Soil Remediation Circular 2013

Soil Remediation Circular 2013, version of 1 July 2013
(This version replaces previous versions of this Circular with effect from 1 July 2013)

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1. Introduction

This chapter covers the reasons for drafting this Circular in 2006 and for amending it in 2008, 2009, and 2011. It also provides an explanation of the subject, the status, and the scope of the Circular, as well as the period it will remain in force. Furthermore, it includes an overview of new and repealed legislation concerning the topic of the Circular.

1.1 Background

The Act amending the Soil Protection Act ('Wbb'; Stb, 2005a) entered into force on 1 January 2006. This statutory amendment implemented the policy intentions formulated in 2002 in the government's Position Statement on modernising policy for soil remediation[1]. Following this, in late December 2003, a Policy Letter on the next step in modernising soil policy was sent to the Lower House of Parliament[2]; it set out the policy intentions that had an impact on the aforementioned statutory amendment.

On 1 January 2008, the first phase of the Soil Quality Decree ('Bbk'; Stb, 2007) entered into force, regulating the use of soil and dredging sludge in bodies of surface water (water bottom). On 1 July 2008, the second phase of the Soil Quality Decree entered into force, regulating the use of soil and dredging sludge on land and the use of building materials on or in the soil and in bodies of surface water.
This Circular focuses on the elaboration of the remediation criterion used to determine whether urgent remediation is necessary. The environmental protection remediation criterion (hereinafter referred to as the Remediation Criterion) is included in the amended text of Section 37 of the Soil Protection Act. This Circular also discusses the details of the Remediation Objective, as included in the amended text of Section 38 of the Soil Protection Act. In working out the Remediation Objective, harmonisation with the Soil Quality Decree was aimed for.

The decision to draw up a Circular was taken in 2006 with the aim of providing clarity quickly about the practical implementation of the two articles above. As a result of two years' practical experience with this Circular, as well as the wish to harmonise it with the new Soil Quality Decree and the repeal of the Circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000) as of 1 October 2008, this Circular from 2006 has been amended as of 1 October 2008. The amendment of the Circular has resulted in a change in the soil Intervention Values.

As a result of the amendment in the standardisation, some adverse situations have occurred in practice since 1 October 2008, constituting an undesirable increase in the number of cases of severe soil contamination. In particular, the problem occurred with regard to the tightened soil Intervention Value for the aggregate value for drins, which resulted in an tremendous increase in the number of sites defined ‘cases of severe contamination’ under the Soil Protection Act. As a result of the undesirable effects, the soil Intervention Values for drins (aggr.), DDE and DDT have been reconsidered. Among other aspects, the Circular has been amended in this respect in 2009. The soil Intervention Value for barium, the assessment of human risks for lead, and the assessment of urgency for ecology (Step 2) have also been partially amended in 2009.

An amended version of the Soil Remediation Circular was published on 3 April 2012. The 2012 amendments include:

- The scope of this Circular as a result of the Water Act entering into force
- The assessment of the ecological risks in Steps 2 and 3
- The amended assessment of the human risks of soil contamination with lead
- The amended protocol for the risk assessment of asbestos
- A clarification of the relation with the Soil Quality Decree

[1] Lower House of Parliament, 2001-2002, 28 199, No. 1
[2] Lower House of Parliament, 2003-2004, 28 199, No. 13

- The area-based approach of contaminated groundwater (distinction between source zone and plume)
- A refinement of the use of the stable end situation as a result of an increasing use of the subsoil
- An updated version of the Directive for handling non-standardized substances has been added, which lost its relevance with the repeal of the Circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000)
- Updated references to legislation and literature

The Soil Remediation Circular was slightly revised in 2013. The main revisions are the following:
- The procedure for measured values below the Limit of Quantification and the application of the soil type correction as set out in Annex 1 to the Circular was aligned with the amended Soil Quality Regulation, which enters into effect on 1 July 2013.
- Updated references to legislation and literature

The Act provides jurisdiction to set general regulations for both the Remediation Criterion and the Remediation Objective. Decisions with regard to framing those regulations will also be made based on practical experience following application of this Circular.

1.2 Status and scope of the Circular, period it will remain in force

This Circular is set up as a number of directives, which is to say that, with a view to exercising caution in decision-making, the competent authority pursuant to the Soil Protection Act (hereinafter referred to as the Competent Authority) must take into account the provisions contained in it. For specific situations, the Competent Authority may justify and allow customisation.

The directives relate to historical cases of soil contamination on land (a duty of care has applied since 1987). The Soil Protection Act no longer applies to water bottoms since the Water Act entered into force on 22 December 2009. As a result, the Circular on the remediation of water bottoms 2008 (Stcrt, 2007d) was repealed. As a matter of transitional policy, cases of soil contamination in water bottoms that were deemed severe and urgent under the Soil Protection Act, will be settled under that Act. After the decision on the assessment report, these cases will be transferred to the regime of the Water Act. With the new Water Act, the terminology for water bottoms has also changed: The term for water bottom in the Soil Quality Decree ('bottom under surface water') has been replaced by that of the Water Act ('bottom and bank/shore of a body of surface water'). This Circular follows the terminology of the Water Act. Whereas previously the remediation of water bottoms was governed by the provisions of the Soil Protection Act, now the European Water Framework Directive – as implemented in the Water Act – is decisive for setting quality requirements for bodies of surface water incorporating the water bottom. The provisions of the Water Act apply for implementing measures in the bottom or bank/shore of a body of surface water. The 'dryer embankment areas' designated pursuant to the Water Act (Section 3.1(3) of the Water Act) are an exception. These are soils that are hardly affected by the water or not at all. This is especially relevant for bodies of surface water belonging to the National Rivers. The dryer embankment areas of National Waters have been designated on maps belonging to the Water Regulation (see www.helpdeskwater.nl). For non-National Waters, the dryer embankment areas are designated by or pursuant to provincial bye-law. The Soil Protection Act and this Circular continue to apply to these soils (Section 6.2(3) of the Water Act in conjunction with Section 99(4) of the Soil Protection Act).

Transboundary contamination is when contaminations in land soil enter the water system and *vice versa*. The approach towards transboundary cases is linked to the site of the contamination source, provided that there is a clear point source. This means that the contamination is handled according to the Soil Protection Act if the source is on land. Section 63c of the Soil Protection Act contains the legal regime for such contaminations and is mirrored by the stipulations in Section 5.17 of the Water Act. The contamination should be deemed 'severe and urgent'. With the act establishing the Water Act, Section 63c of the Soil Protection Act was given its current wording. Section 63c(2) imposes an independent obligation on the Provincial Executive. Within the Competent Authority municipalities, this obligation lies with the mayor and aldermen.

The directives on asbestos have been given their own individual interpretation because asbestos has specific properties that differ from those of other substances. The directives on asbestos are included as Annex 3 to this Circular.

In particular, the scope of this Circular covers risk assessment and the Remediation Objective. The way risks are removed (remediation approach) is determined by the Competent Authority and is not discussed here. As will be explained in Section 4.2 (Remediation Objective – details), the remediation approach is the result of an assessment between the costs and the benefits of removing the risks. For certain ecological risks for instance, removing the contamination may be more damaging to the ecosystem than not intervening.

Relation between the Soil Protection Act and the Environmental Law (General Provisions) Act ('Wabo')
When there are construction activities at a site where there is a case of severe contamination which require a physical environment permit for a building housing occupants (nearly) all of the time, it will not come into effect. The licence will only come into effect if the Competent Authority has established that this is not a case of severe contamination requiring urgent remediation, if the Competent Authority has agreed to the Remediation Plan, or if a BUS[3] report has been made.

1.3 Repeal of previous regulations

This Circular replaces the Circular on the assessment and coordination of the Soil Protection Act remediation regulations (Stcrt, 1998), the Circular on determining the remediation deadline (Stcrt., 1997), the Soil Remediation Circular 2006 (Stcrt, 2006b), the Soil Remediation Circular 2006 as amended on 1 October 2008 (Stcrt, 2008a), and amends the Soil Remediation Circular 2009 (Stcrt, 2009a).
As of October 2002, the Decree and Regulation on site-specific conditions for soil remediation ('LSO') applied, which were intended to substantiate the possibility of departing from the objective of Section 38. With the amendment of Section 38, the Decree and Regulation have been repealed as of 1 January 2006.

When the second part of the Soil Quality Decree – which is concerned with the use of soil and dredging sludge on land – entered into force on 1 July 2008, the Soil Usage Values ('BGWs') were repealed. The Background Values and maximum values that replace the Soil Usage Values as Post-remediation Values are included in the Soil Quality Decree. An explanation of the maximum values is included in the Soil Quality Regulation ('Rbk'; Stcrt, 2007e)[4].

The circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000) was repealed on 1 October 2008. The groundwater Target Values continue to play a role in soil remediation policy and are therefore included in Annex 1 to this Circular. The soil Intervention Values were revised in 2008 on the basis of recent scientific insights. This is discussed extensively in the NOBO Report (VROM, 2008). The Intervention Value for asbestos announced in the Policy Letter on asbestos[5] is also included in Annex 1. The Indicative Levels for severe contamination ('INEVs') are also included in Annex 1.

Annex 7 provides an overview of existing regulations and indicates which regulations have been repealed. The most up-to-date version of the statutory acts and regulations can be found on www.wetten.nl. A complete list of publications is provided in Annex 8 (only available in this

[3] Uniform Remediation Decree
[4] Published as an annex to the Regulation on site-specific conditions for soil remediation, 2002
[5] Lower House of Parliament, 2004, 28 663 and 28 199, No. 15

English version). In the text, literature references are indicated between brackets, e.g. '(RIVM, 2003)'. The complete details, including the Dutch title if applicable, are listed in Annex 8.

It is up to the Competent Authority to determine how to handle situations which have already been assessed, or which were in the process of being assessed when this Circular entered into force. Questions and answers relating to this matter can be found on the website of Bodem+ (please refer to the FAQ section on the Soil Remediation Circular on www.bodemplus.nl).

2. Cases of severe contamination: Section 29 of the Soil Protection Act

This chapter indicates when a case of contamination is deemed severe and what the consequences are. It also examines situations in which contamination exists but which do not constitute a case of severe contamination.

2.1 The case of contamination is severe

A case of contamination is deemed severe if the average concentration of at least one substance measured in a soil volume of at least 25 m^3 in the case of soil contamination, or in a pore-saturated soil volume of at least 100 m^3 in the case of groundwater contamination, is higher than the Intervention Value. In some cases, there may be a case of severe contamination even though the Intervention Value has not been exceeded. Annex 2 describes vulnerable situations of this kind in Step 1 of the Remediation Criterion. A case of contamination may also be deemed severe in cases of contamination with substances for which no Intervention Value has been derived. In specific situations, the Competent Authority can enter into consultation with the National Institute for Public Health and the Environment ('RIVM').

The Environmental Protection Soil Remediation Criterion, Asbestos Protocol, which is included as Annex 3 to this Circular, regulates when a case of soil contamination with asbestos is deemed to constitute a case of severe contamination. In cases of soil contamination with asbestos, the volume criterion is not applicable for determining the severity of the contamination.

The next chapter deals with determining the Remediation Objective and the need for urgent remediation for cases of severe contamination.

2.2 The case of contamination is not severe

If a case of contamination is not severe, there is no need to determine whether urgent remediation is required. Improving soil quality cannot be imposed on the basis of the rules for soil remediation. If a local authority has determined the quality level for a given area on the basis of the Soil Quality Decree (for instance by setting local maximum values), it may lay down that quality level in the Building Decree as the starting point for development activities, depending on its ambition level. This quality level will also apply when soil and dredge is reused in the area. However, if a case of soil contamination is not severe, obligations to make the soil cleaner on the basis of soil remediation regulations cannot be imposed. This is because no potential risk exists that would justify any such obligation.

3. Urgent remediation: Section 37 of the Soil Protection Act

This chapter discusses the criteria that form the basis for determining whether a case of severe contamination requires urgent remediation or not. It also indicates the consequences of the obligation to remediate urgently and of not having to remediate urgently. The chapter concludes with a description of the process for determining the urgency, and with an overview of aspects that the Competent Authority may include in its decision on severity and urgency.

3.1 Urgent remediation

If a case of severe contamination is determined, a potential risk exists that requires a form of remediation or management. Section 37 of the Soil Protection Act is concerned with determining whether the risks for the present or future use of the soil are unacceptable, which would require urgent remediation.
Risks are directly related to the use of the soil and to its function. If the soil's use within the scope of its existing or future function involves unacceptable environmental risks, taking measures as soon as possible is of paramount importance. The primary aim of these measures to be taken is to adequately mitigate the risks occurring. Therefore, it does not mean that the entire case requires urgent remediation. In 2009, this marked a major shift in respect of the former Section 37 of the Soil Protection Act, which formed the basis for determining the urgency of remediation with a view to tackling the entire case in a single operation. The former Section 37 of the Soil Protection Act was concerned with prioritising and tackling cases of contamination, whereas Section 37 of the Soil Protection Act is now primarily concerned with removing the risks in a timely manner. The reason for this shift was that from that moment on, a conscious decision was made to allow a more flexible approach. This is further discussed in Chapter 4.

It should be clear from the decision on severity and urgency which part of the case of severe contamination presents unacceptable risks and requires urgent remediation (see Section 3.5). If the risks concern future use, measures have to be taken to adequately mitigate the risks before any such use takes place. The decision also indicates the management measures that have to be taken – as intended by Section 37(4) of the Soil Protection Act – at the site of the part of the case of severe contamination that does not present unacceptable risks.

The risks that could be a reason for urgent remediation are divided into: a) risks for humans, b) risks for the ecosystem, and c) risks of the contamination spreading to the surrounding area.

Re a) Risks for humans are deemed unacceptable if the site's present or intended use results in a situation in which:

- Chronic adverse effects on health may occur
- Acute adverse effects on health may occur

If the presence of soil contamination in the current use of the soil presents a demonstrable nuisance for humans (e.g. skin irritation and smells), it likewise requires urgent remediation.

Re b) Risks for the ecosystem are deemed unacceptable if the site's present or intended use means that:

- Biodiversity may be harmed (protection of species)
- Recycling functions may be disturbed (protection of processes)
- Bioaccumulation and biomagnification could occur

Re c) Risks of the contamination spreading to the surrounding area are deemed unacceptable in the following situations:

- The ecosystem or the soil's use by humans is jeopardised by contamination spreading through the groundwater and thereby causing nuisance for vulnerable objects
- An uncontrollable situation exists, i.e.:

- There is a layer of floating groundwater contamination which could be moved by activities and processes in the soil, which would result in the contamination spreading
- There is a layer of sinking groundwater contamination which could be moved by activities and processes in the soil, which would result in the contamination spreading
- Spreading contamination has resulted in major groundwater contamination and the contamination continues to spread

In Section 3.4, a step-by-step Risk Assessment Plan is given, with Annex 2 describing the Remediation Criterion method used to determine whether unacceptable risks are deemed to exist for humans, for the ecosystem, or of the contamination spreading. The Remediation Criterion method used for asbestos is described in Annex 3.

3.2 Non-urgent remediation

If, pursuant to Section 37 of the Soil Protection Act, it has been determined that urgent remediation is not required, no term for completing remediation applies. According to Section 37(4) of the Soil Protection Act, (long-term) management measures may be imposed, for instance aimed at specific human or ecological risks. This also applies for risks of contamination spreading related to vulnerable objects (see Annex 2, Section 6). If there is no relation to a vulnerable object, monitoring of contaminated groundwater is not necessary.

Remediation of cases of severe contamination that do not require urgent remediation will usually take place if new developments, such as construction activities or the redevelopment of a site or area, give rise to this. In case of construction activities on or in severely contaminated soil that reduce or displace the contamination, a report to the Competent Authority is compulsory pursuant to Section 28 of the Soil Protection Act. Before the intended activities may be performed, a (partial) Remediation Plan must be drawn up, or a report under the Uniform Remediation Decree ('BUS', Section 39b(3) of the Soil Protection Act) will have to be made. Specific procedures apply for approving the (partial) Remediation Plan and for determining whether the BUS report is in line with the Uniform Remediation Decree.

3.3 Remediation deadline

Any unacceptable risks that exist must be removed as soon as possible. Until remediation has finally removed the risks, unacceptable risks can be mitigated by taking temporary safety measures as intended by Section 37(3) of the Soil Protection Act.
Determining the exact causes of the risks and the necessary measures to remove them may take a considerable time. Therefore, the following guideline applies as an indication of the period that should be adopted within which remediation should commence: within four years of the date on which the decision on severity and urgency was issued.
The Competent Authority sets the exact remediation deadline, tailored to the conditions that site-specific circumstances dictate.

3.4 Step-by-step Risk Assessment Plan

When soil contamination is suspected, sites are assessed at some point to determine whether a case of severe contamination exists. To this end, a more detailed assessment must be performed, in accordance with NTA 5755 (NEN, 2010b).
In cases of severe contamination, the urgency of remediation has to be determined. This is done on the basis of a risk assessment (see Section 3.1). In order to support the calculation of soil contamination risks, the Sanscrit tool is used, available via www.sanscrit.nl. Initially, the risks are determined using a standard risk assessment. This risk assessment is a technical translation of the principles of the Remediation Criterion. For this, a generic model is used in which calculations for various items can be adapted in line with the prevailing circumstances. As it is suitable for

application in the field, this system can be used for any site in the Netherlands, barring bottoms or banks/shores of bodies of surface water. The assessment is generic and errs on the safe side. The idea is that the standard risk assessment suffices in most cases.
In more complex situations however, a more extensive risk assessment may be conducted which takes site-specific circumstances into account. A more detailed and differentiated impression of the risks can be obtained with a site-specific risk assessment, as it focuses on the site, and measurements instead of calculations can be used. Once a site-specific assessment has been conducted, any decisions made must be based on it.

The risk assessment is carried out in the three steps explained below. Steps 1 and 2 must always be carried out. Step 3 is not compulsory but may be carried out if deemed necessary by the initiator or the Competent Authority. Figure 1 shows the risk assessment steps, as well as those of remediation and management. The three risk assessment steps are explained in Annex 2.

Step 1: Determining whether a case of contamination is severe
The objective of Step 1 is to determine whether a case of contamination at a site is severe. This is determined on the basis of a detailed assessment.

Step 1 may yield the following results:

- The case of contamination is not severe

If the case of contamination is not severe, there is no need to determine whether unacceptable risks exist as a result of the contamination being present.

- The case of contamination is severe → Step 2: Standard risk assessment

The following step is always carried out if there is a case of severe contamination: performance of a standard risk assessment (Step 2).

Step 2: Standard risk assessment
The objective of Step 2 is to determine whether unacceptable risks exist for the case of severe contamination or any part of it.

A standard risk assessment method is used to determine whether any risks are involved in the present and/or future use of the contaminated site that would have an unacceptable impact on humans, the ecosystem, or from the point of view of the contamination spreading. Future use is determined by the initiator but must be in keeping with the scope provided by the Land Use Plan. The risk assessment method is

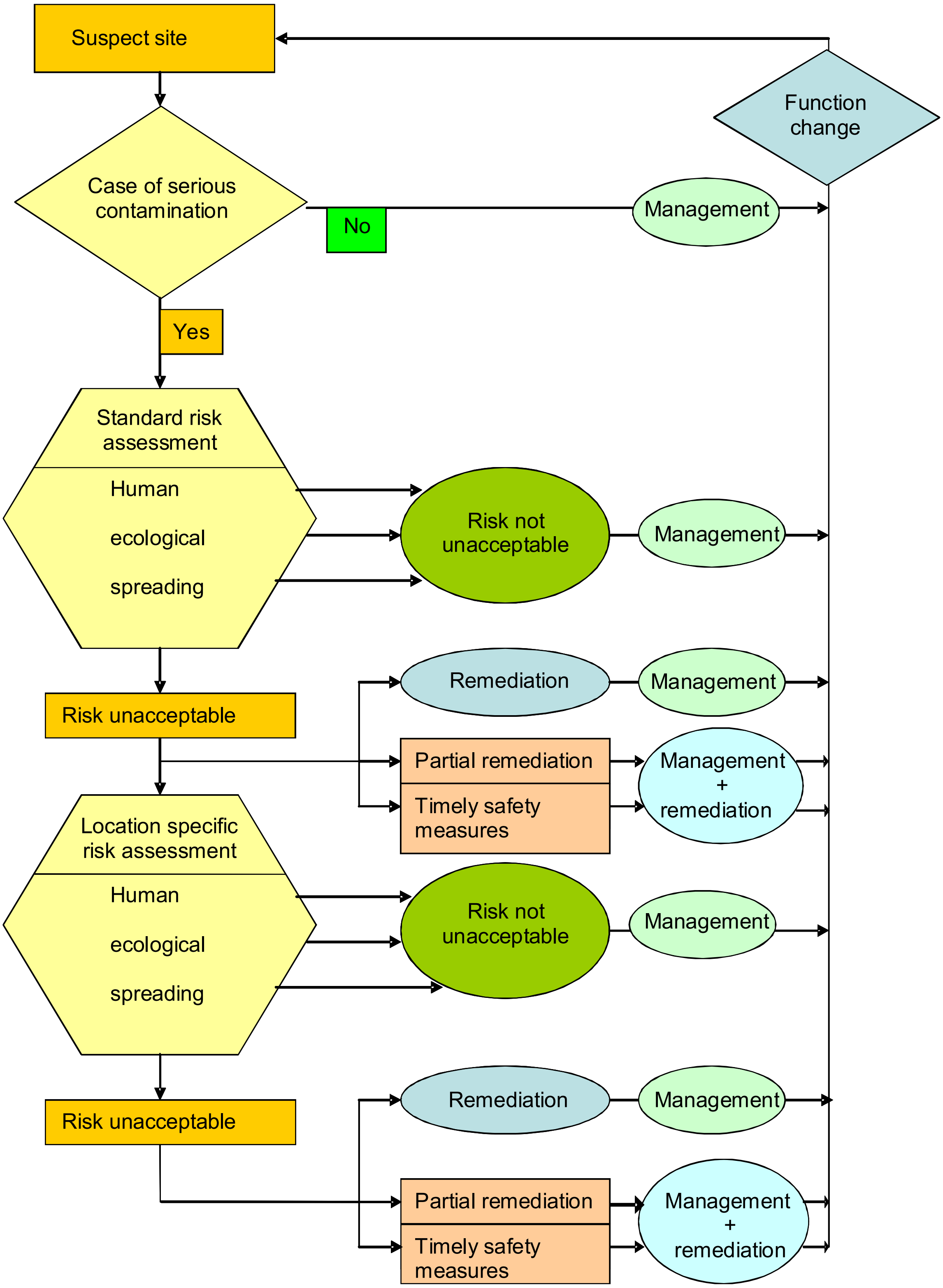

Figure 1: Diagram of soil remediation process

generic and parameters erring on the safe side have been chosen. The risk assessment is conducted as part of the detailed assessment referred to in Step 1.

Step 2 may yield the following results:

- The risk is not unacceptable

If it emerges from the standard risk assessment that the existing soil contamination poses no unacceptable risks in the site's present or future use, urgent remediation is not required. What is required, is a register of limitations with regard to the Intervention Value contour in the soil. Moreover, the Competent Authority has discretion to determine whether some form of management is necessary.

- The risk is unacceptable → Urgent remediation is required

If it emerges from the standard risk assessment that all or part of the existing soil contamination poses an unacceptable risk in the site's present or future use, the part of the case of severe contamination concerned will require urgent remediation.

- The risk is unacceptable → Step 3: Site-specific risk assessment

Given the possibility of an overestimation of the risks in the methods used in Step 2, if it emerges from the standard risk assessment that all or part of the existing contamination poses unacceptable risks in the site's present or future use, there may be cause for expecting a more specific risk assessment for the case of severe contamination concerned to lead to a different conclusion. The initiator may therefore opt to conduct a site-specific risk assessment (Step 3) after the standard risk assessment. The Competent Authority may also call for a site-specific assessment to be carried out if it deems such an assessment necessary for decision-making.

Step 3: Site-specific risk assessment
The objective of Step 3 is to determine for the case of severe contamination or its relevant part whether conducting a site-specific assessment would lead to a different conclusion from that based on the result of the standard risk assessment in Step 2 (‘The risk is unacceptable’), or whether it would confirm and further substantiate the result obtained in Step 2. The result obtained in Step 3 may also lead to better dimensioning of the remediation measures.

Step 3 may yield the following results:

- The risk is not unacceptable

If it emerges from the site-specific risk assessment that the existing soil contamination poses no unacceptable risks in the site's present or future use, urgent remediation is not required. What is required, is a register of limitations with regard to the Intervention Value contour in the soil. Moreover, the Competent Authority has discretion to determine whether some form of management is necessary.

- The risk is unacceptable → Urgent remediation is required

If the site-specific risk assessment leads to the same conclusion as the standard risk assessment in Step 2, it confirms that all or part of the existing soil contamination poses unacceptable risks in the site's present or future use. The part of the case of severe contamination concerned will require urgent remediation. Section 5.3 discusses various possibilities for the approach taken to remediation.

3.5 Decision on severity and urgency

The decision on severity and urgency may cover the following matters, if the site's present or intended use involves unacceptable risks:

- The level of contamination and scale of the case of severe contamination or the part of it that has been assessed

- The register of limitations with regard to the Intervention Value contour in the soil
- The unacceptable risks that exist for the present or intended use
- The part of the contamination that causes unacceptable risks
- When the remediation / remediation phases must commence
- When the Remediation Plans must be submitted
- Which temporary safety measures have to be taken and when a report on their implementation must be made
- Which management measures have to be taken to protect the soil in the part of the case of severe contamination for which it has been established that no unacceptable risks exists and when a report on their implementation must be made; these control measures include:
    - Monitoring measures and the associated reporting obligations
    - Measures to prevent the contamination from spreading
    - Limitations on use
- The relevant changes in use that have to be reported to the Competent Authority

The decision on severity and urgency may cover the following matters, if the site's present or intended use does <u>not</u> involve unacceptable risks:
- The level of contamination and scale of the case of severe contamination or the part of it that has been assessed
- The confirmation that the present or intended use does not involve any unacceptable risks
- The register of limitations with regard to the Intervention Value contour in the soil
- Which control measures have to be taken to protect the soil and when a report on their implementation must be made; these control measures include:
    - Monitoring measures aimed at risks of contamination spreading in relation to vulnerable objects requiring protection
    - Limitations on use
- The relevant changes in use that have to be reported to the Competent Authority

The decision on severity and urgency cannot be a *pro forma* decision. For each case of severe contamination, a standard risk assessment that can be used as a basis for determining whether or not urgent remediation is required has to be made in all instances.

4. Remediation Objective: Section 38 of the Soil Protection Act

Section 38 of the Soil Protection Act contains a description of the Remediation Objective. Based on the objective described, function-based, cost-effective remediation has been possible since 1 January 2006. This chapter discusses the determination of the Remediation Objective for cases of severe contamination and the way in which this function-based, cost-effective remediation can be realised.

4.1 The Remediation Objective of the Soil Protection Act

4.1.1 General

The provisions of Section 38(1) of the Soil Protection Act determine the Remediation Objective. The remediation must make the soil at least suitable for the function designated to it after remediation, whereby the risk for humans, plants, or animals as a result of exposure to the contamination must be minimised. In addition, the remediation must minimise the risks of the contaminants spreading as well as the necessity of taking measures and imposing restrictions on use after remediation (follow-up). This means that the costs must be commensurate with the result of remediation.

In view of the objective to minimise the risks of spreading of contaminations in the groundwater, the following aspects are important:

- The use of the soil because of the direct connection with the presence of vulnerable objects within the area that may be affected by the groundwater contamination. This concerns the risks due to spreading.
- The condition of the soil because of the direct connection with the presence of floating layers, sinking layers, and/or the spreading itself. This mainly concerns the risks of spreading as such, which may cause an uncontrollable situation.

With a view to the risks of spreading, the focus of the remediation must be on the future use of the soil (retaining/restoring functional quality) and on making the contamination present controllable. This can be realised in a cost-effective manner, which means that the expenses must be in proportion to the benefits of the remediation.

Apart from the costs, these may include the duration of remediation, follow-up measures, uncertainty about achieving the intended remediation results, and the impact on other environmental media. Benefits may include the reduced risk, restoration of functional possibilities, the volume removed, the creation of possibilities for natural attenuation, and reduced liability. Besides these generic aspects, expenses and benefits may also relate to regional or local aspects for which the Competent Authority concerned has established a policy.

If follow-up measures are necessary to maintain and/or check the results of remediation (including monitoring), they must be sufficient to ensure that the contamination remaining after remediation will not result in a reduction in the quality of the soil achieved after remediation (Section 39(d) of the Soil Protection Act). It must be clear from reasons set out in the Remediation Plan whether the aforementioned requirements will be met.

For the application of the Remediation Objective in the field, it is important to make a distinction between contamination situations that are immobile and mobile (hereafter referred to simply as immobile and mobile contaminations). For immobile contaminations, the emphasis must be on function-based remediation, whereas for mobile contaminations, the cost-effectiveness of the remediation plays an central role.

4.1.2 Remediation Objective for immobile contaminations

In the case of immobile contaminations, the Remediation Objective will be primarily determined by the suitability of the soil for the existing or intended function (the use of the soil). The Competent Authority should preferably link up with the Soil Quality Decree in such cases. Soil Function Class will then play a central role in determining the Post-remediation Value if removal, reorganisation and/or treatment (e.g. sifting) operations take place at the remediation site. If local maximum values have been determined for the area in which the remediation site is located, these will be used as the Post-remediation Value. If not, the standard value (Background Value, Maximum Housing Value or Maximum Industrial Value) corresponding with the Soil Function Class will apply. The Soil Function Class is determined based on the Function Map, and if no Function Map is available or if the area has not been classified, the Background Value will be used. The Competent Authority under the Soil Protection Act may make a substantiated choice for a different Post-remediation Value, for instance based on future utilisation or the actual function instead of the function as indicated on the Function Map. The reason for a deviating Remediation Objective may also be concerned with area-specific circumstances, as applied in the extensive contamination in the De Kempen area for instance.

For the determination of the details of the Remediation Objective, it is also important whether soil is being supplied from elsewhere. If this is the case (backfill soil, laying topsoil), the Soil Quality Decree will apply. The supplied soil must meet the following requirements:

- If the remediation site is located in an area for which local maximum values have been laid down in accordance with the Soil Quality Decree, these will be used as the quality requirement.
- If not, the generic policy according to the Soil Quality Decree will apply. The quality requirement will be determined based on the Soil Function Class and the Soil Quality Class. The more stringent requirement of the two will be decisive. The Soil Function Class is determined based on the Function Map, and if no Function Map is available or if the area has not been classified, the Background Value will be used as the quality requirement. The Soil Quality Class is determined based on the Soil Quality Map. If no Soil Quality Map is available, the site will be classified based on the soil quality of the area surrounding the remediation site.

It is clear that in an ideal situation, the Remediation Objective corresponds with the requirements of the Soil Quality Decree. In such a situation, the site will be considered suitable for its function in the long term. If in special circumstances, it appears from considerations of cost-effectiveness that a function-based Remediation Objective is not feasible, it can be deviated from, provided that the reasons are stated.

Annex 4 further addresses the remediation result to be realised.

4.1.3 Remediation Objective for mobile contaminations

Soil contamination is considered to be mobile if it has ended up in the groundwater (via the soil's solid phase or otherwise) and can spread within or via the groundwater[6]. For the remediation approach, it is important to distinguish between the source zone and the plume of the contamination. In cases of mobile contamination, the source zone is the area in which the concentrations of contaminants in the soil and/or the groundwater are so high that spreading to the surrounding groundwater will or may occur for a longer period of time[7]. The plume refers to the contamination of the groundwater beyond the source zone.
Based on the above definition, a sinking layer (see Section 6.2.2.) is formally considered part of the source zone. To what extent the sinking layer can actually be remediated in a cost-effective manner will need to be assessed on a case-by-case basis.

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[6] For contaminations covered by the Uniform Remediation Decree, an exceeding of the intermediate value in the groundwater is assumed as the criterion for a mobile contamination situation.

[7] In the NEN 5740 standard (NEN, 2009), ‘source location’ is defined as the geographically defined soil volume which contains such concentrations of one or more contaminants that spreading of the contamination to the plume in the groundwater may or will occur over a longer period of time (as a result of the contaminants being dissolved). As contaminations in the solid phase of the soil may be defined unambiguously, the term ‘source location’ is quite useful. For contaminations also present in the groundwater, the term ‘source zone’ may be more appropriate.

Remediation of mobile contaminations should result in a quality of the soil and groundwater that allows for the intended use of the topsoil and subsoil, minimises the risks of (residual) contamination spreading after remediation, and requires as few follow-up measures as possible. This can be deemed to be a 'stable, environmentally acceptable end result'. This description does not concern a generic, legally binding definition of a 'stable end result'. It mainly has relative significance because of the connection with the cost-effectiveness of remediation.
What is assessed as cost-effective and can be designated as a good proportion between expenses and benefits of remediation (including local methods) depends on a great many factors. This is illustrated by the following examples:

- If the source zone and the plume of a contamination are relatively small, virtually full removal will – depending on the technical feasibility – usually be regarded as the 'most cost-effective' approach to the given situation as a consequence of, among other things, the freedom to decide on the site's utilization and development as well as the absence of any duty of care.
- If the source zone of a contamination is located mainly in the soil, removal of merely the source zone may in practice appear to be the desired cost-effective solution, because in this way, the majority of the contaminated volume will be removed and the spreading into deeper groundwater will be halted.
- In cases where the source zone is large and – due to the nature of the contaminants and the soil composition – mainly located in the groundwater itself, a cost-effective solution will strongly depend on the degree to which the source zone can be removed by means of active remediation, as well as on the benefits to be realised through savings on future management and follow-up measures, environmental benefits, and spatial advantages.
- In cases of contamination where – due to the nature of the contaminants and the soil composition – virtually no soil zone is present or left, and the contamination has spread through a large soil volume, removal of parts of this contamination will in general only pay a limited contribution to the benefits of remediation.

For mobile contaminations, a customised approach will almost always be required, and the Remediation Objective to be achieved will need to be regarded and assessed in a broader (spatial) context.

4.2 Defining the Remediation Objective

The Soil Protection Act provides several options for carrying out remediation in a flexible manner. This is particularly important for the remediation of mobile contaminations. It allows the party carrying out the remediation to take account of planned or intended spatial developments, but also to steer towards efficient, cost-effective remediation operations. The various steering options are explained below.

4.2.1 Type of approach

The Soil Protection Act distinguishes three types of approach: the case-based approach, the cluster-based approach, and the area-based approach.

The *case-based approach* is intended for cases of contamination in which the groundwater is affected by several large-scale contaminations which are located adjacent to or near one another. To the extent that the different contaminations can be approached separately (in technical, organisational, legal and financial terms), a case-based approach based on the Soil Protection Act must be adopted.

The *cluster-based approach* is intended for situations in which multiple cases of (large-scale) groundwater contamination exist within a single area, and one or more of these cases are similar in nature, affect one another, or have become mixed. A cluster-based approach as referred to in the Soil Protection Act offers useful options to arrive at an efficient remediation approach here. In these situations, opportunities for efficiency optimisation exist if the remediation can be integrated into intended or planned spatial developments above or below ground.

The *area-based approach* concerns large or larger areas where there are many overlapping or converging (large-scale) contaminations in a complex environment (e.g. intensive above-ground activities and constructions, exceptional soil compositions, complex hydrological situations, various types of contamination, etc). Often, the individual contaminations in the area cannot be properly charted and remediating (parts of) the groundwater contamination is technically not feasible, would not be effective, and/or would involve enormous costs. An area-based approach can be adopted if area-based groundwater management has already been initiated because of existing groundwater interests in the area, and/or if it is being initiated as a consequence of the existing contaminations which cannot be remediated via a case-based or cluster-based approach, or if such remediation would be highly problematic. The Soil Protection Act sets out the criteria to be used to assess whether area-based management of contaminated groundwater can be opted for, and these criteria are further explained in its Explanatory Memorandum.

4.2.2 Remediation strategy

Because of the Soil Protection Act's Remediation Criterion, the party obliged to carry out remediation operations must urgently remediate at least that part of the severe contamination that leads to unacceptable risks. If – in the opinion of the Competent Authority – this is required by the situation, management measures may also be imposed for the other parts of the case of severe contamination, pending possible remediation at a later date.
The Soil Protection Act distinguishes several strategies to support flexible remediation approaches. Besides remediating the entire contamination in a single operation, it is also possible to carry out phased remediation, partial remediation, and temporary containment for situations which urgently need to be remediated but where remediation is not yet possible or is currently undesirable for whatever reason.

Remediation of the entire case in a single operation

For practical, organisational and/or financial reasons, in relatively minor cases requiring urgent remediation, remediation of the entire case in a single operation will often be preferred by both the party obliged to carry out remediation and the Competent Authority. In cases which are relatively larger and/or where spatial developments are expected which may allow for integration, this can be considerably different. Until the moment that unacceptable risks are removed definitively, the risks may be limited by means of temporary containment measures if this is necessary in the opinion of the Competent Authority.

Phased remediation

Section 38(3) of the Soil Protection Act permits remediation to be carried out in phases. Phased remediation is often more appropriate for the dynamics of the location for relatively large or complex cases. The Remediation Plan then indicates how remediation will be carried out in phases for the entire case. In addition, outlines and schedules are worked out for the various remediation phases, along with a budget for the entire remediation process, and any follow-up activities are described. Following the decision to accept the Remediation Plan, a more detailed description of the measures is submitted to the Competent Authority for substantive evaluation and checking against the decision. Phased remediation can be applied in situations where:

1. It is largely known what spatial developments will take place at a location, but these will be realised in phases over a longer period of time.
2. The subsequent steps of the remediation will for a large part be determined by the results of the previous phase. This may be the case for contaminations for which multiple remediation methods will or must be used sequentially to be able to achieve the Remediation Objective. Examples are excavation of the source zone and/or abstraction of contaminated groundwater from the source zone as the first phase, followed by local methods in the source zone and possibly the plume in the second phase, or deployment of intensive local methods in the first phase followed by extensive local methods in the subsequent period. Other examples are cases in which the necessity of a second phase (the plume approach) will be determined by the effectiveness of the first phase of the remediation (remediation of the source zone). In the latter example, the site can or will be made suitable for its function in the first phase of the remediation, in which case the second phase can then be limited to determining whether an

environmentally acceptable end result has been or will be achieved. This particularly concerns monitoring of the end situation.

In both situations, the objective of the total remediation is specified as much as possible, but this does not or not yet apply to the way in which it will be achieved. The latter will be specified in the subplans to be drawn up at a later date. In the substantiation of its decision, the Competent Authority will clarify how the specific circumstances of the case and the (spatial) plans of the initiator for a location or area will be taken into account.

Partial remediation

Section 40 of the Soil Protection Act permits partial remediation. The difference with phased remediation is that a Remediation Plan is not drawn up for the entire case of severe contamination but for part of it. The detailed survey need not necessarily map out the entire case either. In that case, the decision on severity and urgency is based on the part of the case of severe contamination that has been surveyed.

The term ‘partial remediation’ has been given a broad definition in the Soil Protection Act. This has been done to allow maximum flexibility in the realisation of remediation to enable the best possible alignment with the intended activities and developments. When granting its approval for the approach proposed by the party carrying out the remediation, the Competent Authority must take into account the importance of protecting the soil. Partial remediation is subject to the precondition that it may not be contrary to the interest of soil protection, as set out in the Soil Protection Act.

Therefore it is important that on the one hand, scope has to be provided for carrying out a customised survey and remediation operations, while on the other hand, the provision of that scope must not result in a failure to identify risks. If there are any shortcomings in the information that is required for this purpose, for instance because the scale of the contamination in the case concerned is not yet sufficiently known, the possibility of carrying out partial remediation operations shortly can be considered on the basis of a limited survey, on condition that a detailed survey must be carried out to obtain further information on the case as a whole. Partial remediation can be used in situations in which:

1. Spatial developments or activities will occur in only part of the severely contaminated area, which may include immobile contaminations in the topsoil and possibly localised mobile contaminations within, whether the situation requires urgent remediation or not. This may not – or only in special circumstances – be contrary to the interest of soil protection.
2. It is desirable or necessary for the remediation to separate the source zone of a contamination from the plume. In principle, this will only be the case if the contamination is addressed by means of an area-based approach, and the plume or plume area is subject to area-based groundwater management. The interest of soil protection is not relevant here, because the contaminated groundwater is or will be taken care of in a different way. As this does not apply to case-based and cluster-based approaches, the interest of soil protection can be at issue there because of the risks of spreading. For those situations, phased remediation is therefore more suitable.

The partial remediation should be seen as a complete form of remediation for that part of the contamination to which the remediation applies. Compulsory urgent remediation is linked to unacceptable risks, whereas the option of imposing management measures can be deployed for cases in which there are no such risks.

For the former situation, partial remediation can be carried out for the surveyed part of the case of severe contamination that involves unacceptable risks and is covered by the decision on severity and urgency. Naturally, partial remediation may also be carried out if there are no unacceptable risks but remediation is in aid of the location’s required development. In the case of partial remediation in connection with a Development Plan, the detailed survey will often be limited to the part of the site where construction will take place.

For the second situation, sufficient information will need to be gathered on the entire case before a decision on severity and urgency can be issued. The decision will then apply to the entire contamination. The information to be gathered in that context can subsequently also be used to define the boundaries of the source zone and for redemption of the rest of the groundwater contamination in the context of area-based groundwater management.

4.2.3 The remediation result for mobile contaminations
In practice, assessment of the cost-effectiveness of remediation of mobile contaminations may lead to a different remediation result in individual situations. Due to the enormous variety in the nature, scale and extent of contaminations, the soil condition, the environmental characteristics, and the spatial dynamics, there is a wide range of possible remediation results. In situations where mobile contaminations present risks to drinking-water extraction (or may present such risks in the long term), the Competent Authority will consult with the relevant drinking water company and with other stakeholders about the required remediation result. The Competent Authority may impose certain requirements on the remediation result, in the form of monitoring and/or follow-up measures, if it considers such requirements necessary in the interest of soil protection. Annex 5 provides a directive framework for the requirements that may be laid down, based on a division into four categories of possible result areas.

It is the responsibility of the Competent Authority to assess whether the requirement to minimise the risk of spreading has been reasonably met. Minimisation of the necessity of follow-up measures will also be taken into account here.

In the Remediation Plan to be submitted by the party carrying out the remediation, the choice of the proposed remediation solution must be explained and substantiated, and the solution must subsequently be elaborated in detail. Explanation, substantiation, and elaboration must be such that the Competent Authority can take a well-founded decision to approve or disapprove the preferred solution. If it is not requested to do so, the Competent Authority does not need to issue an opinion on any variants which have or have not been considered during the selection process. To arrive at the most suitable remediation solution, the step-by-step plan shown in Annex 5 can be deployed.

ANNEX 1: Groundwater Target Values, Intervention Values for soil remediation, Indicative Levels for severe contamination, soil type correction, and measurement regulations

Table 1 of this annex shows groundwater Target Values and Intervention Values for soil and groundwater. Table 2 shows Indicative Levels for severe contamination and, if available, groundwater Target Values. The table is preceded by an explanation of the Indicative Levels for severe contamination. The annex concludes with references to formulas for soil type correction and instructions on using them, as well as a reference to measurement regulations.

1. Groundwater Target Values and Intervention Values for soil remediation

Groundwater Target Values provide an indication of the benchmark for environmental quality in the long term, assuming that there is a Negligible Risk (NR) for the ecosystem. The figures for groundwater Target Values are shown exactly as stated in the Circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000). The Target Values were taken from the Integrated Environmental Quality Standards project ('INS') and were published in December 1997 (VROM, 1997). Barring a few exceptions, the INS Target Values have been adopted. The INS Target Values are underpinned by a risk analysis wherever possible and apply to individual substances. For metals, a distinction is made between deep and shallow groundwater. This is because deep and shallow groundwater contain different Background Concentrations. An arbitrary boundary of 10 metres has been adopted to distinguish between shallow and deep groundwater. Note that this boundary is indicative. A different boundary may be adopted if information is available which indicates that another boundary is more plausible for the site to be assessed. For example, information might be available about the boundary between the phreatic groundwater and the first aquifer.

- For shallow groundwater (< 10 metres), the environmental quality objectives for soil and water ('MILBOWA') values have been adopted as Target Values. These are based on Background Concentrations and serve as a guide.
- For deep groundwater (> 10 metres), the Target Values proposed in INS have been adopted. This means that the Target Value comprises the Background Concentration (BC) which is naturally present plus the Negligible Addition (NA). The Background Concentrations included in the INS are provided as a guide (see RIVM, 2001a).

In both cases, the stated Background Concentration should be viewed as a guide. Any information available on the local Background Concentration can be used as a Target Value together with the Negligible Addition. More information on Background Concentrations of metals in groundwater in different areas in the Netherlands can be found in RIVM Report No. 711701017 (RIVM, 2001a). More information on Background Concentrations in soil and groundwater can be found in the file on monitoring networks on www.rivm.nl, via www.dinoloket.nl, and in the Geochemical Atlas of the Netherlands (Alterra, 2010).

The Intervention Values for soil remediation indicate when the functional properties of the soil for humans, plants, and animals is seriously impaired or is in danger of being so. They are representative of the level of contamination above which a case of soil contamination is deemed to be severe. Soil Intervention Values for the first tranche of substances have been evaluated. New proposals have been made for Intervention Values and these are included in Table 7.1 of RIVM Report No. 711701023 (RIVM, 2001b). The new proposed Intervention Values for a number of substances in the first tranche have been adjusted on the basis of policy-related considerations. The amended standards are described in the NOBO Report (VROM, 2008). The soil Intervention Values for the other tranches have not been evaluated and remain the same as those included in the Circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000). The soil Intervention Values apply to dry soil. For bottoms or banks/shores of bodies of surface water, separate Intervention Values have been drawn up that are included in the Soil Quality Regulation. The groundwater Intervention Values have been taken unrevised from the Circular on Target Values and Intervention Values for soil remediation.

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	National Background Concentration	Target Value	Intervention Values	
	Groundwater[G]	Groundwater	Groundwater[G]	Soil	Groundwater
		(BC)	(incl. BC)		
	Shallow	Deep	Deep		
	(< 10 m below ground level)	(> 10 m below ground level)	(> 10 m below ground level)		
	(µg/l)	(µg/l)	(µg/l)	(mg/kg DM)	(µg/l)
1. Metals					
Antimony	-	0.09	0.15	22	20
Arsenic	10	7	7.2	76	60
Barium	50	200	200	-[H]	625
Cadmium	0.4	0.06	0.06	13	6
Chromium	1	2.4	2.5	-	30
Chromium III	-	-	-	180	-
Chromium VI	-	-	-	78	-
Cobalt	20	0.6	0.7	190	100
Copper	15	1.3	1.3	190	75
Mercury	0.05	-	0.01	-	0.3
Mercury (inorganic)	-	-	-	36	-
Mercury (organic)	-	-	-	4	-
Lead	15	1.6	1.7	530	75
Molybdenum	5	0.7	3.6	190	300
Nickel	15	2.1	2.1	100	75
Zinc	65	24	24	720	800

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
2. Other inorganic substances			
Chloride (mg Cl/l)	100 mg/l	-	-
Cyanide (free)	5	20	1,500
Cyanide (complex)	10	50	1,500
Thiocyanate	-	20	1,500
3. Aromatic compounds			
Benzene	0.2	1.1	30
Ethylbenzene	4	110	150
Toluene	7	32	1,000
Xylenes (aggr.)[A]	0.2	17	70
Styrene (vinylbenzene)	6	86	300
Phenol	0.2	14	2,000
Cresols (aggr.)[A]	0.2	13	200

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
4. Polycyclic Aromatic Hydrocarbons (PAHs)[E]			
Naphthalene	0.01	-	70
Phenanthrene	0.003*	-	5
Anthracene	0.0007*	-	5
Fluoranthene	0.003	-	1
Chrysene	0.003*	-	0.2
Benzo(a)anthracene	0.0001*	-	0.5
Benzo(a)pyrene	0.0005*	-	0.05
Benzo(k)fluoranthene	0.0004*	-	0.05
Indeno(1,2,3cd)pyrene	0.0004*	-	0.05
Benzo(ghi)perylene	0.0003	-	0.05
PAHs (total) (aggr. 10)[A]	-	40	-
5. Chlorinated hydrocarbons			
a. (Volatile) hydrocarbons			
Monochloroethene (vinylchloride)[B]	0.01	0.1	5
Dichloromethane	0.01	3.9	1,000
1,1-dichloroethane	7	15	900
1,2-dichloroethane	7	6.4	400
1,1-dichloroethene[B]	0.01	0.3	10
1,2-dichloroethene (aggr.)[A]	0.01	1	20
Dichloropropanes (aggr.)[A]	0.8	2	80
Trichloromethane (chloroform)	6	5.6	400
1,1,1-trichloroethane	0.01	15	300
1,1,2-trichloroethane	0.01	10	130
Trichloroethene (Tri)	24	2.5	500
Tetrachloromethane (Tetra)	0.01	0.7	10
Tetrachloroethene (Per)	0.01	8.8	40

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
b. Chlorobenzenes[E]			
Monochlorobenzene	7	15	180
Dichlorobenzenes (aggr.)[A]	3	19	50
Trichlorobenzenes (aggr.)[A]	0.01	11	10
Tetrachlorobenzenes (aggr.)[A]	0.01	2.2	2.5
Pentachlorobenzenes	0.003	6.7	1
Hexachlorobenzene	0.00009*	2.0	0.5
c. Chlorophenols[E]			
Monochlorophenols (aggr.)[A]	0.3	5.4	100
Dichlorophenols (aggr.)[A]	0.2	22	30
Trichlorophenols (aggr.)[A]	0.03*	22	10
Tetrachlorophenols (aggr.)[A]	0.01*	21	10
Pentachlorophenol	0.04*	12	3
d. Polychlorobiphenyls (PCBs)			
PCBs (aggr. 7)[A]	0.01*	1	0.01

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
e. Other chlorinated hydrocarbons			
Monochloroanilines (aggr.)[A]	-	50	30
Dioxin (aggr. TEQ)[A]	-	0.00018	N/A[F]
Chloronaphthalene (aggr.)[A]	-	23	6
6. Pesticides			
a. Organochloride pesticides			
Chlordane (aggr.)[A]	0.02 ng/l*	4	0.2
DDT (aggr.)[A]	-	1.7	-
DDE (aggr.)[A]	-	2.3	-
DDD (aggr.)[A]	-	34	-
DDT/DDE/DDD (aggr.)[A]	0.004 ng/l*	-	0.01
Aldrin	0.009 ng/l*	0.32	-
Dieldrin	0.1 ng/l*	-	-
Endrin	0.04 ng/l*	-	-
Drins (aggr.)[A]	-	4	0.1
α-endosulphan	0.2 ng/l*	4	5
α-HCH	33 ng/l	17	-
β-HCH	8 ng/l	1.6	-
γ-HCH (lindane)	9 ng/l	1.2	-
HCH compounds (aggr.)[A]	0.05	-	1
Heptachlor	0.005 ng/l*	4	0.3
Heptachloroepoxide (aggr.)[A]	0.005 ng/l*	4	3
b. Organophosphate pesticides			
-			
c. Organotin pesticides			
Organotin compounds (aggr.)[A]	0.05* – 16 ng/l	2.5	0.7
d. Chlorophenoxy-acetic acid herbicides			
MCPA	0.02	4	50
e. Other pesticides			
Atrazine	29 ng/l	0.71	150
Carbaryl	2 ng/l*	0.45	50
Carbofuran[B]	9 ng/l	0.017	100

Table 1: Groundwater Target Values and soil and groundwater Intervention Values[I]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Intervention Values	
	Groundwater[G]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
7. Other substances			
Asbestos[C]	-	100	-
Cyclohexanone	0.5	150	15,000
Dimethyl phthalate	-	82	-
Diethyl phthalate	-	53	-
Di-isobutyl phthalate	-	17	-
Dibutyl phthalate	-	36	-
Butyl benzyl phthalate	-	48	-
Dihexyl phthalate	-	220	-
Di(2-ethylhexyl)phthalate	-	60	-
Phthalates (aggr.)[A]	0.5	-	5
Mineral oil[D]	50	5,000	600
Pyridine	0.5	11	30
Tetrahydrofuran	0.5	7	300
Tetrahydrothiophene	0.5	8.8	5,000
Tribromomethane (bromoform)	-	75	630

* Numeric value below the detection level / no lower detection limit or measurement method available

A For the composition of the aggregate parameters, see Annex N of the Soil Quality Regulation. For the calculation of the aggregate TEQ for dioxin, see Annex B of the Soil Quality Regulation. Please refer to Annex G, item IV of the Soil Quality Regulation for information on adding up measured values below the Limit of Quantification.

B The soil Intervention Value in respect of these substances equals or is lower than the Limit of Quantification (intralaboratory reproducibility). If the substance is detected, the risks must be examined in greater detail. If vinyl chloride or 1,1-dichloroethene is detected in the soil, the groundwater must also be assessed.

C Weighted standard (concentration of serpentine asbestos + 10 x concentration of amphibole asbestos).

D 'Mineral oil' is defined in the analysis standard. Where the contamination is composed of mixtures (e.g. petrol or domestic heating oil), the concentration of aromatic and/or polycyclic aromatic hydrocarbons must be determined in addition to the alkane concentration. This aggregate parameter has been adopted for practical reasons. Further toxicological and chemical disaggregation is under study.

E In the case of groundwater, effects of PAHs, chlorobenzenes, and chlorophenols are indirectly additive and are expressed as a fraction of the individual Intervention Value (i.e. 0.5 of the Intervention Value of Substance A has the same effect as 0.5 of the Intervention Value of Substance B). This means that an aggregate formula must be used to determine whether an Intervention Value has been exceeded. The Intervention Value for the aggregate of a group of substances is exceeded if $\Sigma(C_i/I_i) > 1$, where C_i = measured concentration of a substance in the group of substances in question, and I_i = Intervention Value for the substance concerned in that group.

F There is an Indicative Level for severe contamination for groundwater.

G The groundwater Target Values for a number of substances are lower than the required reporting limit in AS3000. Please refer to Annex G, item IV of the Soil Quality Regulation for information on assessing measured values below the Limit of Quantification.

H The standard for barium has been temporarily repealed. It turned out the Intervention Value for barium was lower than the natural concentration in soil. In case of increased concentrations of barium *vis-à-vis* the natural background due to an anthropogenic source , this concentration can be assessed on the basis of the former Intervention Value for barium of 920 mg/kg DM. This former Intervention Value is substantiated in the same way as the Intervention Values for most of the other metals, and includes a natural Background Concentration of 190 mg/kg DM for barium.

I Please refer to Annex G, item IV of the Soil Quality Regulation for information on dealing with measured values below the Limit of Quantification.

2. Indicative Levels for severe contamination

For the substances in Table 2, Indicative Levels for severe contamination are provided. These concern Intervention Values derived for substances in the second, third and fourth tranches. There are two reasons for giving an Indicative Level for severe contamination instead of an Intervention Value:

1. No standardised measurement and analysis regulations are available or expected in the near future.
2. There is no or a minimal ecotoxicological substantiation of the Intervention Value and, in the latter case, the ecotoxicological effects appear to be more critical than the human toxicological effects.
   The ecotoxicological substantiation must fulfil the following criteria:
   a. At least four units of toxicity data must be available for at least two taxonomic groups
   b. All the data for metals must relate to the soil compartment
   c. In the case of organic substances, no more than two units of data may be derived from data for the water compartment using equilibrium partitioning
   d. At least two units of data must be available for individual species
   In case one or more of these criteria is not being met and ecotoxicological effects are more critical than human toxicological effects, it suffices to determine an Indicative Level for severe contamination.

The Indicative Levels have a greater degree of uncertainty than the Intervention Values. As a result, the status of the Indicative Levels is not equivalent to the status of the Intervention Value. Therefore levels above or below the Indicative Levels do not have a direct impact on the Competent Authority's decision on the severity of the contamination. In addition to the Indicative Levels, the Competent Authority should also take other considerations into account when deciding whether a case of contamination is severe, such as:

- Determining on the basis of other substances whether the case of contamination is severe and whether the need to remediate is urgent. Frequently, several substances occur simultaneously at contaminated sites. If Intervention Values have been established for other substances, these substances can be used as a basis for determining whether the case of contamination is severe and whether remediation is urgent. In such a case, an estimate of the risk for substances for which only Indicative Levels are provided is less relevant. If the case of contamination is not severe or the need for remediation not urgent on the basis of other substances however, it is important to estimate the risk for substances for which only an Indicative Level is given.
- Making an *ad hoc* determination of the actual risks. Besides toxicological criteria, other site-specific factors play a role in determining the actual risks for ascertaining the urgency of remediation. These include exposure possibilities, the use of the site, or the surface areas of the contamination. These factors can frequently be readily determined, which enables a reasonable estimate of the actual risks, in spite of uncertainty about the Indicative Levels. It is advisable here to use bioassays, since this avoids the uncertainties in the ecotoxicological substantiation as well as the uncertainties arising from the absence of standardised measurement and analysis regulations.
- Performing an additional assessment of the risks that the substance involves. Additional toxicity experiments can be conducted to enable a more accurate estimate of the risks that the substance involves.

The Indicative Levels for severe contamination have not been evaluated and remain unchanged to those in the Circular on Target Values and Intervention Values for soil remediation (Stcrt, 2000). Some former Intervention Values have been changed into Indicative Levels for severe contamination. This is explained in the NOBO Report (VROM, 2008). Only for MBTE, the Indicative Level for severe contamination for groundwater has been adapted to the value stated in the Circular on duty of care under the Soil Protection Act for MTBE and ETBE contaminations (Stcrt, 2008b).

Table 2: Groundwater Target Values and Indicative Levels for severe contamination[E]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value		Indicative Level for severe contamination	
	Groundwater		Soil	Groundwater
	Shallow[C]	Deep[C]		
	(< 10 m below ground level)	(> 10 m below ground level)		
	(µg/l)	(µg/l)	(mg/kg DM)	(µg/l)
1. Metals				
Beryllium	-	0.05*	30	15
Selenium	-	0.07	100	160
Tellurium	-	-	600	70
Thallium	-	2*	15	7
Tin	-	2.2*	900	50
Vanadium	-	1.2	250	70
Silver	-	-	15	40

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Indicative Level for severe contamination	
	Groundwater[C]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
3. Aromatic compounds			
Dodecylbenzene	-	1,000	0.02
Aromatic solvents[A]	-	200	150
Dihydroxybenzenes (aggr.)[B]	-	8	-
Catechol (o-dihydroxybenzene)	0.2	-	1,250
Resorcinol (m-dihydroxybenzene)	0.2	-	600
Hydroquinone (p-dihydroxybenzene)	0.2	-	800
5. Chlorinated hydrocarbons			
Dichloroanilines	-	50	100
Trichloroanilines	-	10	10
Tetrachloroanilines	-	30	10
Pentachloroanilines	-	10	1
4-chloromethylphenols	-	15	350
Dioxin (aggr. TEQ)[A]	-	N/A[D]	0.001 ng/l
6. Pesticides			
Azinphos-methyl	0.1 ng/l *	2	2
Maneb	0.05 ng/l*	22	0.1

Table 2: Groundwater Target Values and Indicative Levels for severe contamination[E]

Concentrations in soil are shown for standard soil (10% organic matter and 25% lutite)

Substance	Target Value	Indicative Level for severe contamination	
	Groundwater[C]	Soil	Groundwater
	(µg/l)	(mg/kg DM)	(µg/l)
7. Other compounds			
Acrylonitril	0.08	0.1	5
Butanol	-	30	5,600
1.2 butyl acetate	-	200	6,300
Ethylacetate	-	75	15,000
Diethylene glycol	-	270	13,000
Ethylene glycol	-	100	5,500
Formaldehyde	-	0.1	50
Isopropanol	-	220	31,000
Methanol	-	30	24,000
Methylethylketone	-	35	6,000
Methyl-tert-buthyl ether (MTBE)	-	100	9,400

* Numeric value below the detection level / no lower detection limit or measurement method available.
[A] For the composition of the aggregate parameters, see Annex N of the Soil Quality Regulation. Please refer to Annex G, item IV of the Soil Quality Regulation for information on dealing with measured values below the Limit of Quantification.
[B] Dihydroxybenzenes (aggr.) are understood to be: the aggregate of catechol, resorcinol and hydroquinone.
[C] The groundwater Target Values for a number of substances are lower than the required reporting limit in AS3000. Please refer to Annex G, item IV of the Soil Quality Regulation for information on assessing measured values below the Limit of Quantification.
[D] There is an Intervention Value for soil.
[E] Please refer to Annex G, item IV of the Soil Quality Regulation for information on assessing measured values below the Limit of Quantification.

3. Soil type correction and measurement regulations

The Intervention Values for soil in Tables 1 and 2 depend on the soil type and are based on a standard soil composition with a lutite percentage of 25% and an organic substances percentage of 10%. When assessing soil quality, the measured contents are converted into a standard soil composition by means of a soil type correction. The conversion method is described in Annex G item III of the Soil Quality Regulation.

Measurement regulations

Details of the analysis methods to be used are included in Annex L of the Soil Quality Regulation.

ANNEX 2: Remediation Criterion: Determining the risk for humans, for the ecosystem, or of the contamination spreading

1. General

This annex describes the Remediation Criterion method used to determine whether soil contamination poses unacceptable risks for humans, for the ecosystem, or of the contamination spreading in the groundwater. On the basis of the risks determined, it can established whether urgent remediation is required or not. A computer model called Sanscrit is used to help determine the risks, which is available via www.sanscrit.nl. The changes in the present Circular have also been implemented in the model calculations used in Sanscrit.

2. Starting points

Urgent remediation is required unless the risk assessment demonstrates that the need for remediation is not urgent.

The Remediation Criterion method applies to:
- Cases of severe contamination
- Historical contamination; contaminations occurring after 1987 are covered by Section 13 of the Soil Protection Act (duty of care)
- Present or intended use
- Soil and groundwater
- All substances for which an Intervention Value has been derived, with the exception of asbestos

As asbestos has specific chemical and physical properties, the Environmental Protection Soil Remediation Criterion, Asbestos Protocol, has been developed separately for asbestos (see Annex 3 of this Circular). The Asbestos Protocol is also composed of three steps, but the system for executing Steps 2 and 3 differs from that for other substances (see Section 3 below). In cases of soil contamination with asbestos, it is not always possible to make a statement about the risks on the basis of the results of Step 2. In such cases, Step 3 has to be carried out, and the results are used as a basis for making a statement about the risks.

3. Step-by-step system

The three steps of the Remediation Criterion are discussed below. The main text of the Circular shows the procedure for progressing through the steps. The assessment of the risks for humans, for the ecosystem, and of the contamination spreading is discussed separately for Steps 2 and 3.

Step 1: Determining whether a case of contamination is severe
In the first step, the detailed assessment is used as the basis for determining whether a case of contamination is severe. A case of contamination is deemed severe if the average measured concentration of at least one substance in a soil volume of at least 25 m^3 in the case of soil contamination, or in a pore-saturated soil volume of at least 100 m^3 in the case of groundwater contamination, is higher than the Intervention Value.
In a few specific situations, the case of contamination may be severe even if the concentrations are below the Intervention Values. This applies to what are termed vulnerable situations. Vulnerable situations are situations where, even if the concentrations are below the Intervention Values, the assessment criterion for unacceptable human risks is exceeded for calculations using the CSOIL exposure model in Sanscrit (see Section 4.2 for more details). Typical examples of potentially vulnerable situations are:
- Vegetable garden / allotment
- Places where there are volatile compounds in the phreatic groundwater underneath buildings in combination with high groundwater levels and/or in unsaturated soil

- Places intended for crop consumption where PCB contamination is present in the contact zone

A case of contamination with asbestos is deemed severe at any site with asbestos concentrations in the soil that exceed the Intervention Value [100 mg/kg DM (weighted)], regardless of the volume. Based on the Asbestos Protocol included as Annex 3, it should be determined whether there are any unacceptable risks as a result of soil contamination with asbestos.

Step 2: Standard risk assessment
The second step is a generic model calculation using Sanscrit. The model calculation can be performed based on the results of the detailed assessment. A distinction is made between risks for humans, for the ecosystem, and of the contamination spreading. As the model calculations are generic, model parameters erring on the safe side have been chosen.

Step 3: Site-specific risk assessment
The third step consists of making additional measurements and/or additional model calculations. Concentration figures calculated using the model can be replaced in the model calculations by the figures for concentrations measured at the site. In addition, it is possible to enable or disable specific exposure routes. This makes the third step more site-specific.
It is not necessary to perform measurements or additional model calculations for every component of the generic model calculation. The additional measurements and/or model calculations can focus on critical exposure routes or parts thereof.

The substantiation of Steps 2 and 3 for determining unacceptable risks for humans, for the ecosystem, and of the contamination spreading is discussed below.

4. Risks for humans

4.1 General

The risks for humans are deemed unacceptable if the site's present or intended use results in a situation in which:

- Chronic adverse effects on health may occur
- Acute adverse effects on health may occur

Chronic effects occur at lower concentrations than those that lead to acute effects. Focusing the risk assessment on chronic effects means that it also implicitly protects against acute effects. As acute exposure to hydrocyanic gas for instance can be fatal, the Maximum Acceptable Toxic Concentration (MATC) in air was derived taking into account acute fatal exposure.

If the presence of soil contamination in the current use of the soil presents a demonstrable nuisance (e.g. skin irritation and smells), it is deemed to be an unacceptable situation which likewise requires urgent remediation.

4.2 Step 2: Standard risk assessment

The risks for humans are determined using the CSOIL exposure model included in Sanscrit. The model distinguishes between seven exposure scenarios which are used to describe the site's use and the associated risks on the basis of a model. If the soil is contaminated with non-volatile substances, the standard risk assessment for soil use with ample potential for contact concentrates on the top layer of 1.0 m of the uncovered soil; otherwise, it concentrates on the top layer of 0.5 m of the uncovered soil. In specific cases, a departure from this soil thickness is permitted, provided the reasons are stated.

As standard, the Sanscrit tool assumes a house with a crawl space for the model calculations of the evaporation risks for volatile compounds. This risk is expected to be overestimated for non-standard situations. Early 2012, Sanscrit will be expanded with the possibilities for assuming the construction methods ‘concrete on sand’ and ‘house with cellar’.

The model-based calculated exposure figure (lifelong average in mg/kg_{bw} per day) is checked against the Maximum Permissible Risk level (MPR) for oral and dermal exposure (MPR_{oral}). The quotient of the oral and dermal exposure and the MPR is called the oral Risk Index (RI_{oral}). In the case of inhalational exposure, the calculated inhalational exposure is also tested against the inhalational MPR (MPR_{inhal}), which is calculated on the basis of the MATC (MPR_{inhal} = MATC x tidal volume / body weight). The quotient of the inhalational exposure and the MPR is called the inhalational Risk Index (RI_{inhal}). $RI_{total} = RI_{oral} + RI_{inhal}$. Furthermore, the calculated concentrations in air are checked against the Maximum Acceptable Toxic Concentration (MATC) in air.

This may result in the following two possibilities:

- $RI_{total} \leq 1$ and the concentration in air $\leq$ MATC = risk is not unacceptable
- $RI_{total} > 1$ and/or the concentration in air > MATC = risk is unacceptable

The MPR and MATC values are shown in Table A at the end of this Annex 2.

The model-based calculated exposure figure is only checked against MPR during childhood years for lead because lead has been shown to be more critical in this period *vis-à-vis* its impact during adulthood. In Step 2, a factor 0.74 is used for the human relative bioavailability of lead. More details can be found in the NOBO Report (VROM, 2008).

A case of nuisance is deemed to exist if skin irritation occurs as a result of skin contact with the pure product and/or if there is a smell because the odour threshold has been exceeded. A list of odour thresholds is provided in Table A at the end of this Annex 2.

4.3 Step 3: Site-specific assessment

Step 3 can be carried out if it is concluded on the basis of the generic model calculation that the risks are unacceptable but there is a suspicion they are in fact not. Such a situation could arise because the model parameters have been set too conservatively *vis-à-vis* the actual situation. If Step 3 has been carried out, the Competent Authority must base its conclusion regarding urgency on the results of this step.

In Step 3, site-specific calculations of the evaporation risks may be performed using an updated model, VOLASOIL (see RIVM, 2008a).

To substantiate Step 3, additional measurements may be made in contact media. This concerns determining the concentrations of contaminants in:

- Soil air, indoor and outdoor air
- Crops from vegetable gardens
- Drinking water (from plastic pipes passing through the contamination)
- Water from a private source that is used for consumption
- House dust

In addition, the bioavailability of substances in the soil for humans can be determined. This means measuring the size of the fraction of a substance in the soil that can actually be taken up by the body. This is particularly important for contamination with lead because human risks are often the determining factor in that case. In Step 3, it is possible to opt for decreasing the factor for the human relative bioavailability to 0.4. This lower factor applies for urban layers of fill with a historical lead contamination, for soils with an organic matter concentration of at least 20% and a historical lead contamination, and for comparable soils with a lead contamination with a demonstrable low human bioavailability. The factor 0.4 is a temporary advice; research is on-going. In Step 3, the Competent Authority also has the possibility to take limited crop consumption from vegetable gardens into account, to set limitations on use (to advice against crop consumption from vegetable gardens), or to assume the actual absorption of lead by crops from vegetable gardens on the basis of crop measuring.

In Step 3, the Competent Authority also has the possibility to adjust the soil ingestion rate for specific sites. For soil functions with relative intensive soil contact, such as residential with garden or playgrounds, the standard is 100 mg per day for children and 50 mg per day for adults. For sites with relatively little soil contact, such as forests and greenspaces, buildings, infrastructure, and industry, Sanscrit assumes a soil ingestion rate that is set five times lower (20 mg per day for children and 10 mg per day for adults). When gardens are small, largely paved, or used extensively, it is reasonable to assume a lower soil ingestion rate than the standard for residential with garden, although it is hard to predict to what degree. No scientific substantiation is available for indicating which soil ingestion rate is acceptable under what circumstances. Furthermore, this should be linked to communicating instructions: occupants should be aware they should set up their garden so as to avoid soil contact. For the reasons mentioned, this Circular does not provide a generic guideline for a lower soil ingestion rate in gardens that are used extensively. The Competent Authority, in consultation with the Municipal Public Health Services ('GGD'), can substantiate its own site-specific choices.

There are still no validated measurement methods or established guidelines that must be used for performing the measurements in Step 3. The RIVM has developed two measurement methods (RIVM, 2007a; RIVM, 2007b) that can be used to support the site-specific risk assessment in Step 3. In addition, the GGD has developed a guideline (RIVM, 2009) for a broader assessment of health risks, which may also be used.

Currently, it is not possible to provide advice on a method suitable for measuring the human relative bioavailability factor for lead.
Be that as it may, it is up to the initiator and the Competent Authority to reach agreement about the suitability of the method to be used. Subject to stating the reasons, the Competent Authority may reject the method suggested by the initiator. When assessing any such methods, the Competent Authority may be assisted by the Bodem+ agency, if possible. Depending on the method used, Bodem+ can advise the Competent Authority or refer it to other knowledge organisations.

In Step 3, processes may be described using a different model (state of the art), actual bioavailability may be taken into account, or complete or partial model results may be replaced by measurement results. However, no changes to critical exposure levels (MPR or MATC) or the parameters that describe the normal population may be made in this step. This is because they are set to protect individuals, taking into account vulnerable persons under vulnerable conditions.

The calculated oral and dermal exposure rate is checked against the current MPR. The measured indoor and outdoor air concentrations are checked against the current MATC, and the inhalational exposure is tested against MPR_{inhal} calculated on the basis of the MATC.
As in Step 2, this may result in the following two possibilities:

- $RI_{total} \leq 1$ and the concentration in air $\leq$ MATC = risk is not unacceptable
- $RI_{total} > 1$ and/or the concentration in air > MATC = risk is unacceptable

5. Risks for the ecosystem

5.1 General

Risks for the ecosystem are deemed unacceptable if the site's present or intended use means that the observed impacts upon the ecosystem are widely considered unacceptable. This concerns the following impacts upon the ecosystem:

- Harm to biodiversity (protection of species)
- Disturbance of recycling functions (protection of processes)
- Bioaccumulation and biomagnification

The establishment of the Intervention Values for soil remediation is based on human and ecological risk limits, whereby the lowest risk limit determines how high the Intervention Value is, unless it was not possible to determine either of the two with sufficient reliability. With the exception of antimony and lead, the ecological risk limits for metals are lower than the human risk limits, so they determine the Intervention Value. For PAHs and other organic substances (such as pesticides containing chlorine), the ecological risk limits are also usually lower than the human risk limits, so they determine the Intervention Value. Ecological risk limits for mineral oil and cyanides have not yet been determined. Policy considerations have also played a role in determining the Intervention Value for some substances (e.g. copper and zinc). Further details can be found in the NOBO Report (VROM, 2008).

Prior to publication of this Circular, the Soil Protection Technical Committee ('TCB') issued its advice on the system for ecological risk assessment of soil contamination (TCB, 2011). In this Circular, a number of changes have been implemented on the basis of the TCB's advice. In particular, these concern the addition of options for public consideration in Steps 2 and 3. The way the assessment of Toxic Pressure (TP) occurs is also partly structured after the TCB's advice.

5.2 Step 2: Standard risk assessment

Ecosystems are unique and complex. Therefore, generic relationships between the impacts referred to in the preceding section and figure-based standards for soil quality are relatively uncertain. Nevertheless, a generic framework can offer protection for most ecosystems, in spite of the uncertainties. Adding more site-specific details in the risk assessment can reduce uncertainties. As it is impractical to make a site-specific ecological risk assessment for every site, it was decided to continue using the main features of the generic system as included in the most recent version of Sanscrit in Step 2, supplemented with a module for estimating the generic risk posed by the mixture of contaminants. In this system, contamination in areas with a highly-appreciated ecosystem (nature conservation areas etc.) is more likely to pose unacceptable risks for the ecosystem than the same level of contamination in areas with a lowly-appreciated ecosystem (industrial sites, infrastructure etc.).

In case of soil contamination that is entirely or largely in the top 1.0 m of uncovered soil, a combination of area type, surface area, and Toxic Pressure (TP) of the contaminants determines whether there are unacceptable ecological risks, and consequently whether remediation is urgent (Table 1). The standard thickness of the soil layer to be assessed is 1.0 m. In case the depth of roots exceeds 1.0 m, a thicker soil layer may be chosen for assessment, if substantiated. In case the MLG (Mean Lowest Groundwater level) is less than 1.0 m below ground level, the soil layer up to the MLG may be chosen for assessment, if substantiated. In that case, the minimum thickness of the soil layer to be assessed is 0.5 m. In general, soil life at greater depths has a lower density. That is why the risk for the ecosystem at greater depths is usually deemed acceptable within the Remediation Criterion. The ecosystem at greater depths is protected somewhat via the assessment of the risks of the contamination spreading.

Table 1: Flow chart for ecological substantiation of the decision on the urgency of remediation. Depending on the area type, remediation of a case of contamination need not be carried out urgently if the horizontal extent of the uncovered soil contamination within a contour for Toxic Pressure (TP) is smaller than the indicated surface area. Both contours have to be assessed.

Area type[B]	Surface area of uncovered soil contamination (TPA > 0.25)	Surface area of uncovered soil contamination (TPA > 0.65)
• Nature conservation areas, incl. areas belonging to the EHS[C]	500 m^2	50 m^2
• Agriculture • Residential with garden • Vegetable gardens / allotments • Greenspaces with ecological values	5,000 m^2	500 m^2
• Other greenspaces • Development • Industry • Infrastructure	50,000 m^2	5,000 m^2

[A] *TP is the acute Toxic Pressure of the mixture of contaminants in a (mixed) sample of the site. For the standard assessment in the Remediation Criterion, the contours for TP = 0.25 and TP = 0.65 are used. The TP is calculated using Sanscrit on the basis of the total concentrations of substances in soil samples. All concentrations are corrected for standard soil. The backgrounds for the TP calculation are published in RIVM Report No. 711701072 (RIVM, 2008b).*

[B] *The division into area types is related to the 'ecological value' of areas and adjusted for the soil-use categories defined by the NOBO Working Group (NOBO Report). If a site can be divided into several categories, the most vulnerable category must be chosen.*

[C] *EHS = National Ecological Network.*

The assessment in Step 2 is actually based on the level of contamination, the scale of the uncovered contaminated area, and the area type. Below, the assessment system in Table 1 is substantiated and explained.

The level of contamination is determined by calculating the TP per sample point, based on the mixture and the aggregate concentrations of substances. In order to determine the scale, the contaminated uncovered area is established for contours in which a certain TP is exceeded. There is a contour for the TP based on a 'low' decision criterion (0.25) with associated relatively large contaminated uncovered areas, and there is a contour for the TP based on a 'high' decision criterion (0.65) with smaller contaminated uncovered areas. The level of the decision criteria mentioned has been adjusted as of January 2012 *vis-à-vis* the 2009 Circular. In 2009, the switch to a TP-based assessment was made. In doing so, the policy precondition was assumed that the total number of cases of severe contamination with unacceptable risks for the ecosystem would remain equal to the pre-2009 situation. In the 2009-2011 period, it turned out there was an increase in the number of cases with unacceptable risks for the ecosystem. The decision criteria have now been raised in order to comply with the original policy precondition.

The criteria for the contaminated area within the TP contours are based on principles that have a scientific foundation in ecology. This concerns a minimum soil area for fully accessible systems (natural systems) on which 5% of all species living in the Netherlands are expected to be found. Using a model calculation, this area has been estimated at 50 m^2. The calculation is explained in RIVM Report No. 711701072 (RIVM, 2008b). These 50 m^2 function as the minimum area for the assessment in the surface table. Less accessible systems, (less vulnerable use of soil, such as agriculture and residential with garden) will contain fewer species, and as a result, wider surface contours can be used for the assessment. An inventory study also revealed that the functional aspects (ecosystem services) of the soil system can roughly be assessed in the same way with increasing measures for the area. However, the surface measures resulting from these calculations have a high level of insecurity. In addition, the NOBOWA Working Group has advised on practical grounds to maintain the existing surface table as a basis, and to implement a number of changes to enhance the structure's internal logic and its practical applicability.

The procedure with standardised areas is generic. Nevertheless, this approach offers a balanced system: for higher TP, a surface has been chosen that is ten times smaller than for lower TP, and for less vulnerable soil use, a surface has been chosen that is ten times larger than for more vulnerable soil use. In fact, every ecosystem is unique and should be assessed with customised assessment tools. The generic assessment table in Step 2 of the Remediation Criterion provides a common-sense interpretation of the standard risk assessment.

Based on the above, the following changes have been implemented:

1. The area for nature (including EHS and Natura 2000 areas) has been increased from 50 to 500 m^2 for the low decision criterion for TP. This is substantiated by the fact that 50 m^2 of nature is a very small area for considering remediation options. For the high decision criterion for TP, 50 m^2 has been maintained, so the basis of the surface table is still visible, and contaminated hotspots lead to unacceptable ecological risks. It makes sense to assume a larger surface linked to unacceptable ecological risks for the low decision criterion (a lower TP) than for the high decision criterion (a higher TP).
2. For the average vulnerability of areas (agriculture, residential with garden, vegetable gardens / allotments, and greenspaces with ecological values), the surface contour for the high decision criterion has been increased from 50 to 500 m^2. This is substantiated by the fact that remediation options should not be considered at the level of single gardens, but at the level of multiple adjacent gardens. Furthermore, the average vulnerable areas contain less species, so larger surface measures are more appropriate than in nature.
3. For the lowest vulnerability of areas (other greenspaces, development, industry, and infrastructure) and the low decision criterion, the surface has been decreased to 50,000 m^2. As a result, this surface fits within the system in which the vulnerability of the soil use decreases by a factor 10 every time.

When the criteria set in Table 1 for the TP test are exceeded, Step 2 leads to the conclusion that the ecological risks are unacceptable. The assessment system is an instrument for recognising situations that have the highest probability of ecological risks deemed unacceptable by society. This means exceptions are conceivable where the criteria are not (or not yet) exceeded, but the situation warrants closer examination of the ecological risks, or remediation measures (incl. management) are implemented directly. Such exceptional situations are called ‘vulnerable situations’ in this Circular. If the criteria set in Table 1 for the TP test are not exceeded, the situation is assessed for potential vulnerability. Examples of this might be rare ecosystems, situations that have a high biomagnification risk, and situations where the exposure to contaminants is expected to be above average. We refer to the Sanscrit tool for further explanation and examples. When the situation is deemed to be vulnerable, the risks are deemed unacceptable on the basis of the standard assessment in Step 2. If required, escalation to Step 3 might occur, in which the site-specific impacts upon the ecosystem are assessed.

Figure 1 represents a schematic overview of the standard risk assessment.

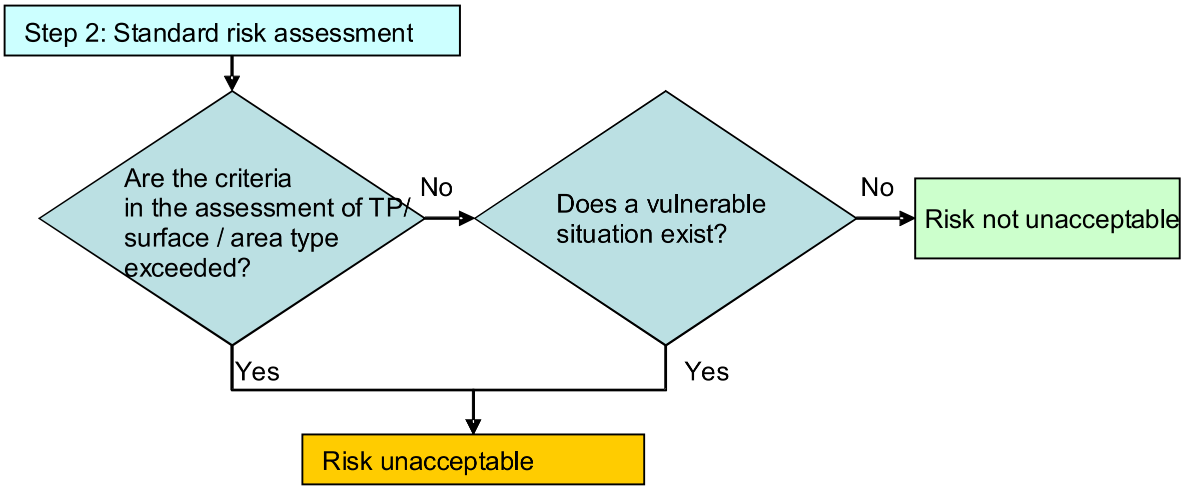

Figure 1: Diagram for Step 2 – Standard risk assessment of ecological risks

5.3 Step 3: Site-specific risk assessment

Step 3 can be carried out if the risks are deemed unacceptable on the basis of the standard assessment but there is a suspicion that they are in fact not. Step 3 can also be carried out to assess the impacts upon the ecosystem by measuring them. If Step 3 has been carried out, the Competent Authority must base its conclusion regarding urgency on the results of this step.

To commence with Step 3, one of two options must be chosen:
1. A structured public consideration to determine whether it is useful to perform a follow-up assessment and base the final conclusion on this, or to decide without a follow-up assessment whether there is a need for remediation and management measures
2. The direct choice for follow-up assessment in the form of a TRIAD assessment or monitoring

Option 1 is a public consideration carried out on the basis of Steps 1 to 3 of the NEN 5737 standard (NEN, 2010a). These steps of the process standard mentioned consist of an inventory of the problems for the soil use posed by the soil contamination, an inventory of the actors involved, and the formation of a Consultative Group. This Consultative Group will make a public consideration and will assess two aspects:
1. The importance of the ecological risk assessment of the soil contamination on the basis of a follow-up assessment
2. The possibilities for implementing remediation and management measures These are assessed for their use and feasibility.

It is possible that the Consultative Group considers further TRIAD assessment unnecessary. Reasons for this may be that the added value of the assessment is expected to be minimal, or that its benefits do not justify its costs. It is also possible that the Consultative Group sees no options for implementing remediation and/or management measures with a positive impact upon the ecosystem (the remedy is worse than the disease), or that other stress factors are more significant to the ecosystem than the contamination. In cases like these, the Consultative Group will not deem a further risk assessment useful on the basis of a public consideration, and will decide that there is no need to implement remediation or management measures. In that case, the risk is not unacceptable in terms of the Remediation Criterion. It is also possible that the Consultative Group will propose useful or feasible remediation and/or management measures on the basis of the consideration, while also concluding that a follow-up assessment is not useful. In that case, the risk is unacceptable in terms of the Remediation Criterion. The Consultative Group may also conclude that there are possible effects for which urgent remediation measures (incl. management) are required, but that a follow-up assessment is needed first in order to assess this. When this follow-up assessment has been performed, the outcome will determine whether the ecological risks are unacceptable or not.

This must be provided with proper and transparent arguments, revealing that a public consideration was made. We refer to the Sanscrit tool for further explanation and examples. The Competent Authority may base its decision on the advice of the Consultative Group.

If, either directly (Option 2) or after public consideration (Option 1), the conclusion was drawn that further assessment of the ecological risks is required, a TRIAD assessment must be performed. In case there is a change in land-use, possibly resulting in an increase of ecological risks in the future, monitoring may also be considered.

A TRIAD assessment comprises three parts:

1. Chemistry: Determining which substances are present in the soil in increased concentrations, and what the combined effect is on the ecosystem on the basis of the toxic properties of the substances. Methodically, this part is linked to Step 2 of the Remediation Criterion in the assessment of ecological risks.
2. Potential toxicity: Using bioassays to measure the toxic effects of the substances present in the soil. This is used to determine whether contaminants in soil samples from the site affect organisms or processes under standardised laboratory conditions.
3. Field surveys: Determining whether the condition of the ecosystem observable in the field can be related to potential effects of the soil contamination present. This implicitly takes into account the effect of a combination of substances and the bioavailability of substances in the field. The impact of the contaminants on the ecosystem can be determined by means of a comparison with a good reference location, or with an anticipated outlook of the ecosystem at the site.

The process-based standard NEN 5737 may be used to perform a TRIAD assessment in order to substantiate a decision on urgency. Guideline Triad 2011: Site-specific ecological risk assessment in Step 3 of the Remediation Criterion (RIVM report no. 607711003/2011) may be used for the technical-substantive aspects of performing TRIAD assessments. This Guideline explains that a TRIAD assessment may also be directed at contaminations in soil layers deeper than the top layer. If a decision is made to perform a TRIAD assessment, SIKB Protocol no. 2501 may be used to draw up the assessment plan and design the sampling procedure for TRIAD assessments.

The aforementioned Guideline indicates how the various parts of a TRIAD assessment can be used as substantiation for a decision on the urgency of remediation. In principle, the process-based approach according to the NEN 5737 standard is written for all cases, but is particularly applied to larger cases.
It is therefore up to the initiator and Competent Authority to make arrangements on the method to be used. Subject to stating the reasons, the Competent Authority may reject the method suggested by the initiator. When assessing any such methods, the Competent Authority may be assisted by the Environment Department of the Directorate-General for Public Works and Water Management (Rijkswaterstaat Environment), if possible. Depending on the method used, Rijkswaterstaat Environment can advise the Competent Authority or refer it to other knowledge organisations.

Figure 2 represents a schematic overview of the site-specific risk assessment.

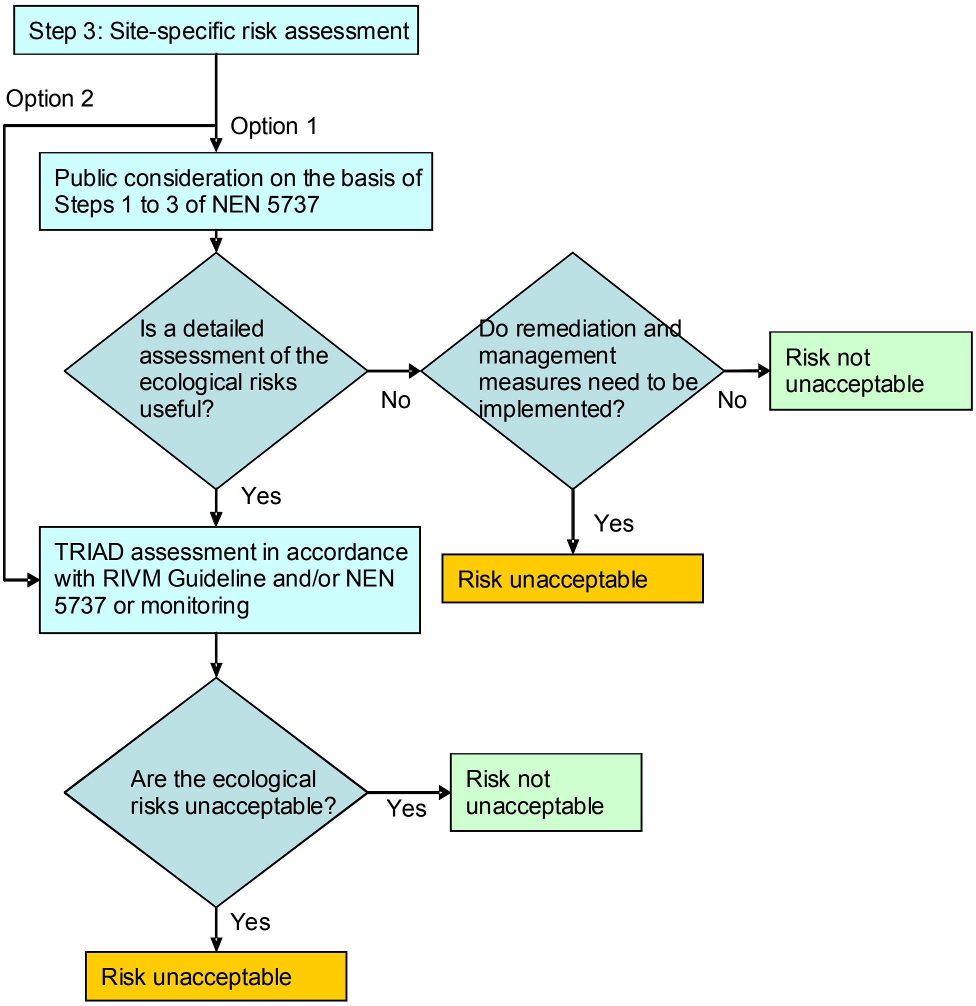

Figure 2: Diagram for Step 3 – Site-specific risk assessment of ecological risks

6. Risks of the contamination spreading to the surrounding area

6.1 General

The risks of the contamination spreading to the surrounding area are deemed unacceptable in the following situations:

- The soil's use by humans or the ecosystem is jeopardised
- An uncontrollable situation exists, i.e.:
  - There is a layer of floating groundwater contamination which could be moved by activities and processes in the soil, which would result in the contamination spreading
  - There is a layer of sinking groundwater contamination which could be moved by activities and processes in the soil, which would result in the contamination spreading
  - Spreading contamination has resulted in major groundwater contamination and the contamination continues to spread

The RIVM information sheet 'Assessment of risks of contamination spreading' describes the stepped assessment of risks of contamination spreading, and discusses the instruments to be used for this purpose. The information sheet may be downloaded from the Sanscrit website.

6.2 Step 2: Standard risk assessment

6.2.1 Use of the soil is jeopardised

Use of the soil is jeopardised when environmental nuisance is deemed unacceptable. Regardless of the extent, nuisance caused by contaminated groundwater spreading is especially important in relation to vulnerable objects. Environmental nuisance is deemed to be unacceptable if the distance between a vulnerable object and the Intervention Value contour in the groundwater is less than 100 m.

Local and regional authorities may register vulnerable objects requiring protection. In principle, this concerns the areas requiring protection designated in the management plans for river basins (implementation of the Water Framework Directive), but also the groundwater functions requiring protection, such as abstractions for drinking water and the industry (implementation of the Groundwater Directive). In addition, the Competent Authority is allowed to designate specific (e.g. small-scale) vulnerable objects.

The following vulnerable objects may be distinguished:
Water catchment areas designated for abstracting groundwater for human consumption within the scope of the Water Framework Directive
Industrial groundwater abstractions
Soil volumes, bodies of surface water, or bottoms or banks/shores of bodies of surface water that fall within the scope or are part of shellfish waters, waters for salmon and cypriniformes, bathing water, and 'Natura 2000' areas
Specific other nature conservation areas
Specific areas for private water collection
Areas falling under a strategic reservation for public drinking water collection

6.2.2 Uncontrollable situation

A situation is deemed uncontrollable in the following instances, which means that the extent of the contamination in the soil is increasing or could increase:

Layer of floating groundwater contamination
If there is a layer of floating groundwater contamination[8] (regardless of its total extent), it is assumed that it may spread in the soil, resulting in an uncontrollable situation. Examples include:
The extent of the case of contamination increases over time because contamination spreads from the floating layer
The floating layer spreads across the plot boundary
Pure product appears at ground level or in a body of surface water
The floating layer may suddenly cover a much larger area if underground obstacles are removed

Layer of sinking groundwater contamination
If there is a layer of sinking groundwater contamination[9] (regardless of its total extent), it is assumed that it may spread in the soil, resulting in an uncontrollable situation. For example, intervention may cause the sinking layer to sink to a deeper level, penetrate an aquifer, and cause groundwater contamination there.
A sinking layer can form relatively quickly. If a sinking layer is present, it is often kept in place for years by capillary forces. If the situation changes, for instance by pile-driving or sheet-piling into

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[8] According to the Land Restoration and Management Guideline (www.bodemrichtlijn.nl), a floating layer is a layer of one or more product contaminants that are hard to dissolve and have a mass density lower than water, and that will float on groundwater as a result.
[9] According to the Land Restoration and Management Guideline (www.bodemrichtlijn.nl), a sinking layer is a layer of one or more contaminants that are hard to dissolve and have a mass density higher than water. Such substances tend to spread vertically through easily permeable soil layers, and to spread horizontally across less permeable soil layers.

the ground, the sinking layer may spread in a vertical direction. Within the soil's zone of use (the part of the subsoil used for human activities such as pile-driving, metro tubes, cold/heat storage), the presence of a sinking layer is deemed to constitute an uncontrollable situation.

Spreading
An uncontrollable situation resulting from contamination spreading through groundwater is deemed to exist if the soil volume that is enclosed by the Intervention Value contour in the groundwater exceeds 6,000 m^3. The assumption here is that the contamination will continue to spread if it was caused in the past (before 1987) and has meanwhile developed into groundwater contamination with a volume exceeding 6,000 m^3. On the other hand, groundwater contamination that has developed an Intervention Value contour of less than 6,000 m^3 soil volume over at least twenty years has only spread to a limited degree. Groundwater contamination of this kind does not require urgent remediation, as long as no other risks are present.
The extent of the contamination can be determined relatively easily and can be deduced from the actual situation in the soil, by demonstrating the substance concentrations in the groundwater at various points at the site.

6.3 Step 3: Site-specific assessment

Step 3 can be carried out if the generic assessment in Step 2 led to the conclusion that the risks are unacceptable but there is a suspicion that they are in fact not. If Step 3 has been carried out, the Competent Authority must base its conclusion regarding urgency on the results of this step. As yet, there are no validated measurement methods or established guidelines for determining groundwater contamination spreading. It is therefore up to the initiator and Competent Authority to make arrangements on the method to be used. Subject to stating the reasons, the Competent Authority may reject the method suggested by the initiator. When assessing any such methods, the Competent Authority may be assisted by the Bodem+ agency, if possible. Depending on the method used, Bodem+ can advise the Competent Authority or refer it to other knowledge organisations.

6.3.1 Use of the soil is jeopardised

Vulnerable objects
In Step 3, if a vulnerable object is present in the soil volume enclosed by the Intervention Value contour in the groundwater and within a radius of 100 m around it, the initiator can use a calibrated model to calculate the spread of contamination (on the basis of several rounds of hydraulic head calculations) to demonstrate that the contamination is not spreading or is spreading to such a limited degree that vulnerable objects will not be jeopardised within the next few years. On the basis of measurement results, decomposition parameters and sorption can also be taken into account. Also, a long-term (at least five years) series of monitoring results can be used to demonstrate that the vulnerable object is not jeopardised.

In Step 3, the initiator can also demonstrate that the vulnerable object will not be subject to any unacceptable environmental nuisance (see Section 6.2.1). In that case, measurements and calculations must demonstrate that:
The quality of a given soil volume, body of surface water, or bottom or bank/shore of a body of surface water will not deteriorate
The quality of the groundwater abstracted for human consumption will not be adversely affected to the extent that water treatment will have to be intensified
Groundwater abstraction will not be adversely affected, i.e. no additional measures will be required on account of the presence of soil contamination

The calculations for the contamination spreading must be conducted for the substance expected to have the largest spread and to reach the vulnerable object first. This will usually be the most mobile substance (lowest retardation factor) that has already spread most. However, a situation may arise in which one substance has been spreading for a considerable time, and the groundwater becomes contaminated by another much more mobile substance at a later stage. In that case, a substantiated choice will have to be made for one of the substances, or calculations will have to be made for the two (or more) substances.

No further calculations need to be made if the contamination cannot reach an aquifer that is in contact with objects requiring protection. However, this will have to be properly substantiated.

6.3.2 Uncontrollable situation

Layer of floating groundwater contamination
In the standard risk assessment, it is assumed that any floating layer of contamination in the groundwater will be able to spread independently, thus creating an uncontrollable situation. However, its spread will largely be determined by the soil's permeability (main flow paths etc.), obstructions in the soil, and the viscosity of the liquid that forms the floating layer. Therefore, cases may occur in which the floating layer is immobile. The uncontrollable situation is determined by the location of the floating layer. For example, a situation will not be deemed uncontrollable if the floating layer is isolated in the middle of the plot, if it is very deep and far from a body of surface water, or if the flow of the floating layer is not affected by removable objects in the subsoil. In Step 3, the initiator can determine to what extent the presence of a floating layer of contamination in the groundwater will not result in uncontrollable situations.
This can be done using a long-term (at least five years) series of monitoring results demonstrating that the floating layer of groundwater contamination has not spread further over a long period. Furthermore, additional assessments may be conducted into the physical properties of the pure product (e.g. viscosity) or into the soil's permeability, possibly in combination with a multi-phase flow model, or by a description of the situation in the subsoil affecting the spreading of the floating layer.

Layer of sinking groundwater contamination
If there is a sinking layer of groundwater contamination, an uncontrollable situation will be assumed to exist in the standard risk assessment. If the initiator can demonstrate that there is no sinking layer in the soil's zone of use or that the depth of the zone of use chosen in Step 2 does not apply to the case concerned, the situation will no longer be deemed uncontrollable. The initiator may also demonstrate that the situation is not uncontrollable, for instance by demonstrating that the volume of the sinking layer is so small that any further spreading to the aquifer would be negligible and that the likelihood of the contamination spreading therefore no longer exists. Furthermore, additional assessments may also be conducted into the physical properties of the pure product (e.g. viscosity) or into the soil's permeability, possibly in combination with a multi-phase flow model, or by a description of the situation in the subsoil that affects the spreading of the sinking layer.

Spreading
In Step 3, the initiator may demonstrate that, even though the soil volume containing groundwater contaminated with one or more substances in concentrations exceeding the Intervention Value is larger than 6,000 m^3, the additional soil volume that will become contaminated annually with groundwater containing one or more substances in concentrations exceeding the Intervention Values will be no larger than 1,000 m^3. This can be demonstrated using calculations or measurements. The criterion of 1,000 m^3 extra per year is the same as the difference between Categories II and III on the basis of the volume score in the repealed Circular on determining the remediation deadline (Stcrt, 1997). Urgent remediation is not required in situations involving extra volumes of less than 1,000 m^3 per year. Management measures may be taken (see the main text of Section 3.5) while waiting for remediation to commence. The management measures and associated reporting obligations are stipulated in the decision on severity and urgency. The nature and intensity of the management measures depend on a number of factors: The regional or local policy on groundwater contamination, the contamination situation and the extent to which the contamination spreads, the soil properties, the nature of the area where contamination is located, and the resulting dynamics in the use of the soil.

Because the plumes contaminated with one or more substances in concentrations exceeding the Intervention Value in a soil volume larger than 6,000 m^3 pose the greatest risk for the groundwater reservoir in the Netherlands, a trend reversal is required to reduce the spread of the contamination over time. European developments play a role in this.

The quality of (ground)water is subject to requirements from the Water Framework Directive and the underlying Groundwater Directive[10]. The general import of this is that good chemical conditions in bodies of groundwater must be achieved by no later than 2015. The Groundwater Directive requires a trend reversal if the quality requirement is not met. The measures to be taken are described in the management plans for river basins, which were submitted in 2009. On the basis of these plans, further requirements on managing groundwater contamination may be set. Examples of possible measures within the scope of any such management include the prevention of new contamination as well as monitoring and possibly intervening in existing contamination situations. Given the regional character of the management plans for river basins, it would be inadvisable to prescribe precise management measures for particular situations in this Circular.

Table A: Overview of MPR and MATC values and odour thresholds

Overview of MPR values, MATC values and odour thresholds for substances for which an Intervention Value has been derived, if available.

MPR_{human} = Maximum Permissible Risk (MPR) for humans, in µg per kg body weight per day. For non-carcinogenic substances, it corresponds to the Tolerable Daily Intake (TDI). For carcinogenic substances, it is based on an additional likelihood of tumour incidence of 1 in 10,000 for lifetime exposure (CR_{oral}).
Table 4.1 of RIVM Report No. 711701023 (RIVM, 2001b) shows the MPR values that were revised in 1999/2000. At a later stage, a change was added for dioxin (see the NOBO Report). For lead, a change was added as well. Based on recent research data, MPR_{human} (of 3.6 µg/kg_{bw} per day) for lead has been provisionally lowered to a value of 2.8 µg/kg_{bw} per day as a matter of policy.
The reasons for this are as follows.
The bioconcentration factors for lead in food crops have been lowered on the basis of RIVM Report No. 607711004 (RIVM, 2011b). This means that there is a lower uptake of lead via food crops than was previously calculated. For soil functions involving crop consumption (such as residential with garden), this means that exposure only becomes critical and only results in effects on humans in higher lead concentrations.
The level of MPR_{human} of 3.6 µg/kg_{bw} per day internationally upheld has lost its foundation following an advice by EFSA/JECFA. In 2010, these organisations have indicated in an advice that there is no safe value for the exposure of children to lead. It is no longer possible to exclude an adverse effect on health for low exposure to lead. This advice probably means that MPR_{human} will be set at a lower level, but at the moment it is unclear how low.
The policy choice for a value of 2.8 µg/kg_{bw} per day for MPR_{human} laid down in this Circular will ensure that the lead concentration in the soil constituting unacceptable risks for humans for the soil function 'residential with garden' will remain unchanged. For the other soil functions, the change is limited.

MATC = Maximum Acceptable Toxic Concentration (MATC) in air, in µg per m^3 air.
For non-carcinogenic substances, it is the Tolerable Concentration in Air (TCA). For carcinogenic substances, it is based on an additional likelihood of tumour incidence of 1 in 10,000 for lifetime exposure (CR_{inhal}). The MATC values of the first tranche of substances are stated in a guide to the urgency of soil remediation (SDU, 1995). The MATC values of the second and third tranche of substances are stated in RIVM Report No. 715810004 (RIVM, 1994) and RIVM Report No.

[10] Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration

715810010 (RIVM, 1995). The MATC values of the fourth tranche of substances are stated in RIVM Report No. 711701004 (RIVM, 1998).
Table 4.1 of RIVM Report No. 711701023 (RIVM, 2001b) shows the MATC values that were revised in 1999/2000 (almost all of them first tranche substances).

Odour threshold = The odour threshold of a gaseous substance is the lowest concentration of the substance in air that is still detectable by humans.

An odour panel composed of several people is used to determine the odour threshold for a substance. They are given various dilutions of the substance to smell and say each time whether they can detect the odour. The odour threshold is the concentration at which half of the panel is still able to distinguish the odour from odourless air.
Odour thresholds are not exact values; people are not all equally sensitive to a given odour. As a result, different odour thresholds are found for the same substance in literature.

The odour threshold is expressed in $\mu g/m^3$, ppm or ppb.

The term 'odour threshold' is closely related to the term 'odour unit': The odour threshold is by definition equal to one Odour Unit (OU) per m^3. The median is taken as representative for the purposes of the criterion.

Substance	MPR_{human}	MATC	Odour threshold[A]	
	(µg/kg/d)	(µg/m^3)	(µg/m^3)	
			Median	Lowest
I Metals				
Antimony	0.9	-	-	-
Arsenic	1.0	1.0	-	-
Barium (soluble)	20	-	-	-
Barium (insoluble)	-	1.0	-	-
Cadmium	0.5	-	-	-
Chromium III (soluble)	5	-	-	-
Chromium III (insoluble + metallic)	5,000	60	-	-
Chromium VI	5	0.0025	-	-
Cobalt	1.4	0.5	-	-
Copper	140	1.0	-	-
Mercury (organic)	0.1	-	-	-
Mercury (inorganic)	2.0	-	-	-
Mercury (metallic)	-	0.2	-	-
Lead	2.8	-	-	-
Molybdenum	10	12	-	-
Nickel	50	0.05	-	-
Zinc	500	-	-	-
II Inorganic compounds				
Free cyanides (hydrogen cyanide)	50	25	2,000	900
Complex cyanides	800	-	-	-
Thiocyanate	11	-	-	-
III Aromatic compounds				
Benzene	3.3	20	80,000	5,000
Ethylbenzene	100	770	90,000	9,000
Phenol	40	20	700	20
Cresols (aggr.)[B]	50	170	-	-
Toluene	223	400	20,000	600
Xylenes (aggr.)[B]	150	870	8,000	400
Catechol (o-dihydroxybenzene)	40	-	-	-
Resorcinol (m-dihydroxybenzene)	20	-	-	-
Hydroquinone (p-dihydroxybenzene)	25	-	-	-
Styrene (vinylbenzene)	120	900	3,000	70

Substance	MPR$_{human}$	MATC	Odour threshold[A]	
	(µg/kg/d)	(µg/m^3)	(µg/m^3)	
			Median	Lowest
IV Polycyclic Aromatic Hydrocarbons (PAHs)				
PAH (sum 10)[B]	-	-	-	-
Naphthalene	40	-	800	50
Antracene	40	-	-	-
Phenanthrene	40	-	-	-
Fluoranthene	50	-	-	-
Benzo(a)anthracene	5.0	-	-	-
Chrysene	50	-	-	-
Benzo(a)pyrene	0.5	-	-	-
Benzo(ghi)perylene	30	-	-	-
Benzo(k)fluoranthene	5.0	-	-	-
Indeno(1,2,3cd)pyrene	5.0	-	-	-
V Chlorinated hydrocarbons: volatile chlorinated hydrocarbons				
Vinyl chloride	0.6	3.6	40,000	30,000
Dichloromethane	60	3,000	300,000	5,000
1,1-dichloroethane	80	370	600,000	200,000
1,2-dichloroethane	14	48	100,000	20,000
1,1-dichloroethene	3	14	-	-
1,2-dichloroethene (cis)	6.0	30	-	-
1,2-dichloroethene (trans)	17	60	-	-
Dichloropropane (1,2)	70	12	10,000	1,000
Dichloropropane (1,3)	50	12	10,000	1,000
Trichloromethane (chloroform)	30	100	700,000	300,000
1,1,1-trichloroethane	80	380	900,000	90,000
1,1,2-trichloroethane	4	17	-	-
Trichloroethene (tri)	50	200	50,000	1,000
Tetrachloromethane (tetra)	4.0	60	1,000,000	300,000
Tetrachloroethene (per)	16	250	100,000	10,000
VI Chlorinated hydrocarbons: chlorobenzenes				
Chlorobenzenes (aggr.)[B]	-	-	7,000	400
Monochlorobenzene	200	500	-	-
1,2-dichlorobenzene	430	600	-	-
1,4-dichlorobenzene	100	670	-	-
Trichlorobenzenes (indiv.)	8.0	50	-	-
Tetrachlorobenzenes (aggr.)[B]	0.5	600	-	-
Pentachlorobenzene	0.5	600	-	-
Hexachlorobenzene	0.16	0.75	-	-
VII Chlorinated hydrocarbons: chlorophenols				
Chlorophenols (aggr.)[B]	-	-	400	20
Monochlorophenols (aggr.)[B]	3	-	-	-
Dichlorophenols (aggr.)[B]	3	-	-	-
Trichlorophenols (aggr.)[B]	3	-	-	-
Tetrachlorophenols (aggr.)[B]	3	-	-	-
Pentachlorophenol	3	-	-	-

Substance	MPR$_{human}$	MATC	Odour threshold[A]	
	(µg/kg/d)	(µg/m^3)	(µg/m^3)	
			Median	Lowest
VIII Other chlorinated hydrocarbons				
Chloronaphthalene (aggr.)[B]	80	1	-	-
Monochloroanilines (aggr.)[B]	0.9	4	-	-
PCBs (aggr.)[B]	0.01	0.5	-	-
Trichlorobiphenyl (2,5,2')	0.09	-	-	-
Hexachlorobiphenyl (2.2',4.4',5.5')	0.09	-	-	-
EOX	-	-	-	-
Dioxins (aggr. TEQ)[B]	0.000002	-	-	-
IX Pesticides				
DDT/DDE/DDD (aggr.)[B]	0.5	-	-	-
DDT (aggr.)[B]	20	-	-	-
DDE (aggr.)[B]	20	-	-	-
Aldrin, dieldrin, endrin (aggr.)[B]	0.1	-	-	-
Aldrin	0.1	0.35	-	-
Dieldrin	0.1	0.35	-	-
Endrin	0.2	0.7	-	-
HCH (aggr.)[B]	1	0.25	-	-
a-HCH	1.0	0.25	-	-
b-HCH	0.02	0.25	-	-
c-HCH	0.04	0.14	-	-
d-HCH	-	-	-	-
Atrazine	5.0	-	-	-
Carbaryl	3.0	10	-	-
Carbofuran	2.0	-	-	-
Chlordane (aggr.)[B]	0.5	0.02	-	-
Endosulfan	6	-	-	-
Heptachlor	0.3	0.5	-	-
Heptachloroepoxide (aggr.)[B]	0.4	0.5	-	-
Maneb	50	18	-	-
MCPA	1.5	7	-	-
Organotin compounds (aggr.)[B]	0.4	-	-	-
Tributyltin	0.4	0.02	-	-
Triphenyltin	0.4	-	-	-
X Other organic compounds				
Cyclohexanone	4,600	136	10,000	500
Butyl benzyl phthalate	500	-	-	-
Di(2-ethylhexyl)phthalate	25	-	-	-
Phthalates (aggr.)[B]	4.0	-	-	-
Mineral oil[C]	-	-	-	-
Pyridine	1	120	900	9
Tetrahydrofuran	10	35	20,000	300
Tetrahydrothiophene	180	650	3	3
Tribromomethane	20	100	-	-

[A] This table provides an overview of odour thresholds for volatile substances / groups of substances that are often found in cases of soil contamination. The odour thresholds were taken from the following sources:
Ruth, J.H. Odor thresholds and irritation levels of several chemical substances; a review. Am. Ind. Hyg. Assoc. J., 47, A 142-151, 1986 HSDB (Hazardous Substance Data Base), National Library of medicine, Bethesda, Maryland, USA, 2001
AIHA (American Industrial Hygiene Association). Odor thresholds for chemicals with established occupational health standards. Akron, OH: AIHA, 1989

Devos, M., F. Patte, J. Rouault, P. Laffort and L.J. van Gemert. Standardized human olfactory thresholds. New York: Oxford University Press, 1990
Because values stated in literature for odour thresholds of a substance sometimes differ considerably, the overview shows both the lowest and median values reported. The median value has to be used for checking the indoor air concentration against the odour threshold.

[B] For the composition of the aggregate parameters, see Annex N of the Soil Quality Regulation. For the calculation of the aggregate TEQ for dioxin, see Annex B of the Soil Quality Regulation.

[C] 'Mineral oil' is defined in the analysis standard. Where the contamination is composed of mixtures (e.g. petrol or domestic heating oil), the concentration of aromatic and/or polycyclic aromatic hydrocarbons must be determined in addition to the alkane concentration. This aggregate parameter has been adopted for practical reasons. Further toxicological and chemical disaggregation is under study.

\- No MPR, MATC or odour threshold available.

ANNEX 3: Environmental Protection Soil Remediation Criterion, Asbestos Protocol

1. Introduction

1.1 Background

The background to drafting the Environmental Protection Soil Remediation Criterion, Asbestos Protocol (hereafter referred to as 'Asbestos Protocol') is the soil policy defined in the Policy Letter on soil (Lower House of Parliament, 24 December 2003, 28 663 and 28 199, No. 13) and the policy on asbestos in the soil, as defined in the Policy Letter on asbestos in soil, soil batches, and rubble / rubble granulate (Lower House of Parliament, 3 March 2004, 28 663 and 28 199, No.15). The aforementioned Policy Letters state that an “environmental protection Remediation Criterion” for soil, including for asbestos, will be developed. The environmental protection Remediation Criterion for soil is a scientifically substantiated system for determining the risks associated with soil contamination for a given use of the soil on a site-specific and area-specific basis. The present Asbestos Protocol specifies the environmental protection soil Remediation Criterion for asbestos. The Asbestos Protocol appeared in 2004 as a separate publication but was later included as an annex to the Soil Remediation Circular 2009. In the present Protocol, a number of adjustments have been made compared to the 2009 version, among other things to incorporate the results of the Health Council’s report on asbestos dated 3 June 2010.

1.2 Objective

The Asbestos Protocol can be used as a basis for determining whether unacceptable risks exist as a result of a case of soil contamination with asbestos. Pursuant to the Policy Letter on soil, the system described in this Protocol leads to a decision on 'no unacceptable risks' or 'unacceptable risks' being present.

2. Principles and scope

2.1. Principles

The following principles apply to the application of the Asbestos Protocol:

- The Protocol only applies to land soil (including 'dryer embankment areas'; See Section 1.2 of the main body text of the Circular) and not to the inspection of batches of soil.
- No volume criterion is used, as is common for other types of contamination, because it is the contaminated surface area in particular that determines the risks. In view of the uncertainties in the model-based determination of the risks of human exposure to asbestos however, no surface area criterion has as yet been established.
- The Protocol only applies to historical cases of asbestos contamination at sites that do not have to undergo remediation on the basis of duty of care (i.e. it only applies to cases of contamination caused before 1 July 1993).

2.2 Restriction to human risks

If asbestos is present, hazardous exposure of humans only results from inhaling asbestos fibres. In principle, oral intake of asbestos is not harmful, and absorption via the skin does not play a role. Impacts on the soil ecosystem do not play a role either. Asbestos particles hardly spread through groundwater at all because asbestos fibres do not dissolve in groundwater. Therefore, asbestos contamination of the soil does not involve ecological risks or risks of spreading, but merely risks to humans as a consequence of inhalation.

2.3 Relationship with soil policy

A distinction is made between two risk categories, i.e. 'no unacceptable risks' and 'unacceptable risks'.

No unacceptable risks
If there are no unacceptable risks, a Register of Limitations in respect of the soil contamination will suffice for the present or future arrangements at the site. The location, type, degree of friability, and level and extent of the soil contamination must also be accurately registered in the municipal Register of Limitations. Moreover, the Competent Authority may prescribe management measures to prevent exposure to the contamination. The Competent Authority may also opt for concentration monitoring, if – due to weathering – the risks of asbestos may increase because of reduced friability. The site-specific risks must be reassessed if arrangements change at the site.

Unacceptable risks
In cases involving unacceptable risks, urgent remediation measures – besides a Register of Limitations – must be taken at the part of the site where there are unacceptable risks as a result of the presence of asbestos. The Competent Authority must make a decision on severity and urgency within the stipulated period. Remediation must commence within four years of the decision being issued. The Competent Authority will determine the exact remediation commencement date on the basis of the site-specific situation.

3. Risk assessment scheme

3.1 Basic information and coordination

The Asbestos Protocol is based on the system developed by RIVM and TNO for the risk assessment of soil contamination with asbestos; Refer to RIVM Report No. 711701034 (RIVM, 2003). Coordination has also taken place with the former soil policy and standardisation working group BONS, the soil and water standardisation working group NOBOWA, and the working group concerned with asbestos in soil, soil batches, and rubble / rubble granulate. The Protocol was also drafted taking into account the TCB's recommendations on the new asbestos policy (TCB, 2003).

3.2 Individual steps

By analogy with the risk assessment for the other types of contamination, the Asbestos Protocol consists of three steps, which are shown in Figure 1.

Step 1 covers the determination of whether a case of contamination is severe. This can be determined on the basis of the results of an exploratory and/or more detailed survey (see explanatory text box on the NEN 5707 standard).
Step 2 covers the standard risk assessment. This step can be executed on the basis of the results of an exploratory and/or more detailed survey (see explanatory text box on the NEN 5707 standard).
Step 3 covers the site-specific risk assessment. This involves making additional measurements concerning the concentration of respirable fibres in the soil's contact zone or the soil layer that is worked, and possibly of the concentration of fibres in house dust. The next chapter discusses the Protocol's individual steps in detail.

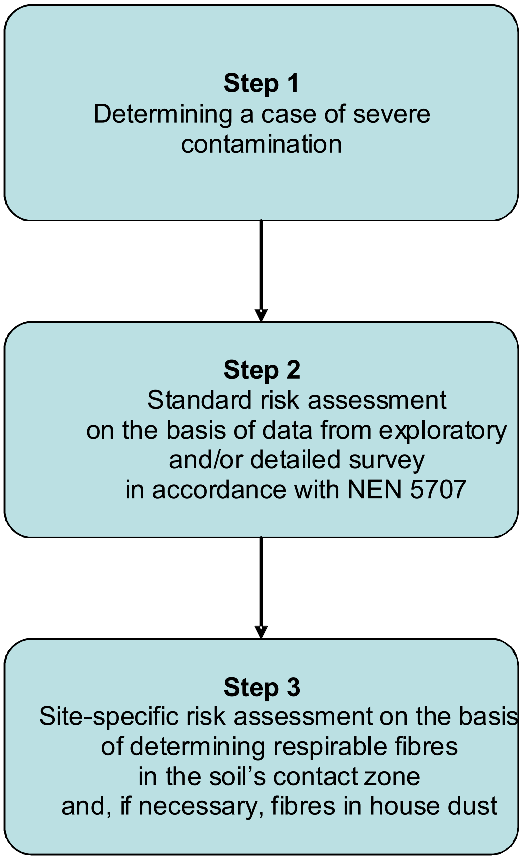

Figure 1: Asbestos Protocol – steps

The Asbestos Protocol's system is organised so that progress through the subsequent steps can be discontinued once a conclusion has been reached on which of the two risk categories apply to the site. Depending on the category, either registration is required – possibly supplemented with management and/or monitoring measures – or remediation measures must be carried out urgently. The Competent Authority determines which management and/or remediation measures must be taken. Examples of management measures include a periodic inspection of the current situation at the site, such as an inspection of the thickness of the uncontaminated topsoil, the presence of buildings, paving, vegetation, and limitations on the site's use.

The Dutch NEN 5707 standard (NEN, 2003) describes a method for the determination of the asbestos concentration in soil and in batches of soil. It describes three survey phases: preliminary study, exploratory survey, and detailed survey. The preliminary study is intended as an aid in drafting a survey hypothesis on the nature and spatial distribution of asbestos in the soil, based on collected (historical) information on the site. The exploratory survey is intended to verify the hypothesis drafted in the preliminary study. The detailed survey is intended to determine the average concentration of asbestos per Spatial Unit (SU = 1,000 m 2) and, secondly, to provide a detailed determination of the extent of the contamination. NEN 5707 also describes the method prescribed for asbestos analyses.

4. Further details of individual steps

4.1 Step 1 – Determining a case of severe contamination

Step 1 is shown by means of a flowchart in Figure 2. In this step, the exploratory survey and/or the detailed survey are used as the basis for determining whether a case of contamination is severe. A case of severe contamination with asbestos in the soil is deemed to exist if the average concentration in a Spatial Unit is higher than the Intervention Value of 100 mg/kg DM (weighted; I.e. the concentration of serpentine asbestos + 10 x the concentration of amphibole asbestos). The average weighted asbestos concentration must be determined in accordance with the NEN 5707 standard. Please note that the volume criterion for asbestos contamination of the soil does not apply when the severity is determined.

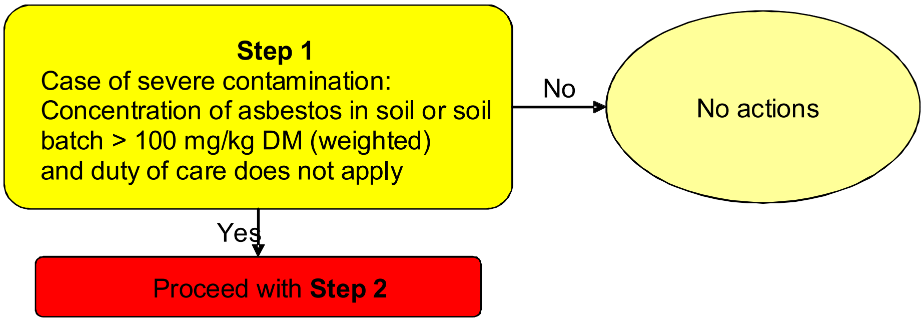

Figure 2: Step 1 – Determining a case of severe contamination

4.2 Step 2 – Standard risk assessment

Step 2 is shown by means of a flowchart in Figure 3. In this step, it is determined based on the potential for contact with asbestos fibres whether the presence of unacceptable risks can be refuted based on the following elements:

- Whether or not the site is located below buildings or a sustainable, contiguous covering layer. A 'sustainable, contiguous covering layer' can for instance be asphalt or paving. Foil does not fall into this category.
- The depth at which the asbestos is located. Unacceptable risks are not deemed to exist if the soil contamination is deeper than 0.5 m below ground level (or deeper than 1.0 m below ground level in case of ample potential for contact) and no excavation work down to the asbestos-containing layer is carried out at the site.
- The degree to which the site is covered with vegetation. If a site is permanently and completely covered with grass or similar dense vegetation and there is no work at or access to the site, no substances can be blown around, and there are no unacceptable risks.
- The concentration and the degree of friability of asbestos in the soil. The concentration is known from the exploratory and/or the more detailed survey. The analyses must be conducted based on the NEN 5707 standard. This standard stipulates that besides distinguishing between amphibole asbestos and serpentine asbestos, the report on the conducted analyses must also make a distinction between non-friable and friable asbestos. This distinction is made by comparing the material found with reference material that has a known friability. It is known from field measurements that no asbestos in excess of the quantification threshold is found in the air in cases of soil contamination with only non-friable asbestos in concentrations of less than 1,000 mg/kg DM (weighted). It is therefore not necessary to make further measurements if the concentration of non-friable asbestos is less than 1,000 mg/kg DM (weighted).

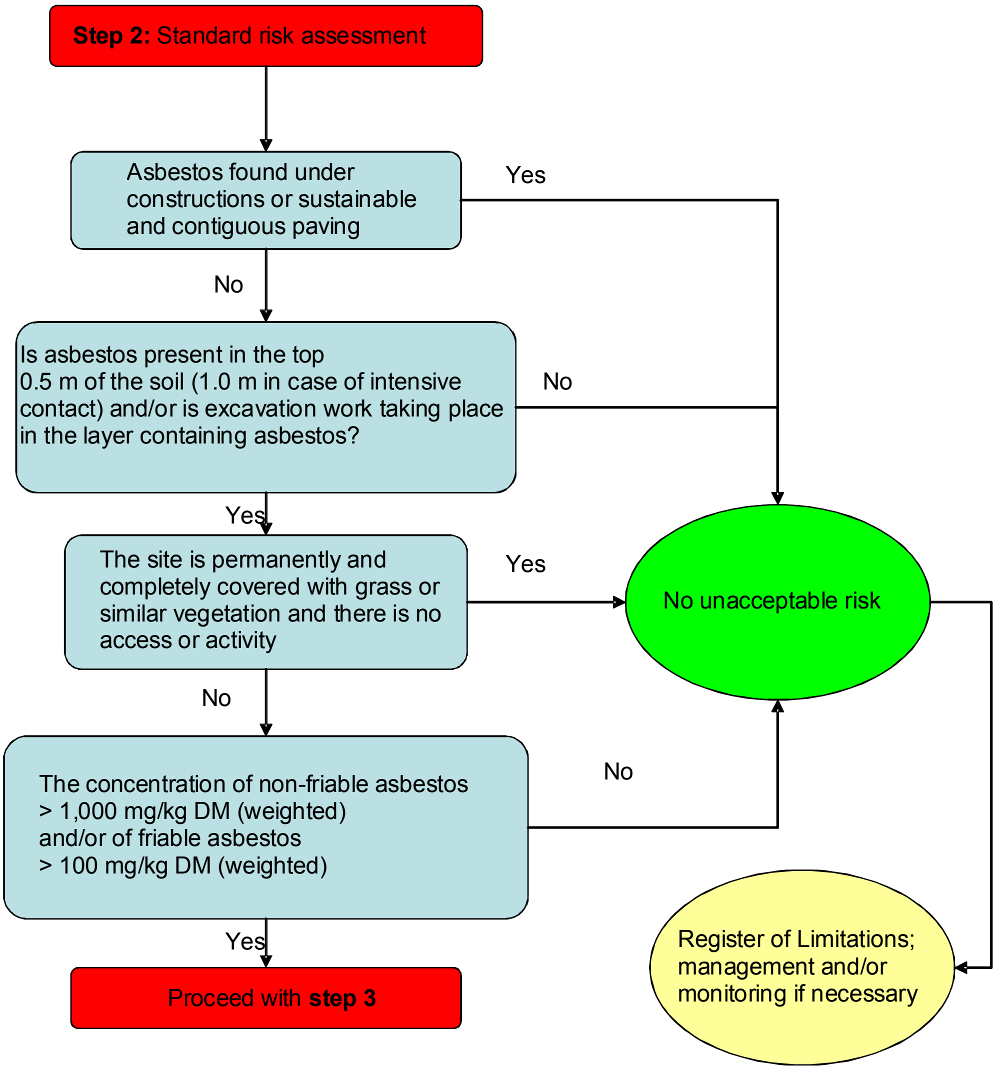

Figure 3: Step 2 – Standard risk assessment

4.3 Step 3 – Site-specific risk assessment

Step 3 is shown by means of a flowchart in Figure 4. In this step, the concentration of respirable fibres in the soil and possibly in house dust is assessed.

Respirable fibres are fibres that can be inhaled and reach the lungs. These are fibres with a diameter of less than 3 µm and a length of less than 200 µm. In the second instance, further measurements may be made of the concentration of fibres that are present as a result of secondary contamination in house dust. Secondary contamination occurs because asbestos from contaminated soil material adheres to clothing or footwear and is carried indoors. Indoors, asbestos fibres can fall from the clothing or footwear. To provide for future situations, the assessment of the expected emission of respirable asbestos fibres from the soil into outdoor air or from house dust into indoor air must occur independently of the actual situation in the site's use and the environmental factors.

Determining and assessing the concentration of respirable fibres in the contact zone
If a site being assessed reaches Step 3, the concentration of respirable fibres in the soil's contact zone must be determined. The contact zone is the part of the soil that is affected by being entered, by driving, or by excavation works. The thickness of the contact zone depends on the soil use and must be explained. For the contact zone, a depth of 2 cm is assumed as standard,

because for entering and driving, the concentration at the surface is the most relevant criterion. In case of excavation work, the thickness is determined by the depth of the soil zone in which these works may take place.
The method for determining the respirable fibres in the contact zone is described in the NEN 5707 standard. Section 1 of Chapter 10 of that standard describes how the soil sample is composed and dried. Section 4 of Chapter 10 describes the method for determining the concentration of respirable fibres. By way of departure from NEN 5707, however, the total dried sample must be passed through a sieve with a screen mesh size of 4 mm, and a sub-sample made up of 20 portions of at least 5 grams must be created. The reason for this deviation from the NEN 5707 standard is that the screening process is intended to free as many fibres as possible, to ensure that a realistic worst case scenario can be determined for the respirable fraction.
Assessment of the concentration of respirable fibres occurs by comparing the measured concentration with a concentration of 10 mg/kg DM (weighted). If this concentration is exceeded, 'unacceptable outdoor risks' are deemed to exist. If this concentration is not exceeded, there are no 'unacceptable outdoor risks'. Because in that case, no high concentration of respirable fibres in house dust due to secondary contamination can occur, there are no 'unacceptable indoor risks' either. The text box below explains the adopted risk limit for respirable fibres in the soil.

In theory, there is a possibility of a case of contamination with respirable asbestos fibres in excess of 10 mg/kg DM while the total asbestos concentration is below the Intervention Value. However, research conducted by the Netherlands Organisation for Applied Scientific Research (TNO) showed that even the respirable fibre percentage of the 'loosest' most friable asbestos (practically unbound asbestos) will never exceed 5-10%; Refer to RIVM Report No. 711701034 (RIVM, 2003). This means that for an asbestos concentration in the soil of 100 mg/kg DM, the respirable fibre concentration will never exceed 5-10 mg/kg DM.

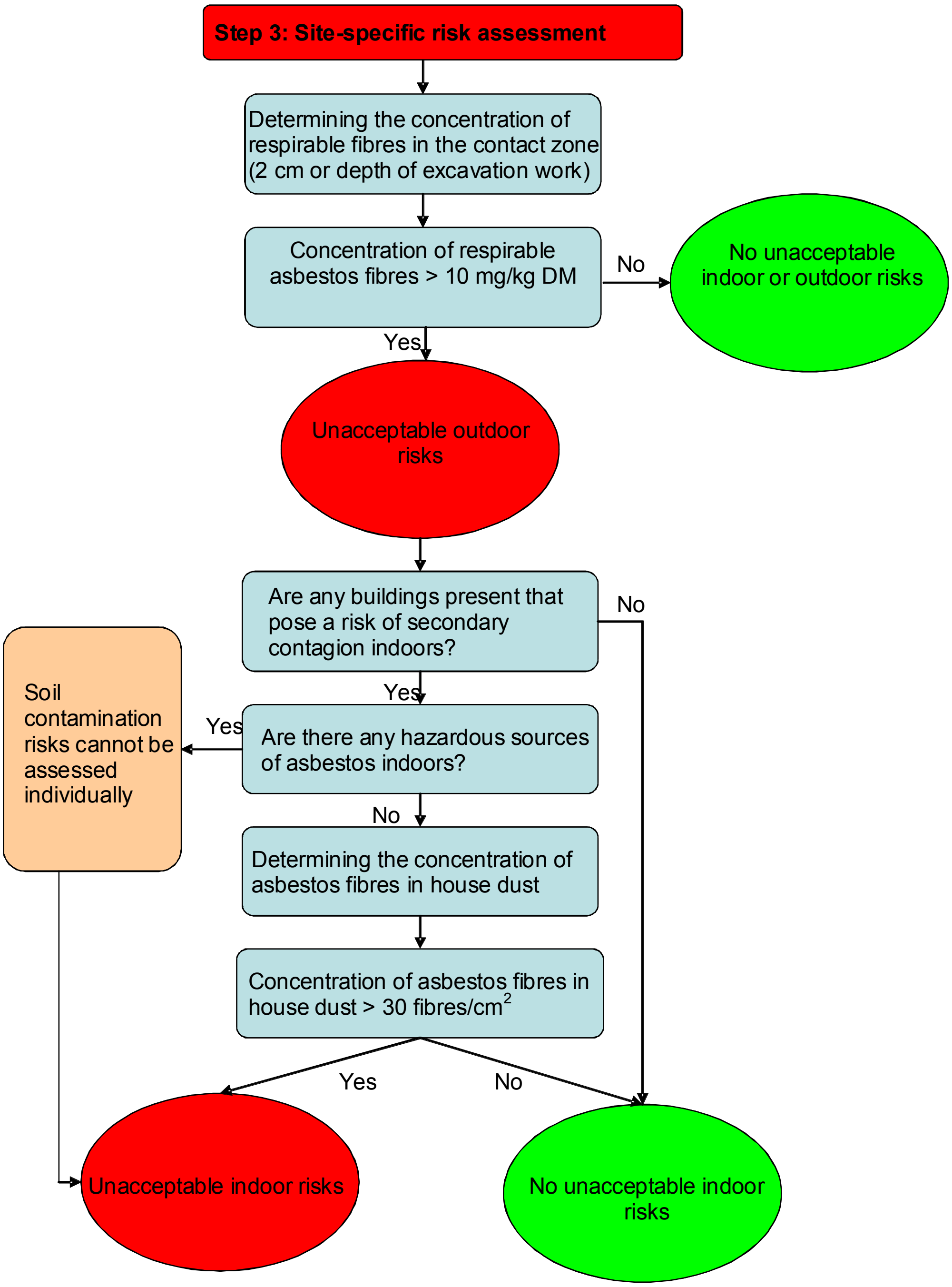

Figure 4: Step 3 – Site-specific risk assessment

Determining and assessing the concentration of asbestos fibres in house dust
If based on the concentration of respirable fibres in the soil, 'unacceptable outdoor risks' are deemed to exist, and secondary contamination within a building cannot be excluded, the concentration of asbestos fibres in house dust must be determined within the scope of this Protocol, based on the NEN 2991 standard (NEN, 2005); See the explanation in the text box below.
In house dust, not only the respirable fibres are assessed, but all other materials containing asbestos as well. This is because it is assumed that the high level of indoor activity may split non-respirable fibre structures in due course. The concentration of 'sedimented' asbestos fibres (in fibres/cm^2) is determined on the basis of the NEN 2991 standard.

Within the scope of the Asbestos Protocol, this determination should not be made if unprotected, friable asbestos-containing materials are present indoors which do not come from the soil, and a risk of fibre emission consequently exists. This is because it is not possible here to determine whether the fibres originate from the contaminated soil or from the indoor materials containing asbestos, and 'unacceptable indoor risks' due to soil contamination cannot be excluded.

Assessment of the concentration of asbestos fibres in house dust occurs by comparing the measured concentration with a concentration of 30 fibres/cm^2. If this concentration is exceeded, 'unacceptable indoor risks' are deemed to exist.

NEN 2991 (NEN, 2005):
The standard describes how to assess on the basis of a visual inspection whether sources of asbestos that pose a risk are present. In certain cases, the inspection must be supplemented by measurements of the asbestos concentration in indoor air. The standard describes the measurement and assessment method to be used.

5. Conclusions and consequences

By means of the Asbestos Protocol, severity and urgency are determined for land soils contaminated with asbestos.
A case of contamination with asbestos in the soil is deemed severe if the average concentration in a Spatial Unit is higher than the Intervention Value of 100 mg/kg DM (weighted). In order to determine the urgency, the site is classified into either the category 'no unacceptable risks' or the category 'unacceptable risks'.

The site is deemed to have 'no unacceptable risks' if the following conditions are met:

- There is no great likelihood of fibre emission because under the site-specific circumstances, it is highly unlikely for people to come into contact with asbestos from the soil.
- Even though the possibility of contact with asbestos from the soil cannot be excluded under the site-specific circumstances, data obtained from experience have shown that airborne asbestos concentrations that lead to unacceptable risks almost never occur in these situations.
- The concentration of respirable fibres does not exceed 10 mg/kg DM (weighted), and the concentration of asbestos fibres in house dust does not exceed 30 fibres/cm^2.

In this case, urgent remediation is not required, but a Register of Limitations has to be compiled. The Competent Authority may prescribe management and/or monitoring measures in addition to registration. The content of the management and/or monitoring measures is determined by the Competent Authority. The site-specific risks must be reassessed if the arrangements at the site or its use change.

If these conditions are not met, the site is deemed to pose 'unacceptable risks', and urgent remediation will be required. Urgent remediation measures must then be taken for the part of the site where there the risks are unacceptable as a result of soil contamination with asbestos. In this context, 'urgent' means that remediation should start within four years of the date on which the decision on severity and urgency was issued.

In a decision on severity and urgency, the Competent Authority lays down the consequences of risk assessment in accordance with this Asbestos Protocol. Section 3.5 of the Soil Remediation Circular 2009 includes points for attention regarding the content of any such decision.

ANNEX 4: Remediation of immobile contaminations: The remediation result

1. General

The nature of the contaminations, in combination with the soil structure and composition, determines whether the contamination situation is deemed mobile or immobile (mobile or immobile contamination in brief). For the approach taken to immobile contaminations, rules and provisions of the Site-specific Conditions Regulation have been included in this Circular without amendment. In the literal sense, the content of the Regulation has been slightly altered below.

2. Interpretation of topsoil quality requirements

2.1 Relationship between soil functions and soil standards

Seven soil functions are recognised (of which three have sub-functions) for which generic protection levels for sustainable suitability have been worked out.
The seven functions of the soil are:

a. Residential with garden
b. Places where children play:
   i With an average ecological value
   ii With low ecological value
c. Vegetable gardens / allotments:
   i Involving considerable crop consumption (large vegetable gardens)
   ii Involving average crop consumption (smaller vegetable gardens)
d. Agriculture
e. Nature conservation
f. Greenspaces with ecological values
g. Other greenspaces, development, infrastructure, and industry:
   i Not entirely paved or almost entirely paved
   ii Entirely or almost entirely paved

Risk scenarios have been worked out for each of the seven soil functions (including sub-functions) on the basis of:

- Amount of human contact with the soil: Considerable or little contact
- Amount of crop consumption: None, limited, average, great
- Protection of agricultural production: Exists or does not exist
- Protection of ecology – generic: Little, average, high
- Protection of ecology – taking biomagnification into account: Little, average, high

The seven functions of the soil have ultimately been clustered into three Soil Function Classes. On the basis of the most vulnerable scenario within a Soil Function Class, a single generic standard for sustainable suitability has been worked out for each Soil Function Class. The classification of soil functions into Soil Function Classes is shown in Table 1. The name of the generic standard for sustainable suitability is also shown. The most vulnerable function was decisive for establishing the level of the standard.

Table 1: Classification into Soil Function Classes and name of soil standard

Soil standard derived for sustainable suitability	Soil functions that form a single Soil Function Class
Background Values	Agriculture Nature conservation Vegetable gardens / allotments
Maximum Housing Value	Residential with garden Places where children play Greenspaces with ecological values
Maximum Industrial Value	Other greenspaces, development, infrastructure, and industry

The substantiation for these standards is described in Bodem+ Report No. 3BODM0704 (SenterNovem, 2007).
The Soil Quality Regulation indicates the values for the various standards per substance.

2.2 Possible remediation measures

Remediation of soil contamination situations can be carried out using the following measures:
a. Excavating the contaminated soil
b. Removing the contaminants from the soil or groundwater
c. Using techniques that result in biological decomposition/transformation or chemical conversion into non-hazardous end products
d. Isolating the contamination situation by laying topsoil or another durable covering layer

Laying topsoil suffices in many cases. Laying topsoil is the standard approach for the soil functions ‘Residential with garden’, ‘Places where children play’, ‘Green areas with ecological values’, and ‘Other greenspaces’.
The contamination situation is automatically isolated where there is paving and/or development, as is usually the case for the soil functions ‘Development, infrastructure, and industry’. In such cases, the isolation is formed by the covering layer of concrete, asphalt, steel-reinforced concrete paving slabs, or large areas of contiguous paving with paving stones and clinkers. Exposure risks can be sufficiently reduced if constructions of this kind are durable and contiguous.
No standard approach has been worked out for the soil functions ‘Nature conservation’, ‘Agriculture’ and ‘Vegetable gardens / allotments’. If remediation is required, the necessary remediation measures will be determined per case.

2.3 Topsoil thickness requirements

If the remediation measure involves laying topsoil, the following requirements apply to the topsoil:
a. The topsoil has a standard thickness of 1.0 m
b. Depending on the depth of roots, a greater depth varying from 1.0 to 1.5 m may be required in gardens and other plant-covered sites
c. At the Competent Authority's discretion, a topsoil thickness other than the standard thickness is possible in case of a special type of development or under certain conditions, such as a high groundwater level; A minimum thickness of 0.5 m will then apply

An indicator layer is generally laid below the topsoil and is intended to provide a warning of contamination below the indicator layer.

2.4 Post-remediation requirements and quality requirements for topsoil and backfill soil

For the determination of the Remediation Objective for immobile contaminations in the topsoil, it does not matter whether soil is supplied from elsewhere.

If soil is supplied from elsewhere (backfill soil, laying of topsoil), the Soil Quality Decree will apply. The supplied soil must meet the following requirements:

- If the remediation site is located in an area for which local maximum values have been laid down in accordance with the Soil Quality Decree, these will be used as the quality requirement.
- If not, the generic policy in accordance with the Soil Quality Decree will apply. The quality requirement will be determined based on the Soil Function Class and the Soil Quality Class. The more stringent requirement of the two will be decisive. The Soil Function Class is determined based on the Function Map, and if no Function Map is available or if the area has not been classified, the Background Value will be used as the quality requirement. The Soil Quality Class is determined based on the Soil Quality Map. If no Soil Quality Map is available, the site will be classified based on the soil quality of the area surrounding the remediation site.

Even though the use of backfill soil at a soil remediation site is subject to the Soil Quality Decree (Section 35) and the Competent Authority under the Soil Quality Decree is therefore responsible for supervision and enforcement, it is not desirable for two different bodies (the Competent Authority under the Soil Protection Act and the Competent Authority under the Soil Quality Decree) to supervise the same aspect during soil remediation operations. In this case, it makes sense for the Competent Authority under the Soil Protection Act to also supervise the use of backfill soil at the remediation site. It is recommended that the two Competent Authorities agree on proper arrangements in this regard.

If no soil is supplied from elsewhere (reorganisation, removal, cleaning through sifting on site), the Soil Quality Decree will not apply. In that case, the suitability for the function will determine the Remediation Objective. The Competent Authority under the Soil Protection Act should preferably link up with the Soil Quality Decree in such cases. The Soil Function Class will then play a central role in determining the Post-remediation Value. If local Maximum Values have been determined for the area concerned, these will be used as the Post-remediation Value. If not, the standard value (Background Value, Maximum Housing Value or Maximum Industrial Value) corresponding with the Soil Function Class will apply. The Soil Function Class is determined based on the Function Map, and if no Function Map is available or if the area has not been classified, the Background Value will be used. The Competent Authority under the Soil Protection Act may make a substantiated choice for a different Post-remediation Value, for instance based on future utilisation or the actual function instead of the function as indicated on the Function Map. The reason for a deviating Remediation Objective may also be concerned with area-specific circumstances, as applied in the extensive contamination in the De Kempen area for instance.

The intended use will not be impeded by the contamination at the site, provided the applicable quality requirement is met. Therefore, enquiries with the local authority will always be required to determine the Soil Function Class of the area that requires remediation, and whether local maximum values exist for the area concerned. If soil supplied from elsewhere is used, enquiries with the local authority will be required to determine whether a Soil Quality Map is available.

ANNEX 5: Remediation of mobile contaminations: remediation results

1. General

The nature of the contaminations, in combination with the soil structure and composition, determines whether the contamination situation is deemed mobile or immobile (mobile or immobile contamination in brief). The Soil Protection Act provides various options for tackling mobile contaminations in order to decide on the most optimum way of carrying out the remediation. This annex provides an explanation of the remediation result to be achieved.

2. Remediation result for case-based and cluster-based approach

In general, mobile contaminations cannot be assumed to have a generic Remediation Objective at case level, so every situation may lead to a different preferred variant as a result. The decision process is about finding a proper balance between the benefits of the remediation to be achieved and the expenses associated with it. Benefits and expenses may be defined at different levels of abstraction, but in principle it is about the environmental and spatial benefits to be achieved by the remediation as well as long-term risk reduction, versus the expenses needed for this, as well as the short-term restrictions, nuisance, and inconvenience caused by implementing the solution. The basic situation of the contamination will strongly determine the outcome of the decision process. This not only includes the nature, intensity and size of a contamination, but also its position in its environment, such as the pedological and hydrological situation, and its position *vis-à-vis* vulnerable objects. The intended spatial developments will also play an essential role in this respect.

Often, the direction of a preferred variant may already be indicated beforehand on the basis of a global consideration of the different factors and characteristics. These can then be stated as such when explaining and substantiating the variant concerned. Only in complex situations, making a broader consideration and taking multiple variants into account may have added value for the party carrying out the remediation.
For relatively small contaminations where there are developments at the site or in the area, the benefits of radically removing the contaminations tend to outweigh the expenses. For extensive groundwater contaminations however, the ratio between the benefits and the expenses may be radically different. This also depends on the (future) utility value of the subsoil and the groundwater it contains. If there is a development potential for the subsoil and/or the vulnerable objects/areas to be protected, this may be considered a benefit in the consideration. If no development potential and/or vulnerable objects are present, the expenses of remediating the groundwater may quickly outweigh the benefits.

From the broad spectrum of possible variants and the results to be achieved by them, a division into four parts is assumed as a guideline for the entire result area and the obligations associated with them in the opinion of the Competent Authority.

- <u>Complete removal, with possible slight residual contamination:</u> Especially for small-scale and straight-forward contaminations with or without spatial developments, it seems obvious – based on the ratio between the benefits and the expenses – to opt for tackling the source zone and the plume in a single operation and to aim for a remediation result that leaves no or little residual contamination. Both the party carrying out the remediation and the Competent Authority will benefit from this, because on the basis of the assessment report, the remediation can be terminated right after it has been carried out, and there will be no future restrictions or obligations.

- <u>Limited residual contamination in the groundwater:</u> In practice, this would be the result of a phased remediation of an extensive contamination, in which the source zone is remediated and the site is prepared for its function in the active first remediation phase, which may be followed by a passive second phase, depending on the results. 'Limited residual contamination' is considered a residual contamination not exceeding 1,000 m^3 with concentrations preferably not exceeding the Intervention Value for the groundwater. At such a scale, spreading is hardly expected to occur. With this remediation result, follow-up monitoring will not be necessary. If the average concentrations of the limited residual contamination exceed the Intervention Value and vulnerable objects are present in the area, the Competent Authority may decide to impose a limited obligation to monitor, depending on the situation. As a result, monitoring is optional in this situation. In that case, the objective of any monitoring would be to gather confirmation that there is indeed no – or no more – spreading towards the vulnerable object.

- <u>Extensive residual contamination in the groundwater:</u> This would be the result of remediating large-scale groundwater contaminations where, after an active first phase with a source zone present, there is no longer any supply of contaminations towards the plume, and where the quality of the plume improves over time after extensive local remediation and/or natural attenuation. For these situations, it is important whether vulnerable objects are present in the contamination plume's (potential) sphere of influence. If no vulnerable objects are present and the utility functions of the (deeper) groundwater are limited, it may be justifiable on the basis of cost effectiveness to primarily opt for tackling the source zone. When granting approval for this approach, it will have to be clear that there is a stable, environmentally acceptable end result, as stipulated in Section 4.1.3 of this Circular, possibly in combination with natural attenuation. In the situation at hand, a certain of degree of spreading may be acceptable on the basis of a consideration between the benefits and the expenses. No limits, including on duration, are imposed on the spreading beforehand. Depending on the situation, and whether the spreading concerns contamination concentrations exceeding the Intervention Value, the Competent Authority may decide upon monitoring after remediation and/or groundwater control. Monitoring is optional for situations where no vulnerable objects are concerned. If there are vulnerable objects in proximity, monitoring may be designated as obligatory. In that case, the objective of any monitoring is to gather confirmation that the risks of spreading have been removed to a sufficient degree. If these risks have not been removed sufficiently by the remediation and there are vulnerable objects in the potential area of spreading, the Competent Authority may decide – possibly via a fall-back scenario – upon groundwater control until the moment that the prescribed monitoring reveals that no more spreading towards vulnerable objects occurs.

- <u>Residual contamination in the groundwater that continues to spread:</u> In special situations, a remediation result where residual contamination continues to spread may be acceptable. This may be the case when the remediation costs are extremely high and are not in proportion to the environmental and spatial benefits to be achieved, for instance due to the absence of utility potential for the groundwater and the absence of spatial dynamics. Remediation variants that could lead to this result are excluded beforehand when there are vulnerable objects in proximity.
  After the remediation, monitoring will be necessary in order to establish the degree of spreading of the residual contamination still present. The Competent Authority may also impose additional control measures if the situation so requires, for instance to protect potential future utility functions. Any such control measures could also function as a fall-back scenario for situations in which monitoring during remediation reveals that the existing spreading deviates from the prognoses and is deemed unacceptable by the Competent Authority in the situation at hand.

The overview below presents a summary of the result areas mentioned.

Table: Result areas and obligations

Remediation result	Almost complete removal (slight residual contamination)		Limited residual contamination (size < 1,000 m^3)		Extensive residual contamination (practically stable or stable within 30 years)		Residual contamination still spreading (controllable and acceptable in the situation at hand)	
	Absence of vulnerable objects	Presence of vulnerable objects	Absence of vulnerable objects	Presence of vulnerable objects	Absence of vulnerable objects	Presence of vulnerable objects	Absence of vulnerable objects	Presence of vulnerable objects*)
Follow-up: Monitoring	--	--	--	**Optional**	**Optional**	**Yes**	**Yes**	
Follow-up: Control	--	--	--	**Optional**	**Optional**	**Optional**	**Optional**	
Fall-back scenario in Remediation Plan	--	--	--	--	--	**Optional**	**Optional**	

**) A remediation solution in which contaminations in the plume can continue to spread after remediation is not allowed if vulnerable objects are in proximity*

A special solution direction is one in which control measures continue to be necessary in the plume even after remediation of the source zone, or in which – as a result of the size and complexity of the contaminations – it is necessary to completely isolate and permanently control and monitor them. In practice, this situation hardly occurs as a case to be remediated, but there have been various cases in the past that have been tackled this way and where an obligation for indefinite follow-up was imposed.

When the source zone and the plume area are tackled separately, a considered choice for the definition and demarcation of the source zone is essential. In case of phased remediation, it is essential that the remediation is carried out as efficiently as possible; in case of area-based remediation, it is essential that agreements – financial or otherwise – are made with the party managing the area (see Section 3). Among other things, the objective of remediating the source zone may be that contaminants are no longer supplied to the groundwater plume after remediation. In this context, it could be important to give a sufficiently robust definition of the source zone. A conceptual model regarding the spreading that is targeted at the situation present may be useful in this regard.

Any obligation to monitor – temporarily or otherwise – after the remediation must be determined on a location-specific basis. An indication of the possible necessity as well as the objective for this has been stated above. This is the Competent Authority's responsibility however.
Any obligation for follow-up is also determined by the Competent Authority. In this respect, the information in the table above and the explanation provided can be used as a guideline. For remediations according to the so-called 'IBC' principle (Isolate, Control, Monitor), there will always be active follow-up. Control and monitoring are fixed components of remediations of this type.

3. Remediation result for area-based approach

The area-based approach aims to be an important incentive to tackle groundwater contamination and to achieve (partial) remediation of source zones as well as (re)development of areas containing contaminated sites. Although the area-based approach is primarily aimed at the deeper groundwater, it also entails an obligation to remediate the source zones. In this sense, there is a broader objective.

It is important that the source zone is properly defined and demarcated, as the responsibility for its remediation in principle remains with the party obliged to carry out the remediation. This obligation results from the fact that this party is allowed to participate in the area-based approach. In addition to preparing the topsoil for its intended function, the objective of remediating the source zone is to prevent or exclude the delayed supply of contaminants towards the plume area. In order to achieve this, the source zone must be defined sufficiently robust. It should be prevented that after remediation, the plume is still supplied with contaminants from the source zone defined in the survey stage. Demarcation is also subject to what is stated above for the separate approach of the source zone as well as for partial remediation.

In concrete terms of groundwater quality, it is essential in the area-based approach that the risks of the contamination spreading outside of the controlled area are prevented or excluded to the furthest extent possible. Based on monitoring, it will be decided if and when the contamination will be tackled. The acceptance of a certain degree of contamination spreading within an area should not lead to unacceptable risks occurring outside that area.

Within the area, the protection of certain functions of, on, and in the soil will be central. The quality of the groundwater to be achieved must be geared to this. In principle, there is no need to implement (more ambitious) remediation measures as long as this condition has been met. This does not alter the fact that the Competent Authority may opt for a more ambitious objective. Often, the long-term improvement of the groundwater quality within the area will be strived for as well. The remediation of source zones will contribute to this, as will the natural attenuation occurring and any facilities to be realised for the development (temporary as well as permanent groundwater extractions, for instance for geothermal heat pumps, cooling systems, etc), plus local remediation methods wherever necessary.
With these measures, aimed at preventing the introduction of new contaminations in the groundwater as well as trend reversal, an area-based approach will also contribute to the realisation of the objectives of the Water Framework Directive and in particular those of the Groundwater Directive.

The Explanatory Memorandum to the Soil Protection Act contains an explanation of the Act's relevant articles. In addition, the Guideline for Area-based Groundwater Management (VROM, 2010) contains information about their meaning in practice.

4. Step-by-step plan for remediation of mobile contaminations

The following steps can be distinguished in the decision process for the preferred remediation solution:

1. Establishing whether the contamination is mobile or immobile
2. Choosing the preferred or only possible remediation approach
3. Choosing the most efficient remediation strategy
4. Choosing and substantiating the remediation variant and the remediation result to be achieved

Step 1:
Based on the definition in Section 4.3.2 and the detailed soil survey carried out, it should be determined whether the contamination is mobile.

Step 2:
The choice for the preferred remediation approach is determined by the location of the contamination present *vis-à-vis* any other contaminations present, as well as the stipulations in Section 4.4.1.

Step 3:
The choice for the most efficient remediation strategy depends on the remediation approach. For ***case-based approaches***, the choice for a strategy strongly depends on the size and complexity of the contamination. In cases of limited size, remediation in a single operation is generally preferred for efficiency as well as financial reasons. For extensive contaminations, a choice in that direction is less obvious. In such cases, phased remediation would be more appropriate for the problems at hand.
With phased remediation, the Remediation Objective is formulated for the entire case, and the various remediation phases are outlined in one Remediation Plan. In principle, phased remediation makes it possible to carry out the remediation of the source zone at a different time

than the remediation of the contamination plume, without losing sight of the objective for the plume. This strategy may also be chosen in situations where it is clear that the plume also requires measures to prevent or restrict further spreading and to make it controllable, for instance out of the necessity to protect vulnerable objects.

For ***cluster-based approaches***, choosing a phased remediation strategy would also seem obvious. Within a phased remediation, further differentiation into partial remediations for the source zone is possible, for instance in situations where the source of the contamination cannot be tackled due to the presence of infrastructure above or below ground, or cannot be tackled yet.

For ***area-based approaches***, the strategy for the party obliged to carry out the remediation is in principle only aimed at partial remediation, as the plume is disconnected and tackled within a different strategy (that of the party managing the area). The source zone is tackled with one or more partial remediations. Multiple partial remediations may be assumed to be necessary if parts of the area within the source zone are unavailable for the methods to be deployed at the time of remediation.

Step 4:
The choice for the most optimum remediation variant is different for the case-based and cluster-based approach than it is for the area-based approach.
For ***case-based and cluster-based approaches***, a description of the decision process is provided in the end report to the A-5 Relaunch Project (SIKB, 2001), with practical tools provided by the ROSA practical document (SKB, 2005) to decide on a preferred variant for mobile contaminations. These documents can be considered instruments to support the party carrying out the remediation in particular.
When substantiating the preferred variant, the current statutory Remediation Objective and the resulting requirements are the starting point. In doing so, the focus will be on the preservation and/or recovery of the functional quality of the soil (by preventing vulnerable objects from being threatened, among other things) and on making the contamination present controllable. The remediation of mobile contaminations must not take longer than 30 years, if this is required for the selected variant. When explaining and substantiating the preferred variant, it should be taken into account that remediation operations that can be completed within a few years are preferable, as long-term remediation requires long-term monitoring and reporting, and the outcome is still often uncertain.

For ***area-based approaches*** of large-scale groundwater contaminations in circumstances where area-based groundwater management is set up, special regulations apply. An area-based approach differs from the traditional way of remediating in that it aims to control the contamination. Risk control is a central notion in this respect. This means that spreading of the contamination outside the managed area is subject to severe restrictions. Within the area, the (intended) functions designated for this must be adequately protected, and the contaminants are neutralised over time via natural attenuation, which may be supported by local remediation methods. In an area-based approach, individual cases of contamination are no longer the point of departure, which is now the groundwater in the area concerned. An area-based approach is aimed at managing the entire groundwater aquifer within the area, with all contaminations known and (as yet) unknown.

As a result, the demarcation of individual cases of contamination in the groundwater is no longer necessary, technically feasible measures can be applied, and the costs will drop significantly compared to a traditional approach.
Furthermore, fewer (expensive) surveys are required, while the effectiveness of the measures can be deemed high. Socially desirable spatial development using the subsoil is facilitated rather than impeded, resulting in an efficient approach.

An area-based approach is not directly aimed at remediating the source zones, but does intend to encourage tackling them. Thus, arrangements regarding remediation of the source zone will be made with parties carrying out the remediation that are willing to participate in an area-based approach. The importance of remediating the source zone is evident. In combination with the natural attenuation mentioned, the remediation of source zones could lead to the desired trend reversal of the groundwater quality in the controlled area. In addition to making the soil suitable for its intended use and/or the utility function present, the objective of remediating the source zone is removing the mobile contaminations as far as possible. The point of departure for this is to prevent the relevant supply of contaminants towards the groundwater in the controlled area from occurring.

In this context, a proper demarcation of the source zone is essential. In an area-based approach, special attention will have to be devoted to this in the survey to be performed.

ANNEX 6: Guideline for handling non-standardised substances

1. Introduction

Standardised substances
This Circular contains Intervention Levels or Indicative Levels for soil and groundwater as well as groundwater Target Values for many substances. The Soil Quality Regulation contains soil Background Values for the same substances (more or less). Where soil and groundwater quality is concerned, these are the standardised substances.

Non-standardised substances
In addition, there are substances that are only incidentally found as soil contamination. This Circular and the Regulation mentioned do not contain standards for these substances, which also applies to nutrients (nitrate, phosphate) or other so-called macro parameters (chloride, iron). Such substances are labelled ‘non-standardised substances' in this guideline.

A contamination can also be deemed severe when non-standardised substances are found (Section 29 of the Soil Protection Act) and may have to be remediated urgently (Section 37 of the Soil Protection Act). In this instance as well, the guideline relates to historical cases of soil contamination (since 1987, duty of care has included non-standardized substances). In addition, there may be restrictions on re-using soil or dredge containing non-standardised substances.

When groundwater Target Values and/or soil Background Values are missing, it is not always clear whether there is a case of soil contamination. When non-standardised substances are concerned, a decision on severity and urgency cannot be substantiated by the fact that the Intervention Values or Indicative Levels are being exceeded. This guideline explains how to proceed in cases like that.

Scope of the guideline
This guideline is primarily concerned with contaminants that occur incidentally and, to a lesser degree, with nutrients or other macro parameters. The preferred approach for nutrients and other macro parameters is via statutory frameworks other than the Soil Protection Act (e.g. regulations for fertilisers or sea sand).

This guideline pertains to the decision whether there is a case of contamination or not, to the possibilities for reusing the soil and dredge, and to the decision on severity and urgency under the Soil Protection Act. The Regulation to the Soil Quality Decree stipulates that duty of care must be observed for non-standardised substances. This means that anyone who is aware or could reasonably suspect that adverse effects may occur as a result of an activity in or with contaminated soil or dredge should take measures to prevent or limit the contamination as far as possible. This duty of care is also aimed at any effects from nutrients and other macro parameters in the soil and dredge to be used.

Content of the guideline
This guideline will first discuss alternative possibilities for soil Background Values or groundwater Target Values (Section 2). When there is no soil Background Value or groundwater Target Value, it is unclear when the threshold for soil contamination is exceeded. In addition, the soil Background Value can be used as the Maximum Housing Value as well as the Maximum Industrial Value from the Soil Quality Regulation. This is consistent with the policy choices for other substances in the Soil Quality Regulation where the maximum values mentioned cannot be based on national Reference Values derived by the RIVM or on a former Composition Value for dirty soil. Refer to the NOBO Report (VROM, 2008) for more information.

Then, this guideline will discuss the assessment of the severity and urgency of a case of contamination (Section 3) and additional alternative options for the Intervention Value and the Indicative Levels (Section 4).

2. Background Values and Target Values for non-standardised substances

When there is no soil Background Value, the following options exits:

- Soil Target Values are derived in the context of the INS (National and International Standards for Substances) project. These soil Target Values can be found via www.rivm.nl/rvs. These Target Values are based on a Negligible Risk Level and can be used as threshold for the presence of a case of contamination.
- For naturally occurring substances, it can be decided to determine the local natural Background Concentration of the substance concerned and use it as the Background Value for this substance. When this Background Value is exceeded, there is a case of contamination. Information on natural soil Background Concentrations of non-standardised macro parameters, nutrients and metals in particular may be found in the data of the LMB (National Monitoring Network for Soil Quality), via the file on monitoring networks at www.rivm.nl and via www.dinoloket.nl. In order to determine the natural Background Concentration, the Guideline for Soil Quality Maps (VROM/V&W, 2007) can be used, or the method to be deployed can be agreed with the Competent Authority.
- If a substance does not naturally occur in the soil and there is no soil Target Value from the INS project, the Limit of Quantification can be used as soil Background Value. The Limit of Quantification may be requested from the various laboratories and research institutes that can analyse the substance concerned. If the measurement method for the substance concerned is not standardised, the Limit of Quantification may differ depending on the method and equipment used. If the substance is found in over 25 m^3 of soil, there is a case of contamination.

When there is no groundwater Target Value, the following approach may be followed:

- The INS project may also be used to derive groundwater Target Values, which may be found via www.rivm.nl. These Target Values are based on a Negligible Risk Level and can be used as threshold for the presence of a case of contamination.
- For substances naturally occurring in the groundwater, the local natural Background Concentration is in principle used as Target Value. As this Circular does for metals, a distinction must be made between deep and shallow groundwater in this respect. Information on natural groundwater Background Concentrations of non-standardised macro parameters, nutrients and metals in particular may be found in the data of the LMG (National Monitoring Network for Groundwater Quality) and the PMGs (Provincial Monitoring Networks for Groundwater Quality), via the file on monitoring networks at www.rivm.nl, via www.dinoloket.nl, and/or via the provincial websites. If these sources do not yield suitable information, it may be decided to determine the local natural Background Concentration on the basis of measurements in the area.
- For substances that do not naturally occur in the groundwater and that do not have a groundwater Target Value from the INS project, the Limit of Quantification may be used as Target Value. The Limit of Quantification may be requested from the various laboratories and research institutes that can analyse the substance concerned. If the measurement method for the substance concerned is not standardised, the Limit of Quantification may differ depending on the method or equipment used. If the substance is found in groundwater in over 100 m^3 of pore-saturated soil volume, there is a case of contamination.

Using the Limit of Quantification as soil Background Value or groundwater Target Value is not preferred, as principally a risk approach is used for establishing standards in environmental policy. There is no risk analysis for non-standardised substances however. As a result, the Limit of Quantification is used for lack of a better alternative.

3. Primary assessment of severity and urgency of the case of contamination

If the Soil Protection Act remediation regulations apply, a case of contamination with a substance that has no Intervention Value or Indicative Level can be primarily assessed by following the steps below.

1. Assessment on the basis of other substances present that do have an Intervention Value or Indicative Level. Often, cases of contamination involve multiple substances. Therefore, the decision on severity of a case of contamination is rarely based on a single substance. As a result, the remediation of a site usually does not have to be delayed when the Intervention Values for one or even more substances are missing.
2. Risk assessment on the basis of *ad hoc* ecotoxicological SRCs (Serious Risk Concentrations), *ad hoc* human-toxicological SRCs, and *ad hoc* Intervention Values for soil and/or groundwater derived for other cases of contamination. Whether such *ad hoc* values are available for the non-standardised substance concerned and whether these are suitable for the site to be assessed, can be found out from the RIVM (via www.rivm.nl/rvs or the Sanscrit helpdesk at www.sanscrit.nl). The next section contains an explanation of the terms used, as well as some comments on the use of the values concerned.
3. Risk assessment using other standards, e.g. from water quality management, fertilisers regulations, or other agricultural standards (via www.wetten.overheid.nl).

Assessment exclusively based on physical-chemical affinity using an Intervention Value for a chemically related substance does not suffice, as physical-chemical affinity of substances is not always related to toxicological affinity.
Based on data from the procedure above, the Competent Authority may take a decision on severity and urgency for a case of contamination or any Remediation Plan.

4. Additional assessment of severity and urgency of the case of contamination

If the Competent Authority is of the opinion that it cannot adequately substantiate its decision on the basis of the data available, the RIVM can derive an *ad hoc* Intervention Value, an *ad hoc* ecotoxicological SRC, and/or an *ad hoc* human-toxicological SRC. Contact the Sanscrit helpdesk in order to do this (www.sanscrit.nl). The terms used in this context are explained below.

Ad hoc Intervention Values and SRCs

Depending on the situation, the RIVM can propose the following values:

- An *ad hoc* ecotoxicological SRC: This is the threshold concentration of a contaminant in the soil which determines the ecotoxicological criterion on which the Intervention Values are based.
- An *ad hoc* human-toxicological SRC: This is the threshold concentration of a contaminant in the soil which determines the human-toxicological criterion on which the Intervention Values are based.
- Both values mentioned above: If both values can be derived, the lowest value is considered the *ad hoc* soil Intervention Value.

If desired, an *ad hoc* Intervention Value for groundwater may be derived simultaneously with that for soil. This occurs on the same toxicological risk assessment basis, supplemented with the use of groundwater as human drinking water, based on the method proposed by the RIVM. Refer to RIVM Report No. 711701023 (RIVM, 2001b).

If the Competent Authority is of the opinion that legal instruments must be deployed for a specific case of contamination to be assessed, it may request the Inspectorate on behalf of the Minister of Infrastructure and the Environment to determine an *ad hoc* ecotoxicological SRC and/or an *ad hoc* human-toxicological SRC, and possibly also an *ad hoc* Intervention Value for soil and for groundwater, based on the RIVM proposals.

An *ad hoc* Intervention Value cannot be used indiscriminately as 'statutory' Intervention Value, as the *ad hoc* Intervention Value is often based on information that is incomplete or unreliable. Furthermore, the determination of *ad hoc* Intervention Values does not entail a comprehensive advisory process, which is the case for 'actual' Intervention Values. With the proposals for Intervention Values that are derived via regular tranches, a greater effort is made to obtain input parameters that are underpinned statistically, and greater emphasis is put on the improvement of the most relevant parameters on the basis of a more intensive sensitivity analysis. As a consequence, a proposal for an Intervention Value may indicate a different concentration of a substance in the soil than the *ad hoc* Intervention Value that was previously derived for the substance concerned.

Over the past couple of years, the RIVM has already derived a number of *ad hoc* ecotoxicological SRCs, *ad hoc* human-toxicological SRCs, and *ad hoc* Intervention Values. The *ad hoc* Intervention Values may be used as an initial indication for the risks of a substance being present in the soil. If these values are available, they may be requested from the RIVM via the Sanscrit helpdesk (www.sanscrit.nl). They do not have legal status for other cases of contamination.

Additional assessment of unacceptable risks
For the purpose of assessing the urgency to remediate, it may be decided to specifically consider certain potential relevant risks.

In order to assess unacceptable human risks, components of the formulas in the human exposure model CSOIL can be used (for instance the calculation of exposure via soil ingestion). CSOIL is described in RIVM Report No. 711701054 (RIVM, 2007c). On the basis of RIVM Report No. 711701049 (RIVM, 2008a), the RIVM will complement the CSOIL module to assess exposure as a result of volatile contaminations evaporating from the soil into indoor air for houses without a crawl space and houses with a cellar. The VOLASOIL program used to be intended for this.

In order to assess unacceptable ecological risks, a TRIAD can be used, as it examines actual ecological effects using bioassays and field surveys (see Section 5.3 in Annex 2 to this Circular for further details).

ANNEX 7: Overview of Soil Protection Act regulations[11]

1. Legislation

Soil Protection Act (Stb, 2005a)

Water Act (Stb, 2009)

Rural Areas (Investment Budget) Act (Stb, 2006b)

2. Decrees and ministerial regulations

Other Non-notifiable Soil Remediation Cases Decree (Stb, 1994)
Compulsory Soil Survey for Industrial Sites Decree (Stb, 1993)

Designation of Competent Authority Municipalities under the Soil Protection Act Decree (Stb, 2000)
Financial Provisions for Soil Remediation Decree (Stb, 2005b) (incl. subsidy scheme for industrial sites)
Financial Provisions for Soil Remediation Regulation 2005 (Stcrt, 2005b)
Uniform Remediation Decree ('BUS'; Stb, 2006a)
Uniform Remediation Decision (Stcrt, 2006a)

Soil Quality Decree (Stb, 2007)
Soil Quality Regulation (Stcrt, 2007e)

Register of Limitations under the Soil Protection Act Regulation (Stcrt, 2007c)

Rural Areas (Investment Budget) Regulation (Stcrt, 2006e)
Assessment of the Treatment and Reuse of Soil Regulation 2006 (Stcrt, 2006c)

3. Mandate/delegation decrees

Mandate, Power of Attorney and Authorisation of Directorate-General for Public Works and Water Management, as amended on 1 January 2013.
Mandate, Power of Attorney, and Authorisation under Section 75, subsection 7, of the Soil Protection Act (Stcrt, 2005a)
Subsidy for Soil Remediation of Industrial Sites Delegation Decree (Stcrt, 2005c)

4. Circulars

Cost Recovery Policy Rule under Section 75 of the Soil Protection Act (Stcrt, 2007a) and rectified (Stcrt, 2007b)

Application of Duty of Care under the Soil Protection Act for MTBE and ETBE Contaminations (Stcrt, 2008b)

5. Legislative proposals under consideration

[11] See www.wetten.nl for all relevant statutory legislation

6. Repealed

Mandate, Power of Attorney and Authorisation of NL Agency / Bodem+
Amendment to the Circular on the Remediation of Water Bottoms 2008 (Stcrt, 2009b)
Circular on the Remediation of Water Bottoms 2008 (Stcrt, 2007d)
Circular on National Coverage (Stcrt, 2002)

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NEN, 2009: *NEN 5740: Bodem – Landbodem – Strategie voor het uitvoeren van verkennend bodemonderzoek – Onderzoek naar de milieuhygiënische kwaliteit van bodem en grond* (Soil quality – Strategy for exploratory survey – Investigation of the environmental quality of soil and soil lots)

NEN, 2010a: *NEN 5737: Bodem – Landbodem – Proces van locatiespecifieke ecologische beoordeling van bodemverontreiniging* (Soil quality – Ecological risk analysis)

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