clause utilises Clause 15(3) of the Conditions of Contract, so that a suitable engineer or engineering geologist is on site full-time to provide technical direction to the Investigation in addition to the Contractor's Agent as defined in Clause 15(2). It is quite probable that these two requirements will be satisfied by one person, but provision is made in the event that the Agent is not technically qualified. The requirements must be set out in Schedule 1.8. The person required under Clause 3.12.1 is included in the Contractor's rates and prices entered in the main Bill of Quantities.

A Traffic Safety and Control Officer may be required and if so will need to be specified in Schedule 1.8.

Location and ground elevation of exploratory holes
NG 3.14 3.15

The Design Organisation/Designer shall provide National Grid references and Ordnance Datum ground levels in Schedule 2. The Contractor is responsible for establishing the position of each exploratory hole from the information given and for confirming its final location and ground elevation. It is recommended that only National Grid references are used. If local grids are used this should be made abundantly clear and the values used should be such that there is no confusion with the National Grid references.

Exploratory work
NG 3.16

The last paragraph requires almost continuous presence on site by the Engineer and this should be taken into account.

The Engineer should not give provisional instructions regarding backfilling and moving off-location. The depth of each completed hole should be measured in the presence of the Engineer.

Mine workings
NG 3.18

Information on known workings should be provided in Schedule 1.5 and on the drawings if appropriate.

Potentially contaminated land
NG 3.19

Ground investigation on potentially contaminated land requires special measures and provisions with respect to health and safety, exploratory techniques and environmental protection. The objective of the statement of working methods is twofold:

- 1 It enables the Design Organisation/Designer to ensure that the Contractor is proposing appropriate and adequate measures.
- 2 It allows the Contractor to propose alternatives to methods specified, which have particular relevance for contamination testing (Specification Appendix 6).

In order to avoid unnecessary Contract Variations, the Design Organisation/Designer should contact relevant authorities during the planning of the ground investigation, to establish specific requirements. It is, however, the Contractor's responsibility to agree working practices with the appropriate authorities.

Authorities which may need to be contacted include:-

- Local Authority Environmental Health Department
- Environment Agency (England and Wales)
- Scottish Environment Protection Agency (Scotland)
- Health and Safety Executive

COSHH assessments are required by the Control of Substances Hazardous to Health Regulations. The Engineer should check the adequacy of these assessments.

It is the Contractor's responsibility to identify health and safety requirements based on the information provided to him by the Design Organisation/Designer (Schedule 1.17). The list in Clause 3.19.5 is for guidance to the Contractor and should be considered as minimum requirements for general safety precautions. The Contractor should detail in a Safety Plan his proposals for the Investigation in general and for each potentially contaminated site in particular (clause 3.19.6).

Traffic safety and management
NG 3.22

The requirements to be applied during work on or adjacent to highways are detailed in this clause which corresponds in general to the requirements of the Specification for Highway Works. The Design Organisation/Designer should consult with the Maintenance Authority and Police to agree the specific requirements to be inserted in Schedule 1.8.

It is the Contractor's responsibility to ensure that he complies with Traffic Management requirements. It is also normal practice for Traffic Management to be an important item at both the inaugural and regular site progress meetings.

Laboratory accreditation
NG 3.25

Accreditation by UKAS (or equivalent) provides third party quality assurance of the specified test results. The Design Organisation/Designer should ensure that the individual test report carries a UKAS logo.

NG4. BORING

Addition of water to the boreholes NG 4.2

The addition of water to facilitate boring may obscure the true level of the water table, if present. The Engineer should ensure that no more water than is necessary for boring operations should be used and that its use is noted on the borehole logs. This will require good supervision.

Hard stratum or obstruction in percussion boring NG 4.3.1

Where the Engineer is confident of the nature of the hard stratum and its position, he may decide to relax the minimum 1 hour chiselling requirement and to instruct the Contractor to follow one of the four procedures set out in clause 4.3.1.

Use of clay cutters NG 4.3.2

The use of clay cutters in soft or sensitive soils can cause considerable disturbance in the material beneath. Where clay cutters are used, their weight including sinker bar (if used to assist penetration) should be restricted to the lightest necessary to advance the borehole.

Use of shell and casing NG 4.3.3

Under normal ground conditions reciprocating action of the cable should not be permitted. However, in exceptionally difficult ground the Engineer may use his discretion.

Hand auger NG 4.4.1

Depths greater than the 4m max specified can be achieved under suitable soil conditions. If greater depths are required a Variation Order will be required. The use of hand auger boring should be kept to a minimum. It is most useful where site disturbance needs to be kept to a minimum (eg gardens, adjacent to old structures etc.), or machine access is difficult.

Continuous flight auger boring NG 4.4.2

Machines capable of going down to 7m depth are most commonly available, however, auger boring may go to greater depths and this will need to be noted in Schedule 1.9.

It is difficult to obtain samples below the water table with continuous flight augers.

Artesian water NG 4.8

Where artesian conditions are known or suspected the Contractor should be warned. Schedule 1.4 is a convenient place for this information.

NG5. ROTARY DRILLING

General NG 5.1

This clause covers the equipment to be used for obtaining cores in rock and other materials. It is incumbent upon the Contractor to bring to site all the necessary equipment, which may include double or triple tube swivel core barrels or special liners, to try to obtain 100% core recovery. The Contract documents should indicate the type of material to be cored and at a preliminary meeting the Engineer and Contractor should agree in detail the actual methods to be used and alternatives if these are thought to be necessary.

Drilling Fluid NG 5.2

Consideration should be given to environmental as well as core recovery issues in agreeing a particular drilling fluid.

Core recovery NG 5.3.2

BS 4019 Part 3 “Rotary Core Drilling Equipment” gives the nominal core diameters for drilling (Table 5). Some thin-wall core-barrels can produce better core recovery than conventional H barrels.

In most weathered rocks double tube core barrels will be required and good core recovery is unlikely below 76.0mm diameter (H size). In extreme conditions it may be necessary to use more complex equipment as in NG 5.1 above.

Cores are sometimes required in over-consolidated clays, boulder clays, weak marls, soft rocks and rocks with discontinuities. These can be difficult to recover intact and can be affected by flush water. The use of air flush or other suitable flushing media may give better recovery as might the use of special plastic or split metal tube inner liners in conjunction with triple tube swivel core barrels.

Wireline drilling is a technique which may prove effective for the coring of relatively difficult deposits, such as overconsolidated clays, chalk and interlayered sands, gravels, limestones and clays.

Removal of cores NG 5.3.4

All core extrusion should be carried out in such a way that the cores suffer minimal disturbance. Much expensive drilling effort can be wasted if the utmost care is not subsequently taken in handling the cores. Any vibration caused by the removal of a core could alter its natural structure hence practices such as tapping out the cores from the barrel directly in the core box should not be allowed. Cores of hard rock may be extruded from horizontally held barrels using a constant pressure but in soft or broken rocks it may be necessary to use special liners in the core barrels and/or split tubes.

Core boxes NG 5.3.5

The design of core boxes should be such that cores are fully restrained by moulds or channels of appropriate size. Where the Engineer wishes to retain any core boxes after the Contract as his property, he should agree rates for payment before issuing a Variation Order to the Contractor.

Preparation of cores for examination NG 5.3.6

Where the Contractor is to provide a geologist on site for the examination and logging of cores the requirements must be set out in Schedule 1.8. The logging of cores on site by an experienced geologist or engineering geologist is considered to be a necessary part of the production of factual information about the strata being investigated. If the Contractor chooses, the geologist may also be the authorised agent required by Clause 15(2) of the Conditions of Contract. The person required under this Clause is included in the rates and prices entered in the main Bill of Quantities.

Protection and transportation of cores NG 5.3.8

The Design Organisation/Designer will need to determine and indicate in the Schedule when the Contractor is required to take cores to the Engineer's store.

Retention and disposal of cores

NG 5.3.9

Where he requires the Contractor to retain any cores or send them elsewhere, the Engineer should agree rates with the Contractor and issue a Variation Order accordingly. This must be issued before the Certificate of Completion.

Rotary drilling without core recovery

NG 5.3.9

Probe drilling, using rotary percussive drilling techniques (normally with air flush) is a commonly used and valuable tool for investigating voided, infilled or broken ground, or to identify rockhead. When undertaking such work, the Design Organisation should consider the value of including in Schedule 1.10 requirements for:

- flush samples at 1.0m intervals of borehole depth (each to weigh 0.5kg)
- use of automatic drilling parameter recorders to provide a continuous measurement of penetration rate, rate of rotation, torque, pressure in the flush medium and volume of flush input.

Proving hard strata

NG 5.7

The proving depth will depend on the expected nature of the hard strata, its weathering characteristics and any loading to be imposed by the proposed works.

NG6. PITS AND TRENCHES

Inspection pits

NG 6.1

The Design Organisation/Designer will need to indicate on Schedule 2 which exploratory holes are to be commenced with the excavation of an inspection pit. Information gleaned from the excavation should be logged and form part of the investigation. These pits should not be considered as only checking for the presence of services.

The Construction (General Provisions) Regulations 1961 requires the sides of excavations and earthworks greater than 1.2m deep to be supported if personnel are at risk from fall of earth. Note that this may be relevant to excavations which are less than 1.2m deep if soil arisings are heaped adjacent to the excavation.

Trial pits and trenches

NG 6.2

The depth required for each trial pit and trench must be set out in Schedule 2. Schedule 2 must also identify the type of pits and trenches (trial pits, observation pits etc.).

Observation pits and trenches

NG 6.3

The Contractor is required to provide sufficient equipment, expertise and staff to carry out the work safely. The Specification includes for the Contractor to provide a 50mm pump. The method of measurement contains provision for itemising moves of the pumping equipment and duration of pumping. An allowance should be included in the Bill of Quantities for moving the pumping equipment to each pit or trench where groundwater is anticipated.

Groundwater

NG 6.6

Keeping inspection pits, observation pits, trial pits and trenches free of surface water is the Contractor's responsibility and is included for in the rates and prices entered in the main Bill of Quantities. However, whilst the Contractor needs to deal with groundwater he will be unable to foresee what measures are required.

Protection to pits and trenches left open

NG 6.8

If pits, trenches etc. are left open overnight or for longer periods the Engineer should inform any affected occupiers of the fact.

NG7. SAMPLING

Bulk disturbed samples

NG 7.2

Bulk samples for the comprehensive list of tests given in BS 1377: Part 1 will range from 100kg for fine grained soils to 160kg for coarse grained soils. Several bulk samples of 25kg (or other specified) minimum size may therefore be required from a particular zone or location, or samples from several zones aggregated.

For compaction tests, bulk disturbed samples of between 25kg - 80kg are required for all soil, depending on the proposed compaction techniques.

Open tube and piston samples

NG 7.3

The Engineer must satisfy himself that the failure to obtain proper samples was not due to any negligence on the part of the Contractor before he agrees to pay for the unsuccessful sampling. This will entail close supervision of the sampling procedures, and the Contractor's word should not be taken unsupported by corroborative evidence from the Engineer's own staff.

Thin-walled tube samples

NG 7.4

Special shock proof boxes will be required for these samples and for piston samples (Clause 7.3).

Undisturbed block samples

NG 7.5

These will only be required in special circumstances. The Design Organisation/Designer should carefully consider the size and weight of sample required and keep these requirements to a minimum. It may be necessary to amend the weight requirements of this clause.

Soil samples for contamination ground investigation

NG 7.7

The Contractor shall use the information on potential contamination provided in Schedule 1.17, and the provisional schedule of laboratory tests for the contamination investigation (Clause 11.5.1.3) to decide on the non-reactive material for rigid containers.

Samples for contamination testing from sampling wells

NG 7.8.2

It is important that purging and sampling are carried out properly prior to sampling from groundwater sampling standpipes. Purging eliminates stagnant water. The use of dedicated pumping systems improves the quality of the samples and in the long run can be more cost effective.

In small diameter sampling wells such as normally specified (ie 50mm), the annular space should be ignored when calculating the well volume.

In low yield sampling wells, it is not uncommon to completely dewater the well. If this is the case, a sample should be taken after the well has recovered. In higher yield wells, at least three volumes should be removed. It is important that the pumping is carried out from just below the top of the water column to ensure full removal of the standing water. Pumping from the bottom of the water column may not give a representative sample.

The Contractor shall use the provisional schedule of laboratory tests for the contamination investigation (Clause 11.5.1.3) to determine the number and type of containers required for each groundwater sample.

Undisturbed sampling and testing frequency

NG 7.9

Schedule 2 will need to indicate which exploratory holes are required and for what purpose. For exploratory holes at proposed bridges and retaining walls the estimated foundation levels should be given in the Schedule.

Special sampling

NG 7.10

Depending on the requirements of the investigation, special methods of sampling may be needed e.g. Delft continuous sampler. A specification for this work must be included in Schedule 1.12. The requirements for, and level of experience of, professional attendance of special sampling shall be detailed.

If this equipment is not normally available, a subcontractor may be necessary for this part of the work.

Samples for the contamination ground investigation
NG 7.11

Different analytical techniques are likely to be used for different contaminants of interest, and therefore sufficiently large samples must be taken for multiple analyses.

Changes in soil and water samples such as oxidation, reduction and biodegradation will affect contamination assessments. Low temperatures will reduce biodegradation, but freezing of soils should be avoided, so as not to adversely affect the soil structure. Headspace in containers should be minimised and containers sealed as soon as possible to avoid loss of volatile contaminants.

Containers for contamination ground investigation samples should be chosen to be of a material which is not reactive with the potential contaminants in the soil or groundwater. For example borosilicate glass jars should be used to contain samples potentially containing organic solvents. Recommendations for containers are given in 'General principles of sampling and accuracy of results' (1980). This document, referenced in the Specification, also gives details of field preparation (such as filtering or pH adjustment) and fixing requirements.

Long term storage of samples for contamination testing is not recommended. Analyses for some determinands in water samples must be undertaken within 24 hours.

The Design Organisation/Designer should detail in Schedule 1.17 any additional samples, such as field blanks which may be required for quality control purposes.

Representative soil sampling ensures that samples accurately reflect the conditions on a site at a given time. However, samples may be deliberately taken which are not representative of a site, in order to focus on a particular area or particular contaminant. The Design Organisation/ Designer should detail sampling requirements in Schedule 1.17, and should be aware of any bias in sampling.

Labelling, protection and transportation of samples
NG 7.15

The location for the delivery of representative samples should be noted in Schedule 1.12.

Retention and disposal of samples
NG 7.16

Where the Engineer requires samples to be retained or sent elsewhere, he should agree appropriate rates with the Contractor and issue a Variation Order accordingly.

NG8. IN-SITU TESTING

Tests

NG 8.3 NG 8.4 and NG 8.5

The lists are not exhaustive and others may be added to the Specification by inclusion in Schedule 1.13. The test procedure will also need to be specified as amendments to Clauses 8.3, 8.4 and 8.5.

Corresponding items must always be included in the Bill of Quantities. Conversely, not all the tests are meant to be applied to every contract. The lists must be examined each time to check that each test will be appropriate to the nature of the ground. The actual testing and probing required should be given in Schedule 1.13.

The Design Organisation/Designer should specify in Schedule 1.13 information for the following tests:

- CPT: capacity of the static cone penetrometer
- Plate loading test: maximum load and manner of application, distance of ground anchors from plate test etc.

Electric friction cone without pore water pressure tip may be specified in Schedule 1.13 if these measurements are not required.

The in situ resistivity test must be specified when it is intended to construct corrugated steel buried structures in partial or total trench condition.

It has been reported that the pressuremeter probe tended to cut the plastic tube liner when being inserted down the exploratory hole, and catch under the bottom edge of the tube when being withdrawn. It is recommended that a 150mm diameter steel casing would be more suitable. If a self-boring pressuremeter is specified, the Design Organisation/Designer should ensure that a suitable cable percussion rig is always available on site to assist.

When in situ CBR tests are specified a corresponding number of in situ density tests should also be specified. If the in-situ dry density is to be obtained using a nuclear densimeter this should be included as a special in situ test in Clause 8.5 and listed in Schedule 1.13.

Geophysical methods of investigation

NG 8.6

Specification for geophysical testing must be detailed in Schedule 1.13 including objective, equipment, procedure and results to be submitted.

Special in-situ testing

NG 8.7

Where in-situ testing is required which is not covered by the Specification, it should be detailed in Schedule 1.13. On potentially contaminated land, this may include the use of screening devices, such as photo-ionisation detectors, to establish whether or not certain contaminants (e.g. solvents) are present.

Self-boring pressuremeter

NG 8.8

Depending on the ground conditions likely to be encountered other types of pressuremeter (e.g. High Pressure Dilatometer, "Menard" pressuremeter, etc.) may be more appropriate, and a full specification will need to be included in Schedule 1.13.

Gas concentrations using a portable gas meter

NG 8.9

Most field instruments require periodic calibration. It is important that equipment is properly calibrated to the manufacturer's recommendations. Prior to start of Site Operations, the Engineer should ensure that the correct instrumentation is being used and periodic calibration of instruments is carried out.

Gas monitoring is required during drilling and on completion of boreholes. The former, measured during advancement of the hole, is to provide an indication of the gas concentrations with regard to health and safety and safe drilling practices. The latter is required for design purposes.

Gas pressure and emission rate measurement
NG 8.10

A hot wire anemometer is recommended for flow measurement. The flow must be measured through a 50mm diameter pipe, not through the valve or narrower extension. This is normally achieved by using a push fit (50mm dia) extension, standing at least 1m above the ground level with a small access hole at the base for the anemometer. This should minimise wind interference, although it is important to report the steady flow.

The gas monitor should be of an infra-red type with in and out ports for gas recirculation. It is important that the sensor is not of the combustible type.

It is important that the tubing used to connect valves to the detector is kept to a minimum.

The sequence of measurements allows for a sample for laboratory testing. In some instances no sample need be taken (eg when no hazardous gases are detected).

The length of recirculation of the gas described in step 3 will often depend on the depth of the standpipe, ie shallow pipes will reach a steady concentration sooner than deeper ones.

Step 6 is included for the following reasons. Over time, gas can accumulate within the standpipe under pressure. This will result in high initial concentrations and gas flow rates. If the gas flow decreases and is exhausted within fifteen minutes a pump should be attached to the suspended tube valve to displace one volume of the standpipe. If, after this operation, the gas concentrations have not been considerably reduced and/or a flow can be measured then it is likely to indicate a significant source of gas.

Field tests on groundwater samples
NG 8.11

It is important that groundwater testing is undertaken by an environmental specialist experienced in conducting such tests.

The field tests on groundwater samples should be undertaken within 10 minutes of sampling.

Field tests on groundwater samples taken from surface water courses and directly from exploratory holes, if required, should be specified in Schedule 1.13.

However, groundwater samples taken directly from exploratory holes are less liable to be representative of actual conditions than samples taken from standpipes or piezometers. after purging.

NG9. INSTRUMENTATION AND MONITORING

Groundwater measurement records NG 9.1

Accurate groundwater observation is an important element of the investigation. Care must be taken to recognise when the true water table levels are temporarily obscured if water has been added to facilitate drilling.

The Engineer shall ensure that every effort has been made to seal off each water table. Great care is needed in identifying multiple strikes in a single borehole. Where there is a need to monitor perched water tables it is preferable to provide piezometers in separate boreholes rather than two or more in a single borehole.

The Engineer will need to keep a record of standing times for payment purposes.

Where it is anticipated that the exploratory holes will be left open for 24 hours, as stated in Clause 9.1.2.3, then additional moves should be allowed for in the Bill of Quantities for the appropriate equipment to return to the hole to extract casings etc.

Standpipes and piezometers NG 9.2

The type of standpipe and/or piezometer, if any, required for each hole must be specified in Schedule 1.14 and Schedule 2. Should it be necessary to change these intentions regarding the piezometers and standpipes during the Contract then a Variation Order will be required. It should be noted that piezometers will not be removed unless otherwise stated. The Design Organisation/ Designer is also responsible for estimating the total number of groundwater readings required during the Contract for the Bill of Quantities, and specifying the frequency of such readings in each piezometer.

Simple standpipes are installed to determine general water level in the ground, and standpipe piezometers are installed to determine water pressure within a particular stratum.

The filter surrounds to standpipes and piezometers specified in Clauses 9.3 to 9.7 should be carefully considered. The gradings may require adjustment in the light of the soils encountered.

Groundwater sampling standpipe NG 9.5

HDPE (or PTFE - polytetrafluoroethylene) screw jointed tubing should be used in preference to uPVC if organic contaminants such as solvents are suspected in the water to be sampled.

The pore size of the sewn sleeve or stocking should be 100 microns unless the silt and clay fraction of the ground adjacent to the slotted pipe is negligible (ie <about 5%).

Gas monitoring standpipes NG 9.6

The detail of the gas monitoring standpipe includes a twin valve cap to enable the recirculation of gases. In very shallow standpipes or those with a high water level, the Engineer may specify a single valve cap.

Removal of piezometers and standpipes NG 9.11

The Engineer should inform the Contractor at a reasonable time before the end of the Site Operations which piezometer and standpipe installations shall be removed before he leaves the site.

Where piezometers and standpipes are required for any length of time, the landowner and tenants of the ground affected should be informed by the Engineer. If necessary there should be a mutually agreed method of protection for the instruments installed. If the monitoring is required beyond the period of the Site Operations, the permission of the landowner/tenant must be obtained by means of a wayleave, as well as agreement to re-enter the land for the purpose of taking the readings.

NG10.LABORATORY TESTING

Schedule of tests

NG 10.1

Tests which are not covered by the Specification should be included in Schedule 1.15. Schedule 1.15 should describe the type and extent of tests required. Corresponding items must always be included in the Bill of Quantities.

The Contract must make clear who will provide the Testing Schedule and this should be stated in Schedule 1.15.

The Engineer will confirm his schedule of laboratory tests for the contamination investigation within 7 days of receipt of the daily report, however, certain tests must be carried out within 24 hours or 48 hours of sampling and in such circumstances the Engineer should confirm his requirements without delay.

The Engineer may wish to consult with the Contractor when preparing the Schedule of Laboratory Tests, to ensure that the samples obtained are adequate for the proposed testing. It may well be that the Contractor, who has to carry out the work, is able to suggest acceptable alternatives if the quality of the samples are inadequate for the ideal testing programme. The Engineer, although fully responsible for producing the Schedule, should not ignore advice from an experienced contractor which may save additional exploratory holes and sampling with their attendant costs.

For measurement purposes a test is deemed to be carried out on a specimen which is prepared from a sample, and samples are obtained from the field work. More than one specimen may be obtained from a sample and, if for a particular result tests are required on a set of three specimens prepared from a single sample, then three tests shall be measured. For example in effective stress testing it may be required to obtain three 38mm specimens from one U100 sample. Each specimen will be tested at a different cell pressure and this is therefore measured as three tests. Conversely a multi-stage triaxial carried out on one specimen is measured as one test.

The description in the Bill of Quantities of tests of a certain maximum duration and the consequent inclusion of an associated adjustment item will generally only apply to those tests that are likely to be of variable

duration (eg due to sample consolidation for effective stress triaxial tests). This will also apply to certain tests for lime stabilisation studies where the maximum duration could be described in the Bill of Quantities as, say, 31 days for the swelling test. This could extend to 59 days if a further 28 day soaking period was necessary, in which case the adjustment item would be used to pay for the extra 28 days.

Testing procedures

NG 10.2

Any sample not utilised for specific tests should still be described, and the descriptions included in the factual report. An item for sample examination is included in the Method of Measurement, and allowance for this should be made in the Bill of Quantities. It should be noted that this is only for samples not tested, the description of samples used for testing is included in the item coverage for the test.

Total sulphate content of soil

NG 10.3.1.7

If the total sulphate content exceeds 0.2% of the dry weight of the soil, a further test under Clause 11.3.1.8 will be required, and this should be allowed for in the testing schedule.

CBR

NG 10.3.1.15

Compaction moisture contents to be specified by the Engineer (Clause 11.3.1.15.3). Testing normally carried on samples in the CBR range 10% to less than 2%.

One dimensional consolidation

NG 10.3.1.16

If this test is specified then the plastic and liquid limit determination should also be specified and allowed for in the testing schedule.

Testing for contamination
10.5

The Design Organisation/Designer should list the contaminants of concern for which testing should be carried out, in Schedule 1.17. The detection limits should also be given in Schedule 1.17, and should match the sensitivity and level of confidence required for the investigation. The Design Organisation/Designer should ensure that the detection limits can be achieved by the test methods specified.

For determinands which are not covered in Appendix 4, Schedule 1.17 must detail the determinands, the units, detection limits and method specifications. Alternatives to the methods given may also be specified in Schedule 1.17.

An environmental scientist should determine necessary tests for the contamination ground investigation.

The Design Organisation/Designer should be aware of the limitations of any tests carried out. Tests should be applicable to the sample type and to the contaminant of concern. The Design Organisation/Designer should note any cross-sensitivity of tests to chemicals other than those being considered.

Certain testing may be required subject to other testing. For example, there may be a need for testing free cyanides if tests for total cyanides exceed a certain trigger level. This approach avoids excessive testing. Trigger levels and subsequent tests must be specified in Schedule 1.17.

Empirical tests, such as leaching tests, should be specified in Schedule 1.17. Details should be given for sample preparation (e.g. extent of sample grinding) and methods of sample extraction (including temperature, amplitude and duration of agitation, leachant and apparatus).

BS 7755, the first parts of which were published in 1994, is intended to cover soil quality tests.

Special laboratory testing
NG 10.7

Permeability tests using the Rowe Cell can be carried out utilising various drainage paths. The required drainage regime will need to be called up.

NG11. REPORTING REQUIREMENTS

Preliminary logs

NG 11.1

A high standard of appearance is not required for these preliminary laboratory test results; legible photo-process copies of work sheets are acceptable.

Digital Data

NG 11.4

Format

NG 11.4.1

By using the same hardware and software to produce the information common to the Factual Report and digital data, the possibility of transcription errors caused by manual data input is avoided.

Method Statement

NG 11.4.2

It is essential that the Engineer understands the system that the Contractor intends to use to produce the digital data. The Contractor should provide a method statement as early as possible in the Contract, for approval by the Engineer. This also ensures that the Contractor gives thought to the digital data production process prior to its start.

Dummy Data

NG 11.4.3

By providing a set of dummy data, the Contractor can prove that his system is capable of producing the specified digital data incorporating any amendments and additions set out in Schedule 1.16.

The dummy data is a set of data based on a few holes from another (or imaginary) ground investigation which has all the digital data groups which will be required in the “actual” ground investigation. It is important that the Contractor uses the same system to produce the dummy data groups that he will use to produce the “actual” ground investigation digital data. If properly applied, this flushes out data production problems before the production of the “actual” ground investigation data begins.

Contents of factual report

NG 11.6

The form of the exploratory hole records and test report sheets should be as set out in Specification Schedule 1.17.

The Design Organisation/Designer must provide

negatives of the site plans and sections where required for the Contractor’s use.

Contents of interpretative report

NG 11.7

If an Interpretative report is or is not required then this should be stated in Schedule 1.16.

Approval of report

NG 11.8

The time period specified will need to be consistent with the period stated in the Appendix to the Form of Tender. It will depend on an assessment of the size and the complexity of the Report to be examined. Approval should be given as quickly as possible, preferably within 3 weeks of receiving the draft, if this can be done. The approval period cannot be linked to the date for submission of the Final Report as the time left for making amendments and for printing should be a decision for the Contractor.

Footnote

If a scheme specific Clause is added to the Specification then it may be necessary to make amendments to the Method of Measurement in order to cover the additional requirements of that Clause.

12. ENQUIRIES

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