INTERNATIONAL STANDARD

ISO 15176

First edition
2002-10-01

Soil quality — Characterization of excavated soil and other soil materials intended for re-use

Qualité du sol — Caractérisation de la terre excavée et d'autres matériaux du sol destinés à la réutilisation

Reference number
ISO 15176:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword ... iv

Introduction ... v

1 Scope ... 1

2 Normative reference ... 1

3 Terms and definitions ... 2
3.1 Types of soil and other soil materials ... 2
3.2 Soil characteristics ... 3
3.3 Land and sites ... 4
3.4 Utilization, reclamation and treatment ... 5
3.5 Assessment ... 6

4 Characterization of soil materials and sites ... 6
4.1 General ... 6
4.2 Investigation strategies ... 8
4.3 Sampling strategies ... 8
4.4 Characterization of soil materials ... 11

5 Data quality, handling and evaluation ... 30

6 Using this International Standard ... 30

Annex A (informative) Data quality, handling and evaluation ... 31

Annex B (informative) Good practice in the re-use of soil materials ... 33
B.1 General ... 33
B.2 General guidance for re-use ... 33
B.3 Handling and storing excavated soil and other soil materials ... 34
B.4 Placement at the target site ... 34
B.5 After-care of the target site ... 35
B.6 Use of soil materials in construction works ... 35

Annex C (informative) Guidance on determination of the scope of investigation needed before excavation of soil materials ... 36
C.1 General ... 36
C.2 Determining the need for investigation ... 36
C.3 Development of analytical strategies ... 37

Annex D (informative) Example of classification and evaluation of soils and other soil materials ... 40
D.1 General ... 40
D.2 The concept of suitability classes ... 40
D.3 Suitability classes depending on harmful substance content ... 40
D.4 Soil unsuitable for re-use ... 42
D.5 Additional suitability classes for soil improvement and reclamation ... 42
D.6 Suitability of soils and soil materials for combining ... 43

Annex E (informative) Examples of elements and compounds belonging to different contaminant groups ... 45

Bibliography ... 47

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15176 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 7, *Soil and site assessment*.

Annexes A, B, C, D and E of this International Standard are for information only.

Introduction

This International Standard is one of a series providing guidance on the assessment of soils and soil materials in relation to certain functions and uses. It should be read in conjunction with these other International Standards, some of which give more specific guidance in relation to some of the uses listed in the Scope or particular aspects of assessments. For example, ISO 15800 gives guidance on assessments relating to human exposure to potentially harmful substances and ISO 15175 gives guidance on characterization of soil related to groundwater.

Soils are the dynamic product of chemical, physical and biological processes. They are the result of interactions between the inherent nature of the parent material, the prevailing environmental conditions and human activities. They are a valuable natural resource which should be conserved wherever possible. When construction, mining or other activities require soils to be excavated and moved from their natural situation, they should as far as possible be reused in a manner consistent with their natural properties and the intended use of the receiving location. Soils intended for re-use are usually required to have certain chemical, leaching, geotechnical, physical, biological and radiochemical attributes consistent with this future use. Particular attention must be paid in situations where there is reason to believe that the surplus soil may be contaminated.

Soils that are to be excavated should be investigated to determine how they may be re-used so as to minimize the quantities to be disposed of as waste and to determine environmental impacts that might arise during re-use. Treatment of soils and soil materials to remove or destroy contaminants or to reduce their availability to the environment may alter soil properties. These properties should therefore be determined before re-use. For manufactured soils, the characteristics of both the components and of the manufactured product may need to be determined.

The purpose of characterizing soil (or other media) as suggested in this International Standard is usually to enable judgements to be made about its suitability for a defined use (e.g. arable farming, domestic gardens). These judgements may be made by reference to published international or national guidance that sets out physical, chemical or other generic criteria that must be met, or against criteria set on a site-specific basis. When substances are present that might be harmful to human health or the environment, the judgement may also be made on the basis of a site-specific qualitative, semi-quantitative or fully quantitative risk assessment. In many jurisdictions, formal guidance on such assessments has been published. In some cases this guidance fits within a legislative framework. Guidance has also been provided by professional organizations and some standardization bodies.

When deciding whether to re-use soil material, other possibly competing or overriding objectives such as protection of soil, nature, water and air; physical planning requirements and national legislative requirements may have to be met.

Assessment of soil material for re-use may require the measurement of the chemical, physical, biological, geotechnical and radiochemical characteristics of soil material and of the source and target sites. The assessor should identify those parameters that are appropriate to the task in hand.

This International Standard identifies the functions and properties of soil materials at the source (point of origin) and also the properties of the target (receiving) site which may be relevant to the potential uses listed in the Scope, and indicates for which parameters or procedures there are International Standards available. Radiochemical and geotechnical aspects are not covered. For guidance on the geotechnical aspects of the use of soil materials as construction material, reference should be made to other relevant International Standards (e.g. those produced by ISO/TC 182, *Geotechnics in the field of civil engineering*) or national standards.

The way the soil is handled after excavation may affect soil properties. Some suggestions regarding good practice in soil handling and related practice and monitoring after placement are provided in annex B.

Soil quality — Characterization of excavated soil and other soil materials intended for re-use

1 Scope

This International Standard provides guidance on the range of tests that may be necessary to characterize soil materials intended to be excavated and re-used, with or without preliminary treatment. Soil materials include excavated soil, dredged materials, fill materials, manufactured soils and soil treated to remove or destroy contaminants.

It takes into account the different requirements of top soil, sub-soil and other soil materials such as sediments or treated soils. International Standard methods are listed where available.

The test methods are intended to cover a range of possible end uses, such as:

— play areas for small children, including nursery schools, kindergardens, etc.,

— schools,

— gardens and other residential areas,

— allotments,

— horticulture,

— agriculture,

— forestry,

— recreational areas, e.g. parks, sport fields,

— restoration of damaged ecosystems,

— construction sites.

It is intended to be of use in determining the suitability of soil materials for re-use, and the assessment of the environmental impacts that might arise from re-use.

This International Standard is not applicable to the placement of soil materials in an aqueous environment or to restore underground workings. It does not address geotechnical requirements when soil materials are to be used as construction material.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For

undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 11259, *Soil quality — Simplified soil description*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1 Types of soil and other soil materials

3.1.1
soil
upper layer of the earth's crust composed of mineral parts, organic substance, water, air and living matter

[ISO 11074-1]

3.1.2
top soil
upper part of a natural soil which is generally dark-coloured and has a higher humus and nutrient content when compared to the subsoil below

[ISO 11074-4]

3.1.3
sub-soil
material underlying the topsoil and overlying the solid (parent) rock beneath

NOTE All or much of the original rock structure has usually been obliterated by pedogenic processes.

3.1.4
soil material
excavated soil, dredged materials, manufactured soils, treated soils and fill materials

3.1.5
excavated soil
any natural material excavated from the ground, including top soil, sub soil, altered parent rock and parent rock itself

NOTE Excavated soil typically arises during construction works.

3.1.6
manufactured soil
manufactured soil material
manufactured product intended to perform specified soil functions produced by blending combinations of natural, waste or manufactured materials with the addition of nutrients or other additives when necessary

3.1.7
treated soil
soil that has been subjected to a process-based treatment method

3.1.8
dredged material
material excavated during maintenance, construction, reconstruction and extension measures from waters

NOTE Dredged material may consist of:

— sediments or subhydric soils,

— soils and their parent material beneath the surface water body.

3.1.9
fill material
made ground
mixed natural (often displaced or disturbed) soil materials and other materials characteristic of urban and industrial sites

EXAMPLES Building rubble, timber and other wastes.

3.2 Soil characteristics

3.2.1
soil function
use of soil which is significant to man and the environment

NOTE Important soil functions are:

— control of substance and energy cycles as compartments of ecosystems;

— basis for the production of agricultural products;

— basis for the life of plants, animals and man;

— carrier of genetic reservoir;

— basis for the stability of buildings;

— buffer inhibiting movement of water, contaminents or other agents into the groundwater;

— reservoir of archeological remains;

— reservoir of paleoecological remains.

NOTE Adapted from ISO 11074-4.

3.2.2
background concentration
concentration of a substance characteristic of a soil type in an area or region arising from both natural sources and non-natural diffuse sources such as atmospheric deposition

cf. **natural background concentration** (3.2.4)

NOTE It is commonly expressed in terms of an average, median, a range of values, or a background value (3.2.3).

3.2.3
background value
expression of the upper limit of the range of the background concentration

NOTE It is commonly expressed as the percentile value.

3.2.4
natural background concentration
concentration of a substance that is derived solely from natural sources

NOTE 1 It is of geogenic origin.

NOTE 2 It is commonly expressed in terms of average, a range of values, or a natural-background value (3.2.5).

3.2.5
natural background value
expression of the upper limit of the range of the natural background concentration

NOTE It is commonly expressed as percentile value.

3.2.6
contaminant
substance or agent present in soil as a result of human activity

cf. **pollutant** (3.2.7), **potentially harmful substance** (3.2.8)

NOTE There is no assumption in this definition that harm results from the presence of the contaminant.

3.2.7
pollutant
substance or agent present in the soil which due to its properties, amount or concentration causes adverse impact on soil functions or soil use

cf. **contaminant** (3.2.6), **potentially harmful substance** (3.2.8)

NOTE See Introduction in ISO 11074-1:1996.

3.2.8
potentially harmful substance
substance which, when present in sufficient concentration or amount, may be harmful to humans or the environment

NOTE It may be present as a result of human activity [**contaminant** (3.2.6)] or naturally.

3.2.9
residual contamination
amount or concentration of contaminants remaining in specific media following remediation

[ISO 11074-4]

3.2.10
trace element
element present in low concentration in soil material

NOTE A trace element may be essential at low concentration but harmful at higher concentration.

3.2.11
essential trace element
element essential at low concentrations for plant or animal (including human) metabolism

NOTE An element may be essential at low concentrations but become harmful at higher concentrations.

3.3 Land and sites

3.3.1
damaged or degraded land
land which, due to natural processes or human activity, is no longer able to properly sustain an economic function and/or its original natural, or near-natural ecological function

3.3.2
target site
site at which soil is to be re-used

3.4 Utilization, reclamation and treatment

3.4.1
re-use of soil materials
useful and harmless utilization of soil materials

NOTE In the context of this International Standard, re-use means transfer of soil materials to another location for use in agriculture, horticulture, forestry, gardens, recreational areas and construction sites.

3.4.2
construction works
soil application including earthworks and embankments, landscape engineering, road construction, construction of waste disposal sites, and backfilling of excavated sites or mines

NOTE Construction works are applications where soil materials are not required to have a direct productive use, although they may support other layers intended to have productive use.

3.4.3
reclamation
restoration
rehabilitation
⟨of land⟩ return of damaged, degraded or derelict land to beneficial use

NOTE The term **remediation** is commonly restricted to the process of dealing with contaminated/polluted sites.

3.4.4
soil rehabilitation
actions taken to improve the capability of damaged or degraded soil to perform specified functions

NOTE An example of such action is the addition of organic matter and nutrients to promote plant growth.

NOTE Adapted from ISO 11074-4.

3.4.5
remediation strategy
combination of remedial techniques and associated work programmes that will meet specified contamination-related remediation objectives and other objectives, and overcome possible restraints

NOTE 1 Adapted from ISO 11074-4.

NOTE 2 Examples of objectives are residual-contaminant concentrations, and engineering-related objectives.

3.4.6
process-based treatment method
application of physical, chemical or biological processes either to remove or destroy contaminants, or to reduce their availability to the environment

[ISO 11074-4]

NOTE Different treatment methods, e.g. biotreatment, are defined in ISO 11074-4.

3.4.7
stockpile
temporary deposit of soil material for later use

3.4.8
investigation for compliance or performance
investigation, or programme of on-going inspection, testing or monitoring, to confirm that a remediation strategy has been properly implemented and/or when a containment approach has been adopted, that this continues to perform to the specified level

EXAMPLE Testing to confirm that all contaminated material has been removed.

[ISO 11074-4]

3.5 Assessment

3.5.1
hazard
property of a substance or material, or any action, which may have an adverse effect on soil functions

NOTE A hazard has the potential to cause harm.

3.5.2
risk
expression of the probability that an adverse effect on soil functions will occur under defined conditions, and the magnitude of the consequences of the effect occurring

3.5.3
harmlessness
condition in which the application of a soil material does not result in damage to the present functions of the soil already existing at the target site

3.5.4
data quality objectives
required detection limits, accuracy, reproducibility and repeatability of the required analytical and other data

NOTE 1 The objectives are often presented in a statement.

NOTE 2 Generic data quality objectives may sometimes be set at national level.

NOTE 3 The objectives may also include the amount of data required for an area of land (or part of a site) to enable a sound comparison with generic guidelines or standards or for a site-specific or material-specific estimation of risk.

4 Characterization of soil materials and sites

4.1 General

The purpose of characterizing soil and soil materials as suggested in this International Standard is usually to enable judgements to be made about its suitability for a defined use (e.g. arable farming, domestic gardens). Before any judgement can be made about suitability, the right type, quantity and quality of data must be available (see annex A). It is likely to be necessary to determine the relevant chemical, physical, biological and other characteristics as appropriate. This requires the development of an overall investigation strategy which needs to include, in particular:

— sampling strategies, and

— analytical and testing strategies

for each location and/or medium that is to be assessed.

The first step, therefore in the assessment of soil materials which have been, or may be, excavated or treated is to review the already available information and data to determine whether they are sufficient to enable an assessment to be made. If the data are not, then an appropriate investigation should be carried out. Subclause 4.2 discusses the situation when there is prior knowledge that excavation is to take place. Obviously the approach described needs to be adjusted for other situations (e.g. when the soil material of interest is a manufactured soil).

Sometimes investigations are required for the sole purpose of deciding whether soil and other soil material such as fill materials are suitable for re-use (the situation envisaged in Figure 1) but often this is only one of a number of objectives of a more comprehensive investigation of a suspect potentially contaminated site. In this latter case, the initial task becomes to ensure that the overall sampling, analytical and testing strategies for the investigation properly address the needs of this specific objective. In practice, investigations are commonly phased for both technical and cost reasons and it may therefore be preferable to carry out at least part of the characterization,

particularly for example of the nutrient and trace element status, physical and biological soil properties, through a supplementary investigation (see Figure 2). The real need to assess the soil material for re-use may only arise during the development of a remediation strategy, and the need to gather supplementary information at this stage is no different than that for other components of the remediation strategy (e.g. the need for geotechnical data relevant to installation of a cut-off wall may become apparent, the need for gas-permeability data for application of soil vapour extraction may become apparent).

The discussion below focuses on soil materials that are to be excavated. This International Standard covers a number of other situations including for example dredged materials, treated soil materials and manufactured soils. Comparable appropriate investigation is required to be sure that there is a good understanding of the source of the material and its components so that appropriate analytical and testing strategies can be developed.

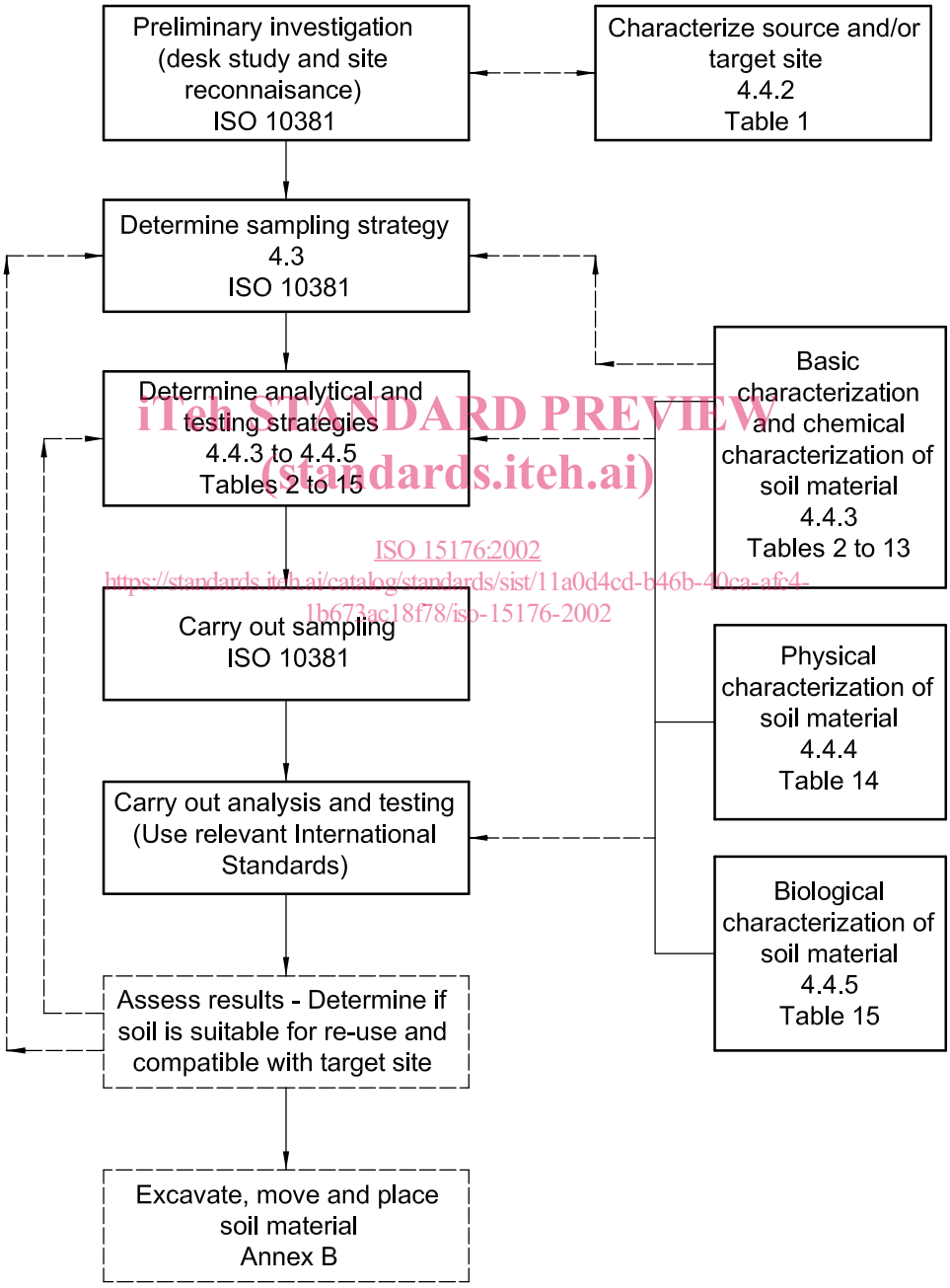

Figure 1 — Overall flow chart for characterization of soil materials for re-use

4.2 Investigation strategies

The typical overall investigation strategy for a potentially contaminated site (i.e. one where it is suspected potentially harmful substances may be present as a result of human activity) is to:

— carry out a preliminary investigation comprising a desk-top study and a site reconnaissance (walk over-survey). The aim is to build up as comprehensive a picture as possible of the history of the site, its geology and hydrogeology, environmental setting, and current condition;

and, on the basis of the resulting conceptual model, to:

— develop a strategy for intrusive investigation which properly takes into account the health and safety of the investigation team and the general public, and which avoids harm to the environment.

Often, but not always, the intrusive investigation will be phased (see Figure 2). An initial exploratory investigation (Phase 2) may be carried out first to attempt to confirm hypotheses drawn from the preliminary investigation (Phase 1) and to provide initial information to be better able to design the subsequent main investigation (Phase 3). In the light of the results of these early phases, it may be necessary to carry out supplementary investigations (Phase 4) to determine, for example the suitability of soil for re-use, or to gather information relevant to the application of a process-based treatment method.

It is important that the information and data required to assess excavated soil material for re-use be identified as far as possible before the investigation starts. In this way appropriate sampling, analytical and testing strategies can be developed at the outset. If this is not done, there may be significant gaps in the information available, necessitating further costly intrusive investigation. As suggested in 4.1, however, some aspects of characterization may often be better addressed through a supplementary investigation.

The approach outlined above should be adapted for other sources of soil materials, for example when soil material is being manufactured it would be appropriate to enquire into the source and history of each of the ingredients. In the case of soil material from a process-based treatment method, it would be appropriate to enquire into the history of the source site. Exploratory sampling programmes could then be carried out before designing and embarking on a programme for continuous monitoring of feed and output materials.

4.3 Sampling strategies

4.3.1 General considerations

Investigation may be required (as appropriate)

— *in situ* at the point of excavation,

— following excavation,

— following treatment,

— following manufacture of manufactured soil,

— *in situ* at the source or target site.

The sampling strategies and the measurements to be made (analytical and testing strategy) should be determined on the basis of

— the history of the site from which the soil material is excavated or dredged,

— the quantity of soil material to be assessed,

— available data or results of previous investigations,

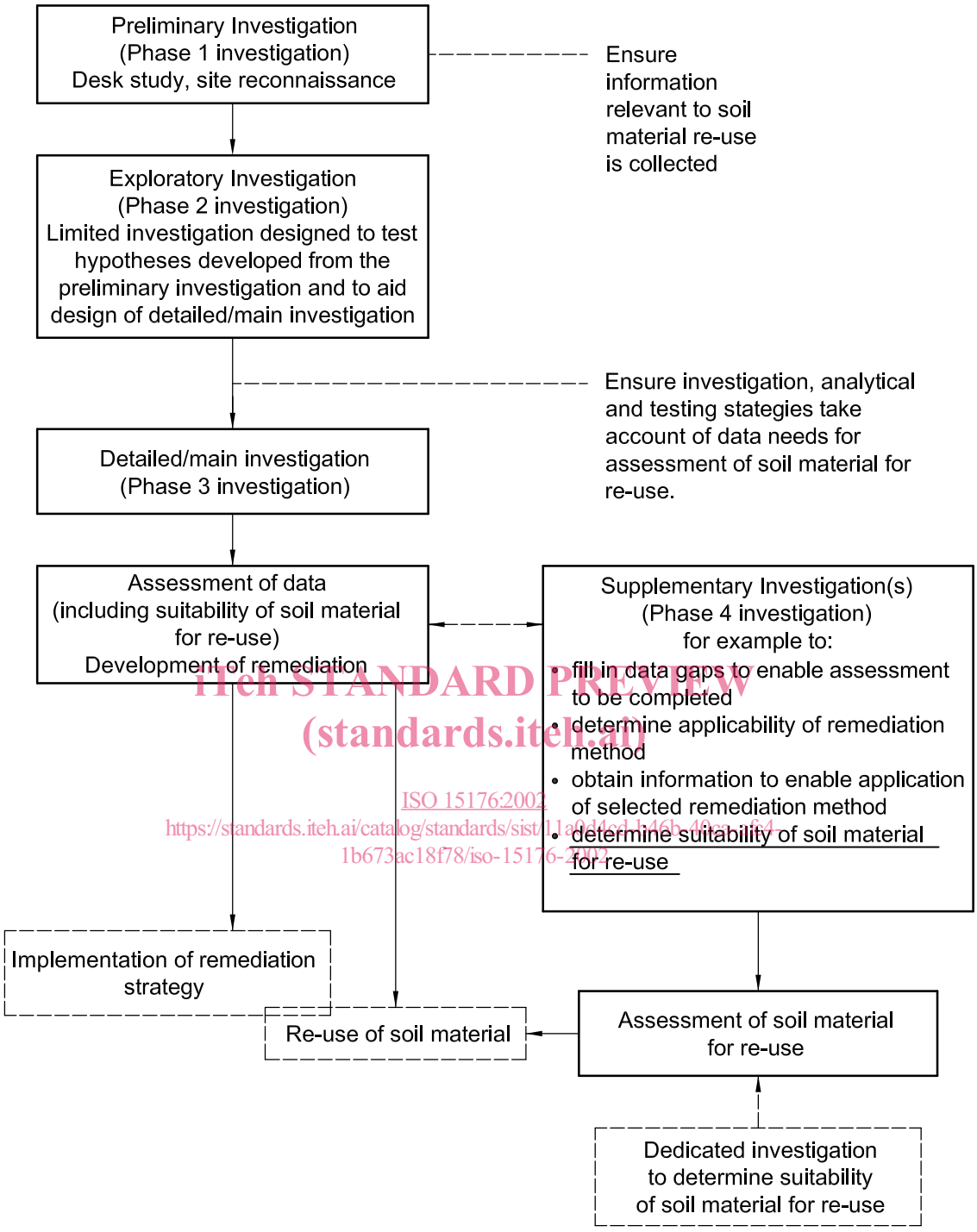

Figure 2 — Diagram showing how assessment of excavated soil material might fit into investigation of a suspect potentially contaminated site (as opposed to the alternative of a dedicated investigation with this sole objective)