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Soil quality — Sampling —

Part 106: Quality control and quality assurance

Qualité du sol — Échantillonnage —

Partie 106: Contrôle de la qualité et assurance de la qualité

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 2, *Sampling*.

A list of all parts in the ISO 18400 series can be found on the ISO website.

Introduction

Quality assurance (QA) comprises all those measures taken to ensure that results of the investigation are “fit for purpose”, including documentation, procedures to be followed, the setting of data quality objectives (i.e. for type, quality, and quantity) and reporting.

The overall quality of soil and site investigations and assessments depends on the quality of each separate step of the overall process, i.e. planning, sampling, pretreatment, analysis and evaluation, and interpretation of all results. This document only applies to sampling. Sampling is a very critical step in the whole procedure because errors made can usually not be recognized nor corrected in the laboratory or in the office afterwards.

A prerequisite for fit for purpose and reproducible analytical and test results is QA for sampling, including assuring:

— representativeness of samples;

— avoiding cross-contamination and unwanted changes or alterations of the sample during sampling, on-site pretreatment, transport, and delivery;

— making, recording, and reporting appropriate field observations;

— fit for purpose field measurements;

— a defined chain of custody process.

In Figure 1, the different steps of an investigation programme are given. This document describes the QA in the first three steps.

This document is part of a series on sampling standards for soil. The role/position of the International Standards within the total investigation programme is also shown in Figure 1.

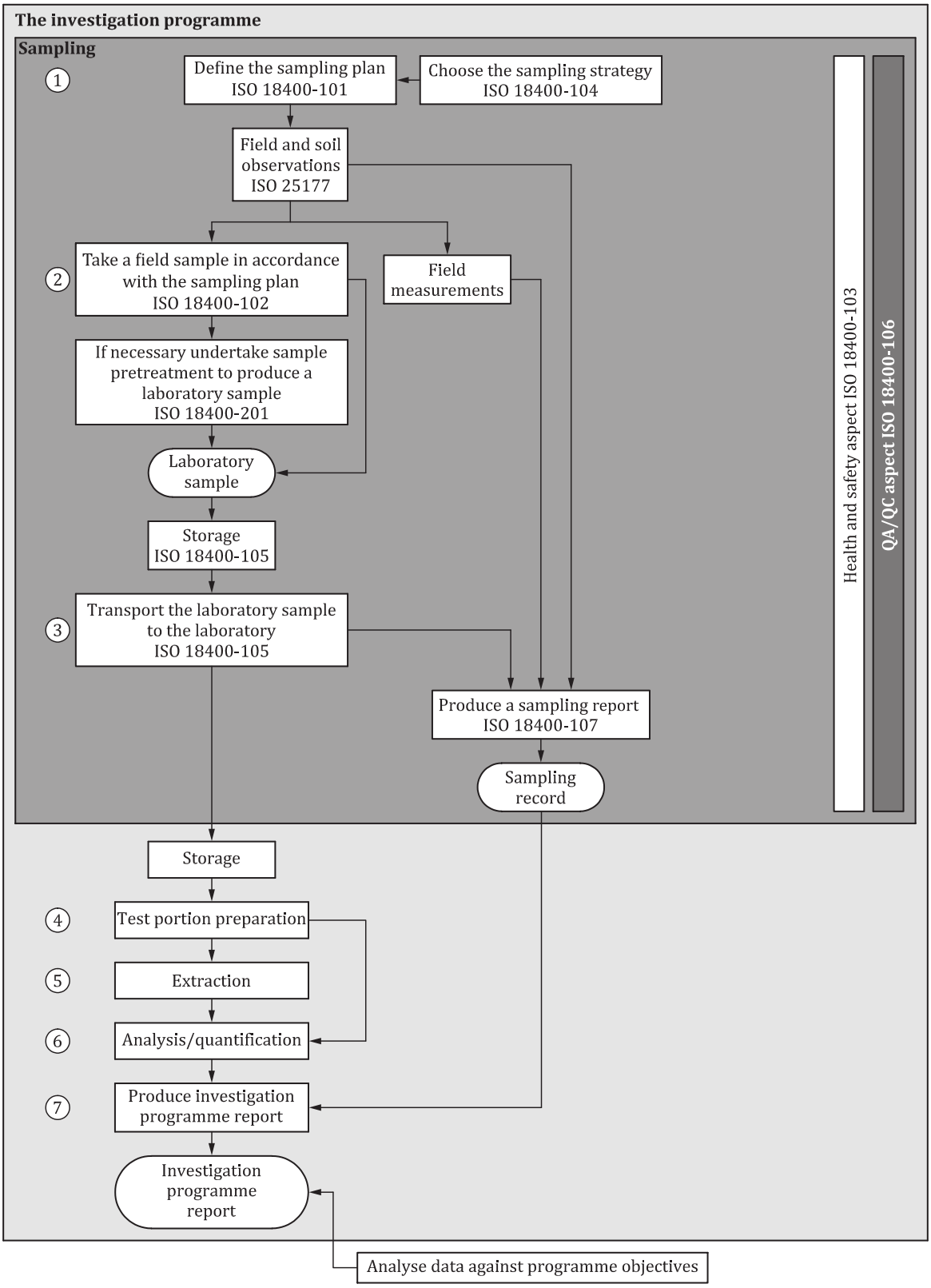


Figure 1 — Links between the essential elements of an investigation programme

NOTE 1 The numbers in circles in Figure 1 define the key elements (1 to 7) of the investigation programme.

NOTE 2 Figure 1 displays a generic process which can be amended when necessary.

Soil quality — Sampling —

Part 106: Quality control and quality assurance

1 Scope

This document provides guidelines for quality assurance and quality control (QA/QC) for soil sampling. It identifies the steps which are subject to QA and QC in situations where QA and QC are required. It addresses aspects of QA and QC of the International Standards under the ISO 18400-100 umbrella (level 1, level 2) and gives guidance to methods on level 3.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11074, *Soil quality — Vocabulary*

ISO 18400-105, *Soil quality — Sampling — Part 105: Packaging, transport, storage and preservation of samples*

ISO 28258, *Soil quality — Digital exchange of soil-related data*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11074 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Quality assurance

4.1 General

QA is applied in two situations:

— in an accredited quality system or certified quality system;

— on a voluntary base in the absence of an accredited quality system or certified quality system.

Because of the various reasons for and objectives of sampling, there can be no single set of QA procedures to be followed by all organizations offering sampling services under all circumstances. It is, consequently, more difficult to set out principles for field activities (e.g. taking samples) than it is for soil analysis procedures. However, it is strongly recommended that, as far as practicable, the guidelines

in ISO 9001 should be followed. Organizations offering analytical services should follow requirements in ISO/IEC 17020, ISO/IEC 17025, ISO/IEC 17011, ISO/IEC 17021, and ISO/IEC 17065.

NOTE For QA usually, accreditation or certification is used. Both use International Standards as mentioned above that can be applied for specific products, processes, organizations, or parts of organizations. An organization that holds an accreditation or certificate uses a quality system that describes the processes, products, and people under the scope of that accreditation or certificate.

If, for QA, a reference to an accreditation or certificate for soil sampling is made, the following aspects shall be checked:

— Are the experts or organizations involved in the project, working within the scope of the accreditation or certificate?

— Is the organization (department, team) in the scope of the accreditation or certificate?

— Are the specific experts working under the (organization) of the accreditation or certificate?

The initial assignment from the customer should always be kept in mind.

For certain cases, for example, governmental regulations, in which a great deal of the sampling plan and methods are given, the prescription of the plan/project can be simplified.

4.2 Sampling process

All steps in a sampling process as described in the parts of the ISO 18400 series should be subject to QA/QC.

To manage all the quality aspects, the sampling process shall be clear, as should be the role and responsibilities of each person.

Detailed actions for QA are described in individual parts of the ISO 18400 series.

NOTE 1 The quality of sampling is a product of the work of different people with different knowledge and different equipment, often working in different organizations.

NOTE 2 Sampling steps can include, for example, making a sampling plan, taking samples in the field, and transport.

NOTE 3 For an overview of the process, see Figure 1.

5 Procedures, documents and data

5.1 Procedures

For every project, the project manager shall determine the organizations, teams, and responsible people involved.

The project manager should define at least the steps in the soil evaluation chain for the project and prescribe the exchanges of information that are to be made between organizations, teams, and individuals, and how these are to be made. The project manager also describes how the required QA is to be achieved, especially for the planning, coordination, and interpretation.

The project manager should ensure that all written procedures are made known to organizations, teams, and individuals, especially key personnel, at the right time and that they are followed correctly. All QC and QA procedures should be integrated within the sampling plan covering:

— procedures to be followed in the field;

— use of standardized field reporting forms or software;

— selection of all available information to be used in the field;

— choice of equipment or instruments to be used in the field, including checking that they can be used in that particular situation;

— taking samples for QA purposes (if possible);

— chain of custody requirements, e.g. choice of laboratory, storage, transport;

— interpretation of the results obtained on samples taken for QA purposes.

The laboratory chosen to carry out the analysis should be independent and competent in the work required, and preferably have an appropriate accreditation or approval.

The last aspect of making a sampling plan is to check in the field that

— the historical information on the site is accurate,

— the site is accessible by samplers and their equipment, and

— proposed safety procedures are “fit for purpose”.

These checks can also be carried out by the sampler, but the first check is always the responsibility of the person preparing the sampling plan (usually the project manager).

If during the fieldwork the circumstances change in a way that could influence the quality of the sampling or the safety at the location, and the project manager cannot be reached, a deputy project manager has to determine if the sampling plan has to be changed or how to proceed. If the deputy project manager cannot be reached also, the responsible fieldworker decides if the fieldwork has to be stopped or paused, or if it is clear how the sampling plan has to be changed. In that case, the change has to be discussed with the project manager after the fieldwork. In all cases, attempts to contact the project manager and the outcome (result for the sampling plan) have to be registered in the field report.

If changes occurred in the field, the project manager decides whether the samples are still fit for purpose.

NOTE Information about quality assurance of brownfield investigation is given in Reference [27].

5.2 Documents and data management

All procedures, documents, and data sets generated by the project should be archived. Unique numbers or codes shall be used to reference the documents and data sets which shall be “tracked” and every version of each document and data set retained.

It is recommended to use report forms in a standardized format, which itself is archived in the documentation system. Blank forms should be registered in the documentation system, usually the quality management system. On a project level, it shall be clear which data are needed and which data are optional.

NOTE 1 Reports can have all kinds of forms or layouts, e.g. paper form, digital forms, specific columns of fields in software or databases, SMS.

If the information is stored in a digital database, access should be controlled so that anyone accessing it is only permitted to access the specific data and other information to which they need to have access. Backups should be made frequently in order to secure the data.

Limit the number of persons who are allowed to change documents and procedures, and make sure that all people involved in the project are able to send comments or suggestions for improvement.

Confirmed and authorized information shall be stored. In Figure 2, the main steps of data exchange are given for a typical soil quality investigation project. The information exchanged at each step should

be stored separately. The information may be in the form of hard copies or in digital form. For every project, at least the confirmed information has to be stored for:

— preliminary information (existing site information) – Step 2;

— fieldwork (observations, measurements, field sampling and sample information, confirmation field phase) – Step 4B;

— laboratory (sample identification, used methods, analytical results, QA and QC confirmation laboratory phase) – Step 5;

— interpretation (interpretation of the information of the earlier steps and conformation QA and QC requirements of the project) – Step 6.

A soil quality project can have the full scope of all phases of a typical soil quality project or only one or more phase(s), e.g. preliminary investigation, fieldwork. This could mean that not all of the steps of Figure 2 are part of the project. If the scope is only a part of a typical soil quality project, the results should include conclusions about the quality of the information from earlier steps and the chain of custody information for any samples that have been taken.

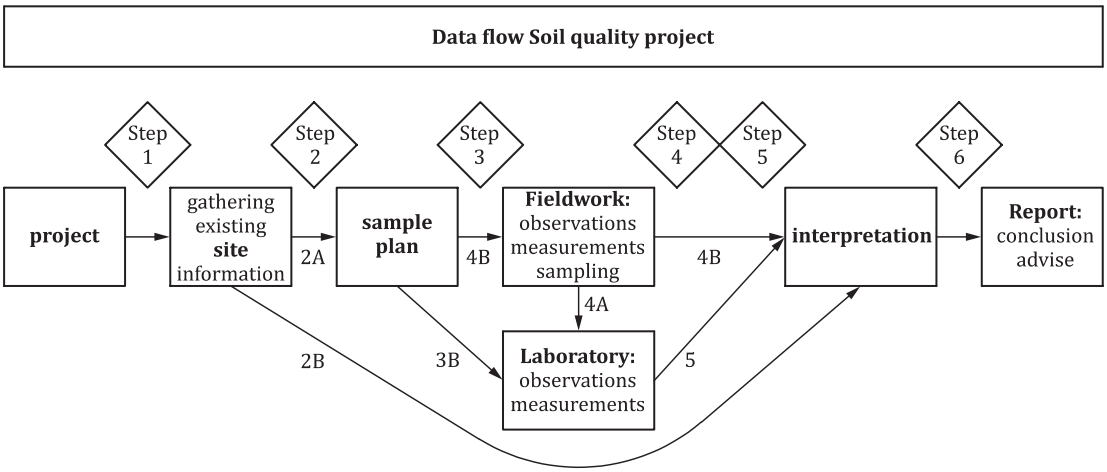
All (raw) data shall be preserved, not only the data considered valid.

When exchanging information, the sender and receiver shall be clear about the definitions used (codes, units, other references). The exchange format and the use of it should be determined prior to the fieldwork. If there is no appropriate format, ISO 28258 shall be used.

ISO 28258 is recommended as a general reference for specific digitally exchanged formats for soil sampling projects. ISO 28258 does not cover all the details that might be needed in all projects. It is more general.

NOTE 2 Information is intended to be examined before it can be used. Not only the data itself, the context of the information has to be clear (e.g. a soil description made in the context of a geotechnical investigation is not automatically useful for environmental use).

There are risks of possible misinterpretation and misunderstanding in exchanges of information, including data, and steps should be taken to minimise these risks. The project manager should supervise most data exchanges, the most common of which are indicated in Figure 2 (adapted from ISO 28258).



NOTE 1 Information between steps can be exchanged as hard copies or in digital form.

NOTE 2 The boxes represent soil quality activities.

NOTE 3 The arrows represent data exchange steps between the activities.

Figure 2 — Data flow soil quality project

5.3 Audits

All common quality systems (e.g. ISO 9001, ISO/IEC 17025) use audits to verify if procedures work in practice.

The purpose of audits is to improve the process, let people learn more about their own work and processes, and to register the state of the quality system regarding soil sampling for management.

If audits are carried out and reported properly, the management know where quality risks lie in the system. Audits that focus on every small technical fault that occurs, without the estimation or determination of the possible consequences, do not improve the quality system.

Whether accreditation or approval (e.g. certification) demand audits or audits are done voluntarily, the following aspects should be taken into account:

— auditors shall not audit their own work;

— auditors need to have skills to observe, listen, and register objectively;

— there shall be a working quality system, at least for the scope of the audit;

— the scope of the audit shall be clear;

NOTE This can be the whole process of soil sampling or a part of it.

— the documentation belonging to the (part of the) quality system shall be available;

— the job qualifications of all auditees shall be clear (see 6.1);

— the relevant procedures shall be clear and available for all personnel;

— the checking of data has to be a part of quality procedures (see 5.2);

— raw data from observations or measurements shall be archived, although interpreted and improved data can be used in subsequent steps of soil sampling procedures;

— audits of soil sampling should include an assessment of the adequacy of chain of custody procedures.

It shall be clear at any time who is responsible for the quality of the data used.

Reports of the audits should give an impression of the quality of the (relevant part of the) total projects.

The results may be used to improve the project.

6 Personnel

6.1 Knowledge and experience

All people involved in the project shall be qualified for their task. Companies that are hired with an accreditation or approval have a responsibility to use only appropriately qualified personnel. The project manager has a responsibility to ensure that this is the case.

Qualified for the task means that one shall have had a proper training and that knowledge, experience, and skills are kept up to date for the task (organizations with an accreditation keep this in a documentary system).

NOTE Guidance on qualification criteria for enterprises and personnel engaged in geotechnical investigations is provided in ISO/TS 22475-2. ISO/TS 22475-3 provides guidance on conformity assessment of enterprises and personnel by a third party.

6.2 Safety

Sampling personnel should comply with ISO 18400-103.

7 Communication

Communication plays a very important part in the quality of investigation and assessment processes. If communication fails, the whole project is in danger. Everyone involved should be kept informed about the status of the project and any problems encountered.

The project manager has the responsibility for communication and reporting during the investigation including in respect of:

— instructions to all personnel (e.g. what, when, and how things are to be done and by whom);

— the reporting of the results and information gathered during site works (e.g. how, to whom, and when), especially in the case of observations that might influence the end result of the investigation.

All responsible people and organizations should be clearly informed about how and to whom questions can be asked and reports supplied (see also 4.2).

The project plan should always include a communication plan and give clear guidance about the communication process, lines of reporting, and the organization of meetings.

NOTE 1 This does not mean that all people need to have all available information. For instance, a laboratory does not need to know who the landowner is.

The sampling plan should provide the list of information that needs to be exchanged. The project manager for the investigation plan should supervise the procedures for the exchange of information and the chain of custody for samples.

All people transferring information should check that the information has reached the right person(s) and that they have understood the instruction, especially if the information concerns changes to the original plan.

NOTE 2 Keep everyone informed about the status of the project. If problems are encountered, inform and consult all relevant people to help dealing with it in the project and to prevent problems in the future. Share and celebrate success.

8 Equipment

8.1 Choice of equipment and general requirements for use

The choice of equipment is to be determined and checked by the experts carrying out the different steps of the investigation. If equipment is specified in earlier steps, the use of other equipment is only permitted if all parties involved agree in advance and the change is reported.

Persons using equipment shall be capable of understanding the use and restrictions of it.

Before, during, and after use, the equipment shall be checked (e.g. damage or contamination; see ISO 18400-102:2017, 7.3). Also check the performance. Observations that the equipment has not been used correctly or that the results are not as expected (i.e. look anomalous in the context of the investigation) should be reported.

8.2 Calibration of equipment and servicing

All equipment should be calibrated and demonstrated to meet the calibration specifications prior to use.

The frequency of calibration depends on how regularly the instrument is used and should be in accordance with the manufacturer's recommendations. Advice on how to carry out calibration should be provided with the instrument.

Regular servicing should be carried out according to the manufacturer's recommendations.

Regardless of whether the calibration is performed off-site or on-site, all calibration data should be recorded and made available on request. Off-site calibration is not suitable for instruments that might undergo changes during transportation.

8.3 Influence on results

All equipment used should be checked for influences on the sample and the analysis to be performed.

The requirements for testing are usually prescribed in the analysis methods.

9 Taking samples

9.1 Sampling

The sampling shall be carried out according to the sampling plan.

QC samples are taken to indicate the quality of the sampling programme, in addition to the samples taken from pre-determined sampling points. They provide information which ideally discounts any errors due to possible sources of cross-contamination, inconsistencies in sampling and checks on the analytical techniques used. In accordance with the data quality objectives of the sampling and investigation programme, consideration should be given to implementing each of the QC procedures described in 9.2 to 9.4.

9.2 Quality control samples

9.2.1 Blind replicate samples

NOTE 1 Blind replicate samples can be used to identify the variation in analyte concentration between samples collected from the same sampling point and/or the repeatability of the laboratory's analysis.

One or more sets of blind samples should be collected during each investigation project. The number of blind replica samples can depend on:

— the total number of samples;

— specific spots that are determined;

— specific sample methods used.

If blind replica samples are to be taken, the number and place and circumstances shall be described in the sampling plan, or reference to the International Standard where this is described.

The blind samples should be removed from the same sampling point in a single operation and divided into two vessels. These samples should be submitted to the same laboratory as individual samples with no indication given that they are duplicates.

NOTE 2 The amounts (x and y) could come from legislation, national or local standards, or could be determined for the specific project.

9.2.2 Split samples

NOTE 1 Split samples provide a check on the analytical proficiency of the laboratories.

One or more sets of split samples can be collected during each investigation project. If split samples have to be taken, the number and place and circumstances shall be described in the sampling plan, or reference to the International Standard where it is described.

NOTE 2 If split samples are to be taken, usually the number of one split sample every 20 samples is used.

The samples should be removed from the same sampling point in a single operation as described in 9.2.1. Each of the two samples should be submitted to a separate laboratory for analysis. The same analytes should be determined by both laboratories using identical analytical techniques.

The number of split samples taken should be determined for each project, taking into account national or other regulation which may exist.

9.2.3 Trip blanks

NOTE 1 Trip blanks are used to detect cross-contamination of samples during transport.

A container or other collection medium, identical to the ones being used for the samples, can be filled with soil or a soil-like material. The parameters that have to be analysed have to be known before filling the container. The container or other collection medium is sealed as for a sample from the project location, placed with the samples, and transported back to the laboratory. The blank is then analysed along with the collected samples.

NOTE 2 A trip blank is not required when using a pressurised canister, as no gas is present to enable the analysis to be carried out.

9.2.4 Field blanks

NOTE Field blanks are similar to trip blanks but are used to detect inconsistencies in the whole process from taking the sample until the analysis in the laboratory.

A container or other collection medium, identical to the ones being used for the samples, can be filled with soil or a soil-like material. The parameters that have to be analysed have to be known before filling the container. The container or other collection medium is sealed as for a sample from the project location, placed with the samples, and transported back to the laboratory. The blank is then analysed along with the collected samples.

9.2.5 Evaluation of quality control sample results

The analytical results and QC data should be evaluated, following recognized procedures to allow the interpretation of accuracy, precision, and representativeness of the data.

9.3 Preservation

Sample preservation shall be carried out according to ISO 18400-105.

9.4 Storage and transport

The conditions for storage and transport are outlined in ISO 18512 and in ISO 18400-105.

Be sure to monitor these conditions and store the data for evaluation if necessary.

If preservation and storage is done by people other than the sampler, chain of custody (see ISO 18400-105) information has to be exchanged.

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