

BS 10175:2011+A2:2017



BSI Standards Publication

Investigation of potentially contaminated sites – Code of practice

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Foreword

Publishing information

This British Standard was published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2011. It was prepared by Technical Committee EH/4, *Soil quality*. A list of organizations represented on this committee can be obtained on request to its secretary.

The initial drafting of this British Standard was produced in association with BIS as part of their on-going programme of support for standardization.

Supersession

BS 10175:2011+A1:2013 superseded BS 10175:2011, which has been withdrawn.

BS 10175:2011+A2:2017 supersedes BS 10175:2011+A1:2013, which is withdrawn.

Information about this document

This standard is intended to be read in conjunction with ISO 18400-102, BS ISO 18400-103, BS ISO 18400-104, BS ISO 18400-105, BS ISO 18400-106, BS ISO 18400-107, BS ISO 18400-201, BS ISO 202, and BS ISO 18400-206 which deal with various aspects of investigation and sampling of soil and soil materials to determine quality, not only on land potentially affected by contamination, but also agricultural, natural and near-natural sites.

This edition is consistent with current methodologies and has been updated. Amendment No. 1 was introduced in 2013 to take account of developments in planning, sampling, testing and assessment since the publication of BS 10175:2001 and in particular the publication of BS 8576.

Text introduced or altered by Amendment No. 1 and Amendment No. 2 respectively is indicated in the text by tags **A1** and **A1** and **A2** **A2**. Minor editorial changes are not tagged.

One of the changes introduced in Amendment 1 of BS 10175 was the deletion of [Annex I](#). Annex A in BS 8576 summarizes the regulatory regimes dealing with land contamination with reference to the Part 2A Contaminated Land regime, the Building Control regulations and the planning process. These represent the main contexts in which the investigations for land contamination and for ground gas are carried out following the processes set out in BS 10175.

The primary purpose of Amendment No. 2 is to take into account the publication of the BS ISO 18400 series of standards. However, the opportunity has been taken to make a few minor corrections and amendments, e.g. the formation of Natural Resources Wales and the publication of BS 5930:2015.

It is noted that BS ISO 17924, BS ISO 18400-104, BS ISO 18400-202, BS ISO 18400-205 and BS ISO 18400-206 are informatively referenced in this standard but are yet to be published. It is expected these will be published in 2018.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

In particular, attention is drawn to the following primary legislation and statutory regulations.

- The Environmental Protection Act 1990, as amended [\[1\]](#);
- The Contaminated Land (Wales) Regulations 2006 [\[2\]](#);
- The Contaminated land (Scotland) Regulations 2000, as amended [\[3\]](#);
- The Contaminated Land (England) Regulations 2006 [\[4\]](#);
- The Environment Act 1995 [\[5\]](#);
- The Radioactive Contaminated Land (Modifications of Enactments) (England) Regulations 2006 [\[6\]](#);
- The Radioactive Contaminated Land (Modifications of Enactments) (Wales) Regulations 2006 [\[7\]](#);
- The Radioactive Contaminated Land (Scotland) Regulations 2007, as amended [\[8\]](#);
- The Water Resources Act 1991, as amended [\[9\]](#);
- The Water Act 2003 [\[10\]](#);
- The Water Environment and Water Services (Scotland) Act 2003 [\[11\]](#);
- The Water (Northern Ireland) Order 1999 [\[12\]](#);
- The Wildlife and Countryside Act 1981 [\[13\]](#);
- The Conservation (Natural Habitats, etc.) Regulations 1994 [\[14\]](#);
- The Town and Country Planning Act 1990 [\[15\]](#);
- The Town and Country Planning (Scotland) Act 1997 [\[16\]](#);
- The Building Control Act 1990 [\[17\]](#);
- The Construction Design and Management (CDM) Regulations 2015 [\[18\]](#);
- The Control of Substances Hazardous to Health (COSHH) Regulations 2002 [\[19\]](#);
- The Factories Act 1961 [\[20\]](#);
- The Offices, Shops and Railway Premises Act 1963 [\[21\]](#);
- The Health and Safety at Work, etc. Act 1974 [\[22\]](#);
- The Pollution Prevention and Control Act 1999 [\[23\]](#);
- The Control of Pollution Act 1974, as amended [\[24\]](#);
- The Environmental Damage (Prevention and Remediation) Regulations 2009 [\[25\]](#);
- The Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009 [\[26\]](#);
- The Environmental Liability (Scotland) Regulations 2009 [\[27\]](#);
- The Environmental Protection (Duty of Care) Regulations 1991 [\[28\]](#);
- The Environmental Permitting (England and Wales) Regulations 2007 [\[29\]](#);

- The Pollution Prevention and Control (Scotland) Regulations 2000 [[30](#)].

Introduction

The recommendations and guidance of this British Standard are applicable to the investigation of all potentially contaminated sites and also to land with naturally elevated concentrations of potentially harmful substances.

A2 BS 10175 is to be used in conjunction with other relevant standards, in particular BS 8576 and the BS ISO 18400 series of standards (see NOTE 4). **A2**

The management of land potentially affected by contamination involves identifying risks arising from the presence of contaminants in order that appropriate action can be taken. The risk assessment of a potentially contaminated site requires a variety of information, including:

- a) details of the historical uses of the site and surrounding area and the potential for the presence of contaminants (the potential sources);
- b) identification of who or what could be affected by the contaminants (i.e. receptors);
- c) information on the pathways by which contaminants could migrate or come into contact with receptors (including details of any physical characteristics of the site that will affect contaminant movement).

This information is gathered by a process of site investigation as set out in this standard.

The results of the investigation ought to delineate all known aspects of the site that could impinge upon or affect source-pathway-receptor scenarios defined within the conceptual model.

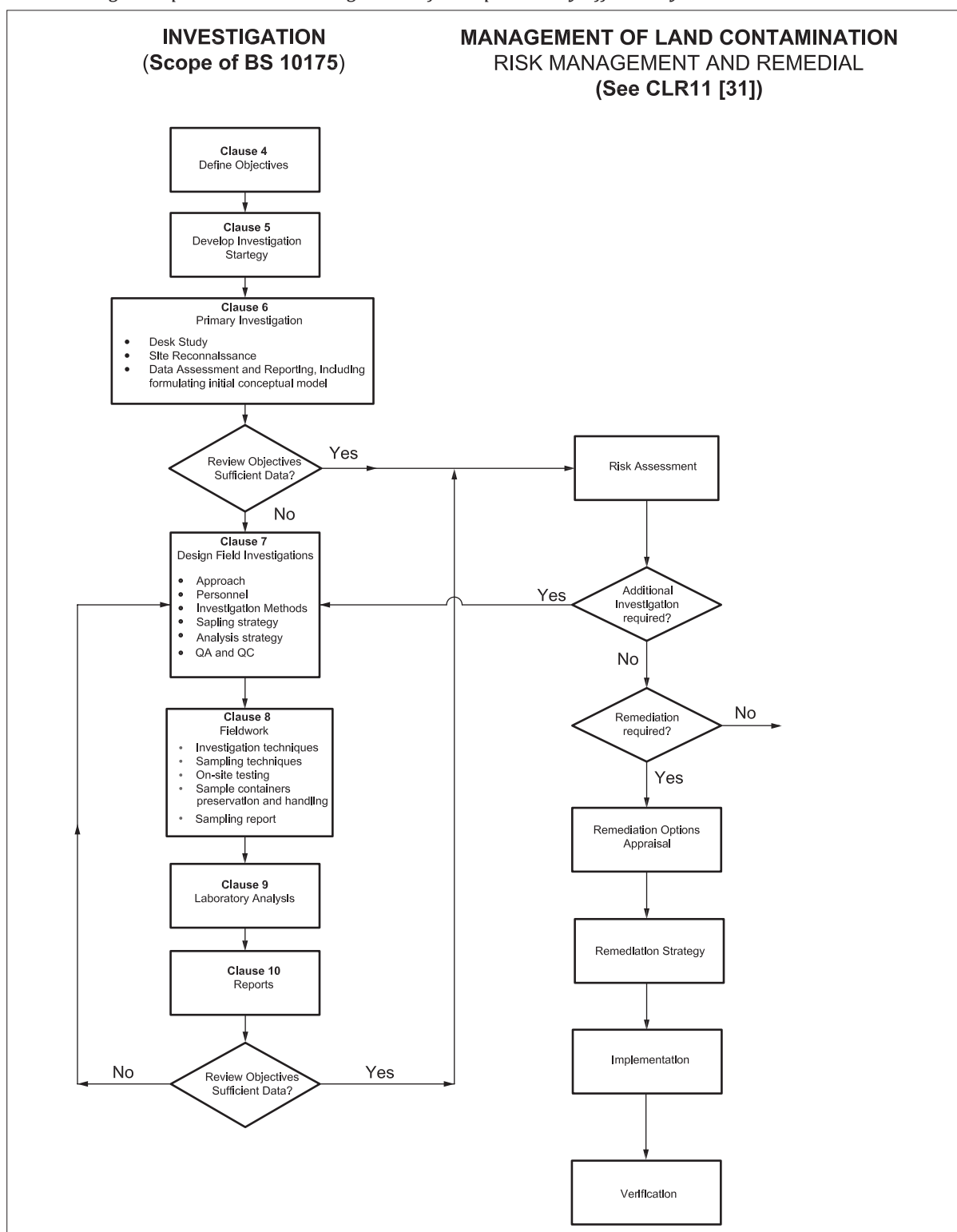
The conceptual model is a description and/or representation of the site, incorporating what is known about the ground and groundwater conditions; the actual and potential contamination; the physical conditions and environmental setting; the receptors; and potential pathway linkages between contamination sources and receptors.

Depending upon the objectives of the investigations, it could be relevant to consider new future receptors associated with the construction and completion of a new development, as well as existing receptors. The conceptual model leads to the formulation of contamination-related hypotheses, which the investigation process examines through the collection of relevant data.

The conceptual model is first formulated during the preliminary investigation (desk study) and informs subsequent investigations, if these are necessary, to meet the objectives of the overall investigation. One of the objectives will be reduction of uncertainty in the conceptual model.

The process of investigation involves a number of phases and typically begins with setting the objectives of the investigation. At the end of each phase of investigation, the information obtained is reviewed to determine whether the objectives have been met or there is a need for further investigation, and to address data gaps or uncertainties in the conceptual model. Where further investigation is necessary, the design of the next phase is based on, and utilizes, the information previously obtained.

The process of investigation, and how it relates to the management of land potentially affected by contamination, is illustrated in [Figure 1](#). The recommendations of this standard are presented in the sequence of steps that are to be followed in the investigation process, and [Figure 1](#) indicates which clause refers to each step. [Annex A](#) provides examples of how the recommendations of this standard can be applied.

Figure 1 — Site investigation process in the management of land potentially affected by contamination

The use of the conceptual model to assess the need for remedial action of land affected by contamination is a part of the risk assessment process. Guidance on how to carry out a risk assessment is outside the scope of this standard.

NOTE 1 Guidance on the management of contaminated land has been published by the Department of the Environment, Food and Rural Affairs (Defra) and the Environment Agency [31]. This gives guidance on the assessment of land known to be or potentially affected by contamination and can be used in conjunction with the recommendations of this standard. Particular attention is drawn to chapter 2, Risk Assessment.

NOTE 2 Some requirements for investigation lie beyond the needs of a risk assessment, for example, a sampling scheme for remediation verification or the selection and detailed design of a remediation scheme. In such situations the procedures and methods described in this standard can be used to design the relevant investigation.

A1 *NOTE 3 Guidance on investigations for Volatile Organic Compounds (VOCs) and permanent gases such as methane and carbon dioxide, is provided in BS 8576, which has been prepared to be used in conjunction with this British Standard.* **A1**

A2 *NOTE 4 The ISO 18400 series of standards is intended to cover all situations where soil samples are to be collected for determination of soil quality. The standards in the series are not only relevant to the investigation of potentially contaminated sites but also, for example, to the investigation of natural, near-natural and agricultural sites (see for example BS ISO 18400-205). In the case of agricultural sites, the intent could be to assess soil fertility and in the case of natural sites to determine properties related to carbon sequestration. The thinking underlying the series and the structure of the series is described in BS ISO 18400-100.*

NOTE 5 ISO 18400-203 and ISO 18400-204 have not been adopted as British Standards because they overlap respectively with this standard and BS 8576. The guidance the two standards contain is generally compatible with the guidance in the corresponding British Standard.

NOTE 6 Some of the terminology used in the ISO 18400 series differs from that in BS 10175. For example, "conceptual site model" is used where "conceptual model" is used in this standard. Some of these differences are noted in the amended text. There are also some differences in how terms are used in BS 10175 and BS 5930 and some minor editorial differences between the formal definitions for some terms in different members of the ISO 18400 series of standards. **A2**

1 Scope

This British Standard gives recommendations for, and guidance on, the investigation of land potentially affected by contamination and land with naturally elevated concentrations of potentially harmful substances, to determine or manage any risks. It covers:

- a) setting the objectives of an investigation;
- b) developing a strategy for the investigation;
- c) designing the different phases of the investigation;
- d) sampling and field testing;
- e) laboratory analysis;
- f) reporting,

in order to obtain scientifically robust data on soil, groundwater, surface water and ground gas contamination.

It is intended for use by those with an understanding of the risk-based approach to the assessment of sites (as described in the Model Procedures for the Management of Land Contamination (CLR 11) [31]).

The relevant recommendations and guidance within this standard are intended to ensure that the objectives of an investigation are achieved and that appropriate data for the risk assessment are obtained. However, it is not feasible to provide detailed guidance for every possible investigation scenario.

This British Standard does not give:

- 1) guidance on certain constraints or problems that can affect a site, such as geotechnical aspects (which are covered by BS 5930);
- 2) guidance on legal aspects, including the need for licences and permits, etc.;

- 3) detailed guidance for the investigation and assessment of radioactively contaminated sites (see Note 1);
- 4) procedures for the formal assessment of the potential risks posed by land potentially affected by contamination (see Note 2);
- 5) guidance on sampling from stockpiles (see Note 3);
- 6) A1 detailed guidance on investigations for ground gases, i.e. Volatile Organic Compounds (VOCs) and permanent gases such as methane and carbon dioxide. A1

A2 Text deleted A2

When relevant, this standard is to be used in conjunction with other standards and codes of practice, for example, A1 BS 8576 for investigations for ground gas and A1 BS 5930 for investigations for civil engineering purposes.

NOTE 1 A2 Guidance on the investigation and assessment of radioactivity in soils is given in the BS ISO 18589 series. The appropriate methodology for such works will be dependent on the nature of the contamination and the site conditions and ought to be discussed with the regulator in advance.

NOTE 2 See the guidance published by Defra and the Environment Agency in CLR 11 31.

NOTE 3 Guidance on sampling stockpiles is given in BS ISO 18400-102 and BS ISO 18400-104.

NOTE 4 Guidance on the investigation of uncontaminated natural, near-natural and agricultural sites, for example to determine factors relevant to assessment of potential productivity, is provided in BS ISO 18400-205.

NOTE 5 Further guidance on assessment of soil quality in relation to particular purposes can also be found in BS EN ISO 15175, BS ISO 15176, BS ISO 15799, ISO 15800 and BS ISO 19258. A2

2 Normative references

The following referenced documents are indispensable for the application 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.

A1 BS 5930:2015, *Code of practice for ground investigations* A1

A2 Text deleted A2

BS 6187, *Code of practice for demolition*

BS 8485, *Code of practice for the characterization and remediation from ground gas in affected developments*

A1 BS 8576:2013, *Guidance on investigations for ground gas — Permanent gases and Volatile Organic Compounds (VOCs)* A1

BS EN 12457 (all parts), *Characterisation of waste — Leaching — Compliance test for leaching of granular waste materials and sludges*

BS EN ISO 5667-6, *Water quality — Sampling — Part 6: Guidance on sampling of rivers and streams*

A2 BS EN ISO 5667-14, *Water quality — Sampling — Part 14: Guidance on quality assurance and quality control of environmental water sampling and handling* A2

BS EN ISO 5667-1, *Water quality: Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

BS EN ISO 5667-3, *Water quality: Sampling — Part 3: Guidance on the preservation and handling of samples*

BS EN ISO 14688, *Geotechnical investigation and testing*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

 BS ISO 5667-4, *Water quality — Sampling — Part 4: Guidance on sampling from lakes, natural and man-made* 

BS ISO 5667-5, *Water quality — Sampling — Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems*

BS ISO 5667-11, *Water quality — Sampling — Part 11: Guidance on sampling of groundwaters*

 BS ISO 5667-12, *Water quality. Sampling — Part 12: Guidance on sampling of bottom sediments from rivers, lakes and estuarine areas* 

 Text deleted 

BS ISO 11074, *Soil quality — Vocabulary*

BS ISO 11464, *Soil quality — Pretreatment of samples for physio-chemical analysis*

BS ISO 14507, *Soil quality — Pretreatment of samples for the determination of organic contaminants*

 BS ISO 18400-102:2017, *Soil quality — Sampling — Part 102: Selection and application of sampling techniques*

BS ISO 18400-103, *Soil quality — Sampling — Part 103: Safety*

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

BS ISO 18400-106, *Soil quality — Sampling — Part 106: Quality control and quality assurance*

BS ISO 18400-107, *Soil quality — Sampling — Part 107: Recording and reporting*

BS ISO 18400-201, *Soil quality — Sampling — Part 201: Physical pretreatment in the field* 

BS ISO 18512:2007, *Soil quality — Guidance on short and long term storage of soil samples*

3 Terms and definitions

For the purposes of this British Standard the terms and definitions given in BS ISO 11074 apply, together with the following.

3.1 Definitions

3.1.1 accuracy

closeness of agreement between a measurement result and the true value of the measurand

NOTE The term “accuracy”, when applied to a set of measurement results, describes a combination of random components and a common systematic error or bias component.

[SOURCE: Adapted from BS ISO 3534-1]

3.1.2 conceptual model

characteristics of a site that are relevant to the occurrence and potential effects of ground contamination that describe the nature and sources of contamination; the ground, groundwater, surface water, ground gases and volatile organic compounds (VOCs) that could be present; the environmental setting; potential migration pathways; and potential receptors

NOTE 1 A conceptual model is usually presented in a tabular, textual and/or diagrammatic form.

NOTE 2  The ISO 18400 series of standards and other standards produced by ISO/TC 190 use the term “conceptual site model” with a similar meaning although it is variously defined in individual standards. 

3.1.3 contamination

presence of a substance or agent, as a result of human activity, in, on or under land, which has the potential to cause harm or to cause pollution

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

3.1.4 controlled waters

inland freshwater, water contained in underground strata and any coastal water between the limit of highest tide or the freshwater line to the three mile limit of territorial waters

NOTE 1 See Section 104 of The Water Resources Act 1991 [9]. "Inland freshwater" includes any lake, pond or watercourse above the freshwater limit.

NOTE 2 In Scotland, references to "controlled waters" in Part IIA of the EPA [1] have been replaced by the statutory definition of "the water environment" pursuant to the Water Environment and Water Services (Scotland) Act 2003 [11]. This definition includes all surface water, groundwater and wetlands.

NOTE 3 In Northern Ireland, controlled waters are defined in Article 2 (2) of the Water (Northern Ireland) Order 1999 [12] as water in waterways and underground strata.

3.1.5 harm

measurable adverse effect on a receptor

NOTE This definition is broader than that given in Section 7(A)(4) of the Environmental Protection Act [1].

3.1.6 hazard

property or situation that in particular circumstances could lead to harm or pollution

[SOURCE: (CLR 11 [31])]

3.1.7 measurement uncertainty

estimate attached to a test result which characterizes the range of values within which the true value is asserted to lie

3.1.8 pathway

mechanism or route by which a contaminant could come into contact with, or otherwise affect, a receptor

3.1.9 receptor

entity that could be adversely affected by a contaminant(s)

NOTE Examples of receptors include persons, other living organisms, ecological systems, controlled waters, atmosphere, structures and utilities.

3.1.10 risk

combination of the probability, or frequency of occurrence, of a defined hazard and the magnitude of the consequences of the occurrence

[SOURCE: (CLR 11 [31])]

3.1.11 risk assessment

formal process of identifying, assessing and evaluating the health and environmental risks that could be associated with a hazard

[SOURCE: (CLR 11 [31])]

3.1.12 sampling uncertainty

part of the total measurement uncertainty attributable to sampling

[SOURCE: [IUPAC (2005) [32]]]

3.1.13 soil

topsoil and subsoils; deposits such as clays, silt, sand, gravel, cobbles, boulders and organic matter and deposits such as peat; material of human origin such as wastes; ground gas and moisture; and living organisms

NOTE This is the meaning ascribed through ground engineering and encompasses fills and deposited wastes.

3.1.14 source

location or feature from which contamination is, or was, derived

3.1.15 uncertainty

lack of knowledge about specific factors

A2 3.1.16 anthropogenic ground

deposits which have accumulated through human activity

NOTE These could consist of natural materials placed/replaced by man, e.g. clay, or man-made materials, e.g. refuse.

[SOURCE: BS 5930:2015, 3.1]

3.1.17 cluster sample

composite sample for which the increments are taken over a small area around a predefined sampling point

NOTE 1 Sampled area is typically about 0.5 m² to 1.0 m².

NOTE 2 Material sampled is taken from within the same stratum or from material with the same characteristics.

[SOURCE: BS ISO 18400-102:2017, 3.1]

3.1.18 composite sample

sample made of a number of increments (3.1.21) [cluster sample (3.1.17) or spatial composite sample (3.1.29)]

3.1.19 disturbed sample

sample obtained from the ground without any attempt to preserve the soil structure

EXAMPLE Sample obtained by using a hand auger.

[SOURCE: BS ISO 18400-102:2017, 3.3]

3.1.20 fill

anthropogenic ground (3.1.16) in which the material has been selected, placed and compacted in accordance with an engineering specification

[SOURCE: BS 5930:2015, 3.4]

3.1.21 increment

material forming part of a composite sample (3.1.18) obtained by a single operation of a sampling device, for instance, the filling of a scoop or auger

3.1.22 judgemental sampling

target sampling

process of taking samples from particular zones or features of a site taking into account existing knowledge, including what is known about the history and layout of a site or a zone within a site

NOTE 1 Judgemental sampling could be required, for example, around underground storage tanks or pipelines where there might have been leaks, above ground storage tanks where there might have been spills, and for areas where raw materials or wastes have been stored or deposited.

NOTE 2 Sampling locations are usually predetermined based on what is known about the target area but some locations may be selected in the field in response to on-site observations.

3.1.23 kubiēna tin

metal box with removable top and base which can be forced into the surface of exposed soil to obtain an *undisturbed sample* (3.1.32)

NOTE Usually made to desired size from aluminium, galvanized steel, or stainless steel sheet. Size varies, but a typical example might have an area of about 55 mm × 75 mm with a depth of 40 mm. The sample, once obtained, can be used to determine bulk density or may be impregnated with resin prior to the production of thin sections for microscopic examination.

[SOURCE: BS ISO 18400-102:2017, 3.4]

3.1.24 made ground

anthropogenic ground (3.1.16) comprising material placed without engineering control and/or manufactured by man in some way, such as through crushing or washing, or arising from an industrial process

[SOURCE: BS 5930:2015, 3.10]

NOTE Amended in BS ISO 18400-104 to: *anthropogenic ground in which the material has been placed without engineering control and/or manufactured by man in some way, such as through crushing or washing, or arising from an industrial process.*

3.1.25 probabilistic sampling

sampling to ensure that each particle or element in the population has an equal chance of being part of the sample

NOTE This means it is easy to obtain a quantifiable level of reliability (or uncertainty) in the estimated mean value and enable estimation of variability of the results for the population being tested.

[SOURCE: BS EN ISO 11074:2015, 4.2.10]

3.1.26 regular sampling

process of taking samples at the nodes of a regular pattern, such as a square or triangular grid, i.e. the sampling locations are evenly spaced

3.1.27 sampling pattern

set of predetermined sampling points

3.1.28 selective sample

sample deliberately chosen or formed, based on some specific characteristic(s) of the material to be sampled

EXAMPLE Appearance, odour, particle sizes.

3.1.29 spatial composite sampling

composite sample formed from small incremental point samples taken over an area (such as a field)

NOTE The general premise is that the distribution of soil constituents is relatively homogeneous. The increments may be located according to a regular grid, random, or other pattern. In agricultural/horticultural land investigations "N", "S", "W" and "X" sampling patterns are commonly used. Along the outline of such a pattern, a number of samples or increments are taken which are bulked and mixed to provide one [composite] sample for analysis.

3.1.30 spot sample

sample from a discrete location

NOTE 1 Sample can be formed from one or more contiguous portions of material.

NOTE 2 Sample may be a disturbed (3.1.19) or undisturbed sample (3.1.32).

3.1.31 systematic sampling

process of taking samples from locations that have been pre-designated according to a geometric pattern

NOTE 1 Systematic sampling can include a random positioning component.

NOTE 2 Some systematic sampling patterns are regarded as "probabilistic" (3.1.25).

NOTE 3 This definition is wider than the usual definition found in the literature, where systematic sampling commonly means regular sampling.

3.1.32 undisturbed sample

sample obtained from the ground with soil structure unaltered during sampling procedure

NOTE Special sampling equipment is used so that the soil particles and voids cannot change from the distribution which exists in the ground before sampling (these can provide volume-proportional or mass-proportional results).

[SOURCE: BS ISO 18400-102:2017, 3.7 ]

3.2 Abbreviations

bgl	below ground level
BGS	British Geological Survey
BOD	biochemical oxygen demand
CDM	construction design and management
CLO	contaminated land officer (of a local authority)
CLR	Contaminated Land Report
COD	chemical oxygen demand
COSHH	Control of Substances Hazardous to Health Regulations 2002 [19]
Defra	Department for Environment, Food and Rural Affairs
DO	dissolved oxygen
DQRA	detailed quantitative risk assessment
 EA	Environment Agency 
ECD	electron capture detector

EPA (1990)	Environmental Protection Act (1990) [1]
FAAS	flame atomic absorption spectrometry
FID	flame ionization detectors
FP-XRF	field portable X-ray fluorescence
FTIR	Fourier-transform infra-red spectroscopy
GC/MS	gas chromatography/mass spectrometry
HPA	Health Protection Agency
HSE	Health and Safety Executive
HPLC	high performance liquid chromatography
ICP-MS	inductively coupled plasma – mass spectrometry
ICP-OES	inductively coupled plasma – optical emission spectrometry
MCERTS	Environment Agency's Monitoring Certification Scheme
MTBE	methyl-tert butyl ether
NIEA	Northern Ireland Environment Agency
NISMR	Northern Ireland Sites and Monuments Record
 NRW	Natural Resources Wales 
OS	Ordnance Survey
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PET	polyethylene terephthalate
 PHE	Public Health England 
PID	photo-ionization detector
PPS	Planning Policy Statement
QA	quality assurance
QC	quality control
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
RCAHMW	Royal Commission on the Ancient and Historical Monuments of Wales
RFMMs	rapid field measurement methods
SEPA	Scottish Environment Protection Agency
SVOC	semi-volatile organic compound
TCE	trichloroethene
TPHs	total petroleum hydrocarbons
UKAS	United Kingdom Accreditation Service

USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
VOCs	volatile organic compounds
XRF	X-ray fluorescence

4 Setting the objectives of an investigation

4.1 General

The first step in any investigation of land potentially affected by contamination should be to set clear and appropriate objectives (see [4.2](#)) taking into account:

- a) the client's reasons for requesting the investigation to be undertaken (these should be clearly set out by the client);
- b) the decisions that need to be made regarding the site;
- c) the confidence required for making these decisions;
- d) the findings of any investigations already carried out;
- e) the findings of any risk assessment(s) completed to date.

NOTE 1 The client might require the investigation and/or risk assessment for their own use or to comply with a regulatory requirement.

The objectives should be set before the strategy of the investigation ([Clause 5](#)) is established and the investigation is designed ([Clause 6](#) to [Clause 10](#)).

The objectives of a site investigation will vary, depending upon the stage in the process that has been reached and the underlying intentions for the land involved, but may, for example, be to:

- 1) provide information on contamination of the ground and groundwater;
- 2) provide information on natural concentrations of potentially hazardous substances;
- 3) gather the information needed to form, or further develop, a conceptual model, including identification of potential pathways and receptors for the purposes of the risk assessment.
- 4) support a risk assessment;
- 5) provide data for the design of remedial works;
- 6) provide data for re-use or disposal of soils as waste.

The formulation or refinement of a conceptual model should always be one of the investigation objectives and the model should be reviewed and revised in response to the additional information.

In some circumstances benefits can be gained from investigations that combine the needs of contamination and geotechnical objectives. However, the use of an integrated investigation should not be allowed to compromise the objectives or requirements of either investigation (see [7.2](#)).

Before entering into a contract, the prospective investigator should endeavour to make sure that the client or the client's adviser understands the likely regulatory requirements and that it has been set down whether the investigator is or is not to be responsible for meeting these requirements.

NOTE 2 Sometimes the primary purpose of an investigation may be to "benchmark" site conditions (e.g. contamination levels) for future reference.

NOTE 3 An investigation will often be carried out in one of the following contexts.

- i) In support of a planning proposal carried out on behalf of the client (who may or may not be the site owner).
- ii) In connection with the potential sale and purchase of a site to enable its value to be estimated, taking into account potential contaminated land liabilities and possible remediation requirements.
- iii) In connection with the potential determination of a site under the Part 2A regime [1,5] commissioned by the regulator or appropriate person.

NOTE 4 When the investigation is carried out in connection with a planning application or discharge of a Planning Condition, the resulting report will be submitted to the planning authority and be reviewed by the local authority's designated technical specialist, who is typically the "contaminated land officer" (CLO). ^{A2} When the investigation is carried out in connection with a Part 2A determination under the Environmental Protection Act 1990 [1], the resulting report will be submitted to the relevant regulator, usually the local authority, but the Environment Agency in England, and NRW in Wales in the case of Special Sites (in Scotland, local authorities are responsible for sites which pose a risk of pollution to the water environment and not all such sites will be designated Special Sites). ^{A2} In both these situations, early consultation with the primary regulator's technical representative is recommended to ensure that the detailed investigation meets the needs of the regulator. ^{A1} Further information on regulatory regimes dealing with land contamination can be found in Annex A of BS 8576:2013. ^{A1}

4.2 Setting investigation objectives

Answers to the following questions, amongst others, should be provided when drawing up the investigation objectives.

- a) What are the reasons for the investigation?
- b) What data gaps or uncertainties need to be addressed?
- c) What information is needed?
- d) What level of detail and accuracy of measurements are required?
- e) What are the spatial and temporal investigation boundaries?
- f) In the context of providing information for a risk assessment, what are the specific purposes of the risk assessment?

NOTE 1 Examples of typical investigation objectives that can be associated with different phases of investigation (see 5.2) are provided in Table 1. Further examples of typical objectives and applications are given in Annex B.

^{A2} *NOTE 2 For further discussion about setting investigation objectives see BS ISO 18400-104. ^{A2}*

As information is developed during an investigation, the impact on the objectives and the objectives themselves should be reviewed to determine whether these require modification or extension.

Table 1 — Typical objectives of different phases of an investigation

Phase	Typical objectives
Preliminary investigation (desk study and site reconnaissance) (Clause 6)	To provide information on past and current uses of the site and surrounding area and the nature of any hazards and physical constraints. To identify current and likely future receptors, potential sources of contamination and likely pathways and any features of immediate concern, including those that could be introduced in the future. To identify any aspect of the site requiring immediate attention (e.g. insecure fences, hazardous substances accessible to trespassers or likely to be dispersed by wind or water). To provide information on the geology, geochemistry, soil, hydrogeology and hydrology of the site. To identify potentially different sub-areas (zones) of a site, based on differing ground conditions; potential contamination; and past, present and future uses. To produce an initial conceptual model for the site as a whole and/or for zones within the site. To provide information for the preliminary risk assessment (see 6.3.2). To identify areas where informed decisions are to be made using specialist assessment techniques or advisors, e.g. if there are ecological, unexploded ordnance (UXO) or archaeological considerations. To provide data to assist in the design of potential subsequent exploratory and detailed investigations and to give an early indication of possible remedial requirements. To provide information relevant to worker health and safety and to the protection of the environment during field investigations (Annex C). To identify the need to involve regulatory bodies prior to intrusive investigation.
Exploratory investigation (optional) (Clauses 7, 8, 9 and 10)	To test the conceptual model(s) of contamination and site characteristics. To obtain further information in relation to potential sources of contamination, likely pathways and features of immediate concern. To obtain further information on the geology, geochemistry, soil, hydrogeology and hydrology of the site. To provide further information to aid the design of the detailed investigation, including health and safety aspects. To provide data for a review of the conceptual model and to update the risk assessment.

NOTE 1 For the purposes of this British Standard, geology includes made ground and fill.

NOTE 2 A phase of investigation might be undertaken in a number of stages if necessary to achieve the full objectives of the investigation and in response to the findings of the previous phase(s).

NOTE 3  The term “main investigation” has been changed to “detailed investigation” throughout this amended standard to align it with the ISO 18400 series of standards. 

NOTE 4 When an exploratory investigation is not carried out prior to a detailed investigation, the latter needs to embrace the relevant typical objectives listed here for the exploratory investigation.

Table 1 (continued)

Phase	Typical objectives
Detailed investigation (Clauses 7, 8, 9 and 10)	To obtain data on the nature and extent of contamination, the geology, geochemistry, soil, hydrogeology and hydrology of a site. To provide data to review the conceptual model and to update the risk assessment. To provide data for the selection and design of remedial works.
Supplementary investigation(s) (if required) (Clauses 7, 8, 9 and 10)	To provide clearer delineation of a particular area (zone) of contamination or a contamination plume. To address or clarify specific technical matters (e.g. to confirm the applicability and feasibility of potential remedial options or obtain information for their design).

NOTE 1 For the purposes of this British Standard, geology includes made ground and fill.

NOTE 2 A phase of investigation might be undertaken in a number of stages if necessary to achieve the full objectives of the investigation and in response to the findings of the previous phase(s).

NOTE 3  The term “main investigation” has been changed to “detailed investigation” throughout this amended standard to align it with the ISO 18400 series of standards. 

NOTE 4 When an exploratory investigation is not carried out prior to a detailed investigation, the latter needs to embrace the relevant typical objectives listed here for the exploratory investigation.

5 Developing an investigation strategy

5.1 General

Having set the objectives of the investigation, an overall strategy should be developed. This should address not only what to do, but also:

- how it is to be done;
- when it is to be done (including sequencing of works);
- who is to do it;
- what needs to be done to enable the work to be done (e.g. consultations, gaining access and preparation of documentation, including, for example, safety plans, method statements and specifications).

These and other relevant issues should be addressed as the strategies are developed for each phase of the work and zone.

NOTE 1 Recommendations for the development of the overall investigation strategy are given in 5.2.  Guidance is also provided in BS ISO 18400-104. 

More detailed strategies for each phase of the work should be developed as the work progresses. These may include development of a sampling (and field testing) strategy and an analytical and testing strategy.

NOTE 2 Sub-clauses 5.2.7.1 to 5.2.7.4 describe the contexts in which the preliminary, exploratory, detailed and supplementary investigations are likely to be carried out and the important factors to be taken into account when developing the respective strategies. Sub-clause 5.3 refers specifically to the development of strategies for field investigations.

Decisions should be taken early in the project about:

- what additional expertise (if any) is needed to develop the investigation strategy;
- whether a formal project team is to be formed, for example to help develop the strategy;

- 3) whether to assign specific tasks to specific individuals or organizations.

5.2 Overall strategy

5.2.1 General

Development of the overall strategy should include deciding which of the investigation types described in [5.2.7.1](#) to [5.2.7.4](#) are to be used, the timing and sequencing of the investigation works and who is to carry out various activities, and identifying what enabling works are required. It should also involve consultation and reporting arrangements during execution and on completion, and formal reviews of the data so that previous decisions taken can be reconsidered in the light of the newly obtained data and other information as the investigation proceeds. The process of identifying and quantifying risks should be ongoing and iterative.

The overall strategy should take into account, amongst other things:

- a) the objectives of the work;
- b) the site constraints;
- c) the suitability of available investigation techniques;
- d) the availability of suitable analytical and other test methods.

5.2.2 Phases of investigation

Because the identification, quantification and delineation of contamination (or areas of naturally elevated concentrations of harmful substances) and the assessment of human and environmental risks can be complex, a site investigation should usually be carried out in a series of phases, with each phase designed to achieve specific objectives.

The phases will typically comprise preliminary, exploratory, detailed and supplementary investigations. A preliminary investigation will always be required. However, the requirement for subsequent exploratory, detailed and supplementary field investigations will depend on the objectives. Each phase of subsequent field investigations should be split into a number of stages, when necessary, in order to obtain sufficient relevant data to characterize potential source-pathway-receptor scenarios.

NOTE ^{A2} The terminology used in other contexts and by other professionals might differ from that used in this British Standard. For example, BS 5930 refers to “desk study and field reconnaissance” where “preliminary investigation” is used in this standard and applies the term “preliminary investigation” to what is called an “exploratory investigation” in this standard. ^{A2}

The approach to site investigations on potentially contaminated sites, including the various phases of investigation, should be in accordance with [Figure 2](#). Data and information obtained at each phase should be reviewed in order to determine whether the strategy requires modification or the objectives have been met. This review process also enables the conceptual model to be revised, and the requirements of the risk assessment and the objectives of the site investigation to be reassessed.

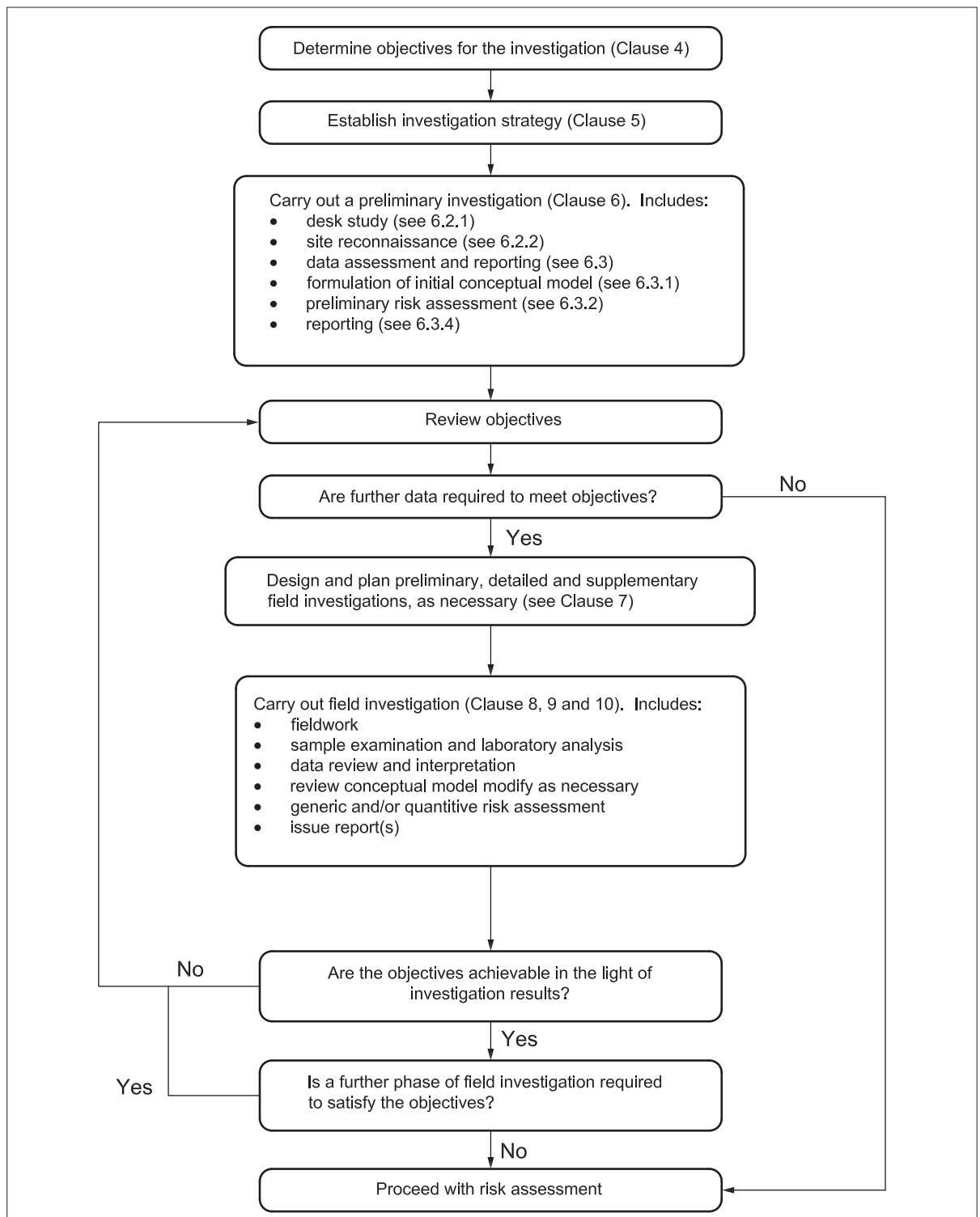
Where unacceptable levels of uncertainty remain after completion of the preliminary investigation ([5.2.7.1](#)) and any risk assessment based on it, the investigation strategy should establish how further information (of an appropriate quality and amount) is to be obtained. The strategy for this further investigation should:

- 1) be based on the conceptual model, the preliminary risk assessment if one has been prepared, the information available and the information that is not available but deemed essential;
- 2) take into account the requirements of the risk assessment and the objectives of the overall investigation, and include intrusive ([8.2.3](#)) and/or non-intrusive ([8.2.2](#)) investigations as necessary.

The further investigation may comprise an exploratory investigation (5.2.7.2) (this could, among other things, provide information that helps to make the strategy for the detailed investigation (5.2.7.3) more cost-effective). However, in some cases, an exploratory investigation may be considered unnecessary, in which case the detailed investigation should then be implemented directly. A further supplementary investigation (5.2.7.4) could later be found to be necessary.

Sufficient time should be allowed between each phase of the overall investigation to enable the information from one phase to **A2** inform **A2** the design of the next.

Figure 2 — Recommended approach to site investigation



5.2.3 Zoning

Where logical and appropriate, the site should be divided into zones and separate strategies developed for each zone. Zoning may be based, for example, on:

- near-surface geology (e.g. made ground or natural ground);
- deeper geology;
- topography;
- probable absence or presence of contamination;
- previous and current land uses;
- nature of probable contaminants (e.g. VOCs or inorganic compounds);
- intended future use.

Separate conceptual models should be developed for each zone. Zoning should be reviewed after each phase (and stage) of the investigation.

5.2.4 Consultation with regulators

Where there is not already a regulatory requirement to do so, subject to the approval of the client, the relevant regulatory authorities should be consulted and involved in the development of the strategy.

NOTE 1 The benefits of involving the relevant regulatory authorities, particularly the local authority and relevant agencies, in the development of the investigation strategy and consulting these organizations in the early part of the investigation cannot be overstated. Early involvement can assist optimization of intrusive investigations and remediation strategy in line with any regulatory requirements. [A1] Annex A in BS 8576:2013 [A1] provides an account of the regulation of land contamination, those responsible for regulation and the officers to be consulted, especially in the context of the planning process.

NOTE 2 Consultation with the regulatory authorities can be extremely helpful when the investigation is being undertaken to support a planning or permit application, or to satisfy a permit or Planning Condition. Such consultation could be a regulatory requirement.

5.2.5 Preparing to investigate

Consideration should be given to the range of actions that need to be taken to enable the investigation to be carried out, including, for example, team building, assigning roles (5.2.6), obtaining permissions and preparation of documentation. These activities are integral components of the investigation but formalizing them into a preparatory stage can help to ensure that everything that needs to be done is done.

NOTE 1 The following lists of activities are not intended to be exhaustive, but as aids to a systematic approach.

The following should be considered in setting the strategy for the investigation.

- a) Whether to set up a formal project team.
- b) What additional expertise is required, either off- or on-site (e.g. ecological specialists).
- c) Whom to consult.
- d) What welfare facilities are to be provided.
- e) Physical access arrangements.
- f) Legal access arrangements, including whether licences or permits are required.
- g) Who should undertake which aspects of the investigation.
- h) How to carry out and, if necessary, procure the investigation in terms of employment of consultants, contractors, sub-contractors, etc.

- i) What interim reports are to be prepared during the investigation (e.g. a sampling report/record, reports of ground gas, monitoring reports as the results are obtained).
- j) What information is to be provided to members of the public.

NOTE 2 Any field activities can attract the attention of neighbours and passers-by. Field operatives have therefore to be prepared to answer reasonable enquiries. Such people can be a source of useful anecdotal information; indeed, they might have worked on the site.

The following should be determined.

- 1) What necessary regulatory permits are required, if any.
- 2) Whether there are any formal requirements (e.g. conditions attached to planning permissions or environmental permits) for consultation and/or permissions from regulators.
- 3) Whether an intrusive investigation requires planning permission (this could be required for large investigations considered by the planning authority to be “engineering works”).

The following should be prepared, as appropriate.

- i) A sampling plan **A2** (see NOTE 3 and BS ISO 18400-101) **A2** (instructions to field staff as to where to sample, what samples to take and what measurements to make).
- ii) Health and safety risk assessments.
- iii) Safety-related documentation, **A2** including method statements **A2**.
- iv) Environmental risk assessments.
- v) Specifications for site investigation and analysis and testing, etc.
- vi) Contract documentation.
- vii) Method statements for particular activities.

*NOTE 3 **A2** BS ISO 18400-101 provides guidance on how to prepare and apply a sampling plan. The sampling plan describes among other things what samples are to be taken, how they are to be taken and from where they are to be taken, in order that the objectives of the investigation programme can be achieved.*

*A checklist to aid preparation of a sampling plan is provided in an annex to BS ISO 18400-101. **A2***

NOTE 4 General guidance on the management of projects on contaminated sites is provided in CIRIA SP111 [33] and on the selection of consultants in CLR 12 [34].

NOTE 5 A guidance paper describing the common areas of tension and disagreement and the compromise arrangements that might be adopted when contaminated land consultants are employed has been published jointly by the Association of Geotechnical and Geoenvironmental Specialists (AGS), the Environmental Industries Commission (EIC) and the Association of Consulting Engineers (ACE) [35]. The AGS has also published a number of client guides on aspects of site investigation. While these refer mainly to geotechnical investigations, they could be useful by analogy to clients commissioning investigations of potentially contaminated sites.

5.2.6 Personnel

5.2.6.1 General

There are various roles that need to be performed by one or a number of persons, including project leader, field manager, field investigator and skilled operatives (e.g. drillers). Tasks to be carried out include direction, planning and execution, supervision in the field, sampling and measurement, formation of exploratory holes and logging of excavations and boreholes, etc. Whoever performs these roles should be appropriately knowledgeable, qualified, trained and experienced. The prescription of the qualifications, etc., required by those performing these roles is outside the scope

of this standard, except for lead drillers, support operative drillers and the operators of excavating plant for whom the corresponding provisions of BS 5930:2015, [A2](#) 6.8, apply [A2](#).

NOTE 1 Reference to BS 5930, and related geotechnical standards (e.g. BS 22475-2:2011) can be useful by analogy regarding the roles to be performed and appropriate levels of qualification, etc.

NOTE 2 Those performing these various roles could work for the client, a consultant or a contractor.

[A1](#) Clause deleted [A1](#)

5.2.7 Scope and application of investigations

5.2.7.1 Preliminary investigation (desk study and site reconnaissance)

The first phase in the overall investigation process should always be a preliminary investigation (see [Clause 6](#)) [A2](#) in accordance with the guidance below.

NOTE 1 It is recommended that the guidance in BS ISO 18400-202 is also used as appropriate. [A2](#).

This should include reference to historical records ([6.2.1.2.1](#)) and other sources of information ([6.2.1.2.2](#)), consultation with relevant sources ([6.2.1.3](#)) and a site reconnaissance ([6.2.2](#)). However, the objectives might not require all the elements recommended in [6.2](#), in which case the strategy should identify what elements of the preliminary investigation are essential and those that do not need to be addressed.

Where elements of a preliminary investigation described in [6.2](#) are not to be included, these should be documented in the report, and any limitations on the final assessment arising from the omissions should be clearly understood by all parties involved and stated in the report.

The strategy should provide for a review of the information obtained at the conclusion of the preliminary investigation to determine if the objectives have been achieved (and are still appropriate) and whether there is a need to carry out an exploratory investigation and/or detailed investigation ([6.3.3](#)).

Consideration should be given to whether the site should be divided into zones (see [5.2.3](#)) if this has not already been done. Separate conceptual models should be developed for each zone that is identified.

The output from the preliminary investigation should include the initial conceptual model ([6.3.1](#)) and a preliminary risk assessment ([6.3.2](#)) based on the information available.

NOTE 2 Preparation of a preliminary risk assessment requires interpretation of the information gathered during the preliminary investigation. Although a preliminary risk assessment will usually be an essential prerequisite for the design of further phases of investigation, guidance on how to do this is outside of the scope of this standard, so reference needs to be made to CLR 11 [\[31\]](#).

NOTE 3 It is likely that there will be different requirements for further investigation of each zone.

NOTE 4 [A1](#) For sites where it is anticipated ground gases might be present and requires an investigation, additional guidance on preliminary investigations is provided in BS 8576. [A1](#)

NOTE 5 [A2](#) Further guidance on preliminary investigations is provided in BS ISO 18400-202 which provides guidance on the design and execution of preliminary investigations comprising desk studies and site reconnaissance, and where appropriate, preliminary risk assessment. It is applicable whenever sampling exercises or investigations are to be carried out to determine soil quality. For example, specific guidance is provided about the possible contamination of agricultural sites and wooded sites. An annex is included tabulating possible contamination/industry linkages.

NOTE 6 BS 5930:2015, Clause 6 provides comprehensive guidance for desk studies and field reconnaissance (the equivalent of the Preliminary Investigation here) for geotechnical ground investigations. Annex B of BS 5930:2015 gives general guidance for desk studies and Annex C of BS 5930:2015 provides information about sources of information. [A2](#)

5.2.7.2 Exploratory investigation

An exploratory investigation is a limited investigation and should be designed to:

- a) reduce uncertainty in knowledge of the site, including determining the accuracy or otherwise of contamination-related and other hypotheses developed in the preliminary investigation, thereby enabling the initial conceptual model to be refined;
- b) provide information that helps the design of any subsequent detailed investigation.

Depending on the objectives of the investigation, and such other considerations as site access, land ownership and project programme, a decision may be taken to not carry out an exploratory investigation, but to proceed directly with a detailed investigation (5.2.7.3).

However, where an exploratory investigation is undertaken, it should comprise non-intrusive and/or intrusive elements as appropriate. The intrusive element should include as appropriate collection and analysis of soil (7.6 and 8.3.2), surface water (7.7.3.6), groundwater (7.7.3 and 8.3.3) and ground gas (7.7.4 and 8.3.4) samples, and the *in situ* monitoring of ground gas, certain groundwater parameters and groundwater levels.

A non-intrusive investigation technique (see 7.6, 8.2.2 and Table 5) can be used, for example, as an aid to locating below-ground structures or other features of the site.

Whether to apply a particular non-intrusive technique before or after some or all of any intrusive works have been carried out should be decided and justified, with the input of any necessary expert advice as appropriate.

Where the conceptual model output from the preliminary investigation identifies the likelihood of localized sources of contamination, and there is inadequate information to confirm the direction of groundwater flow, an appropriate strategy should be developed to investigate contamination at the suspect locations, the water table at several (triangulated) positions and groundwater quality. In this situation, the use of targeted sampling locations is likely to be most appropriate (see 7.7.2.2).

The information obtained from the exploratory investigation should be used to refine the conceptual model and in the design of any subsequent investigation(s).

NOTE 1 An exploratory investigation is not intended to provide sufficient data to permit a site-wide detailed quantitative risk assessment (DQRA). It might, however, provide sufficient data for a DQRA on a small part of the site or on a specific element if the investigation is specifically designed with this intent in mind. It might also be sufficient (depending on the objectives and uncertainty reduction required) to fulfil a regulatory requirement.

NOTE 2 The exploratory investigation could indicate that the contamination pattern is more complex or the concentrations and/or the extent of contamination are greater than anticipated. In such situations it is likely that further investigatory work will be necessary in order to refine the conceptual model and provide adequate robust information for the risk assessment.

5.2.7.3 Detailed investigation

The detailed investigation should comprise, as far as is practical, collection of:

- a) all information necessary to test the accuracy or otherwise of contamination-related and other hypotheses developed in earlier phases of the overall investigation;
- b) all information necessary for the assessment of risks to all potential receptors;
- c) information relevant to the selection, design and costing of remedial works.

NOTE 1 The detail required will depend upon the objectives of the investigation.

NOTE 2 When an exploratory investigation has not been carried out, it could be necessary to test a number of contamination-related and other hypotheses in the detailed investigation as would be done during an exploratory investigation.

The detailed investigation should include the use of non-intrusive investigation methods, as well as intrusive methods, as necessary. Expert advice should be obtained as to whether it is best to apply a particular non-intrusive technique before or after some or all of any intrusive works have been carried out.

The investigation should include, as appropriate, collection and analysis/testing of soil (7.6.2 and 8.3.2), surface water (7.7.3.6), groundwater (7.7.3 and 8.3.3) and ground gas including VOCs (7.7.4 and 8.3.4) samples, and the *in situ* monitoring of ground gas, certain groundwater parameters and groundwater levels.

The design of the investigation should take into account all the information and hypotheses developed in the earlier phases of investigation and the objectives for this phase of the work. Particular attention should be paid to the sufficiency and quality of the data, taking full account of the historical and current use(s), likely heterogeneity and underlying stratigraphy.

NOTE 3 The amount and nature of the information required from the detailed investigation will vary according to the nature of the site and the possible requirements for remedial action. The implications of the decisions on what actions need to be implemented will vary from site to site. The amount and quality of information available will dictate the degree of confidence that can be attributed to the decision making process.

During the subsequent assessment of risks and hazards, all possible migration pathways relevant to the contamination should be considered, and an appreciation in space and time of the contamination established. The possible migration pathways should inform the design of the detailed investigation, since detailed knowledge of physical and chemical soil properties and the local hydrology is essential for reaching defensible conclusions.

The risk assessment should take into account the risks of making incorrect decisions based on the amount and quality of information available.

All parties involved in the decision making process should be fully informed as information is produced, to confirm that the information is sufficient for the purpose intended.

In a detailed investigation, the greater proportion of sampling locations should be non-targeted to aid the reliability of interpretation (see 7.7.2.3) and the use of statistical methods for assessment of the data. However, targeted sampling should also be employed as necessary, for example, to delineate or confirm an area of contamination detected during an exploratory investigation.

The relative density of sampling in each zone should take into account the findings of earlier phases of investigation, including the uncertainty associated with each zone.

5.2.7.4 Supplementary investigations

A review of the outcome of the detailed investigation could identify aspects and areas where an unacceptable level of uncertainty or deficiency of information remains. Where such uncertainties or deficiencies are identified, a supplementary investigation should be carried out. This should be designed to produce specific information. It should use targeted and/or non-targeted sampling as appropriate.

NOTE A supplementary investigation could be required, for example:

- to provide additional information to design and cost remedial works, for example, to delineate volumes of soil requiring remediation, or to carry out specific tests to evaluate the suitability of specific remedial treatment techniques;
- to provide chemical testing information for the classification of wastes;
- to monitor groundwater quality and levels, and/or ground gas conditions, after completion of the detailed investigation to determine any changes in site conditions and to provide additional data to assess risks and aid design of protective measures;

- to monitor groundwater and ground gas conditions during and after construction or remediation to determine whether there have been any adverse changes in site conditions.

5.3 Specific strategies for field investigations

When a field investigation (A2 exploratory, detailed A2 or supplementary) is to be carried out, decisions should be made A2 and recorded (e.g. in an investigation and/or sampling plan – see 5.2.5, NOTE 3) A2 regarding:

- a) the objectives of the investigation;
- b) the form of the investigation [non-intrusive and/or intrusive (see 7.6, 8.2 and Table 5 and Table 6)] necessary to obtain appropriate, suitably robust and defensible data in accordance with the objectives;
- c) the purposes for which samples are required (e.g. for chemical analysis or other tests);
- d) the locations from which samples are to be collected and the number of locations required (see sampling strategy in 7.7);
- e) the number and type of samples to be collected (i.e. soil, water, gas) from each location, the depths at which they are to be collected (see 7.7.2.5), whether replicate samples are to be taken [for example, to allow assessment and reporting of sampling uncertainty (see Annex D)], and any monitoring requirements (see sampling strategy in 7.7);
- f) the techniques to be used to collect the samples (see Figure 2, A2 Table 6, BS ISO 18400-102:2017, Table 3 and BS ISO 18400-102:2017, Table 4 A2, 8.3.2, 8.3.3 and 8.3.4), taking into account: the soil types, groundwater conditions, topography, services and access (e.g. soft landscape, tarmac, presence of buildings, etc), the quality of reinstatement necessary, the depths at which samples are to be collected (7.7.2.5), whether a ground gas investigation is included (7.7.4), whether water samples are to be collected (7.7.3), and the monitoring installations required (7.7.3 and 7.7.4);

NOTE 1 The selection of the sampling technique may involve some compromise, for example due to access, headroom, underground services or other constraint. If samples are only required from 2 m to 3 m below ground level (bgl) and the location of buried services is known with sufficient certainty, trial pits might be regarded as the most appropriate technique. However, where there is over-site concrete which is still in use and a good standard of reinstatement is necessary in order, for example, to minimize disruption of the site and allow satisfactory reinstatement, coring through the concrete followed, for example, by use of a dynamic sampling tool could be the more appropriate approach (A2 See Table 6, BS ISO 18400-102:2017, Table 3 and BS ISO 18400-102:2017, Table 4 A2).

- g) how samples are to be taken to avoid or minimize cross-contamination (8.2.3.3);
- h) what provisions are to be made for cleaning field equipment between sampling points (8.2.3.3);
- i) quality assurance procedures to provide an auditable process to enable confirmation that sampling has been carried out in a satisfactory manner (7.9);
- j) the analyses and tests to be carried out on each sample, and whether these are to be carried out in a laboratory or in the field (see 7.7, 8.4, 9.4 and 9.6), and the analytical and testing strategy.

NOTE 2 Whilst decisions about the type of analyses and testing can usually be made during formulation of the investigation strategy, final decisions about what samples to analyze or test are often deferred until the samples have been obtained. This permits field observations to be taken into account.

- k) selection of an accredited laboratory (e.g. UKAS) which can perform tests to an accredited standard (e.g. MCERTS [36]), accommodate the workload (see Clause 9) and confirm that the analytical methods chosen are appropriate for the planned risk assessment process;

- l) how samples are to be handled, stored, preserved and transported to the laboratory so as to minimize alteration prior to analysis or testing (8.6);
- m) the process for dispatch of samples to the laboratory, issue of instructions to the laboratory and the date by which the results are required;
- n) requirements for field instrumentation (8.4).

Decisions should also be made about the programme for the fieldworks and the logistics of the site investigation, including the availability of relevant machinery and personnel, permission for site access, liaison with regulatory authorities, completion of health and safety and environmental risk assessments and compliance as appropriate with the CDM [18] and other regulations.

6 Preliminary investigation

6.1 General

A preliminary investigation should always be carried out before any systematic sampling or analysis is specified or undertaken (see 5.3).

The preliminary investigation should obtain information in order to:

- a) assess the likelihood of contamination, its nature and its extent;
- b) evaluate the environmental setting of the site and identify sensitive receptors;
- c) provide information from which likely source-pathway-receptor relationships can be identified, and which can then be used to formulate a conceptual model to enable the design of a field investigation (if required);
- d) determine the requirements for further investigation, if any;
- e) identify any special procedures and precautions that will be necessary during subsequent sampling and examination of the site.

A preliminary investigation should be a two-step process involving data collection followed by interpretation and reporting (see Table 2).

The specific scope of each step of the preliminary investigation should vary according to the overall purpose of the investigation and objectives, the availability of existing information, the size and complexity of the site, known or projected future land uses and other relevant site-specific factors.

NOTE 1 A1 Additional guidance on preliminary investigations for sites where it is anticipated ground gases might be present is provided in BS 8576. A1

NOTE 2 A2 Further guidance on preliminary investigations is provided in BS ISO 18400-202 which provides guidance on the design and execution of preliminary investigations comprising desk studies and site reconnaissance, and where appropriate, preliminary risk assessment. It is applicable whenever sampling exercises or investigations are to be carried out to determine soil quality. For example, specific guidance is provided about the possible contamination of agricultural sites and wooded sites. An annex is included tabulating possible contamination/industry linkages. A2

Table 2 — *Scope of a preliminary investigation*

Step	Activity
Data collection	Desk study Documentary research (see 6.2.1.2): • site history; • site setting (location, surroundings, topography); • site usage (including adjacent areas); • site geology, hydrogeology, geochemistry, hydrology; • site ecology and archaeology; • future plans for the site. Consultations (see 6.2.1.3 and Table 3) Site reconnaissance (see 6.2.2): • detailed inspection; • interviews; • limited ad hoc sampling and field measurements (if appropriate).
Interpretation and reporting	Formulate initial conceptual model (see 6.3.1). Assess need for, and scope of, further investigation. Preliminary risk assessment (see 6.3.2) (outside the scope of this British Standard). Prepare preliminary investigation report (see 10.2).

6.2 Data collection

6.2.1 Desk study

6.2.1.1 General

The desk study should comprise a combination of documentary research (see [6.2.1.2](#)) and consultations (see [6.2.1.3](#)).

The desk study should include the following topics, amongst others.

- The history of the site and adjoining areas, with particular attention to the nature of any industrial processes and other activities that could have been potentially contaminative or could have modified the ground structure to create potential migration pathways.
- Review of any previous desk study or investigation of the site.
- The geological, geochemical, hydrogeological, hydrological, topographical, archaeological and ecological setting of the site.
- Potential receptors of contamination (for example, trespassers, current and intended users, construction workers, surface waters, groundwaters or nearby water abstractions, ecological receptors, property).
- The proximity of waste disposal sites or other sources of contamination that could have an impact on the site.
- The existence of naturally occurring harmful materials, such as radon, or naturally elevated concentrations of $[A_2]$ potentially $\langle A_2 \rangle$ harmful substances.
- The presence of any mining activities.
- Any constraints on an intrusive site investigation (access or height limitations, underground and overhead services or obstructions, noise, working hours, etc.).

- i) The potential for the site to contain or have been affected by UXO (see CIRIA C681: *Unexploded ordnance (UXO): A guide for the construction industry* [37]).
- j) Review of developers' designs and plans where the site is to have a change of use, with details recorded of the future use/characteristics of the site.
- k) Any foreseeable events or changes (e.g. flooding, rising groundwater, change of use of neighbouring sites) that could have an impact on the assessment.

6.2.1.2 Documentary research

6.2.1.2.1 Site location and historical setting

The site location and site boundaries should be accurately established before any investigatory work is commenced.

The site history should be determined using the following and any other appropriate sources of information.

- a) Ordnance Survey (OS) maps.
- b) Other published maps, for example, insurance, tithe, enclosure or parish maps.
- c) Aerial photographs.
- d) Documentary records, particularly any previous desk study or investigation reports held by the current (and former) owners of the land, trade directories, the local authority planning records and local libraries.

The level of historical research undertaken should be compatible with the objectives of the investigation. The extent of research into the history of the site will depend upon a number of factors including the complexity of past potentially contaminative uses on and adjacent to the site, the vulnerability of the site geology and local water environment, and the degree of confidence required by the client. The methods and extent of research should be agreed with the client in advance and modified as necessary according to the findings of the preliminary investigation.

A2 Where the presence of tunnels or underground structures is a possibility, they should be taken into account. It should not be assumed that they are all shown on Ordnance Survey mapping. Information from transport and services/utility infrastructure owners should be requested as needed. **A2**

NOTE 1 Table 3 gives a list of the types of information held by national and regulatory bodies. See also 6.2.1.3 for other organizations to be contacted and the type of information to be discussed.

*NOTE 2 Reports can be purchased from a number of private companies which provide a collation of publicly available information relevant to characterizing a site's history, geology, hydrogeology and environmental setting and identifying the locations of potentially contaminative land uses, pollution incidents and other features of relevance to a preliminary investigation. **A2** Text deleted **A2***

*NOTE 3 Geological maps, datasets and logs of borehole and wells can be purchased from the British Geological Survey **A2** (BGS) and be viewed and ordered online at www.bgs.ac.uk. A detailed description of the information available from BGS is provided in BS 5930:2015, Annex C **A2**.*

*NOTE 4 Old OS map editions do not represent a complete record of historical land use, but can assist understanding of historical land use. **A2** There may be several years between survey date and the publication of OS maps. In addition, because of the sometimes large time intervals between surveys, activities can occur in an area (e.g. formation and filling of a pit) without being recorded on an OS map. **A2***

NOTE 5 Other base maps that can be considered alongside OS maps are UKMap (<http://www.geoinformationgroup.co.uk/products/mapping>) and Russian Maps, (<http://www.russianmaps.co.uk/>) which have the benefit of focusing on military establishments.

NOTE 6 Both historical and current aerial photography have to be considered, together with suitable metadata detailing the date when the imagery was taken. English Heritage hold the National Library of Aerial Photographs for England at the National Monuments Record in Swindon. Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) hold the National Collection of Aerial Photography for Scotland in Edinburgh. Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW) hold the National collection for Wales in Aberystwyth. Aerial photographs for Northern Ireland are held by the Northern Ireland Environment Agency Built Environment.

NOTE 7 ^{A2} Available soil and hydrogeological maps are listed and described in BS 5930:2015, C.3.

NOTE 8 PAS 128 provides guidance on the detection, verification and location of active, abandoned, redundant or unknown underground utilities and the location of their associated surface features (e.g. manhole covers and utility markers). It applies regardless of where these utilities are located (e.g. in urban or rural areas, in the street, or on private sites such as hospitals or airfields). It applies to utilities buried no deeper than three metres.

Where ground investigation, borehole, trial pit works and other construction works are proposed, a current utility mapping survey conforming to PAS 128 can be used as an indicator of the presence or absence of underground utilities before conducting further ground investigation prior to breaking ground. ^{A2}

Table 3 — Types of information available from ^{A2} national and regulatory organizations ^{A2}

^{A2} Organization ^{A2}	Information
Environment Agency (EA), Northern Ireland Environment Agency (NIEA)	Information held on groundwater and surface water quality; aquifer designation and groundwater vulnerability maps; information on pollution incidents; environmental permitting authorizations; current groundwater abstraction licences; operational and closed landfill and waste treatment sites, Special Sites. NIEA also maintains the Northern Ireland Sites and Monuments Record (NISMR), a national record of historical and archaeological sites.
^{A2} Natural Resources Wales (NRW) ^{A2}	^{A2} NRW catalogue on the Lle Geo-Portal includes data sets for Environmental Permitting Regulations for both waste and industrial sites, environmental pollution incidents, historic landfill sites, protected sites, historic river quality objectives and Source Protection Zones in Wales. Flood maps available on the NRW website. Aquifer designation data available only upon written request. NRW do not hold a contaminated land dataset. ^{A2}
Scottish Environment Protection Agency (SEPA)	Information held on regulatory history (spill/accidents); PPC and IPC authorizations; waste management licenses or exemptions; registrations or licenses issued under the Controlled Activities Regulations [38] (groundwater abstractions and authorized discharges); action taken under the Environmental Liabilities Regulations 2009 [39]; surface water quality and monitoring data; groundwater quality and hydrogeological conditions; protected areas (drinking water protected areas, nitrate sensitive areas, bathing waters, areas designated to protect economically significant species, or for the protection of habitats or species); flood risk information; records of SEPA inspections under Radioactive Contaminated Land (Scotland) Regulations [8].

Table 3 (continued)

A2 Organization A2	Information
Local authorities	Contaminated Land Inspection Strategy for their area, identifying potentially contaminated sites (required by Part 2A, EPA [1]). Public register of statutory “contaminated land” in their area. Information on remediation of land affected by contamination. Historical experience of environmental nuisances. Historical planning records describing former land use, including conditions of any relevant planning consents. Closed landfill sites and private water abstractions. (Old) layouts shown in drawings attached to (old) planning applications. Building control records, including former layout of sites and actual or planned locations of underground and above-ground storage tanks. Details of sites with Environmental Permits.
Health and Safety Executive (HSE) and fire authorities	Records of accidents and incidents, fuel storage.
Petroleum Officer (normally located within the local authority or Fire Service)	Location and status of petroleum storage tanks. <i>NOTE Information is usually only available with the permission of the site owner.</i>
Coal Authority	Mining records, coal, brine extraction hazards.
A2 Public Health England (PHE) A2	A2 Reports containing Radon Affected Area maps for the United Kingdom. An interactive map and address-specific reports available via the PHE website. A2
English Heritage	Historical aerial photographs held at the National Monuments Record. National Monuments Record also maintains a national record of archaeological and historical sites in England.
Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS)	Historical aerial photographs for Scotland. Maintains a national record of historical and archaeological sites for Scotland.
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)	Maintains a national record of historical and archaeological sites for Wales.

6.2.1.2.2 Site usage

Details of the past and current usage of the site and its immediate environs, together with information on any incidents (such as spills or detected leakages), should be collated and used in the development of the initial conceptual model. Any available plans of the previous or current layout of different usages on the site should be inspected, as well as any plans of site drainage or underground services.

NOTE 1 Recent aerial views, and sometimes street-level views of the site, can be obtained on internet map sites. These can help establish the context of the site and recent condition. However, the date of the imagery might not be stated and the current condition of the site could be very different to that shown online.

*NOTE 2 **A2** Examples of some land uses that can give rise to contamination are listed in BS ISO 18400-202.*

NOTE 3 An agricultural site or a wooded site might be a potentially contaminated site, not only because of activities associated with their current use, but because they were developed in the past for example on old refuse disposal sites (landfills) or mining waste. A_2

Research should be conducted to determine whether any of the following common causes of contamination could have occurred:

- a) spills or leaks of potentially harmful liquids from tanks, pipes and drains on the surface or underground;
- b) deposition or burial of industrial, agricultural or domestic waste or temporary stockpiling of leachable materials (for example, road salt);
- c) demolition of industrial structures and dispersal or burial of contaminated rubble and other materials;
- d) importation of potentially contaminated fill material onto the land.

In addition, it should be determined whether UXO is likely to be present.

6.2.1.2.3 Geology, geochemistry, hydrology and hydrogeology

All available sources of information on the geological, geochemical, hydrological and hydrogeological conditions of the site should be collected and examined.

COMMENTARY ON 6.2.1.2.3

The following sources can be consulted, though this is not an exhaustive list of the available resources.

- *British Geological Survey (BGS) for radon, geological, geochemical and hydrogeological maps for England and Wales, for groundwater vulnerability maps for Scotland, and for borehole and well records*¹.
- *Environment Agency A_2 and Natural Resources Wales A_2 for aquifer designation maps, for earlier groundwater vulnerability maps*² *and information on source protection zones for England and Wales and SEPA.*
- *English Heritage (for aerial photographs).*
- *The results of any previous ground investigations carried out on, or in the vicinity of, the site, or information from national surveys covering the vicinity.*

*BS 5930 gives a comprehensive list of geological information sources. The supplement published in the Quarterly Journal of Engineering Geology [40] also contains useful information*¹.

BGS and Environment Agency A_2 and Natural Resources Wales A_2 mapping and the locations of previous site investigation and well logs deposited with the BGS are sometimes included in reports collating publically available information for preliminary investigations which can be purchased from private companies.

In Scotland, groundwater vulnerability maps are available from the BGS and outline vulnerability information is also available on SEPA's website. There are no formal source protection zones in Scotland.

Information on drinking water protected areas and groundwater resource potential can be obtained on SEPA's website.

¹ More information can be obtained from British Geological Survey, Keyworth, Nottingham NG 12 5GG. Tel 01 15 936 3143. <http://www.bgs.ac.uk>

² More information can be obtained from the local Environment Agency office. <http://www.environment-agency.gov.uk>

6.2.1.2.4 Ecology and archaeology

The preliminary investigation should determine whether the site (or its immediate environs) has been designated as an area of ecological or archaeological significance.

NOTE 1 If it has been so designated, it is likely that there will be constraints on the methods of ground investigation that can be used. It is also likely that ecological and/or archaeological surveys and desk studies will need to be undertaken before any contamination-related field investigations.

NOTE 2 ^{A2} Historic England has published guidance about the interactions between archaeology and land contamination including during investigation and assessment, and design and implementation of remedial measures [114]. ^{A2}

The preliminary investigation should also determine whether there are species (e.g. bats, nesting birds and water voles) or habitats of importance subject to legal protection (e.g. Wildlife and Countryside Act [13] or Habitat Regulations [14]).

NOTE 3 The presence of these species or habitats could restrict the timing or method of investigation.

The presence of invasive plant species, such as Japanese Knotweed and Giant Hogweed, should also be determined. Subsequent ground investigations should be designed to avoid any spread of these species.

NOTE 4 The presence of Japanese Knotweed can add to waste disposal and other remediation costs.

NOTE 5 Examples of the organizations to be contacted to determine if there are any ecological or archaeological designations are listed in 6.2.1.3.

6.2.1.3 Consultations

Relevant parties should be consulted, normally in parallel with the documentary research. Client approval should be obtained before entering consultations with third parties and regulators, in case of confidentiality issues, though this could be required by a Planning Condition.

Interviews with persons possessing knowledge of activities on, or adjacent to, the site may be combined with the site reconnaissance visit (6.2.2) to obtain further information on, or enhance knowledge of, suspect locations or features, underground services, etc. Anecdotal evidence should be viewed with caution.

Consultations with the local authority's contaminated land officer (CLO) and, when applicable, the Environment Agency ^{A2} (England), Natural Resources Wales or SEPA (Scotland) as appropriate should cover methods of ground investigation ^{A2}. It is vital that potential risks to controlled waters, caused by the creation of migration routes during boring or trial pitting, are avoided.

If investigations are likely to be undertaken on (or accessed via) ecologically sensitive sites or agricultural land, organizations such as Natural England, ^{A2} Natural Resources Wales ^{A2}, Scottish Natural Heritage or the Council for Nature Conservation or the Countryside Office should be consulted about methods of work. Alternatively, the Joint Nature Conservation Committee, which holds information for the whole of the UK, may be contacted for Sites of Special Scientific Interest and European Sites³.

NOTE 1 ^{A2} The MAGIC website (<http://www.natureonthemap.naturalengland.org.uk>) provides geographic information about the natural environment from across government. The information covers rural, urban, coastal and marine environments across Great Britain. It is presented in an interactive map which can be explored using various mapping tools that are included. MAGIC provides links to other sources of data in order to make best use of a wide range of information available on other websites. Natural England manages the service under the direction of a Steering Group who represent the MAGIC partnership organizations.

³ More information can be obtained from Natural England, Website <http://www.naturalengland.org.uk>; Scottish Natural Heritage, Website <http://www.snh.org.uk> or email enquiries@snh.gov.uk; ^{A2} <https://naturalresources.wales/> ^{A2}; Council for Nature Conservation and the Countryside (Northern Ireland), Website <http://www.cncni.gov.uk/>; Joint Nature Conservation Committee, Website <http://www.jncc.gov.uk/>; Tel: 01733 562 626; Association of Local Government Archaeological Officers UK (ALGOA), Website <http://www.algoa.org.uk/>.

The MAGIC partners are:

- [Department for Environment, Food and Rural Affairs](#)
- [Historic England](#)
- [Natural England](#)
- [Environment Agency](#)
- [Forestry Commission](#)
- [Marine Management Organisation](#) 

The local authority development plan should be consulted to determine whether the site is of national or international importance, as designated by Natural England,  Natural Resources Wales , Council for Nature Conservation and the Countryside and Scottish Natural Heritage, respectively, or of county or local importance.

If investigations are likely to be undertaken on (or accessed via) archaeologically sensitive sites, the archaeological adviser to the local authority should be consulted about the proposed programme and methods of work. In England and Wales it is usually the County Archaeological Adviser who should be contacted, although in London English Heritage advises the local authorities for all boroughs, except Southwark and the City of London.

NOTE 2 A full list of advisers for the United Kingdom is available from the Association of Local Government Archaeological Officers (ALGAO) website (<http://www.algao.org.uk/>).

6.2.2 Site reconnaissance

A reconnaissance of the site, neighbouring land and the local area should be made, ideally after carrying out documentary research (see also [6.2.1.2](#)). Arrangements for the reconnaissance visit, including access, should be agreed with the client and the site owner and/or occupier, as appropriate, before being undertaken. The visit should be made by a suitably qualified, trained and experienced person.

The principal objectives of the visit should be to:

- a) verify information on the site collated during the desk study;
- b) collect additional information about the site, its environs and any potential contaminants, pathways and receptors;
- c) record observations of aspects of the site and its environs not revealed by the desk study, including the presence of invasive plant species;
- d) collect information that will assist in the planning of any subsequent phases of field investigation (for example any constraints to access).

The topography of the site should be observed and compared to levels anticipated by the desk study. Raised ground and artificial slopes could be indicative of made ground imported onto the site.

A strategy for the visit should be decided in advance and suitable plans, checklists and reference documentation prepared.

A health and safety risk assessment should also be carried out for the visit. This assessment should be based on the results of the desk study, but may be refined once the preliminary investigation is completed. The assessment should be kept under review as the investigation proceeds, but where there is any doubt as to the presence or degree of contamination then protective equipment should be used. Personnel undertaking the visit should be briefed on any hazards that could be encountered and any precautions to be taken.

If buildings still remain in which potentially contaminating processes could have taken place, the past and present usage should be reviewed and the buildings inspected for evidence of actual and potential contamination.

A request should be made for personnel visiting the site to be accompanied by someone familiar with the site, such as a plant manager or safety officer in the case of an industrial site.

During the site visit photographs of salient features should be taken, where permissible.

If during the site reconnaissance anything is seen that is considered likely to pose an immediate threat to human health and safety or the environment, this should be reported immediately to whoever is in control of the site so that any essential urgent action can be taken.

NOTE 1 Sampling is not normally undertaken during a site reconnaissance. However, it might be appropriate to do so where materials are identified during the visit that could potentially present an immediate hazard to vulnerable receptors. This ought only to be undertaken if it can be done safely using appropriate containers and protective equipment. If not, an urgent exploratory investigation could be planned where the objective is to determine whether an immediate risk is present from the identified site materials.

NOTE 2 There might be a duty under the Health and Safety at Work Act [22] and/or professional Code of Conduct to do this.

NOTE 3 Additional, detailed guidance on carrying out preliminary field inspections of land potentially affected by contamination is given in:

- a) CLR 2, published by Defra/Environment Agency [41];
- b) SP103, published by CIRIA [42].

NOTE 4 Detailed guidance on the field inspection of buildings prior to decommissioning or demolition is provided in SP102, published by CIRIA [43].

6.3 Data assessment and reporting

6.3.1 Formulating the initial conceptual model

The information from the desk study, site reconnaissance visit and consultations should be collated and evaluated to formulate an initial conceptual model of the site.

The initial conceptual model should identify, as far as possible:

- a) potential types, depths and extent of soil, groundwater and ground gas contamination present in different zones of the site;
- b) the likely vertical and horizontal stratification of natural and man-made layers beneath the site;
- c) strata variability (occurrence and thickness) in different areas of the site and their relative permeability, both vertically and horizontally;
- d) potential migration routes (including airborne dispersion);
- e) the presence of physical features such as service trenches, drainage runs, soakaways, underground storage tanks, power lines and former foundations that could influence the occurrence or migration of contamination or provide a constraint to investigation;
- f) the occurrence of any biological, chemical or physical processes that could affect contaminant concentrations and migration (including natural attenuation);
- g) the characteristics of groundwater bodies beneath the site, including groundwater levels and flow directions;
- h) the presence of surface water bodies on, or adjacent to, the site;
- i) presence and planned (or potential) presence of human receptors;

- j) presence of other actual or potential receptors;
- k) presence of controlled waters;
- l) any foreseeable event, for example rising groundwater, variable sea water levels or nearby construction, that might affect a) to k).

The initial conceptual model may also include hypotheses about the presence of made ground, underground obstructions, buried river channels, the expected directions of groundwater flow, number of aquifers and details of groundwater recharge, permeability of the ground, the physical and chemical properties of the expected contaminants, their possible degradation products, the location and form of the contaminant source, duration, etc.

When further investigations are carried out the additional information should then be used to refine the conceptual model.

Where there are data gaps or uncertainty in the initial conceptual model, these should be highlighted.

NOTE  *ISO 18400-203 suggests that formal contamination-related hypotheses about the nature and distribution of possible contamination are formulated that can then be tested in subsequent exploratory and detailed investigations. Other aspects of the conceptual model can also be presented as formal hypotheses that can be tested.* 

COMMENTARY ON 6.3.1

Guidance on formulating an initial conceptual model is outside the scope of this standard. ASTM E1689-95 [44] and National Groundwater and Contaminated Land Centre report NC/99/38/2 [45] give guidance on formulating a conceptual model.

6.3.2 Preliminary risk assessment

A preliminary risk assessment should be undertaken once the initial conceptual model has been formulated and the source-pathway- receptor linkages identified. Where adequate site investigation information has been obtained during the preliminary investigation, a qualitative, or generic-quantitative, risk assessment can be undertaken. Information from previous investigative works should be either verified or used with caution.

However, where little or no previous investigation has been undertaken, only a qualitative assessment can be made. The effects of uncertainties in the information available on the outcome of a risk assessment should be identified and recorded.

COMMENTARY ON 6.3.2

Guidance on carrying out a formal risk assessment is outside the scope of this standard. Risk assessment covers: a) identification of contaminants, pathways and receptors; b) estimation of the likelihood, nature and extent of exposure to a hazard, and the risk of adverse effects; c) assessment of the likely pollutant linkages and the degree of risk; and d) evaluation of the need for controlling the identified risk. Site investigation provides baseline information for stage a) of the process. CLR 11 [31] provides guidance on risk assessment.

6.3.3 Further investigations

The findings of the preliminary investigation should form the basis upon which the requirement for, scopes of and phasing of subsequent exploratory or detailed investigations are decided.

The risk assessment and the objectives of the investigation should be reviewed and the need for further investigation considered (see [Figure 1](#)), based upon the quantity and quality of previous site investigation information available, the level of confidence required from the actual characterization of ground conditions and hazards and the results of the risk assessment.

6.3.4 Reporting

The preliminary investigation should be completed by the issue of a report. Subject to the specific brief for the investigation, the report should include the factual results of the desk study, site reconnaissance and consultations, together with the conclusions drawn (including presentation of the conceptual model), and recommendations for further research and/or ground investigation.

NOTE For further guidance on reporting, see [Clause 10](#).

7 Design and planning of field investigations

7.1 General

One, two or three phases of field investigation (exploratory, detailed and supplementary) could be necessary to meet the investigation objectives (see [Clause 4](#) and [Table 1](#)) and implement the strategy (see [Clause 5](#)). Generally the field investigations should be designed to provide further information for revisions and updates of the conceptual model and risk assessment and/or the design of remedial works.

Field investigation should be designed to:

- achieve the stated objectives, including the reduction of uncertainty (see [7.7.1](#));
- determine the presence or absence of contamination and, if present, determine the concentrations and distribution of contaminants, in accordance with the objectives of the investigation and based on the conceptual model;
- examine ground, [A2](#) ground gas [A2](#) and groundwater conditions, including hydraulic gradient, soil permeability, porosity, density, moisture, particle size, etc. (see [G.6](#)), which can influence movement of contaminants;
- characterize any actual and potential pathways in terms of migration and possible attenuation;
- where contamination is known to be present, collect additional data for the delineation of the contamination and the design of remediation plans;
- where necessary, gather specialized information on receptors' characteristics and behaviour;
- confirm the extent of contamination in areas where it is suspected and to confirm the presence or absence of contamination in the remainder of the site.

The analytical suite of contaminants identified for analysis (see [9.4](#)) should be based on the conceptual model and include contaminants linked to the historical activities on the site.

Migration of contamination originating on-site to off-site receptors and migration of contamination from off-site sources onto the site being investigated are important considerations. In situations where the preliminary investigation has identified potentially sensitive receptors or sources of contamination located outside the site, the fieldwork should include investigation at, or beyond, the site boundary. In practice, however, off-site access can be restricted due to land ownership issues. Permission for access to such adjacent areas should be obtained.

The permission of the site owner should be obtained, preferably in writing, prior to the commencement of the field investigation.

NOTE 1 Permits to dig could be required at a site before works can commence. These might be required from the landowner, the tenant, the manager and/or archaeologists.

Where relevant to the objective of the investigation and findings of the risk assessment, field investigation proposals should be discussed with the Environment Agency [A2](#) or NRW as appropriate [A2](#) and the relevant local authority in order to incorporate any specific measures they

require and ensure that the outcome of the investigation will satisfy regulatory requirements (see [6.2.1.3](#)). In Scotland discussions with SEPA might be appropriate where pollution of the water environment is being considered or where the site is a potential Special Site under Part IIA.

NOTE 2 Since the development of the conceptual model is an iterative process, each investigation phase will reflect different stages of the process, with different associated uncertainties in the quality of information. For example, in the exploratory investigation information confirming the presence of a potential contaminant might be sufficient, whilst in the detailed investigation quantitative data will always be required together with more accurate delineation of the area affected and confirmation of migration pathways. In the supplementary investigation additional information is gathered, for example, to enable further detailed delineation of contamination, to provide further information to aid development of a remediation strategy, or to aid application of a remediation method.

7.2 Integrated field investigations

The degree of integration of contaminated land field investigations with other studies (such as geotechnical or archaeological investigations) should be based upon the findings of the preliminary investigation.

A2 Detailed guidance, which should be followed as appropriate, on the design and conduct of integrated investigations is provided in BS 5930:2015, **17.8** and Annex G. **A2**

Any integrated field investigation should be designed so that it does not compromise the requirements of either investigation. For example, sampling locations for contamination should not be moved from a selected grid pattern (see [7.7.2](#)) in order to accommodate geotechnical requirements.

COMMENTARY ON 7.2

Integrated contamination and geotechnical investigations have the following advantages (which result in lower costs compared to undertaking separate field investigations):

- a) *simplified project management;*
- b) *common use of equipment and procedures;*
- c) *exploratory holes can be used for more than one purpose;*
- d) *joint health and safety procedures can be established;*
- e) *joint environmental protection procedures can be established;*
- f) *integrated consideration of resultant data.*

Linking the field investigation with other types of studies can also be appropriate in some circumstances. In particular, the ecological survey of a site and surrounding area could indicate contamination on the basis of observed impacts on flora. Archaeological and contamination investigations can share information from geophysical survey work (see [8.2.2](#)).

7.3 Site safety and environmental protection

A2 7.3.1 General

The guidance provided in BS ISO 18400-103 and BS 5930 should be followed as appropriate.

NOTE 1 [Annex C](#) provides some general guidance together with some detailed guidance on a limited number of particular aspects and hazards, some of which are not dealt with in BS ISO 18400-103.

NOTE 2 BS ISO 18400-103 provides guidance on:

- identification of hazards that could be encountered during a site investigation and when collecting samples of soil and other ground material, including hazards that are intrinsic in the sampling operation (e.g. physical hazards) in addition to the hazards that might arise, e.g. from contamination with chemicals or biological agents;

- measures to be adopted to control risks once an appropriate risk assessment has been carried out.

Topics covered include risk assessment, risk management, safety policies, planning and managing for safety, personnel, personnel protective equipment, safety precautions in relation to particular hazards, and safety procedures in relation to particular activities.

NOTE 3 The Association of Geotechnical and Geoenvironmental Specialists (AGS) produces a range of health and safety guidance notes that are available for download at www.ags.org.uk.

The British Drilling Association has also produced a number of health and safety guidance documents (see www.britishdrillingassociation.co.uk).

NOTE 4 Guidance on environmental protection during field investigations is provided in [8.2.3.2](#) and BS ISO 18400-102.

7.3.2 Asbestos

NOTE 1 All work activities that could potentially disturb asbestos on or in the ground fall under the strict requirements of the Control of Asbestos Regulations 2012 [[118](#)] (CAR2012), as well as accompanying HSE Approved Code of Practice L143 [[119](#)]. In 2016, CL:AIRE published guidance on the interpretation of CAR2012 and L143 for all work activities that might disturb asbestos in the ground [[120](#)].

It is now generally held that potentially up to 80%–90% of brownfield sites might be contaminated to a degree by asbestos. Such materials can be present in soil, especially made ground, because of deliberate dumping of wastes, dispersion during demolition and repair works and as a contaminant of imported recycled fill materials.

The presence of loose asbestos fibres and/or asbestos-containing materials (e.g. asbestos insulation or fragments of insulating board, asbestos cement sheeting, etc.) in the ground can present risks to health and requires particular care in the selection of appropriate sampling techniques and design of sampling procedures.

Regard should be paid during any disturbance of the ground to the possible presence of asbestos and asbestos-containing materials.

The potential presence of asbestos should be considered during the preliminary risk assessment at all sites unless adequate justification for not doing so can be documented [[111](#)].

Contingency plans should always be in place so that investigation personnel know how safely to proceed if asbestos is unexpectedly encountered in the ground [[106](#)].

NOTE 2 In practice, most ground investigation activities where asbestos is likely to be, or is proven to be present, is likely to be Non-Licensable Work with asbestos which requires a certain level of competency to ensure employee safety.

Asbestos awareness training alone is not sufficient to allow employees to safely carry out work in asbestos-contaminated ground.

When engaging on ground investigation activities that potentially could or are likely to disturb asbestos, employees should have additional adequate information, instruction and training to be safe.

NOTE 3 Attention is drawn to Regulation 10 CAR2012 [[118](#)], which includes requirements on training, and Reference [[120](#)].

NOTE 4 The risk to health from asbestos arises from inhalation of fibres which might become airborne when the soil or other material in which it is present is disturbed. The magnitude of the risk depends on the probability that this happens. This depends on such factors as whether the fibres are bound firmly in a matrix, the activity that causes disturbance of the soil (e.g. excavation, construction works, gardening), the nature and condition of the soil (e.g. is it wet?), and weather conditions (e.g. is it windy?). Provided that the soil is not disturbed then whilst there might be a significant hazard present, the actual risks might be insignificant. The main considerations then become whether there might be disturbance in the future and whether this can be guarded against.

NOTE 5 There has been considerable effort in recent years by industry in conjunction with the HSE to produce guidance on how to assess and deal with asbestos in the ground. See for example references [[106](#)] and [[111](#)] to [[113](#)] and [[120](#)].