

Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV)

dated 12 July 1999

On the basis of Article 6, Article 8 (1) and (2) and Article 13 (1) second sentence of the Federal Soil Protection Act of 17 March 1998 (Federal Law Gazette I p. 502), the Federal Government, after hearing the parties concerned, decrees the following:

Table of Contents

Part One

General provisions

- Article 1 Scope of application
- Article 2 Definitions

Part Two

Requirements concerning the investigation and evaluation of suspected sites and sites suspected of being contaminated

- Article 3 Investigation
- Article 4 Evaluation

Part Three

Requirements concerning the remediation of adverse soil alterations and contaminated sites

- Article 5 Remediation measures, protective and restrictive measures

Part Four

Supplementary provisions for contaminated sites

- Article 6 Investigation and planning for remediation

**Part Five
Exceptions**

Article 7 Exceptions

**Part Six
Supplementary provisions for preventing the risk of adverse soil alterations
resulting from soil erosion by water**

Article 8 Preventing the risk of adverse soil alterations resulting from soil erosion by
water

**Part Seven
Precautions against the formation of adverse soil alterations**

Article 9 Concern about adverse soil alterations
Article 10 Precaution requirements
Article 11 Permissible additional pollution load
Article 12 Requirements concerning the application and introduction of materials onto
or into the soil

**Part Eight
Final Provisions**

Article 13 Accessibility of technical regulations and standard specifications
Article 14 Entry into force

**Annex 1
Requirements concerning sampling, methods of analysis and
quality assurance during the investigation**

1. Scope of the investigation and required level of knowledge
 - 1.1 Exploratory investigation
 - 1.2 Detailed investigation
2. Sampling
 - 2.1 Planning the sampling for soil investigations - determination of sampling points
and sampling depths
 - 2.1.1 Soil - human health pathway

- 2.1.2 Soil - plant pathway
- 2.1.3 Soil – groundwater pathway
- 2.2 Planning the sampling of soil gas
- 2.3 Planning the sampling of scraped and excavated soil material
- 2.4 Taking of samples
 - 2.4.1 Soils, soil material and other materials
 - 2.4.2 Soil gas
- 2.5 Preservation, transport and storage of samples

- 3. Investigation methods
 - 3.1 Investigation methods for soils, soil material and other materials
 - 3.1.1 Selection and pretreatment of samples
 - 3.1.2 Extraction, elution
 - 3.1.3 Methods of analysis
 - 3.2 Investigation of soil gas
 - 3.3 Methods for the estimation of substance inputs into the groundwater from suspected areas or from sites suspected of being contaminated

- 4. Quality assurance
 - 4.1 Sampling and storage of samples
 - 4.2 Pretreatment and analysis of samples

- 5. Index of abbreviations
 - 5.1 Units of measure
 - 5.2 Instrumental analysis
 - 5.3 Other abbreviations

- 6. Standards, technical regulations and other methods, sources of supply
 - 6.1 Standards, technical rules and other methods
 - 6.2 Sources of reference

Annex 2

Action, trigger and precautionary values

- 1. Soil - human health pathway (direct contact)
 - 1.1 Definition of uses
 - 1.2 Action values
 - 1.3 Application of action values
 - 1.4 Trigger values

- 2. Soil – plant pathway
 - 2.1 Definition of uses

- 2.2 Trigger and action and values - agricultural land and vegetable gardens with regard to plant quality
- 2.3 Action values - green areas with regard to plant quality
- 2.4 Trigger values - agricultural land with regard to impairments of the growth of cultivated plants
- 2.5 Application of trigger and action values
- 3. Soil – groundwater pathway
 - 3.1 Trigger values to rate the soil – groundwater pathway
 - 3.2 Application of trigger values
- 4. Precautionary values for soils
 - 4.1 Precautionary values for metals
 - 4.2 Precautionary values for organic substances
 - 4.3 Application of precautionary values
- 5. Permissible additional annual pollutant loads through all pathways

Annex 3

Requirements concerning remediation investigations and the remediation plan

- 1. Remediation investigations
- 2. Remediation plan

Annex 4

Requirements concerning the investigation and evaluation of areas where there is suspicion of the existence of an adverse soil alteration resulting from soil erosion by water

- 1. Application
- 2. Investigation and evaluation

Part One

General Provisions

Article 1

Scope of application

This Ordinance shall be applied to

1. the investigation and evaluation of suspected sites, sites suspected of being contaminated, adverse soil alterations and contaminated sites as well as to the requirements with respect to sampling, analysis and quality assurance pursuant to Article 8 (3) and Article 9 of the Federal Soil Protection Act;
2. requirements with respect to risk prevention through decontamination and securing measures well as other protective and restrictive measures pursuant to Article 4 (2) to (5) and Article 8 (1) second sentence No. 3 of the Federal Soil Protection Act;
3. supplementary requirements with respect to investigations and plans for remediation for specific contaminated sites pursuant to Article 13 (1) of the Federal Soil Protection Act;
4. requirements concerning precautions against the formation of adverse soil alterations pursuant to Article 7 of the Federal Soil Protection Act, including the requirements with respect to the application and introduction of materials pursuant to Article 6 of the Federal Soil Protection Act;
5. the determination of trigger and action values as well as of precautionary values including the permissible additional pollution load pursuant to Article 8 (1) second sentence Nos. 1 and 2 and paragraph (2) Nos. 1 and 2 of the Federal Soil Protection Act.

Article 2

Definitions

For the purposes of this Ordinance,

- (1) soil material

shall be material from soils as defined by Article 2 (1) of the Federal Soil Protection Act and from their initial substrates, to include topsoil, which is excavated, scraped or

treated in connection with construction works or other changes to the surface of the earth;

(2) area of impact

shall be an area where impacts on resources to be protected are likely that originate from a plot of land within the meaning of Article 2 (3) to (6) of the Federal Soil Protection Act or where impacts on the soil cause concern about the formation of adverse soil alterations;

(3) exploratory investigation

shall be on-site examinations, in particular measurements, on the basis of the results of a survey to determine whether the suspicion of an adverse soil alteration or contaminated site can be ruled out or whether there is reasonable suspicion within the meaning of Article 9 (2) first sentence of the Federal Soil Protection Act;

(4) detailed investigation

shall be a comprehensive further examination for the final risk assessment which particularly serves the determination of amount and spatial distribution of pollutants, their mobile or mobilisable components, possibilities for their spread in soil, water and air, as well as the possibility of their intake by human beings, animals and plants;

(5) leachate forecast

shall be the estimation of the amount of pollutants reaching the groundwater with the leachate and originating, or likely to originate in the foreseeable future, from a suspected site, a site suspected of being contaminated, an adverse soil alteration or a contaminated site, in consideration of pollutant concentrations and loads and related to the transition zone from the unsaturated zone to the water-saturated zone;

(6) pollutants

shall be the substances and preparations which, due to their harmfulness for health, their longevity or bio-availability in the soil or due to other characteristics and their concentration, are likely to harm the functions of the soil or to cause other risks;

(7) conditions of exposure

shall be the way, influenced by the local conditions and the use of a plot of land in an individual case, in which the resources to be protected may be exposed to the effects of pollutants;

(8) pathway

shall be the route of a pollutant from the source of pollution to the place of potential effect on a resource to be protected;

(9) background content

shall be the pollutant content in a soil which is composed of the geogenic (natural) basic content of a soil and the ubiquitous substance distribution resulting from non-point inputs into the soil;

(10) erosion area

shall be the area from which the soil material is washed away through surface run-off;

(11) root-penetrable soil layer

shall be the soil layer which can be penetrated by the roots of plants in dependence of natural conditions at the site.

Part Two

Requirements concerning the investigation and evaluation of suspected sites and sites suspected of being contaminated

Article 3 Investigation

(1) Evidence of the existence of a contaminated site at an abandoned industrial site shall be deemed to exist in particular where pollutants were handled on given plots of land over an extended period of time or in significant amounts and where operation, management or other methods used in the individual case or disturbances of proper operation suggest the existence of significant inputs of such substances into the soil. At abandoned waste deposits, such evidence shall in particular be deemed to exist in cases in which the type of operation or the time of closure suggest that the waste was not properly treated, stored or deposited.

(2) Paragraph (1) first sentence shall be applied mutatis mutandis to adverse soil alterations. Evidence of the existence of an adverse soil alteration shall be deemed to exist, in addition to the circumstances described in paragraph (1), particularly in the form of general or specific indications of

1. the input of a significant amount of pollutants over an extended period of time through the air or a body of water or through the application of significant loads of waste or waste waters onto soils;
2. a significant release of naturally increased pollutant contents in soils;
3. increased pollutant contents in food or forage crops at the site;
4. water with significant loads of pollutants coming out of soils or abandoned waste deposits;
5. significant erosion and deposition of soil by water or wind.

Due consideration shall also be given to the results of general investigations or to empirical values from comparable situations, in particular with respect to the spread of pollutants.

(3) Where evidence pursuant to paragraphs (1) or (2) exists, the suspected site or site suspected of being contaminated shall, after being registered, be subjected to an exploratory investigation first.

(4) As a rule, specific evidence which constitutes sufficient grounds for the suspicion of an adverse soil alteration or a contaminated site (Article 9 (2) first sentence of the Federal Soil Protection Act) shall be deemed to exist when examinations reveal an exceeding of trigger values or when an evaluation pursuant to Article 4 (3) suggests that an exceeding of trigger values is likely to occur. If there is reasonable suspicion as defined in the first sentence or on the basis of other findings, a detailed investigation shall be conducted.

(5) In the course of detailed investigations, it shall also be established whether risks result from spatially limited accumulations of pollutants within a suspected site or a site suspected of being contaminated and whether and in what form a delimitation of unpolluted areas is necessary. A detailed investigation shall be deemed unnecessary in cases in which the risks or the considerable disadvantages or nuisances emanating from adverse soil alterations or contaminated sites can be prevented or otherwise eliminated by simple means, as decided by the competent authority.

(6) Where, due to local conditions or on the basis of the results of soil gas investigations, there is evidence of the spread of volatile pollutants into buildings from a suspected site or a site suspected of being contaminated, the indoor air shall be examined; the duties and powers of other authorities remain unaffected.

(7) Within the framework of an official order of investigation pursuant to Article 9 (2) first sentence of the Federal Soil Protection Act, recurrent investigations of the pollutant spread and the relevant circumstances are another possibility.

(8) In all other respects, the requirements concerning the investigation of soils, soil material and other materials, as well as of soil gas, landfill gas and leachate are governed by the provisions of Annex 1.

Article 4 Evaluation

(1) Pursuant to this Ordinance, the results of the exploratory investigations shall be evaluated after taking due account of the circumstances of each individual case, above all on the basis of trigger values.

(2) In cases in which the content or concentration of a pollutant is below the relevant trigger value laid down in Annex 2, the suspicion of the existence of an adverse soil alteration or a contaminated site shall be deemed to be eliminated in this respect. If a trigger value pursuant to Annex 2 No. 3 is exceeded at the sampling site, it shall be ascertained in each individual case whether the pollutant concentration in the leachate exceeds the trigger value at the place of assessment. Measures specified in Article 2 (7) or (8) of the Federal Soil Protection Act may already become necessary if, in an individual case, all unfavorable circumstances assumed when deriving a trigger value pursuant to Annex 2 coincide and the content or concentration of a pollutant is slightly above the relevant trigger value defined in Annex 2.

(3) A leachate forecast shall be conducted to evaluate the groundwater risks emanating from suspected sites or from sites suspected of being contaminated. Where a leachate forecast is based on investigations pursuant to Annex 1 No. 3.3, it shall above all be estimated and evaluated in that particular case whether the pollutant concentration in the leachate can be expected to exceed the trigger value at the place of assessment. Place of assessment shall mean the transition zone from the unsaturated zone to the saturated zone.

(4) Pursuant to this Ordinance, the results of the detailed investigation shall be evaluated after giving due consideration to the circumstances of the individual case, especially on the basis of action values, in order to determine the extent to which measures pursuant to Article 2 (7) or (8) of the Federal Soil Protection Act are required.

(5) Where this Ordinance does not establish any trigger or action values for a given pollutant, the methods and standards applied in Annex 2 for the derivation of such values shall be taken into account for the evaluation. They are published in Federal Law Gazette No. 161a of 28 August 1999.

(6) In the event of use on sections of a suspected site or a site suspected of being contaminated which deviates from and is more sensitive than the prevailing use, these sections shall be evaluated in accordance with the standards established for their use.

(7) If any information is available from groundwater examinations in an individual case, this information shall be taken into account in the evaluation regarding pollutant inputs into the groundwater. Where increased pollutant concentrations in the leachate or other pollutant discharges suggest that there will, in the long run, be only small pollutant loads and only locally increased pollutant concentrations in water bodies, these facts shall be taken into account when looking into the proportionality of investigation and remediation measures. Any applicable provisions of water law remain unaffected.

(8) In the case of soils with naturally increased pollutant contents, an adverse soil alteration shall not be deemed to exist solely on the basis of these contents, unless these substances have been or are being released to a significant extent as a result of impacts on the soil. In the case of soils with settlement-related increases in pollutant contents over large areas, a comparison of these contents with the pollutant contents established in the individual case may be included in the risk assessment.

Part Three

Requirements concerning the remediation of adverse soil alterations and contaminated sites

Article 5

Remediation measures, protective and restrictive measures

(1) Decontamination measures are suited for remediation if they are based on technically and economically feasible methods which make their practical suitability for the environmentally sound elimination or reduction of pollutants appear certain. In this connection, due account must be taken of the consequences of the interference, in particular for soils and water bodies. Upon completion of a decontamination measure, proof shall be furnished to the competent authority that the remediation objective was achieved.

(2) In cases in which pollutants have to be eliminated pursuant to Article 4 (5) of the Federal Soil Protection Act and in which previous pollution exists, the responsible party shall in principle be required to take all measures it would have had to take even without that previous pollution load. The plot of land concerned shall be restored to allow all uses that were possible before.

(3) Securing measures are suited for remediation if they guarantee that the pollutants remaining in the soil or on contaminated sites will not lead to any lasting risks or considerable disadvantages or nuisances for individuals or the general public. Due account must be taken of the risk potential of the pollutants remaining in the soil and of their transformation products. A subsequent restoration of the securing effect within the meaning of the first sentence must be possible. The effectiveness of securing measures shall be demonstrated to the competent authority and be monitored permanently.

- (4) Another possible securing measure is to cover soils that underwent an adverse alteration or contaminated sites with a suitable soil layer or sealing.
- (5) In the case of adverse soil alterations or contaminated sites in areas used for agricultural or forestry purposes, possible options notably include protective and restrictive measures for adjustment of use and management of soils, as well as changes in the characteristics of the soil. Records shall be kept on any protective or restrictive measures taken. Agreement shall be reached with the competent agricultural authority. Article 17 (3) of the Federal Soil Protection Act remains unaffected.
- (6) Where scraped, excavated or treated material is applied or introduced again or shifted during remediation operations in the area which includes the adverse soil alteration or contaminated site or within the area covered by a remediation plan declared as binding, the provisions of Article 4 (3) of the Federal Soil Protection Act shall apply.

Part Four

Supplementary provisions for contaminated sites

Article 6

Investigation and planning for remediation

- (1) Any remediation investigations shall in particular study the questions of what measures are suitable for achieving remediation within the meaning of Article 4 (3) of the Federal Soil Protection Act, to what extent soil alterations will remain after the accomplished remediation, and which legal, organisational and financial circumstances are relevant to the implementation of the measures.
- (2) When establishing a remediation plan, the measures specified in Article 13 (1) first sentence No. 3 of the Federal Soil Protection Act shall be represented completely in both text and drawing. It shall be demonstrated in the remediation plan that the scheduled measures are suitable for permanently avoiding risks or considerable disadvantages or nuisances for the individual or the general public. In particular, the plan shall specify the impacts of the measures on the environment and the expected costs as well as any required licences, even where a remediation plan declared as binding pursuant to Article 13 (6) of the Federal Soil Protection Act cannot include these costs.
- (3) In all other respects, the requirements with respect to remediation investigations and remediation plans are governed by Annex 3.

Part Five Exceptions

Article 7 Exceptions

Article 6 shall not be applied to any adverse soil alterations and contaminated sites for which, according to the competent authority, any risks or any considerable disadvantages or nuisances can be prevented or otherwise eliminated by simple means.

Part Six Supplementary provisions for preventing the risk of adverse soil alterations resulting from soil erosion by water

Article 8 Preventing the risk of adverse soil alterations resulting from soil erosion by water

(1) The existence of an adverse soil alteration resulting from soil erosion by water can be assumed especially in cases in which

1. significant amounts of soil material were washed out of an erosion area by surface runoff and
2. further soil erosion according to No. 1 is likely to occur.

(2) Evidence of the existence of an adverse soil alteration resulting from soil erosion by water shall be deemed to exist especially when areas located outside the supposed erosion area were loaded with washed-off soil material.

(3) Where there is evidence pursuant to paragraph (2), it shall be determined whether an adverse soil alteration is the result of soil erosion by water. If it can be established from which erosion area the washed-off soil originated and that significant amounts of soil material were washed off from this area, it shall be examined whether the prerequisites of paragraph (1) No. 2 are fulfilled.

(4) Evaluation of the results of the investigations shall be based on each individual case, taking due account of the peculiarities of the site. Further soil erosion is to be expected where

1. significant amounts of soil material were already washed out of the same erosion area on various occasions in the previous years or
2. the relevant site data and the data on long-term precipitations in the area reveal that, within a period of ten years, more soil erosion as defined in paragraph (1) No. 1 can be expected to occur with reasonable probability.

(5) Further requirements concerning the investigation and evaluation of areas where there is suspicion of an adverse soil alteration resulting from soil erosion by water are laid down in Annex 4.

(6) In cases in which the erosion area is used for agricultural purposes, the competent advisory body referred to in Article 17 of the Federal Soil Protection Act shall be given an opportunity in the course of consultations to recommend suitable erosion-reducing measures to allow the use of the erosion area. In the event of official orders, agreement shall be reached with the competent agricultural authority.

Part Seven

Precautions against the formation of adverse soil alterations

Article 9

Concern about adverse soil alterations

(1) As a rule, cause for concern about the formation of adverse soil alterations pursuant to Article 7 of the Federal Soil Protection Act shall be deemed to exist if

1. any pollutant contents are measured in the soil that exceed the precautionary values laid down in Annex 2 No. 4 or if
2. a significant accumulation of other pollutants occurs which, because of their carcinogenic, mutagenic, toxic-to-reproduction or toxic properties, are particularly likely to cause adverse soil alterations.

Article 17 (1) of the Federal Soil Protection Act remains unaffected.

(2) In the case of soils with naturally increased pollutant contents, the exceeding of precautionary values pursuant to Annex 2 No. 4 shall only be deemed to be cause for concern about the formation of adverse soil alterations if a significant release of pollutants or additional inputs by the parties obligated under Article 7 first sentence of the Federal Soil Protection Act can be expected to have adverse impacts on the soil functions.

(3) Paragraph (2) shall apply mutatis mutandis to soils with settlement-related increases in pollutant contents over large areas.

Article 10 Precaution requirements

(1) In cases in which the prerequisites of Article 9 (1) first sentence No. 1 or of paragraphs (2) or (3) are fulfilled, the party obligated under Article 7 of the Federal Soil Protection Act shall take precautions in order to avoid or effectively reduce further pollutant inputs caused by him on the plot of land in question and its area of impact, as far as this is reasonable also with regard to the intended use of the plot of land. This shall include technical precautions on installations or methods as well as measures for the examination and monitoring of soils. Annex 1 shall apply mutatis mutandis to examination.

(2) Pollutant inputs within the meaning of Article 9 (1) first sentence No. 2 for which no precautionary values have been established shall be limited in accordance with paragraph (1), provided that this is technically feasible and economically justifiable. This shall in particular apply to substances that are classified in Article 4a (1) of the Hazardous Substances Ordinance as carcinogenic, mutagenic or toxic to reproduction.

Article 11 Permissible additional pollution load

(1) In cases in which the precautionary values established in Annex 2 No. 4.1 are exceeded for a pollutant, an additional load up to the amount of the annual pollutant loads established in Annex 2 No. 5 shall be admissible. Due account shall be taken of impacts on the soil through air and water bodies as well as by direct inputs.

(2) Where the permissible additional load established in Annex 2 No. 5 is exceeded for a pollutant, the geogenic or settlement-related previous loads over large areas shall be taken into account in each individual case.

(3) The loads established in Annex 2 No. 5 do not determine, in the sense of Article 3 (3) second sentence of the Federal Soil Protection Act, which additional loads resulting from the operation of an installation are not to be regarded as causal contribution to the formation of adverse soil alterations.

Article 12
Requirements concerning the application and introduction of
materials onto or into the soil

(1) To provide a root-penetrable soil layer, only soil material as well as dredged material according to DIN 19731 (edition 5/98) and mixtures of soil material and waste that satisfies the substance quality requirements laid down in the ordinances issued pursuant to Article 8 of the Closed Substance Cycle and Waste Management Act as well as in the Sewage Sludge Ordinance may be applied onto or introduced or into soils.

(2) The application and introduction of materials onto or into a root-penetrable soil layer or for the purpose of providing a root-penetrable soil layer within the scope of recultivation projects, including restoration for utilisation, shall be admissible if

- especially the type, amount, pollutant contents and physical properties of the materials as well as the pollutant contents of the soils at the place of application or introduction do not represent cause for concern about the formation of adverse soil alterations pursuant to Article 7 second sentence of the Federal Soil Protection Act and Article 9 of this Ordinance and if
- at least one of the soil functions referred to in Article 2 (2) Nos. 1 and 3 b and c of the Federal Soil Protection Act is permanently secured or restored.

The intermediate storage and the shifting of soil material on a plot of land in connection with the establishment or modification of structures and operational facilities shall not be subject to the provisions of this Article if the soil material is used again at the place of origin.

(3) Before the application and introduction of materials, the parties obligated under Article 7 of the Federal Soil Protection Act shall themselves perform or arrange for performance of the necessary examinations of the materials in accordance with Annex 1. The competent authority pursuant to Article 10 (1) of the Federal Soil Protection Act may order further investigations with regard to the properties of site and soil if the formation of an adverse soil alteration must be feared; the requirements of DIN 19731 (edition 5/98) shall be complied with.

(4) In the case of subsequent use for agricultural purposes, the pollutant contents in the root-penetrable soil layer shall not exceed 70 percent of the precautionary values laid down in Annex 2 No. 4, given the inevitability of future pollutant inputs resulting from land management measures, or of atmospheric pollutant inputs.

(5) When soil material is applied onto agricultural soils, including soils used for horticultural purposes, the yield capacity of such soils shall be secured or restored in a sustainable manner and must not be permanently reduced.

(6) When a root-penetrable soil layer is created for subsequent agricultural use within the framework of recultivation projects, including restoration for utilisation, the soil material applied or introduced shall be suitable with regard to its type, amount and pollutant content.

(7) The nutrient supply resulting from the application and introduction of materials onto or into the soil shall be adapted, with regard to amount and availability, to the demand of the subsequent vegetation in order to avoid particularly nutrient inputs into water bodies to the largest extent possible. The provisions of DIN 18919 (edition 09/90) shall be complied with.

(8) Soils which to a particular degree match the soil functions specified in Article 2 (2) Nos. 1 and 2 of the Federal Soil Protection Act shall be excluded from the application and introduction of materials. This shall also apply to soils in forests, in water protection zones pursuant to Article 19 (1) of the Federal Water Act and in areas and parts of nature and landscape legally declared protected areas pursuant to Articles 13, 14, 14a, 17, 18, 19b and 20c of the Federal Nature Conservation Act, as well as to soils in the core zones of major nature conservation projects of the Federal Government that are of national importance. The competent authorities may allow deviations therefrom if an application or introduction is necessary from a forestry or nature conservation point of view or for reasons of groundwater protection.

(9) When materials are applied onto and introduced or into the soil, compaction, waterlogging and any other unfavorable soil alterations shall be avoided by suitable technical measures as well as by taking into account the applied amount and the time of application. When materials of a thickness of more than 20 centimetres are applied, an effort must be made to secure or build up a solid soil structure. The provisions of DIN 19731 (edition 5/98) shall be complied with.

(10) In areas with increased pollutant contents in soils, it shall be admissible to shift the soil material around within the area provided that this does not constitute an additional impairment for the soil functions referred to in Article 2 (2) Nos. 1 and 3 b and c of the Federal Soil Protection Act and, in particular, does not have a negative effect on the pollution situation at the place of application. Areas of increased pollutant contents may be determined by the competent authority. The competent authority may also allow deviations from paragraphs (3) and (4).

(11) Article 5 (6) remains unaffected.

(12) Paragraph (3) shall not govern the application or introduction of soil material onto or into agricultural land after limited local erosion events or for the return of soil material from the cleaning of harvested crops.

Part Eight
Final provisions

Article 13

Accessibility of technical regulations and standard specifications

(1) Technical regulations and standard specifications to which reference is made in this Ordinance are deposited for safe custody in the archives of the German Patent Office. Sources of supply are listed in Annex 1 No. 6.2

(2) References to drafts of technical standards in the annexes shall always relate to the version published at the time indicated in the reference.

Article 14

Entry into force

This Ordinance shall enter into force on the day following its promulgation.

The *Bundesrat* has given its consent.

Bonn, 12 July 1999

The Federal Chancellor
Gerhard Schröder

The Federal Minister for the Environment, Nature Conservation and Nuclear Safety
Jürgen Trittin

Requirements concerning sampling, methods of analysis and quality assurance during the investigation

This Annex shall be applied to the investigation of soils, soil materials and other materials that occur in the soil or on the soils of suspected sites or sites suspected of being contaminated or are intended for application or introduction, as well as to the investigation of soil gas.

For abandoned waste deposits suspected of being contaminated, the scope of the investigation and the taking of samples, in particular with regard to testing for landfill gas, highly volatile pollutants, deposited waste and the transition of pollutants into the groundwater, depend on the requirements of the individual case.

For the purpose of this Annex, state of the art of procedures and methods means the level of development of advanced procedures and methods that makes their practical suitability for the aforementioned investigations appear certain. The knowledge about such procedures and methods and their application is compiled by a selected group of experts representing the Federal and *Länder* governments as well as the parties concerned, in consultation with the *Länder*; this group is convened by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

1. Scope of the Investigation and required level of knowledge

The investigations pursuant to Article 3 of this Ordinance are related to pathways for which the information available in the individual case suggests the existence of a risk. The determination of the scope of investigation must take into account the results of the survey, especially the knowledge or justified assumptions concerning the occurrence of certain pollutants and their distribution, the present use and the use pursuant to Article 4 (4) of the Federal Soil Protection Act and the protection requirements resulting therefrom, as well as other local circumstances of relevance for the assessment. The provisions of E DIN ISO 10381-3:03.96 must be complied with. As regards industrial safety, reference is made to ZH 1/183:04.97.

For investigations regarding the soil - human health pathway, a distinction must be made between the following types of land use:

- playgrounds
- residential areas
- parks and recreational facilities
- plots of land used for industrial and commercial purposes;

for investigations regarding the soil - plant pathway, a distinction must be made between the following types of use:

- agriculture, vegetable garden
- grassland

For investigations regarding the soil - groundwater pathway, no distinction needs to be made based on the type of soil use involved.

1.1 Exploratory investigation

Exploratory investigations of suspected sites and abandoned industrial sites suspected of being contaminated must aim particularly at identifying and estimating the size of sections with varying pollutant contents.

In the case of abandoned waste deposits suspected of being contaminated, investigations must, as a rule, be conducted with respect to landfill gas and highly volatile pollutants and in particular with regard to the transition of pollutants into the groundwater.

Where the groundwater or surface water must be examined on suspected sites or sites suspected of being contaminated at the request of the competent authority, this fact must be taken into account when determining scope and course of the exploratory investigation for soil or leachate investigations.

Where, in the case of suspected sites, no relevant soil maps exist or where there is no appropriate soil-related information, the exploratory investigation must include, to the extent necessary for risk assessment, pedological mapping or a descriptive soil characterisation at the sampling site on the basis of the Pedological Mapping Guide, 4th edition, corrected reprint 1996.

The provisions on investigation of soils and soil materials apply *mutatis mutandis* to Articles 9, 10 and 12.

1.2 Detailed investigation

In the detailed investigation, the circumstances specified in Article 3 (5) and (6) of this Ordinance must be clarified in addition to the conditions of exposure relevant for the pathways, in particular the mobile or mobilisable portions of pollutant contents that are of relevance for the various pathways. It must further be determined whether any risks result from spatially limited accumulations of pollutants within a suspected site or a site suspected of being contaminated and whether and in what form a delimitation of uncontaminated areas is necessary.

2. Sampling

The approach chosen for sampling depends in particular on the relevant pathways in the individual case, the size of the area in question, the vertical and horizontal pollutant distribution assumed on the basis of survey results, as well as on the present use, the use admissible under planning law and the previous use. The requirements laid down in Nos. 2.1 to 2.3 must be complied with. The approach chosen for sampling must be justified and documented. The relevant requirements of industrial safety must be complied with.

Areas to be investigated should be divided into sections suitable for sampling. The purpose of such a division should be to differentiate between these sections with regard to risk suspicion, soil use, the type of the terrain or the characteristics of the soil, as well as peculiarities such as vegetation development, or on the basis of established facts from the survey.

2.1 Planning the sampling for soil investigations - determination of sampling points and sampling depths

Where the spatial distribution of pollutants is to be determined, the area or section to be investigated must in principle be sampled representatively with the aid of a grid. Where a hypothesis on the spatial distribution of pollutants can be derived from existing knowledge – or in the case of abandoned industrial sites suspected of being contaminated, notably from the results of the survey -, this hypothesis must be taken into account when determining the sampling points and the grid. The results of a suitable on-site analysis may also be used for the determination of sampling sites.

Any suspected pollutant accumulations must be sampled selectively. Sampling, especially with regard to number and spatial distribution of the sampling points, must be conducted in such a way that the risk suspicion can be clarified, any potential risk evaluated, and a spatial delimitation of pollutant accumulations effected.

In the determination of sampling depths for the soil - human health and soil – plant pathways, testing for inorganic and nonvolatile organic pollutants must be conducted on the basis of the sampling depths listed in Table 1.

Table 1

**Use-oriented sampling depth in investigations concerning
the soil - human health and soil - plant pathways**

Pathway	Use	Sampling depth
soil - human health	playground, residential area	0-10 cm ¹⁾ 10-35 cm ²⁾
	park and recreational facility	0-10 cm ¹⁾
	plots of land used for industrial and commercial purposes	0-10 cm ¹⁾
soil - plant	agriculture, vegetable garden	0-30 cm ³⁾ 30-60 cm
	grassland	0-10 cm ⁴⁾ 10-30 cm

- 1) Contact area for oral and dermal pollutant intake, additional 0-2 cm in cases in which the inhalational intake is relevant
- 2) 0-35 cm: average thickness of applied soil layers; at the same time, maximum depth that can be reached by children
- 3) Working horizon
- 4) Primary rooting depth

Soils must be sampled by horizon, where possible. The basis for the ascertainment of the sequence of the horizons is the Pedological Mapping Guide of the Geological State Offices (*AG Bodenkunde*, 4th edition 1994). Soils that are unbalanced down to the subsoil must be sampled in layers (see Table 1). The thickness of layers or horizons which can be represented by the taking of samples is normally 30 cm. Horizons or layers of greater thickness must be subdivided, as required. In addition to Table 1, that sampling depth must be considered for which special precautions must be taken for a use to be taken into account pursuant to Article 4 (4) of the Federal Soil Protection Act. If any other sampling depths are used, the reasons for doing so must be documented.

During sampling, the following must be observed with regard to the various pathways:

2.1.1 Soil - human health pathway

In connection with the determination of sampling points and sampling depth, existing exposure conditions must be examined in each individual case, especially

- the actual use of the area (type, frequency, duration)
- the accessibility of the area
- the sealing of the area as well as vegetation cover
- the possibility of inhalational intake of soil particles
- the relevance of further pathways.

The uppermost two centimetres of the soil are relevant for the assessment of risks resulting from the inhalational intake of soil particles. Those pollutants which are of relevance with regard to inhalation are those for which, according to the derivation standards laid down in Article 4 (5) of this Ordinance, the inhalation pathway has proved to be decisive for the establishment of the trigger value. It must be ensured by means of reserve samples that the pollutant content in the fine-grain fraction up to 63 µm, which is relevant for dust formation, can be analysed separately, as required.

Where available knowledge suggests that the pollutants in the soil layer of relevance for the assessment are almost evenly distributed over the area in question, one mixed sample may be taken for every 1000 m², however at least from 3 sections, in areas up to 10,000 m² in size. The mixed sample must be obtained from 15 to 25 individual samples taken at the same sampling depth. In the case of areas smaller than 500 m², as well as in back gardens or other gardens of similar use, a subdivision is not considered necessary. For areas larger than 10,000 m², however, samples must be taken from at least 10 sections.

2.1.2 Soil - plant pathway

In the case of soils showing almost even soil characteristics and pollutant distribution patterns and used for agricultural - including horticultural - purposes, one mixed sample should be taken, as a rule, from each hectare in areas up to 10 hectares in size, however at least from 3 sections, in line with the sampling depths used. In the case of areas smaller than 5,000 m², a subdivision is not considered necessary. For areas larger than 10 hectares, however, samples must be taken from at least 10 sections. Sampling must conform to the rules for sampling on agricultural land (E DIN ISO 10381-1: 02.96, E DIN ISO 10381-4: 02.96) and include 15 to 25 hand-bore samples per section which are combined to one mixed sample each.

In vegetable gardens, sampling usually takes the form of one plot-related mixed sample being taken from each sampling depth; in all other respects, the rules for sampling on agricultural land apply.

The suitability of sampling devices is governed by E DIN ISO 10381-2: 02.96.

2.1.3 Soil - groundwater pathway

In the case of a soil - groundwater pathway, samples must be taken from the unsaturated soil zone as far down as below a presumed pollutant accumulation or a conspicuous soil body in order to allow the establishment of vertical pollutant distribution. Samples must be taken from specific horizons or layers. In the subsoil, samples may be taken from depth intervals up to 1 m at the most. In justified cases, the consolidation of narrow soil horizons or layers up to a maximum depth interval of 1 m is admissible. Peculiarities must be evaluated and, if applicable, separate samples be taken. The sampling depth should be reduced if it becomes apparent that a groundwater contamination must be feared as a result of the drilling into water-bearing strata in the subsoil. In cases in which such drilling into water-bearing strata is necessary, special securing measures must be taken. The suitability of sampling devices is governed by DIN 4021:10.90.

2.2 Planning the sampling for soil gas

Sampling must comply with the provisions of VDI Guideline 3865, sheets 1 and 2.

2.3 Planning the sampling of scraped and excavated soil material

Sampling must comply with the provisions of DIN 52101: 03.88 or DIN EN 932-1: 11.96.

2.4 Taking of samples

2.4.1 Soils, soil material and other materials

According to DIN 18123: 11.96, the required sample quantity depends on the biggest grain size and must be enough to guarantee - after the correct pretreatment of the sample - the laboratory test as well as, if applicable, the provision of reserve samples. Coordination with the investigating agency should be ensured.

Coarse materials (materials > 2 mm) and foreign materials that may contain pollutants or to which pollutants may adhere must be removed from the total sample quantity and sent to a laboratory test separately. Their mass proportion in the sampled soil horizon or layer unit must be established and documented.

Removal of soil, soil material and other materials is subject to the methods listed in DIN 4021: 10.90 and E DIN ISO 10381-2: 02.96. For the selection of methods, account must be taken of the required sample quantity and the structure of the subsoil, as well as the specifications contained in the standard.

2.4.2 Soil gas

The taking of soil gas samples is governed by the provisions of VDI Guideline 3865, sheet 2.

2.5 Preservation, transport and storage of samples

The selection of sample containers as well as the preservation, transport and storage of samples are subject to the relevant provisions contained in the regulations on investigations pursuant to No. 3.1.3, Tables 3 to 7. Where such provisions do not exist, E DIN ISO 10381-1: 02.96 and DIN EN ISO 5667-3: 04.96 must be complied with.

The transport of soil samples for testing for organic pollutants as well as the storage of such samples are governed by E DIN ISO 14507: 02.96.

3. Investigation methods

3.1 Investigation methods for soils, soil material and other materials

3.1.1 Selection and pretreatment of samples

In the case of investigations carried out in several stages, a decision must be made in each individual case in what sequence samples taken in the field are to be analysed, and, if applicable, whether the consolidation of several samples is advisable. The decision and the underlying reasons must be documented.

The pretreatment of samples, including the drying of the sampled material, is to allow the determination of physico-chemical properties (No. 3.1.3 Table 3) and the determination of inorganic pollutants (No. 3.1.3 Table 4) pursuant to DIN ISO 11464: 12.96. Organic pollutants are governed by the provisions of E DIN ISO 14507: 02.96.

Where a division into coarse and fine grain sizes must be made for soils, soil material and other materials (in particular slags and construction debris), a screen of 2 mm mesh width must be used to divide the material into size fractions of ≤ 2 mm (fine portion) and > 2 mm (coarse portion) in grain diameter. Agglomerations should be crushed; however, aggregates of low stability (e.g. carbonate, iron concretions, pumice) should not be broken, if possible. Both size fractions must be weighed, described and documented;

their dry matter portion must be determined. The fine portion must be homogenised and examined. If there is evidence of an increased pollutant content in the size fraction > 2 mm, this fraction must be obtained and, after crushing and homogenisation, also be examined. Any foreign matter contained in the sampled material must be examined separately, as required, and included in the evaluation.

Representative portions of the samples taken in the field must be kept as reserve samples. The type and scope of sample reserving must be agreed on the basis of the requirements of each individual case.

3.1.2 Extraction, elution

Aqua regia extract

The content of inorganic pollutants for comparing the pollutant intake through the soil - human health pathway with the values laid down in Annex 2 No. 1 except for cyanides, for the soil - plant pathway on agricultural land and in vegetable gardens, with regard to arsenic and mercury according to Annex 2 No. 2.2, and for the soil - plant pathway on grassland according to Annex 2 No. 2.3, as well as with regard to the precautionary values laid down in Annex 2 No. 4.1 must be determined from ground samples (grain size < 150 µm) by way of the aqua regia extract according to DIN ISO 11466: 06.97.

Ammonium nitrate extraction

The method of ammonium nitrate extract according to DIN 19730: 06.97 must be used to establish the contents of inorganic pollutants for evaluation of the pollutants on the soil - plant pathway on agricultural land and in vegetable gardens with regard to the plant quality concerning cadmium, lead and thallium pursuant to Annex 2 No. 2.2, as well as on agricultural land with regard to growth impairments of cultivated plants pursuant to Annex 2 No. 2.4, and can be used for estimating inorganic pollutant concentrations in the leachate pursuant to No. 3.3 of this Annex.

Extraction of organic pollutants

The content of organic pollutants for comparing the pollutant intake through the soil - human health pathway with the values pursuant to Annex 2 No. 1.2 as well as with regard to the precautionary values pursuant to Annex 2 No. 4.2 is determined on the basis of the soil extracts referred to in No. 3.1.3 of Table 5. Where other methods are to be applied, this must be justified, and proof must be furnished that the results of these methods are equivalent or comparable to the results of the methods referred to above.

Elution with water

The preparation of eluates with water to estimate pollutant concentrations in the leachate pursuant to No. 3.3 of this Annex is subject to the methods referred to in Table 2.

Table 2

Methods for the preparation of eluates with water

Process	Specifications	Method
inorganic substances		
soil saturation extract	for process see (1)	
elution with water	- sample mass in consideration of the dry matter according to DIN 38414-2: 11.85 or DIN ISO 11465: 12.96 - for filtration see (2)	DIN 38414-4: 10.84
organic substances		
column or lysimeter test	Note the speed with which the substance-specific equilibrium concentration establishes itself	

(1) Preparation of the soil saturation extract:

In preparation, a sufficient quantity of bidistilled water is slowly added to the soil sample in a polyethylene receptacle so as to moisten it completely. The amount of water needed for pre-moistening depends on the type of soil involved and should correspond approximately to the field capacity. In the case of sandy samples, approx. 25 % of the weighed portion of air-dried soil is taken as a basis, for loamy/silty samples approx. 35 %, and for clayey samples approx. 40 %. The amount of water added is gravimetrically determined and recorded. The sample is mixed thoroughly and left to stand under evaporation protection for 24 hours at a temperature of 5°C.

To prepare the soil saturation extract, the pre-moistened soil material is placed in centrifuge beakers. Bidistilled water is slowly added under constant stirring until the flow limit is reached (forming a glossy surface and deliquescing of a spatula groove). In the case of clayey samples, 15 minutes must have passed until the swelling is finished, and, if necessary, water must be added. The amount of water added is gravimetrically determined, and the soil paste mixed up with a glass rod. To establish the equilibrium, the soil paste must be kept under evaporation protection in the refrigerator or cooling room for 24 hours at a temperature of 5°C.

From the weighed portion of air-dried soil and the two additions of water, the soil/water ratio is calculated. The water content of the air-dried sample must be determined separately by an aliquot (drying at 105°C to constant weight) and included in the calculation.

To prepare the equilibrium soil solution, centrifugation is carried out in a refrigerated centrifuge for 30 minutes. The supernatant solution is decanted and filtered through a membrane to separate suspended particles into pre-weighed polyethylene wide-neck bottles under reduced pressure. The filtrated amount must be gravimetrically determined. The solutions must be stabilised by adding 10 volume percent of nitric acid ($c = 5 \text{ mol/l}$); the addition of acid must be taken into account in the evaluation of measuring results and the preparation of calibrating solutions.

(2) Filtration:

A pressure filtration unit for membrane filters is used (142 mm in diameter, media-carrying components of PTFE) with a membrane filter with 0.45 µm pore size. If any different devices are used, the volume to be filtered must be changed according to the filter surface; the ratio of filtering volume and filter surface must be observed.

After shaking, the suspension must be left to stand for approx. 15 minutes to allow sedimentation of the coarse particles. The supernatant liquid must be decanted as far as possible in the centrifuge beaker. The centrifugation process takes 30 minutes; a quantity of 2000 g is used. The result is a virtually complete decanting of the supernatant liquid in the membrane pressure filtration apparatus. After 5 minutes of pressure-free filtration, a pressure of 1 bar is applied to accelerate filtration. If, after 15 minutes, less than two thirds of the eluate have passed the filter, the pressure is raised to 2 bar. If necessary, pressure is increased to 3.5 bar after another 30 minutes. The filtration process must be continued until the entire supernatant liquid of the centrifugation process has passed the filter. If the filtration process is still not completed after 120 minutes, it is stopped, and work is continued with the incomplete filtrate.

3.1.3 Methods of analysis

Soils, soil material and other materials

Soils, soil material and, if applicable, other materials must be analysed in accordance with the investigation methods specified in Tables 3 to 5.

Where other methods are to be used, for which reasons have to be given, it must be proven and documented that the results of these methods are equivalent or comparable to the results of the methods indicated in Tables 3 to 5. It must be examined in each individual case to what extent individual methods can be applied notably under the aspects referred to in No. 4.2. The pollutant concentrations must be related to the dry matter (105°C). They must be indicated in the same unit as the relevant trigger, action and precautionary values in Annex 2.

Table 3
Analysis of physico-chemical properties

Investigation parameter	Specifications	Method
determination of the dry matter	soil samples fresh from the field or air-dried	DIN ISO 11465: 12.96
organic carbon and total carbon after dry combustion	air-dried soil samples	DIN ISO 10694: 08.96
pH-value (CaCl ₂)	suspension of the soil sample fresh from the field or air-dried in CaCl ₂ solution; c(CaCl ₂): 0.01 mol/l	DIN ISO 10390: 05.97
grain-size distribution	1) "finger test" in the field *	Pedological Mapping Guide, 4 th edition, 1994; DIN 19682-2: 04.97
	2) screening, dispersion, pipette analysis *	E DIN ISO 11277: 06.94 DIN 19683-2: 04.97
	3) screening, dispersion, areometer method	DIN 18123: 11.96 E DIN ISO 11277: 06.94
Bulk density	drying of a soil sample taken in the proper volume at 105°C, back weighing	E DIN ISO 11272: 01.94 DIN 19683-12: 04.73

* Recommended methods

Table 4
Analysis of inorganic pollutant concentrations

Investigation parameter	Specifications	Method
Cd, Cr, Cu, Ni, Pb, Tl, Zn	AAS	E DIN ISO 11047: 06.95
As, Cd, Cr, Cu, Ni, Pb, Tl, Zn	ICP-AES (ICP-MS possible) must consider spectral disturbances in the case of great matrix concentrations	DIN EN ISO 11885: 04.98
arsenic (As)	ET-AAS hydrid AAS	in analogy to E DIN ISO 11047: 06.95 DIN EN ISO 11969: 11.96
mercury (Hg)	AAS vapor compression technique During sample pretreatment, the drying temperature must not exceed 40°C	DIN EN 1483: 08.97 reduction with tin(II) chloride or NaBH ₄
chromium (VI)	1) extraction with phosphate-buffered aluminum sulphate solution 2) elution with water, separation of Cr(III), determination of soluble Cr(VI) in soils	spectrophotometry DIN 18734: 01.99 DIN 38405-24: 05.87
Cyanides		E DIN ISO 11262: 06.94

Table 5
Analysis of organic pollutant concentrations

Investigation parameter	Specifications	Method
polycyclic aromatic hydrocarbons (PAH): 16 PAH (EPA) benzo(a)pyrene	1) Soxhlet extraction with toluene, chromatographic clean-up; quantification by means of GC-MS* 2) extraction with tetrahydrofuran or acetonitrile; quantification by means of HPLC-UV/DAD/F* 3) extraction with acetone, adding petroleum ether, removal of acetone, chromatographic clean-up of the petroleum ether extract, take-up in acetonitrile; quantification by means of HPLC-UV/DAD/F 4) extraction with a water/acetone/petroleum ether mix in the presence of NaCl;	Guidelines No. 1 of LUA-NRW, 1994* Guidelines No. 1 of LUA-NRW, 1994* E DIN ISO 13877: 06.95 VDLUFA Book of Methods, vol. VII; Contaminated Sites Manual vol. 7 LfU HE

	quantification by means of GC-MS or HPLC-UV/DAD/F	
Investigation parameter	Specifications	Method
Hexachlorobenzene	extraction using acetone/cyclohexane mix or acetone/petroleum ether; if necessary, chromatographic clean-up after removal of the acetone; quantification by means of GC-ECD or GC-MS	E DIN ISO 10382: 02.98
Pentachlorophenol	Soxhlet extraction using heptane or acetone/heptane (50:50); derivatisation with acetic anhydride; quantification by means of GC-ECD or GC-MS	E DIN ISO 14154: 10.97
aldrin, DDT, HCH-mix	1) extraction using petroleum ether or acetone/petroleum ether mix, chromatographic clean-up; quantification by means of GC-ECD or GC-MS* 2) extraction using water/acetone/petroleum ether mix, quantification by means of GC-ECD or GC-MS	E DIN ISO 10382: 02.98* VDLUFA Book of Methods, vol. VII
polychlorinated biphenyls (PCB): 6 PCB-congeners (No. 28, 52, 101, 138, 153, 180 according to Ballschmitter)	1) extraction using heptane or acetone/petroleum ether, chromatographic clean-up, quantification by means of GC-ECD (GC-MS possible) 2) Soxhlet extraction using heptane, hexane or pentane, chromatographic clean-up involving AgNO ₃ /silica column; quantification by means of GC-ECD (GC-MS possible) 3) extraction with a water/acetone/petroleum ether mix in the presence of NaCl; quantification by means of GC-ECD (GC-MS possible)	E DIN ISO 10382: 02.98* DIN 38414-20: 01.96 VDLUFA Book of Methods, vol. VII
polychlorinated dibenzodioxins and dibenzofurans	Soxhlet extraction of freeze-dried samples with toluene, chromatographic clean-up; quantification by means of GC-MS	according to the Sewage Sludge Ordinance and in consideration of DIN 38414-24: 04.98, VDI Guideline 3499, sheet 1: 03.90

* Recommended method

Eluates and leachate

The analytical determination of inorganic substance concentrations in eluates and leachate must be carried out in accordance with the methods of analysis listed in Table 6, the determination of organic substance concentrations in the leachate must be made in accordance with the methods referred to in Table 7.

Where other methods are to be applied, for which reasons have to be indicated, proof must be furnished that the results of these methods are equivalent to or comparable with the results of the methods listed in Tables 6 and 7.

Table 6

Determination of the concentration of inorganic pollutants in eluates and leachate

Investigation parameter	Specifications	Method
As, Cd, Cr, Co, Cu, Mo, Ni, Pb, Sb, Se, Sn, Tl, Zn	ICP-AES (ICP-MS possible)	on the basis of DIN EN ISO 11885: 04.98*
arsenic (As), antimony (Sb)	hydrid AAS	DIN EN ISO 11969: 11.96
Lead (Pb)	AAS	DIN 38406-6: 07.98
cadmium (Cd)	AAS	DIN EN ISO 5961: 05.95
chromium (Cr), total	AAS	DIN EN 1233: 08.96
chromium (Cr VI)	spectrophotometry ion chromatography	DIN 38405-24: 05.87 DIN EN ISO 10304-3: 11.97
cobalt (Co)	AAS	DIN 38406-24: 03.93
copper (Cu)	AAS	DIN 38406-7: 09.91
nickel (Ni)	AAS	DIN 38406-11: 09.91
mercury (Hg)	AAS vapor compression technique	DIN EN 1483: 08.97
selenium (Se)	AAS	DIN 38405-23: 10.94
Zinc (Zn)	AAS	DIN 38406-8: 10.80
cyanide (CN-), total	spectrophotometry	DIN 38405-13: 02.81 E DIN EN ISO 14403: 05.98
cyanide (CN-)	spectrophotometry	DIN 38405-13: 02.81
fluoride (F-)	fluoride-sensitive electrode ion chromatography	DIN 38405-4: 07.85 DIN EN ISO 10304-1: 04.95

*The determination limit must be adapted to the examination target by suitable measures or suitable technical equipment.

Table 7
Determination of the concentration of organic pollutants in the soil leachate

Investigation parameter	Specifications	Method
benzene	GC-FID	DIN 38407-9: 05.91*
BTEX	GC-FID matrix load must be complied with	DIN 38407-9: 05.91
highly volatile halogenated hydrocarbons	GC-ECD	DIN EN ISO 10301: 08.97
Aldrin	GC-ECD (GC-MS possible)	DIN 38407-2: 02.93
DDT	GC-ECD (GC-MS possible)	DIN 38407-2: 02.93
phenols	GC-ECD	ISO/DIS 8165-2: 01.97
chlorophenols	GC-ECD or GC-MS	ISO/DIS 8165-2: 01.97
chlorobenzenes	GC-ECD (GC-MS possible)	DIN 38407-2: 02.93
PCB, total	GC-ECD GC-ECD or GC-MS	DIN EN ISO 6468: 02.97 DIN 51527-1: 05.87 DIN 38407-2: 07.98
PAH, total	HPLC-F	DIN 38407-8: 10.95
naphthalene	GC-FID or GC-MS	DIN 38407-9: 05.91
petroleum hydrocarbons	extraction with petroleum ether, gas chromatographic quantification	according to ISO/TR 11046: 06.94

* The determination limit must be adapted.

3.2 Investigation of soil gas

The investigation of soil gas must be undertaken according to VDI Guideline 3865, sheets 2 and 3.

3.3 Methods for the estimation of substance inputs into the groundwater from suspected sites or from sites suspected of being contaminated

The substance concentrations and substance loads in the leachate and the pollutant input into the groundwater in the transition area from the unsaturated to the water-saturated soil zone (place of assessment) may be estimated unless favorable circumstances allow representative sampling of the leachate at the place of assessment.

This estimation can also be approximated, including with the use of mass transport models

- through conclusions or reverse projections from investigations in the groundwater flow-off in consideration of the substance concentration in the groundwater influx,

dilution, the pollutant behavior in the unsaturated and saturated soil zones, as well as the pollutant stock in the soil

- on the basis of in-situ investigations or
- on the basis of material testing in the laboratory (elution, extraction), in the case of inorganic substances, elution with water, according to Table 2, in particular.

At the site of sampling, the substance concentrations in the leachate can be

- equated in principle with the results of the soil saturation extract, in the case of inorganic pollutants; estimations using the results from Table 6 and other elution processes (e.g. DIN 19730 or DIN 38414-4) are admissible, provided that the equivalence of the results is ensured in particular by relating these results to the soil saturation extract; results according to DIN 38414-4: 10.84 can only be used if filtration in accordance with No. 3.1.2 of this Ordinance was used;
- established with the help of methods listed in Table 7 for organic substances from column tests carried out with the samples taken; due account must be taken of conditions at the sampling site, in particular with regard to the time of contact.

The results from the investigation of the leachate, groundwater, extracts and eluates, as well as of soil samples must be indicated together with the investigation method used in each case. The resulting estimation of leachate quality and leachate loads for the transition area from the unsaturated to the water-saturated zone must be explained in detail and reasons be given.

For the estimation, especially those methods must be applied which have been used successfully in practical cases. Expert comments are required in each individual case.

In addition, the following specifications for application must be observed:

If, in an individual case of an adverse soil alteration or a contaminated site, an impact of acidic leachates or of dissolving agents or a change in the redox potential is to be expected, suitable additional extraction methods must be applied.

When estimating the pollutant input in the transition area from the unsaturated to the water-saturated zone, special attention must be paid to the degradation and retention effect of the unsaturated zone. The following criteria are of special importance:

- isobath of groundwater table
- soil type
- content of organic matter (humus content)
- pH-value
- rate of natural groundwater recharge /leachate rate

- mobility and degradability of substances.

The impact of these factors on substance retention in the unsaturated zone is estimated on the basis of generally available scientific knowledge and experience for the location in question. The use of mass transport models may also be expedient.

In the case of direct sampling and investigation of leachate, the resulting evaluation of the measured substance concentrations must take due account of the weather-dependent dynamics.

4. Quality assurance

4.1 Sampling and storage of samples

The determination of sampling points and sampling depths as well as the taking of samples itself must be handled by qualified personnel.

Sampling, transport and storage of samples must be made in such a way that the possibility of working methods and/or working materials or storage conditions having an impact on the chemical, physical and biological quality of the sampled material is precluded as far as possible.

Sampling must be documented. The documentation must contain all the information relevant for laboratory tests and the evaluation of test results, in particular information on

- date of sampling, person taking the sample
- location of the examined area and sampling points
- designation of the area
- sampling depth
- soil horizons, according to Pedological Mapping Guide, 4th edition, corrected reprint 1996
- index of layers
- withdrawal method
- former and present use of the area, existing knowledge of contaminations.

Existing standards, regulations of the *Länder* and technical rules concerning quality assurance must be complied with.

4.2 Pretreatment and analysis of samples

Suitable internal and external quality assurance measures, in particular with respect to reproducibility (precision) and correctness of the investigation results must be carried out, monitored and documented.

Internal quality assurance measures include:

- performance of independent multiple determinations
- calibration of measuring and testing instruments
- use of certified and/or lab-internal reference materials for quality control of reproducibility and correctness
- credibility control of the investigation results.

External quality assurance measures include:

- successful participation in comparative investigations, in particular inter-laboratory tests
- confirmation of competence according to DIN EN 45001:05.90.

The detection and determination limits pursuant to DIN 32645:05.94 must be indicated for the investigation methods applied. The determination method must be selected in such a way that, on the basis of the determination limit, the exceeding and staying below the trigger, action and precautionary values laid down in Annex 2 can be evaluated for certain. The determination methods applied must be documented.

Any uncertainty of measurement pursuant to DIN 1319-3: 05.96 and/or DIN 1319-4: 12.85 must be indicated for the result of the analysis.

5. Index of abbreviations

5.1 Units of measure

$$1 \text{ ng (nanogramme)} = 10^{-9} \text{ g} = 0.000\ 000\ 001 \text{ gramme}$$

$$1 \text{ } \mu\text{g (microgramme)} = 10^{-6} \text{ g} = 0.000\ 001 \text{ gramme}$$

$$1 \text{ mg (milligramme)} = 10^{-3} \text{ g} = 0.001 \text{ gramme}$$

$$1 \text{ kg (kilogramme)} = 10^3 \text{ g} = 1,000 \text{ grammes}$$

$$1 \text{ } \mu\text{m (micrometre)} = 10^{-6} \text{ m} = 0.000\ 001 \text{ metre}$$

$$1 \text{ mm (millimetre)} = 10^{-3} \text{ m} = 0.001 \text{ metre}$$

$$1 \text{ cm (centimetre)} = 10^{-2} \text{ m} = 0.01 \text{ metre}$$

$$1 \text{ ha (hectare)} = 10^4 \text{ m}^2 = 10,000 \text{ square metres}$$

°C - degree Celsius

5.2 Instrumental analysis

AAS	-	atomic absorption spectrometry
ET AAS	-	atomic absorption spectrometry using electrothermal excitation
ICP-AES	-	atomic emission spectrometry using inductively coupled plasma
GC	-	gas chromatography
HPLC	-	high-power liquid chromatography

Detectors (GC, HPLC)

DAD	-	diode-array-detector
ECD	-	electron capture detector
FID	-	flame ionisation detector
F	-	fluorescence detector
UV	-	ultraviolet detector
MS	-	mass spectrometer

5.3 Other abbreviations

TM	-	dry matter
I-TEq	-	international toxicity equivalency factor
PTFE	-	polytetrafluoroethylene

6 PCB congeners (PCB₆) according to Ballschmiter:

Nr. 28:	2,4,4'	trichlorobiphenyl
Nr. 52:	2,2',5,5'	tetrachlorobiphenyl

Nr. 101:	2,2',4,5,5'	pentachlorobiphenyl
Nr. 138:	2,2',3,4,4',5'	hexachlorobiphenyl
Nr. 153:	2,2',4,4',5,5'	hexachlorobiphenyl
Nr. 180:	2,2',3,4,4',5,5'	heptachlorobiphenyl

16 PAH (EPA):

naphthalene
 acenaphthylene
 acenaphthene
 fluorene
 phenanthrene
 anthracene
 fluoranthene
 pyrene
 benz(a)anthracene
 chrysene
 benzo(b)fluoranthene
 benzo(k)fluoranthene
 benzo(a)pyrene
 dibenz(a,h)anthracene
 Indeno(1,2,3-cd)pyrene
 benzo(g,h,i)perylene

6. Standards, technical regulations and other methods, sources of supply

6.1 Standards, technical regulations and other methods

E DIN ISO 10381 - 1: 02.96

Bodenbeschaffenheit - Probenahme - Teil 1: Anleitung zur Aufstellung von Probenahmeprogrammen
 (ISO/ DIS 10381 - 1: 1995)

Soil quality – Sampling – Part 1: Guidance on the design of sampling programmes
 (ISO/DIS 10381 - 1: 1995)

E DIN ISO 10381 - 2: 02.96

Bodenbeschaffenheit - Probenahme - Teil 2: Anleitung für Probenahmeverfahren
 (ISO/ DIS 10381 - 2: 1995)

Soil quality – Sampling – Part 2: Guidance on sampling techniques
 (ISO/DIS 10381 - 2: 1995)

E DIN ISO 10381-3: 02.96

Bodenbeschaffenheit - Probenahme - Teil 3: Anleitung zur Sicherheit
 (ISO/ DIS 10381 - 3: 1995)

Soil quality – Sampling – Part 3: Guidance on safety
(ISO/DIS 10381 - 3: 1995)

E DIN ISO 10381 - 4: 02.96

Bodenbeschaffenheit - Probenahme - Teil 4: Anleitung für das Vorgehen bei der
Untersuchung von natürlichen, naturnahen und Kulturstandorten
(ISO/ DIS 10381 - 4: 1995)

Soil quality – Sampling – Part 4: Guidance on the procedure for the investigation of
natural, near natural an cultivated sites
(ISO/DIS 10381 - 4: 1995)

E DIN ISO 10382: 02.98

Bodenbeschaffenheit - Gaschromatographische Bestimmung des Gehaltes an
polychlorierten Biphenylen (PCB) und Organopestiziden (OCP)
(ISO/ CD 10382: 1995)

Soil quality – Gas chromatographic determination of the contents of polychlorinated
biphenyls (PCB) and organochloropesticides (OCP)
(ISO/CD 10382: 1995)

DIN ISO 10390: 05.97

Bodenbeschaffenheit - Bestimmung des pH-Wertes (ISO 10390: 1994)
Soil quality – Determination of pH; (ISO 10390: 1994)

DIN ISO 10694: 08.96

Bodenbeschaffenheit - Bestimmung von organischem Kohlenstoff und
Gesamtkohlenstoff nach trockener Verbrennung (Elementaranalyse)
(ISO 10694: 1995)

Soil quality – Determination of organic and total carbon after dry combustion (elementary
analysis) –
(ISO 10694: 1995)

ISO/ TR 11046: 06.94

Bodenbeschaffenheit – Bestimmung von Mineralölkohlenwasserstoffen –
Infrarotspektrometrie und Gaschromatographie

Soil quality - Determination of mineral oil content - Method by infrared spectrometry and
gas chromatographic method
(ISO/TR 11046: 1994(E))

E DIN ISO 11047: 06.95

Bodenbeschaffenheit - Bestimmung von Cadmium, Chrom, Cobalt, Kupfer, Blei,
Mangan, Nickel und Zink - Flammen- und elektrothermisches
atomabsorptionsspektrometrisches Verfahren
(ISO/ DIS 11047)

Soil quality – Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc – Flame and electrothermal atomic absorption spectrometric methods (ISO/DIS 11047)

E DIN ISO 11262: 06.94

Bodenbeschaffenheit - Bestimmung von Cyaniden

Soil quality; Determination of Cyanide

(ISO/CD 11262: 1993)

E DIN ISO 11272: 01.94

Bodenbeschaffenheit - Bestimmung der Trockenrohddichte

(ISO/ DIS 11272: 1992)

Soil quality; Determination of dry bulk density;

(ISO/DIS 11272: 1992)

E DIN ISO 11277: 06.94

Bodenbeschaffenheit - Bestimmung der Partikelgrößenverteilung in Mineralböden - Verfahren durch Sieben und Sedimentation nach Entfernen der löslichen Salze, der organischen Substanz und der Carbonate

(ISO/ DIS 11277: 1994)

Soil quality; Determination of particle size distribution in mineral soil material; Method by sieving and sedimentation following removal of soluble salts, organic matter and carbonates;

(ISO/DIS 11277: 1994)

DIN ISO 11464: 12.96

Bodenbeschaffenheit - Probenvorbehandlung für physikalisch-chemische Untersuchungen

(ISO/ DIS 11464: 1994)

Soil quality – Pretreatment of samples for physico-chemical analyses;

(ISO 11464: 1994)

DIN ISO 11465: 12.96

Bodenbeschaffenheit - Bestimmung des Trockenrückstandes und des Wassergehalts auf Grundlage der Masse - Gravimetrisches Verfahren

(ISO 11465: 1993)

Soil quality – Determination of dry matter and water content on a mass basis – Gravimetric method,

(ISO 11465: 1993)

DIN ISO 11466: 06.97

Bodenbeschaffenheit - Extraktion in Königswasser löslicher Spurenelemente

(ISO 11466: 1995)

Soil quality – Extraction of trace elements soluble in aqua regia

(ISO 11466: 1995)

E DIN ISO 13877: 06.95

Bodenbeschaffenheit - Bestimmung von polycyclischen aromatischen Kohlenwasserstoffen (PAK) - Hochleistungs-Flüssigkeitschromatographie- (HPLC) Verfahren

(ISO/ DIS 13877)

Soil quality – Determination of polynuclear aromatic hydrocarbons (PAH) – High performance liquid chromatographic – (HPLC-) method

(ISO/DIS 13877)

E DIN ISO 14154: 10.97

Bodenbeschaffenheit - Bestimmung von ausgewählten Chlorphenolen in Böden - Gaschromatographisches Verfahren

(ISO/ CD 14154: 1997)

Soil quality – Determination of some selected chlorophenols in soils – Gaschromatographic methods

E DIN ISO 14507: 02.96

Bodenbeschaffenheit - Probenvorbehandlung für die Bestimmung von organischen Verunreinigungen in Böden

(ISO/ DIS 14507)

Soil quality – Sample pretreatment for determination of organic contaminants in soil (ISO/DIS 14507)

DIN 19730: 06.97

Bodenbeschaffenheit -Extraktion von Spurenelementen mit Ammoniumnitratlösung
Soil quality – Extraction of trace elements with ammonium nitrate solution

DIN 19731: 05.98

Bodenbeschaffenheit - Verwertung von Bodenmaterial
Soil quality – Utilization of soil material

DIN 19734: 01.99

Bodenbeschaffenheit - Bestimmung von Chrom(VI) in phosphatgepufferter Lösung
Soil quality – Determination of chromium (VI) in phosphate buffered extract

DIN 19682 - 2: 04.97

Bodenuntersuchungsverfahren im Landwirtschaftlichen Wasserbau - Felduntersuchungen
- Teil 2: Bestimmung der Bodenart

Methods of soil investigations for agricultural water engineering – Field test – Part 2:
Determination of soil texture

DIN 19683 - 2: 04.97

Bodenuntersuchungsverfahren im Landwirtschaftlichen Wasserbau - Physikalische Laboruntersuchungen, Bestimmung der Korngrößenzusammensetzung nach Vorbehandlung mit Natriumpyrophosphat

Methods of soil investigations for agricultural engineering; physical laboratory tests; determination of the grain size composition after pretreatment with sodium pyrophosphate

DIN 19683 - 12: 04.73

Bodenuntersuchungsverfahren im Landwirtschaftlichen Wasserbau; Physikalische Laboruntersuchungen, Bestimmung der Rohdichte

DIN EN 1233: 08.96

Wasserbeschaffenheit - Bestimmung von Chrom - Verfahren mittels Atomabsorptionsspektrometrie; Deutsche Fassung EN 1233: 1996

Water quality – Determination of chromium – Atomic absorption spectrometric methods; German version EN 1233: 1996

DIN EN ISO 5667 - 3: 04.96

Wasserbeschaffenheit - Probenahme - Teil 3: Anleitung zur Konservierung und Handhabung von Proben

(ISO 5667 - 3: 1994); Deutsche Fassung EN ISO 5667 - 3: 1995 (A 21)

Water quality, Sampling – Part 3: Guidance on the preservation and handling of samples (ISO 5667-3: 1994); German version EN ISO 5667-3: 1995

DIN EN ISO 5961: 05.95

Wasserbeschaffenheit - Bestimmung von Cadmium durch Atomabsorptionsspektrometrie (ISO 5961: 1994); Deutsche Fassung EN ISO 5961: 1995 (A 19)

Water quality – Determination of cadmium by atomic absorption spectrometry (ISO 5961: 1994); German version EN ISO 5961: 1995

DIN EN ISO 6468: 02.97

Wasserbeschaffenheit - Bestimmung ausgewählter Organoinsektizide, Polychlorbiphenyle und Chlorbenzole; Gaschromatographisches Verfahren nach Flüssig-Flüssig-Extraktion

(ISO 6468: 1996); Deutsche Fassung EN ISO 6468: 1996

Water quality – Determination of certain organochlorine insecticides, polychlorine biphenyls and chlorobenzenes – Gas-chromatographic method after liquid-liquid extraction

(ISO 6468: 1996); German version EN ISO 6468: 1996

ISO/ DIS 8165 - 2: 01.97

Water quality - Determination of Selected Monohydric Phenols by Derivatization and Gas Chromatography

DIN EN ISO 10301: 08.97

Wasserbeschaffenheit - Bestimmung leichtflüchtiger halogenierter Kohlenwasserstoffe - Gaschromatographische Verfahren

(ISO 10301: 1997); Deutsche Fassung EN ISO 10301: 1997

Water quality – Determination of highly volatile halogenated hydrocarbons – Gas-chromatographic methods

(ISO 10301: 1997); German version EN ISO 10301: 1997

DIN EN ISO 10304 - 1: 04.95

Wasserbeschaffenheit - Bestimmung der gelösten Anionen Fluorid, Chlorid, Nitrit, Orthophosphat, Bromid, Nitrat und Sulfat mittels Ionenchromatographie - Teil 1:

Verfahren für gering belastete Wässer

(ISO 10304 - 1: 1992); Deutsche Fassung EN ISO 10304 - 1: 1995 (D 19)

Water quality – Determination of dissolved fluoride, chloride, nitrite, orthophosphate, bromide, nitrate and sulfate ions, using liquid chromatography of ions – Part 1: Method for water with low contamination

(ISO 10304-1: 1992); German version EN ISO 10304-1: 1995

DIN EN ISO 10304 - 3: 11.97

Wasserbeschaffenheit - Bestimmung der gelösten Anionen mittels Ionenchromatographie - Teil 3: Bestimmung von Chromat, Iodid, Sulfit, Thiocyanat und Thiosulfat

(ISO 10304 - 3: 1997); Deutsche Fassung EN ISO 10304 - 3: 1997 (D 22)

Water quality – Determination of dissolved anions by liquid chromatography of ions – Part 3: Determination of chromate, iodide, sulfite, thiocyanate and thiosulfate

(ISO 10304-3: 1997); German version EN ISO 10304-3: 1997

DIN EN ISO 11885: 04.98

Wasserbeschaffenheit - Bestimmung von 33 Elementen durch induktiv gekoppelte Plasma-Atom-Emissionsspektrometrie

(ISO 11885: 1996); Deutsche Fassung EN ISO 11885: 1997

Water quality – Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy

ISO 11885: 1996); German version EN ISO 11885: 1997

DIN EN ISO 11969: 11.96

Wasserbeschaffenheit - Bestimmung von Arsen - Atomabsorptionsspektrometrie (Hydridverfahren)

Water quality – Determination of arsenic – Atomic absorption spectrometric method (hydride technique)

(ISO 11969: 1996); German version EN ISO 11969: 1996

E DIN EN ISO 14403: 05.98

Wasserbeschaffenheit - Bestimmung des gesamten Cyanids und des freien Cyanids mit der kontinuierlichen Fließanalytik

(ISO/ DIS 14403: 1998); Deutsche Fassung prEN ISO 14403: 1998
Water quality – Determination of total cyanide and free cyanide by continuous flow analysis

(ISO/DIS 14403: 1998); German version prEN ISO 14403: 1998

DIN 38405 - 4:07.85

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Anionen (Gruppe D); Bestimmung von Fluorid (D 4)

German standard methods for the examination of water, waste water and sludge; anions (group D); determination of fluoride (D 4)

DIN 38405 - 13: 02.81

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Anionen (Gruppe D); Bestimmung von Cyaniden (D 13)

German standard methods for the examination of water, waste water and sludge; anions (group D); determination of cyanides (D 13)

DIN 38405 - 23: 10.94

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Anionen (Gruppe D) - Teil 23: Bestimmung von Selen mittels Atomabsorptionsspektrometrie (AAS) (D 23)

German standard methods for the examination of water, waste water, and sludge – Anions (group D) – Part 23: Determination of selenium by atomic absorption spectrometry (D23)

DIN 38405 - 24: 05.87

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Anionen (Gruppe D) - Teil 24: Photometrische Bestimmung von Chrom(VI) mittels 1,5-Diphenylcarbazid (D 24)

German standard methods for the examination of water, waste water and sludge; anions (group D); photometric determination of chromium (VI) using 1,5-diphenyl carbazide (D 24)

DIN 38406 - 6: 07.98

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Kationen (Gruppe E) - Bestimmung von Blei mittels Atomabsorptionsspektrometrie (AAS) (E 6)

German standard methods for the examination of water, waste water and sludge – Cations (group E) – Part 6: Determination of lead by atomic absorption spectrometry (AAS) (E 6)

DIN 38406 - 7: 09.91

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Kationen (Gruppe E); Bestimmung von Kupfer mittels Atomabsorptionsspektrometrie (AAS) (E 7)

German standard methods for the examination of water, waste water and sludge; cations (group E); determination of copper by atomic absorption spectrometry (AAS) (E 7)

DIN 38406 - 8: 10.80

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Kationen (Gruppe E); Bestimmung von Zink (E 8)

German standard methods for the examination of water, waste water and sludge; cations (group E); determination of zinc (E 8)

DIN 38406 - 11: 09.91

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Kationen (Gruppe E); Bestimmung von Nickel mittels Atomabsorptionsspektrometrie (AAS) (E 11)

German standard methods for the examination of water, waste water and sludge; cations (group E); determination of nickel by atomic absorption spectrometry (AAS) (E 11)

DIN 38406 - 24: 03.93

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Kationen (Gruppe E); Bestimmung von Cobalt mittels Atomabsorptionsspektrometrie (AAS) (E 24)

German standard methods for the examination of water, waste water and sludge; cations (group E); determination of cobalt by atomic absorption spectrometry (AAS) (E 24)

DIN 38407 - 2: 02.93

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Gemeinsam erfaßbare Stoffgruppen (Gruppe F); Gaschromatographische Bestimmung von schwerflüchtigen Halogenkohlenwasserstoffen (F 2)

German standard methods for the determination of water, waste water and sludge; jointly determinable substances (group F); determination of low volatile halogenated hydrocarbons by gas chromatography (F 2)

DIN 38407 - 3: 07.98

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Gemeinsam erfaßbare Stoffgruppen (Gruppe F); Teil 3: Gaschromatographische Bestimmung von polychlorierten Biphenylen (F 3)

German standard methods for the determination of water, waste water and sludge – Jointly determinable substances (group F) – Part 3: Determination of polychlorinated biphenyls (F 3)

DIN 38407 - 8: 10.95

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Gemeinsam erfaßbare Stoffgruppen (Gruppe F); Bestimmung von 6 polycyclischen aromatischen Kohlenwasserstoffen (PAK) in Wasser mittels Hochleistungs-Flüssigkeitschromatographie (HPLC) mit Fluoreszenzdetektion (F 8)

German standard methods for the examination of water, waste water and sludge; Jointly determinable substances (group F); Determination of 6 polynuclear aromatic hydrocarbons (PAH) in water by high performance liquid chromatography (HPLC) with fluorescence detection (F 8)

DIN 38407 - 9: 05.91

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Gemeinsam erfaßbare Stoffgruppen (Gruppe F); Bestimmung von Benzol und einigen Derivaten mittels Gaschromatographie (F 9)

German standard methods for the examination of water, waste water and sludge; jointly determinable substances (group F); determination of benzene and some derivatives by gas chromatography (F 9)

DIN 38414 - 2: 11.85

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Schlamm und Sedimente (Gruppe S); Bestimmung des Wassergehaltes und des Trockenrückstandes bzw. der Trockensubstanz (S 2)

German standard methods for the examination of water, waste water and sludge; sludge and sediments (group S); determination of the moisture content and total solids residue (S 2)

DIN 38414 - 4: 10.84

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung; Schlamm und Sedimente (Gruppe S); Bestimmung der Eluierbarkeit mit Wasser (S 4)

German standard methods for the examination of water, waste water and sludge; sludge and sediments (group S); determination of the leachability by water (S 4)

DIN 38414 - 20: 01.96

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Schlamm und Sedimente (Gruppe S) - Teil 20: Bestimmung von 6 polychlorierten Biphenylen (PCB) (S 20)

German standard methods for the examination of water, waste water and sludge – Sludge and sediments (group S) – Part 20: Determination of 6 polychlorinated biphenyls (PCB) (S 20)

DIN 38414 - 24: 04.98

Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung - Schlamm und Sedimente (Gruppe S) - Teil 24: Bestimmung von polychlorierten Dibenzodioxinen (PCDD) und polychlorierten Dibenzofuranen (PCDF) (S 24)

German standard methods for the examination of water, waste water and sludge – Sludge and sediments (group S) – Part 24: Determination of polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofuranes (PCDF) (S 24)

DIN EN 1483: 08.97

Wasseranalytik - Bestimmung von Quecksilber; Deutsche Fassung EN 1483: 1997 (E 12)

Water analysis – Determination of mercury; German version prEN 1483: 1994

DIN 32645: 05.94

Chemische Analytik - Nachweis-, Erfassungs- und Bestimmungsgrenze - Ermittlung unter Wiederholungsbedingungen - Begriffe, Verfahren, Auswertung

Chemical analysis; Decision limit, Detection limit and determination limit; Estimation in case of repeatability, terms, methods, evaluation

DIN 1319 - 3: 05.96

Grundlagen der Meßtechnik - Teil 3: Auswertung von Messungen einer Meßgröße, Meßunsicherheit

Fundamentals of metrology – Part 3: Evaluation of measurements of a single measurand, measurement uncertainty

DIN 1319 - 4: 12.85

Grundbegriffe der Meßtechnik; Behandlung von Unsicherheiten bei der Auswertung von Messungen

Basic concepts of measurements; treatment of uncertainties in the evaluation of measurements

DIN EN 45001: 05.90

Allgemeine Kriterien zum Betreiben von Prüflaboratorien; Identisch mit EN 45001: 1989

General criteria for the operation of testing laboratories; EN 45001: 1989

DIN 4021: 10.90

Baugrund - Aufschluß durch Schürfe und Bohrungen sowie Entnahme von Proben

Soil; exploration by excavation and borings; sampling

DIN 18123: 11.96

Baugrund - Untersuchung von Bodenproben - Bestimmung der Korngrößenverteilung

Soil, Investigation and testing – Determination of grain-size distribution

DIN EN 932 - 1: 11.96

Prüfverfahren für allgemeine Eigenschaften von Gesteinskörnungen - Teil 1: Probenahmeverfahren; Deutsche Fassung EN 932-1: 1996

Test for general properties of aggregates – Partie 1: Methods for sampling

DIN 52101: 03.88

Prüfung von Naturstein und Gesteinskörnungen - Probenahme
Testing of natural stone and mineral aggregates; Sampling

DIN 51527 - 1: 05.87

Prüfung von Mineralölerzeugnissen; Bestimmung polychlorierter Biphenyle (PCB) - Flüssigchromatographische Vortrennung und Bestimmung 6 ausgewählter PCB mittels eines Gaschromatographen mit Elektronen- Einfang- Detektor (ECD)
Testing of petroleum products; determination of polychlorinated biphenyls (PCB); prepreparation by liquid chromatography and determination of 6 selected PCB by gaschromatography with electron capture detector

ZH 1/183: 04.97

Regeln für Sicherheit und Gesundheitsschutz bei der Arbeit in kontaminierten Bereichen, Hauptverband der gewerblichen Berufsgenossenschaften – Fachausschuß Tiefbau, Ausgabe April 1997
Occupational safety and health protection rules for work in contaminated areas, German Federation of statutory accident insurance institutions for the industrial sector - Technical Committee for Civil Engineering, edition April 1997

VDI-Richtlinie 3865: Messen organischer Bodenverunreinigungen

VDI Guideline 3865: Measuring organic soil contaminations

- Blatt 1: Messen leichtflüchtiger halogenierter Kohlenwasserstoffe, Meßplanung für Bodenluft-Untersuchungsverfahren (Okt. 1992);

- Sheet 1: Measurement of volatile halogenated hydrocarbons; planning of soil gas measurement methods (October 1992)

- Blatt 2: Techniken für die aktive Entnahme von Bodenluftproben (Januar 1998);

- Sheet 2: Techniques of active sampling of soil gas (January 1998)

- Blatt 3: Messen organischer Bodenverunreinigungen; Gaschromatographische Bestimmung von niedrigsiedenden organischen Verbindungen in Bodenluft nach Anreicherung an Aktivkohle oder XAD-4 und Desorption mit organischen Lösungsmitteln (Entwurf November 1996);

- Sheet 3: Measurement of organic soil pollutants; gas-chromatographic determination of volatile organic compounds in soil gas adsorption at activated coal and desorption with organic solvents (draft November 1996);

VDI-Richtlinie 3499, Blatt 1: Messen von Emissionen – Messen von Reststoffen, Messen von polychlorierten Dibenzodioxinen und –furanen in Rein- und Rohgas von Feuerungsanlagen mit der Verdünnungsmethode, Bestimmung in Filterstaub, Kesselasche und in Schlacken. VDI-Handbuch Reinhaltung der Luft, Band 5 (Entwurf März 1990)

VDI Guideline 3499, Sheet 1: Emission measurement – measurement of residual materials, determination of polychlorinated dibenzodioxins and dibenzofurans in flue and

stack gas from incineration and firing plants; dilution method; determination in filter dust, pot ash and slag. VDI Manual on Air Pollution Control, vol. 5 (draft March 1990)

Arbeitsgruppe Bodenkunde der Geologischen Landesämter und der Bundesanstalt für Geowissenschaften und Rohstoffe (1994): Bodenkundliche Kartieranleitung – 4. Auflage, berichtigter Nachdruck Hannover 1996, E. Schweizerbart'sche Verlagsbuchhandlung Stuttgart

Working Group on Pedology of the Geological State Offices and the Federal Institute for Geoscience and Natural Resources (1994): Pedological Mapping Guide - 4th edition, corrected reprint, Hannover 1996, E. Schweizerbart'sche Verlagsbuchhandlung Stuttgart

Landesumweltamt Nordrhein-Westfalen (LUA NRW): Bestimmung von polyzyklischen aromatischen Kohlenwasserstoffen (PAK) in Bodenproben. Merkblätter LUA NRW Nr. 1, Essen 1994

State Environment Agency of North Rhine-Westphalia (LUA NRW): Determination of polycyclic aromatic hydrocarbons (PAH) in soil samples, Guidelines LUA NRW No. 1, Essen 1994

Hessische Landesanstalt für Umwelt (LfU HE): Bestimmung von Polycyclischen Aromatischen Kohlenwasserstoffen in Feststoffen aus dem Altlastenbereich, Handbuch Altlasten, Band 7, Wiesbaden 1998

Hessen State Institute for the Environment (LfU HE): Determination of polycyclic aromatic hydrocarbons (PAH) in solids from the contaminated sites sector. Manual on Contaminated Sites Management, vol. 7, Wiesbaden 1998

Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten (VDLUFA): Methodenbuch, Band VII Umweltanalytik, VDLUFA-Verlag Darmstadt 1996

Association of German Agricultural Testing and Research Institutions (VDLUFA): Book of Methods, vol. VII Environmental Analyses, VDLUFA-Verlag Darmstadt 1996

6.2 Sources of Supply

The standards, technical regulations and other provisions on methods can be obtained from:

- a) DIN and ISO standards and draft standards, VDI Guidelines -
DIN- und ISO-Normen und Normenentwürfe, VDI-Richtlinien: Beuth-Verlag GmbH, 10772 Berlin
- b) Pedological Mapping Guide -
Bodenkundliche Kartieranleitung: E. Schweizerbart'sche Verlagsbuchhandlung, 70176 Stuttgart

- c) VDLUFA Book of Methods (Methodenbuch): VDLUFA-Verlag, 64293 Darmstadt
- d) Guidelines of the LUA NRW: Landesumweltamt NRW, 45023 Essen
- e) Manual on Contaminated Sites Management of the LfU HE: Hessische Landesanstalt für Umwelt, 65022 Wiesbaden
- f) ZH 1/183: Main Federation of Trade Cooperative Associations - Technical Committee for Civil Engineering
Hauptverband der gewerblichen Berufsgenossenschaften, Fachausschuß Tiefbau, 81241 München

Action, trigger and precautionary values

1. Soil - human health pathway (direct contact)

1.1 Definition of uses

a) Playgrounds

Places for children that are generally used for playing, without the play sand in sandpits. If necessary, officially designated playgrounds must be evaluated on the basis of public health standards.

b) Residential areas

Areas serving housing purposes, including back gardens or any other gardens of similar use, including where they are not represented or specified under planning law within the meaning of the Building Use Ordinance, except for parks and recreational facilities, playgrounds, as well as paved traffic surfaces.

c) Parks and recreational facilities

Facilities serving social, health and sports purposes, in particular public and private green areas as well as unpaved areas that are regularly accessible and used in a comparable way.

d) Plots of land used for industrial and commercial purposes

Unpaved areas within workplaces or manufacturing plants which are used only during working hours.

1.2 Action values pursuant to Article 8 (1) second sentence No. 2 of the Federal Soil Protection Act for the direct intake of dioxins/furanes at playgrounds, in residential areas, parks and recreational facilities, and plots of land used for industrial and commercial purposes (in ng/kg dry matter, fine soil, analysis according to Annex 1).

Substance	Action values [ng I-TEq/kg TM]*)			
	Playgrounds	Residential areas	Parks and recreational facilities	Land used for industrial and commercial purposes
Dioxins/furanes (PCDD/F)	100	1,000	1,000	10,000

*) Sum of the 2,3,7,8-TCDD-toxicity equivalents (according to NATO/CCMS).

1.3 Application of the Action Values

In the event of dioxin-containing lye residues from copper slate, the action values, due to the low level of resorption in the human organism, must be applied not directly to protect human health but for long-term risk prevention.

1.4 Trigger values pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act for the direct intake of pollutants at playgrounds, in residential areas, parks and recreational facilities, and plots of land used for industrial and commercial purposes (in mg/kg dry matter, fine soil, analysis according to Annex 1)

Substance	Trigger values [mg/kg TM]			
	Playgrounds	Residential areas	Parks and recreational facilities	Land used for industrial and commercial purposes
Arsenic	25	50	125	140
Lead	200	400	1,000	2,000
Cadmium	10 ¹⁾	20 ¹⁾	50	60
Cyanides	50	50	50	100
Chromium	200	400	1,000	1,000
Nickel	70	140	350	900
Mercury	10	20	50	80
Aldrin	2	4	10	--
Benzo(a)pyrene	2	4	10	12
DDT	40	80	200	--
Hexachlorobenzene	4	8	20	200
Hexachlorocyclohexane (HCH-mix or β -HCH)	5	10	25	400
Pentachlorophenol	50	100	250	250
Polychlorinated biphenyls (PCP ₆) ²⁾	0.4	0.8	2	40

1) In back gardens and small gardens where children stay and food plants are grown, the trigger value 2.0 mg/kg TM must be applied in the case of cadmium.

2) Where PCB total contents are determined, the measured values must be divided by a factor of 5.

2. Soil – plant pathway

2.1 Definition of uses

a) Agriculture

areas for the cultivation of varying field crops, including vegetables and field forage plants; this also includes areas used for commercial gardening

b) Vegetable garden

back garden, small garden and any other garden areas used for growing food crops

c) Grassland

permanent green areas

2.2 Trigger and action values pursuant to Article 8 (1) second sentence Nos. 1 and 2 of the Federal Soil Protection Act for the pollutant transition soil - plant in agricultural land and in vegetable gardens, with regard to plant quality (in mg/kg dry matter, fine soil, analysis according to Annex 1)

Substance	Agriculture, vegetable garden		
	Method ¹⁾	Trigger value	Action value
Arsenic	KW	200 ²⁾	--
Cadmium	AN	--	0.04/0.1 ³⁾
Lead	AN	0.1	--
Mercury	KW	5	--
Thallium	AN	0.1	--
Benzo(a)pyrene	--	1	--

1) Extraction process for arsenic and heavy metals: AN - ammonium nitrate, KW = aqua regia (Königswasser)

2) In the case of soils with temporarily decreasing conditions, a trigger value of 50 mg/kg dry matter must be applied.

3) In areas that are used for growing bread wheat or strongly cadmium-accumulating vegetables, an action value of 0.04 mg/kg dry matter must be applied; otherwise, the action value is 0.1 mg/kg dry matter

2.3 Action values (pursuant to Article 8 (1) second sentence No. 2 of the Federal Soil Protection Act) in relation to plant quality for the pollutant transition soil - plant on grassland areas (in mg/kg dry matter, fine soil, arsenic and heavy metals in aqua regia extract, analysis according to Annex 1)

	Grassland
Substance	Action value
Arsenic	50
Lead	1,200
Cadmium	20
Copper	1,300 ¹⁾
Nickel	1,900
Mercury	2
Thallium	15
Polychlorinated biphenyls (PCB ₆)	0.2

1) Where sheep are kept on grassland, the applicable action value is 200 mg/kg dry matter.

2.4 Trigger values pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act for the pollutant transition soil - plant on agricultural land, with regard to growth impairments of cultivated plants (in mg/kg dry matter, fine soil, in ammonium nitrate extract, analysis according to Annex 1)

	Agriculture
Substance	Trigger value
Arsenic	0.4
Copper	1
Nickel	1.5
Zinc	2

2.5 Application of the trigger and action values

The trigger and action values must be applied in the assessment of pollutant concentrations at soil depths ranging from 0 to 30 cm for agricultural land and in vegetable gardens, as well as soil depths ranging from 0 to 10 cm for grassland according to Annex 1 No. 2.1 table 1. For greater soil depths referred to in Annex 1 No. 2.1 table 1, the values must be multiplied by a factor of 1.5.

3. Soil – groundwater pathway

3.1 Trigger values for the assessment of the soil - groundwater pathway pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act (in µg/l, analysis according to Annex 1)

Inorganic substances	Trigger value [$\mu\text{g/l}$]
Antimony	10
Arsenic	10
Lead	25
Cadmium	5
Chromium, total	50
Chromate	8
Cobalt	50
Copper	50
Molybdenum	50
Nickel	50
Mercury	1
Selenium	10
Zinc	500
Tin	40
Cyanides, total	50
Cyanides, volatile	10
Fluoride	750

Organic substances	Trigger value [$\mu\text{g/l}$]
Petroleum hydrocarbons ¹⁾	200
BTEX ²⁾	20
Benzene	1
Volatile halogenated hydrocarbons ³⁾	10
Aldrin	0.1
DDT	0.1
Phenols	20
PCB, total ⁴⁾	0.05
PAH, total ⁵⁾	0.20
Naphthalene	2

1) n-alkanes (C10 C39), isoalkanes, cycloalkanes and aromatic hydrocarbons

2) Volatile aromatic hydrocarbons (benzene, toluene, xylenes, ethylbenzene, styrene, cumene)

3) Volatile halogenated hydrocarbons (sum of the halogenated C1 and C2 hydrocarbons)

4) PCB, total: sum of the polychlorinated biphenyls; as a rule, determination by way of the 6 congeners according to Ballschmiter pursuant to Ordinance on Waste Oils (DIN 51527) multiplied by a factor of 5; if applicable, for example in the case of a known substance spectrum, simple formation of the sum of all relevant individual substances (DIN 38407-32 or 3-3).

5) PAH, total: sum of the polycyclic aromatic hydrocarbons without naphthalene and methylnaphthalenes; as a rule, determination by way of the sum of 15 individual substances according to the list of the US Environmental Protection Agency (EPA) without naphthalene; if applicable, inclusion of other relevant PAHs (e.g. quinolines).

3.2 Application of the trigger values

- a) The trigger values are applicable to the transition area from the unsaturated to the water-saturated soil zone (place of assessment). The place where the soil samples are taken is not necessarily identical with the place of assessment for the groundwater.

- b) When assessing whether the trigger values for leachate are likely to be exceeded at the place of assessment, account must be taken of changes in pollutant concentrations in the leachate passing through the unsaturated soil zone, as well as of the isobaths of the groundwater table and their variations.
- c) In the case of abandoned waste deposits, it is generally not expedient to estimate pollutant concentrations in the leachate on the basis of material tests because of inhomogeneities in the deposited wastes. This applies accordingly to abandoned industrial sites showing particularly uneven patterns of pollutant distribution. In these cases, the pollutant concentrations in the leachate can be estimated by drawing conclusions or calculating back from flow-off measurements in the groundwater, in particular by giving consideration to the substance concentration in the influx.
- d) If the pollutant concentrations in the leachate can be measured directly, soil samples must, where possible, be taken at the place of assessment for the groundwater.
- e) If adverse soil alterations and contaminated sites are located in the water-saturated soil zone, they must be examined in accordance with the applicable provisions of water law to assess their risk for the groundwater.
- f) When trigger values are applied, account must be taken of the geogenic background of the groundwater region in question.

4. Precautionary values for soils pursuant to Article 8 (2) No. 1 of the Federal Soil Protection Act (analysis according to Annex 1)

4.1 Precautionary values for metals (in mg/kg dry matter, fine soil, aqua regia decomposition)

Soils	Cadmium	Lead	Chromium	Copper	Mercury	Nickel	Zinc
Soil type <i>clay</i>	1.5	100	100	60	1	70	200
Soil type <i>loam/silt</i>	1	70	60	40	0.5	50	150
Soil type <i>sand</i>	0.4	40	30	20	0.1	15	60
Soils with naturally increased and settlement-related increased background concentrations over large areas	safe, provided that the release of pollutants or additional inputs pursuant to Article 9 (2) and (3) of this Ordinance do not give reason to expect any adverse impacts on the soil functions						

4.2 Precautionary values for organic substances (in mg/kg dry matter, fine soil)

Soils	Polychlorinated biphenyls (PCB ₆)	Benzo(a)pyrene	Polycyclic aromatic hydrocarbons (PAH ₁₆)
Humus content > 8 %	0.1	1	10
Humus content ≤ 8 %	0.05	0.3	3

4.3 Application of the precautionary values

- a) The precautionary values are differentiated by the main soil types in accordance with the Pedological Mapping Guide, 4th edition, corrected reprint 1996; they consider the precautionary protection of the soil functions in the case of sensitive uses. Agricultural soil use is governed by Article 17 (1) of the Federal Soil Protection Act.
- b) Highly silty sands must be evaluated according to soil type loam/silt.
- c) For the precautionary values of table 4.1, the acid content of the soils must be considered as follows:
 - For soils of soil type clay with a pH-value < 6.0, cadmium, nickel and zinc are subject to the precautionary values for soil type loam/silt.
 - For soils of soil type loam/silt with a pH-value of < 6.0, cadmium, nickel and zinc are subject to the precautionary values for soil type sand. Article 4 (8) second sentence of the Sewage Sludge Ordinance of 15 April 1992 (BGBI. I p. 912), last amended by the Ordinance of 6 March 1997 (BGBI. I p. 446) remains unaffected.
 - For soils with a pH-value of < 5.0, the precautionary values for lead must be reduced in accordance with the first two indents above.
- d) The precautionary values of table 4.1 are not applied to soils and soil horizons with a humus content exceeding 8 %. If applicable, the competent authorities may take region-specific decisions for these soils.

5. Permissible additional annual pollutant loads through all pathways pursuant to Article 8 (2) No. 2 of the Federal Soil Protection Act (in g/ha)

Element	Load [g/ha a]
Lead	400
Cadmium	6
Chromium	300
Copper	360
Nickel	100
Mercury	1.5
Zinc	1,200

Annex 3

Requirements concerning remediation investigations and the remediation plan

1. Remediation investigations

Remediation investigations in the case of contaminated sites are to identify the measures that are suitable, necessary and appropriate for the fulfilment of duties specified in Article 4 (3) of the Federal Soil Protection Act. Measures that qualify must be represented, taking into account combinations of measures and necessary accompanying measures.

The study must examine in particular

- the suitability of methods with respect to pollutants, soil, material and location
- the technical feasibility
- the time requirement
- the effectiveness with regard to the remediation objective
- a cost estimate as well as the proportion of costs and effectiveness
- the impacts on the parties concerned as defined by Article 12 first sentence of the Federal Soil Protection Act as well as on the environment
- the requirement of licences
- the generation, recovery and disposal of waste
- industrial safety
- duration of the effect of the measures and possibilities for monitoring them
- aftercare requirements and
- possibilities for subsequent improvement.

The study must be conducted making use of available data, in particular from investigations pursuant to Article 3 of this Ordinance, as well as on the basis of any other reliable findings. Where such information does not suffice, especially for allowing a reliable delimitation of polluted areas or for assessing the suitability of remediation methods in the individual case, supplementary investigations must be conducted to verify the suitability of the method in question.

The results of the study and the concept of measures to be given preference in view of these results must be represented.

2. Remediation plan

A remediation plan must contain the information listed under Nos. 1 to 5 below as well as the information and documents necessary for it to be declared binding pursuant to Article 13 (6) of the Federal Soil Protection Act.

1. Statement of the initial situation, in particular with regard to
 - the local conditions (among others, geological, hydrogeological situation; current use and use admissible under planning law)
 - the hazard situation (summary of the investigations pursuant to Article 3 of this Ordinance with a focus on the pollutant stock, which specifies pollutant type, amount and distribution, as well as on affected pathways and resources and needs requiring protection)
 - the remediation objectives
 - the decisions taken by authorities and the public-law contracts concluded (notably with regard to the concept of measures) which will have an effect on the fulfilment of duties pursuant to Article 4 of the Federal Soil Protection Act, and
 - the results of the remediation investigations.

2. Description in text and drawing of the measures to be carried out and provision of proof of their suitability, in particular with regard to
 - the area of impact of the contaminated site and the land that will be needed for the planned measures
 - the area covered by the remediation plan
 - the elements and the course of the remediation with regard to
 - o the construction schedule
 - o earthwork (in particular excavation, separation, re-placing, shifting of soil in the area covered by the remediation plan)
 - o demolition work
 - o intermediate storage of soil material and other materials
 - o waste disposal during operation of installations
 - o the use of soils and the deposition of waste in landfills and
 - o industrial safety and immission control measures
 - specific technical calculations regarding
 - o on-site soil treatment facilities
 - o in-situ measures
 - o installations for the collection and treatment of landfill gas or soil gas
 - o groundwater treatment facilities
 - o installations and measures for the collection and treatment of leachate in particular

- the amounts to be treated and the transport routes in the case of soil treatment at off-site installations
 - the technical planning of securing measures and accompanying measures, in particular of
 - o surface, vertical and base sealings
 - o surface covering layers
 - o intermediate storage and/or disposition depots
 - o accompanying passive pneumatic, hydraulic or other measures (e.g. drainage of the construction field, drainage of the excavated material, encasement, exhaust air collection and treatment) and
 - the requirements in connection with official licences for the measures to be carried out.
3. Description of the internal control measures to check the correct execution and effectiveness of the planned measures, in particular
- the monitoring concept with regard to
 - o soil management in cases involving excavation, separation and re-placing
 - o soil and groundwater treatment, degassing or soil gas extraction
 - o industrial safety and immission control
 - o the accompanying sampling and analyses and
 - the investigation concept for materials and construction components in building construction.
4. Description of the internal control measures within the scope of aftercare including monitoring, in particular with regard to
- the requirement and design of facilities or installations for the collection and treatment of groundwater, leachate, surface water, soil gas or landfill gas which are intended for long-term operation, as well as requirements with respect to their monitoring and maintenance
 - monitoring measures (e.g. measuring stations) and
 - function control with regard to compliance with remediation requirements and maintenance of securing structures or facilities
5. Description of time schedule and costs.

Requirements concerning the investigation and evaluation
of areas where there is suspicion of the existence of an adverse soil
alteration resulting from soil erosion by water

1. Application

Pursuant to Article 8, this Annex shall be applied to the investigation of areas where there is suspicion of the existence of an adverse soil alteration resulting from soil erosion by water.

2. Investigation and evaluation

If there is evidence of the existence of an adverse soil alteration resulting from soil erosion by water, it must first be examined

- a) whether significant amounts of soil material were washed out of the erosion area and
- b) from which erosion areas the washed-off soil originated and what were the causes of the erosion.

Evidence for identifying the erosion area includes in particular clearly noticeable points of transition of soil material from the erosion area to areas located outside the erosion area and affected by the soil material. Other possible clues include the existence of clearly visible erosion forms in the erosion area. In an investigation according to letter a., it may be necessary to estimate the amount of soil washed off a suspected site during a given erosion event or as a consequence of erosion events that took place at intervals of a few weeks at the most. This can be done by means of the "Mapping Guide for the Identification of Current Forms of Erosion" (DVWK 1996).

For an assessment of the probability of a re-occurrence of soil erosion events pursuant to Article 8 (1), particular attention must be given to the statistical evaluations of precipitation recordings taken by the *Deutscher Wetterdienst* in a specific area over many years. Erosion forecast models may also be used for this purpose, provided that they can be proven to be suitable for assessing, with sufficient accuracy, the amounts of soil washed off from the erosion areas during given erosion events.

The prerequisites for the expectation of further soil erosion pursuant to Article 8 (1) No. 2 are normally deemed to be fulfilled if significant amounts of soil material have been washed out of the same erosion area on at least one other occasion during the past ten years.