Topic report No 13/1999

Management of contaminated sites in Western Europe

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Executive summary

The European Environment Agency was established by Council Regulation No. 1210/90. Its overall objective is 'to provide the Community and its Member States with objective, reliable and comparable information at European level enabling them to take the requisite measures to protect the environment, to assess the results of such measures and to ensure that the public is properly informed about the state of the environment'.

The European Topic Centre on Soil (ETC/S) was established by EEA with the objective to contribute to the development of the EEA Work Programme and started activities in September 1996. The ETC/S is providing and developing information and data on soil aspects, covering all the EEA member countries, to increase understanding of soil as a natural resource, document soil degradation processes, and improve the level of reliable and comparable information about contaminated sites.

The EEA Regulation considers 10 priority areas, two of which, 'State of Soil' and 'Land Use and Natural Resources' are addressed by ETC/Soil, initially through two projects on:

Soil characteristics, monitoring and mapping
Methodologies for inventories of contaminated sites

The objective of current work on contaminated sites is to improve the level of reliable and comparable information under existing national programmes, enabling the collection of comparable information at the European level and as a basis for a European assessment of the extent of contaminated land, the level of contamination, and the extent of remediation being achieved.

Problems related to contaminated sites are closely related to the development of modern industrial and consumption-oriented society. Many incidents of soil contamination are due to inadequate waste disposal during the past decades. In the same period not only the amount of waste has been increasing dramatically but also the number of hazardous substances included in the waste. A second major source of soil contamination is the handling of hazardous substances within industrial processes. In view of the extensive use of chemical substances there is hardly any industrial sector where the possibility of soil or groundwater contamination in the course of operation can be excluded.

The current report is dedicated to an examination of sites which are limited in size, and which have a direct link to the source of contamination, regarding the following major sources of contamination:

- inadequate disposal of waste, and
- industrial emissions, i.e. losses during production, inadequate storage, leaking processes, accidents.

Soil contamination may have different impacts on the environment. The following examples illustrate major hazards and dangers frequently occurring at or near contaminated sites:

- effects on the quality of groundwater or surface-waters due to contaminated leachates from the sites;
- direct contact with contaminated soil at former industrial sites (e.g. children at playgrounds);
- explosion of landfill gas in closed rooms (e.g. buildings at former landfill sites);

- absorption of soil contaminants by plants, resulting in concentration of contaminants and transportation to the food chain and general vegetation damage due to emissions of landfill gas into the root zone of plants, and
- corrosion of underground pipelines and other building components due to contaminated leachates from the sites.

The hazards arising from soil contamination are only gradually being realised. In the last decade public awareness has been stimulated by a variety of incidents. In the beginning action was taken more or less on a case-by-case basis. Whereas in more recent years many countries have started to develop strategies to tackle these problems, including legislative measures, assessment procedures, remediation, and funding.

Structure of the report

The current report consists of three parts, namely:

Part 1 – **Management of Contaminated Sites** in the EU and EFTA Member States reviews the contaminated sites management systems which are currently applied in these countries. This is done in accordance with a defined structure, namely legal aspects, existence of inventories or registers, data on potentially and definitely contaminated sites, funding systems and estimates on the scale of the problem.

Part 2 – **Terminology** reviews existing terminology on contaminated sites and proposes two definitions.

Part 3 – **Review of Site Identification Methodologies** reviews and compares existing guidelines and standards; secondly the type of sites covered by the individual systems and the currently available figures on the number of potentially and definitely contaminated sites are indicated.

Results

Of the 18 countries surveyed data are not always available on a national basis but in some cases on a more regional level. This applies especially to Belgium and Germany but also to some other countries.

There is no EU policy document that would directly address contaminated sites issues. A range of EU policy documents indirectly address the contaminated sites problems. Countries operate along national policies.

With regard to regulatory aspects only very few countries address contaminated sites in specific legislation. In most countries the issue is handled by more general environment legislation or by legislation on waste or groundwater.

Table 1: Most relevant type of legislation addressing contaminated sites management

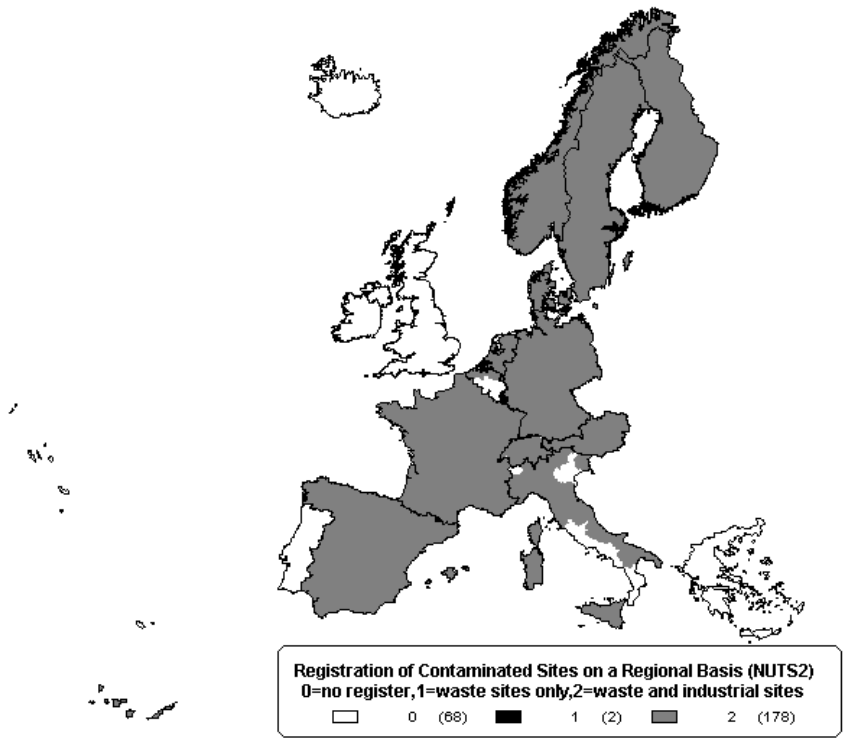
	AT	BE[1]	CH	DE[2]	DK	ES	FI	FR	GR	IC	IE	IT	LU	NL	NO	PT	SE	UK
Environmental Protection	●							●	●	●	●			●		●	●	●
Waste legislation						●	●	●			●	●	●					
Groundwater legislation	●							●										
Soil protection				●	●	●								●	●			
Soil clean-up		●	●	●	●										●			

1) the Flemish Region
2) at the Länder level.

The majority of EU and EFTA countries follows a systematic approach to identifying contaminated sites. Figure 1 gives an overview of those countries or regions that systematically register potentially contaminated sites, being either waste sites or industrial sites.

In total, 13 countries have started a systematic identification process covering industrial sites and/or waste disposals, and are at different levels of progress. 10 of the surveyed countries also include military sites in this process. Most of the approaches include both abandoned sites and sites in operation. Germany and Denmark exclude waste disposal sites in operation. The type of industries included in the identification process has not been investigated in detail and major differences can be expected.

Figure 1: Systematic identification of potentially contaminated sites in EU and EFTA countries. Source: ETC/S data collection, 1997



Data availability of potentially contaminated and definitely contaminated sites is very heterogeneous. Table 2 illustrates the categories included in the individual registers and further specifies whether or not only abandoned or also operating sites are included. If available the number of registered sites is indicated, and furthermore the estimated total number of sites after completion of the inventory.

The information available reveals that individual countries are at different levels of progress within this process. Consequently, figures on the number of suspected or contaminated sites do not represent the scale of the problem but only give a picture of how much effort has already been made in this area.

Table 2: Available data on the number of potentially contaminated and definitely contaminated sites, regarding the categories waste sites, industrial sites, military sites (as of August 1999)

	Industrial sites		waste sites		milit. sites	potentially contaminated		Contaminated sites	
	abandoned	operating	abandoned	operating		identified	estimated total	identified	estim. tot.
Austria	●	●	●	●	●	28 000	~80 000	135	~1 500
Belgium[1]	●	●	●	●	●	7 728	14 000	8 020	n.i.
Denmark[2]	●	●	●		●	37 000	~40 000	3 673	~14 000
Finland	●	●	●	●	●	10 396	25 000	1 200	n.i.
France	●	●	●	●	●	n.i.	700 000-800 000	896	n.i.
Germany[3]	●	●	●		●	202 880	~240.000	n.i.	n.i.
Greece						n.i.	n.i.	n.i.	n.i.
Iceland			●			n.i.	300-400	2	n.i.
Ireland	●	●	●	●		n.i.	~2 000	n.i.	n.i.
Italy	●	●	●	●		8 873	n.i.	1 251	n.i.
Luxemb.			●	●		616	n.i.	175	n.i.
Netherl.	●	●	●	●	●	n.i.	110 000-120 000	n.i.	n.i.
Norway	●	●	●	●	●	2 121	n.i.	n.i.	n.i.
Portugal						n.i.	n.i.	n.i.	n.i.
Spain	●	●	●	●		4 902	n.i.	370	n.i.
Sweden	●	●	●	●	●	7 000	n.i.	2 000	n.i.
Switzerl.	●	●	●	●	●	35 000	50 000	~3 500	n.i.
UK						n.i.	~100 000	n.i.	~10 000

n.i. = no information available

[1] PCS identified: 5,528/Flamish Region + 2 200/Walloon Region, PCS estimated: 9 000/Flamish region + 5 000/Walloon Region, CS identified: 7 870/Flamish region + 150/Walloon Region. Figures of the Flemish Region regard contamination generated before 1994 and refer to grounds, one site can consist of several grounds or 'cadastral lots'

[2] includes contamination generated before the mid 1970's,

[3] military sites are not included in this figure

12 countries have been identified which have issued guidelines on site identification and investigation, either at a national or at a regional level.

Almost all countries regard land use, groundwater and surface waters as potential targets for contamination. On the basis of the available information it has not been possible to assess whether only certain types of current land use are considered or also possible future land use. With regard to groundwater, it is not clear whether the risk for groundwater contamination is restricted to certain areas only, e.g. specific drinking water areas.

Some countries have made an attempt to calculate the size of the problem posed by contaminated sites, by calculating total clean-up costs (Table 3). The data provided covers approximately 62 %of the population and 68 %of the area of the surveyed countries.

Table 3: Available data on estimated total clean-up costs by country or region

Country	costs (million EURO)	specification/total costs	population [million inh.]	area [10^3km^2]
Austria	1 500	300 priority cases	7.7	84
Bel./Flan.	6 900	total clean-up costs	5.8	13
Denmark	1 138	total clean-up costs	5.1	43
Finland	900	total clean-up costs	4.9	338
Ger./Bav	2 500	total clean-up costs	11.6	71
Ger./SaA	1 600 – 2 600	large scale clean-ups	2.9	20
Ger./SchH	100	26 priority sites	2.6	16
Ger./Thür	178	3 large scale projects	2.6	16
Italy	510	1.250 priority sites	57.7	301
Netherl.	23 000 – 46 000	total clean-up costs	14.9	37
Norway	375 – 500	700 priority sites	4.2	324
Spain	800	clean-up of 38Mm^3 soil and 9Mm^3 groundwater	38.9	505
Sweden	3 532	total clean-up costs	85.7	450
Switzerland	3 000	total clean-up costs	6.7	41
UK	13 000 – 39 000	10.000 ha cont. Land	57.4	245
			total: 231.5	*total: 2 0504*

Table 4: Coverage (area, population) of the data included in the costs calculation

	Total	Provided	Share of the total
Area (10^3 km^2)	3 707	2 504	68 %
Population (million inhabitants)	376	232	62 %

With respect to liability, each of the surveyed countries supports the polluter-pays-principle. However, the majority of countries has realised the difficulties involved in implementing this principle. In many cases liable parties cannot be traced back or are not able to cover the necessary clean-up costs.

Subsequently, most countries have established a public budget in order to finance major clean-up measures. Furthermore, several of countries have developed special funding tools such as waste taxes, loan systems or agreements with industry.

Conclusions

The existence and availability of data on contaminated sites have been investigated within this survey. In line with expectations, the obtained data are very heterogeneous. However, the survey gives an overview of the currently applied systems and the available data and will facilitate the establishment of a European framework for data collection and assessment.

Soil and land development are subject to the subsidiarity principle. This fact is very well reflected by the obtained results. A common European contaminated sites policy does not exist and is currently not on the political agenda. This fact influences the establishment of a European data collection framework in the way that it

- has to respect the national differences, and
- can only be based on voluntary commitments.

The European Environment Agency will continue to tackle the topic of contaminated sites. The major goal of the future work is to give a comprehensive overview of the problems posed by contaminated sites by establishing a European data collection and assessment system in line with the current policy background.

The results from the first survey will be reviewed and completed. The definition of contaminated sites indicators will be the central issue of the future work, and furthermore the testing of such indicators in volunteering European regions. The monitoring of contaminated sites is a demanding process. Many countries have only recently started to set up monitoring systems. In order to be able to describe in detail the problems posed by contaminated sites at a European level it will be necessary to find solutions for these data gaps. Methods to better estimate the scale and remediation requirements of contaminated sites will be needed.

Introduction

The European Environment Agency and its mandate
The European Environment Agency was established by Council Regulation No. 1210/90. Its overall objective is 'to provide the Community and the Member States with objective, reliable and comparable information at European level enabling them to take the requisite measures to protect the environment, to assess the results of such measures and to ensure that the public is properly informed about the state of the environment'. To this end the Agency is establishing the European Environmental Information and Observation Network (EIONET), which comprises the national networks and European Topic Centres (ETCs). EIONET is coordinated by the Agency and collaborates in retrieving information, identifying special issues and producing efficient and timely information on Europe's environment. The Agency uses not only existing capacities in member countries, but cooperates actively with other bodies and international organisations to build synergy and to avoid duplication.

ETCs are consortia of European institutions and organisations which are contracted by EEA to execute tasks identified in the Multiannual Work Programme (MAWP).

Up to 1999, nine European Topic Centres have been established with the objective to help the EEA in developing its Annual and Multiannual Work Programmes (AWP, MAWP). The European Topic Centre on Soil (ETC/S) started in September 1996. ETC/S is providing and developing information and data on soil aspects, covering all the member countries, to increase the understanding of soil as a natural resource, document soil degradation processes, and improve the level of reliable and comparable information about contaminated sites.

The EEA Regulation considers 10 priority areas of which two 'State of Soil' and Land Use and Natural Resources' are addressed by ETC/Soil, initially through two projects on:

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As part of the Danish support programme for the EEA, the Danish Ministry of Environment and Energy financed a Scoping Study for the establishment of a European Topic Centre on Soil, which analysed user requirements and possibly activities concerning contaminated sites and soil quality. The part covering contaminated sites provided a background summary of the current state in Europe and included information that will be valuable in any future effort to establish a European inventory of contaminated sites. The work on contaminated sites was presented at an EEA workshop in Vienna in November 1995, with representatives of all EU Member States in order to discuss the importance of the issue. It was agreed that 'contaminated sites' should be incorporated into the Multiannual Workprogramme of the EEA. The Scoping Study was followed by a Bridging Study in 1996, again as part of the Danish support programme, where the work to be done by the European Topic Centre on Soil was described in more detail.

The first part of the Bridging Study consisted of a compilation of the results of the Vienna workshop, including recommendations to the EEA, which were included in the *Scoping study on establishing a European Topic Centre for soil* (DGU, 1995).

The second part of the Bridging Study, concentrated on taking the results of the summary report one step further. International activities taking place in the framework of the Ad Hoc Group on contaminated land, Common Forum (on contaminated land) and the Concerted action on risk assessment for contaminated sites in the European Union (CARACAS) were analysed. The results of this work were presented in the report 'Proposal for a common framework for an inventory of contaminated sites (GEUS, 1998).

The present report, developed within the framework described above, includes a review of the state-of-the-art in EU and EFTA countries, a review of terminology, and a review of applied site identification methodologies.

A long term goal of EEA work on contaminated sites is to set up a common framework for data collection at the national level and the set up of national inventories, in order to create a data 'repository' and provide the EEA with objective, reliable and comparable data on contaminated land. The design and feasibility of such a framework will be the subject of future work.

Soil contamination is a Europe-wide problem

Contaminated sites are the legacy of a long period of industrialisation involving inconsiderate production and handling of hazardous substances and inadequate dumping of wastes. The expansion of industry and the increasing amount of industrial wastes have led to considerable environmental problems that apply in all industrialised countries.

In the past a variety of prominent incidents created enormous public awareness. The following examples illustrate the scale and diversity of such incidents:

- in Lower Austria at the Fischer waste site and in Mellery, Belgium two large scale waste sites created a major threat to groundwater and drinking water resources of the involved areas. In both cases the technology of the waste sites proved insufficient and hazardous substances were leaking to the groundwater;
- in the Swansea valley in the UK metal processing industries generated a major human health risk due to exposure to heavy metals;
- at a Norwegian Fjord near Bergen fish exploitation has been inhibited on a long term basis due to PCB contaminated fjord sediments generated by industrial waste water discharges.

In the last two decades most EU and EFTA countries have developed national strategies to tackle the problems posed by contaminated sites. However, the various approaches vary considerably and can hardly be compared among each other.

In some countries the management of contaminated sites is regulated by specific soil clean-up legislation, whereas other countries address the issue by generic legislation, for example on water protection or the protection of the environment.

In most cases the appropriate legislation is issued at a national level and only in very few countries (among EU and EFTA Countries) at the sub-national level, namely in Belgium, United Kingdom and Germany.

Initially for this study, the main interest was put on the collection and compilation of data concerning approaches, policies, definitions and the state-of-the art in individual countries. The initial methodology review puts most emphasis on site identification and site investigation.

The results obtained create the basis to meet the long-term objectives of this task group, as defined in section 1.2.

1. Management of contaminated sites in Western Europe

In this part, the contaminated sites management systems which are currently applied in the EU and EFTA countries are analysed. This is done in accordance to a defined structure, namely legal aspects, existence of inventories or registers, data on potentially and definitely contaminated sites, funding systems and estimates on the scale of the problem.

Explanatory remarks
The following sections present a summary of the findings on contaminated sites management in EU and EFTA countries. Data were retrieved by directly contacting officially appointed national bodies.

Each section, in total 18, covers one country and has the following structure:

1. **Country characteristics**
   gives a brief introduction into characteristic national approaches and historic events. In addition some economic and geographic information is included, such as statistics on the size of the country, population density, land use, and water resources in relation to EU average values.

2. **Legal background**
   describes the current legislation addressing contaminated sites, responsible bodies and definitions in use.

3. **Register and inventories**
   refers to the existence of registers or inventories, the target groups they include and the objectives of compiling such a register or inventory.

4. **Characterised sites**
   provides information on the registered suspected or contaminated sites. If possible these data are further specified and assigned to branches, risk categories or regions. Information on the level of completion of the addressed registration system is given wherever possible.

5. **Site identification methodologies**
   illustrates the principles of site identification and investigation systems; information is provided on the availability and existence of national guidance documents.

6. **Funding and liability**
   explains current liability regulations and the existence of public funding systems. Monetary values are expressed in the national currency and in EURO. The abbreviation MEURO indicates million EURO.

7. **Scale of the problem**
   refers to national estimates on the scale of the problem; information may be provided in terms of clean-up costs of priority sites, in terms of total polluted areas, total polluted volume of contaminated land, but also in terms of annual expenditures on contaminated sites management.

1.1. Austria

1.1.1. Country characteristics

Austria started to develop a national policy towards contaminated sites in the late 1980s since existing legislation turned out to be insufficient to solve the problems of various contaminated soil incidents. The most striking incident was the 'Fischer Deponie', a municipal waste disposal site, where hazardous chemicals had been dumped. Due to this incident drinking water resources of some 500 000 inhabitants were threatened.

In 1989 a national remediation programme was introduced and the Federal Act on the Clean-up of Contaminated Sites (Altlastensanierungsgesetz, ALSAG) was promulgated. The act regulates the funding of site investigation and site remediation, by levying the disposal of wastes.

Since then inventories on contaminated sites are run and up-dated. The governments of the Federal States are obliged to report potentially contaminated sites to the national authorities. The Republic of Austria consists of 9 Federal States, each having its own government. Statistical data (Table 3.1-1, and Table 3.1-2) reveal that:

- the increase in population between 1950 and 1990 was very low compared to the EU average value;
- renewable water resources are abundant since exploitation of available/renewable water resources is only 2 %, being 9 times lower than the EU average value;
- agriculture and forestry are equally important.

Table 1.1-1: Some selected geographical statistics of Austria in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Area		Agricultural Area		Wooded Area		Nationally Protected Area		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Austria	83 850	2.6	35 000	41.7	32 270	38.5	15 939	19.0	92 000	2	72
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.1-2: Some selected population statistics of Austria in comparison with total and average EU values; [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Austria	7 712	2.1	92	11.0	72.6	79.2
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.1.2. Legal background

There is no specific national law on soil protection. The following laws are of major importance for the management of contaminated sites.

Water Act as amended 1959
Most problems raised by contaminated sites are addressed in the Austrian Water Act. The clean-up of contaminated sites is based on the aim to maintain clean water resources. Local authorities to a great extent act under the provisions of this act.

1989 Federal Act on the Clean-up of Contaminated Sites (ALSAG, Altlastensanierungsgesetz)
This regulation deals with the financial aspects of the remediation of contaminated sites. Additionally, it includes regulations for site identification and site investigation. Main objective of the Act is the establishment of a remediation fund by retrieving money from a waste tax. The fund to some extent covers the costs of site investigation and remediation-measures. Major features are:

- funds are provided for abandoned and operating waste sites and industrial sites;
- exclusively contamination at sites that already existed before 1989 is taken into consideration, since current legislation is supposed to cover the problems of recently built sites;
- the provision of funds is carried out according to priorities set at national level.

Trade Regulations as amended 1994
Within the Trade Regulations most emphasis is put on

- facilities that handle CHCs, i.e. dry cleaners, metal degreasing
- facilities that abandon their activities, in this case the operator is obliged to prove that the site is not contaminated.

Responsible bodies
The Ministry of the Environment, Youth and Family coordinates the activities related to the Federal Clean-up Act and is responsible for the allocation of money to fund clean-ups.

The Federal Environment Agency (UBA) is responsible for central control. Its major function is the maintenance of the contaminated sites register and the assignment of priorities to sites which are supposed to be publicly funded. UBA issues appropriate technical guidance to site investigations and clean-up measures.

The Local Authorities act under the provisions of the Austrian Water Act and the Trade Regulations; they are obliged to report contaminated sites to the Ministry of the Environment.

Definitions
According to the 1989 Federal Act on the Clean-up of Contaminated Sites, the definition contaminated sites refers to *'waste sites and industrial sites, including the consequently polluted soils and aquifers, that pose a considerable threat to human health and the environment, – according to the results of a Risk Assessment'.*

1.1.3. Registers and inventories

At a national level inventories on potentially contaminated sites and proven contaminated sites have been run and up-dated since 1989. The governments of the Federal States are obliged to report potentially contaminated sites to the national authorities.
The reporting system is based on the activity of the local authorities; reasons to identify potentially contaminated sites are

- execution of the provisions of the Water Act;
- execution of the provisions of the Trade Regulations;
- systematic regional surveys in particular regions.

The register covers industrial sites and waste sites. Up to now military sites have not been of major concern. The number of military bases is negligible, not least because Austria does not join the NATO. The register does not take into account large-scale contamination due to agricultural activities or air emissions. The register is maintained with the major aim to have a database at hand in order to manage and prioritise contaminated sites and to allocate funding resources. Planning aspects and land use are secondary objectives.

Inventory of potentially contaminated sites
Potentially contaminated sites require a minimum data-set in order to be included in the inventory. The minimum data-set allows to preliminarily rank the risks of a given site and to assign a risk category. Potentially contaminated sites with a high-risk category have priority for further investigations.

Inventory of contaminated sites
To be included in the inventory of contaminated sites a detailed risk assessment needs to be conducted based on results of comprehensive investigations.

1.1.4. Characterised sites

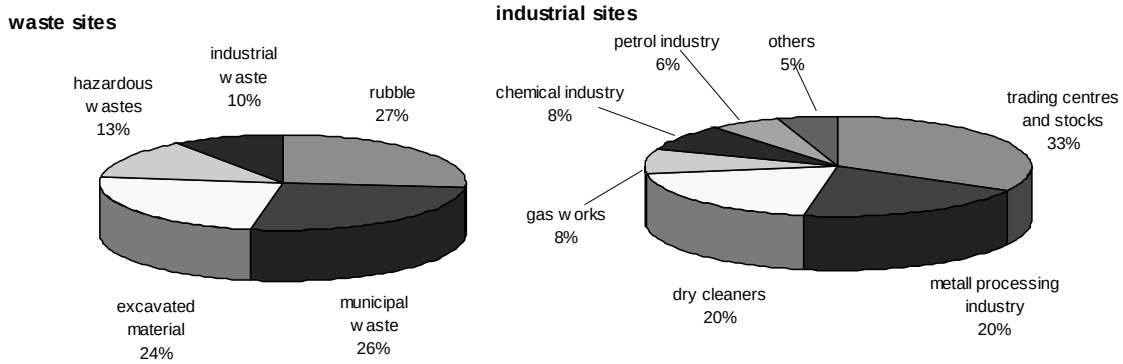
Potentially contaminated sites
By January 1997 2 545 potentially contaminated sites were included in the inventory, of which only 6 %are reported to be industrial sites.

Table 1.1-3: Inventory of potentially contaminated sites

Type of site	no. of sites	(%)
Waste Disposals	2 387	94%
Industrial Sites	158	6%
Total	2 545	100%

Major categories at waste sites are above all rubble, municipal waste, and excavated material. Major branches of industrial sites are above all trading centres and stocks, metal processing industry, and dry cleaners (see Figure 1.1-1).

Figure 1.1-1: Major categories of disposed materials at 2,387 waste sites; distribution of branches within 158 industrial sites, [37]



Contaminated sites
Up to now 136 sites have been investigated in detail and declared to be in-fact contaminated, 6 sites of these have already been completely remediated. It should be mentioned that the national registration scheme disregards a great number of voluntary clean-up measures. Voluntary clean-up is usually favoured in the case of minor incidents and whenever time pressure is more important than clean-up costs.

Table 1.1-4: Inventory of contaminated sites and corresponding priority classes, [37]

Priority	Required measures	Deposits	Industrial Sites	Total
	priority not yet defined	7	29	36
I	very urgent, imminent risk	17	16	33
II	urgent	25	15	40
III	remediation action necessary	19	2	21
	Total	*68*	*62*	*130*

1.1.5. Site identification methodologies

The Federal Environment Agency has published a detailed guideline on how to identify contaminated sites [204]. In addition a National Standard has been issued recently giving information on the identification and investigation of (suspected) contaminated sites; i.e. definitions, methods to be applied, data sources, investigation objectives etc. [205].

Preliminary survey
According to the Federal Clean-up Act local authorities have to report potentially contaminated sites to the Ministry of the Environment.

The identification of major waste sites is almost completed, since local authorities were acquainted with these sites due to their responsibility to execute the provisions of the Water Act and other environmental regulations.

As far as industrial sites are concerned the identification process is more complex. Systematic regional surveys, initiated by the Ministry for the Environment and local authorities are usually the main source for their identification.

Site identification is based on desk studies, site investigations are usually not included. The process of site identification ends with the decision whether a site shall be registered in the register of potentially contaminated sites and hence requires site investigations.

Preliminary investigation and main site investigation
Main objective of the process is to further characterise the

- potential hazards of substances at the site in question;
- their dispersal, and
- geological and hydrogeological conditions at the site.

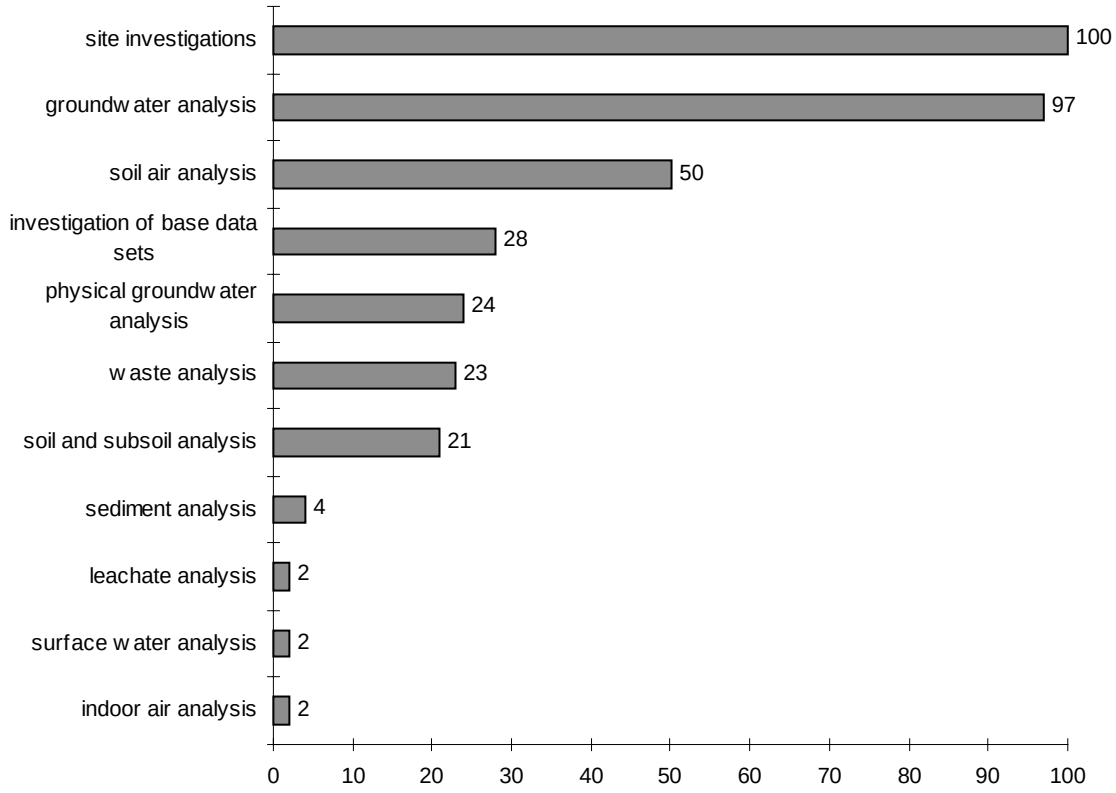
Site investigations are carried out either

- by the polluter, in line with the requirements of the Water Act or the Trade Regulations (polluter-pays-principle), or
- by volunteers, or
- by the local authority, according to the provisions of the Clean-up Act, which is only possible in urgent cases, provided that no other law is valid.

Methods most frequently applied within site investigations are illustrated in Figure 1.1-2. The obtained results create the basis for the decision whether or not a site poses a considerable

and continuous threat to human health or the environment and therefore needs to be remediated.

Figure 1.1-2: Frequency of methods applied per 100 site investigations [37]



1.1.6. Funding and liability

The polluter-pays-principle is applied as far as possible. In practice the liable party is usually not able to cover the clean-up costs, in most cases public funding is required.

The resources for funding are retrieved from a tax, which has been levied on municipal wastes and hazardous wastes since 1989. The tax is progressive, on average the annual budget of the fund is about ATS 300 million (22 MEURO). For the allocation of public funds priorities are set at the national level. About 15 %of the funds is dedicated to site investigations and about 85 %to remediation measures.

Funding rates have changed dramatically by the end of 1996. Until February 1997 public funding for priority sites covered up to 90 %of the total remediation costs and 100 %for sites where contamination resulted from the war. The actual funding rates were lowered in line with the requirements of the European Union on maximum funding rates for active companies, and range currently between 15 %and 40 %for small and medium enterprises. The clean-up of municipal waste sites is funded with a maximum rate of 65 %, the clean-up of war damages and orphan sites with a maximum rate of 95 %.

1.1.7. Scale of the problem

In 1994 the Federal Environment Agency made an attempt to roughly quantify the problems posed by contaminated sites. The total number of potentially contaminated sites was calculated to amount to 80 000 sites, including approximately 10 000 waste sites and 70 000 industrial sites. Some 20 %of the total are calculated to need further investigations and some 10 %to need remediation. For the calculation of total clean-up costs 300 most imminent cases

were projected to need clean-up measures, which were calculated to amount to approximately 1.5 billion EURO (20 billion shilling) [147].

1.1.8. References

Exchange rates: 100 ATS (Austrian Shillings) = 7.3 EURO (as of November, 1999).

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1.2. Belgium

1.2.1. Country characteristics

Though Belgium has a long tradition of heavy industry contaminate sites have not been of major importance up to the beginning of the 1990s. The need for a comprehensive soil protection and remediation policy started with the establishment of a general waste management policy in the 1980s.

Some major incidents created growing awareness in the public, above all the cases Mellery and Bocholt. In Mellery in the Walloon Region a huge waste site became a serious hazard to the surrounding community whereas in Bocholt, in the Flemish Region, an abandoned factory, caused severe groundwater contamination [3], [96].

The Kingdom of Belgium has a complicated federal structure. The three Federal States, the Walloon, the Flemish and the Brussels region, each have a high degree of autonomy. Legislation concerning contaminated sites is issued at the regional level. In the Flemish Region contaminated sites management is most advanced. In 1995 a decree on ground remediation was enforced, representing a comprehensive contaminated sites policy regulating liability, funding, and responsibilities.

In the Walloon region most emphasis is put on waste sites and reclamation of derelict industrial land. In 1992 a programme was set up to investigate the most problematic waste sites. Another programme is focused on urban and industrial derelict land [290]. At present four large-scale remediation projects are going on and 13 important waste sites are further investigated.

Statistical data (Table 1.2-1, Table 1.2-2) reveal that:

- the population density is among the highest within the EU countries;
- the population increase between 1950 and 1990 has been very low, being only about half of the EU average;
- the water use intensity of renewable water is the highest among the EU Member states.

Table 1.2-1: Some selected geographical statistics of Belgium in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Belgium	**30 518**	**0.9**	**13 620**	**44.6**	**6 170**	**20.2**	**718**	**2.4**	**12 500**	**72**	**-**
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.2-2: Some selected population statistics of Belgium in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Belgium	**9 967**	**2.7**	**327**	**15.0**	**71.4**	**78.2**
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.2.2. Legal background

The Flemish Region
Oct. 1995 *Soil Remediation Decree*
The Decree distinguishes between historical pollution, generated before the Decree was enforced, and new pollution, generated after the Decree was enforced. Historical pollution is handled 'softer' as regards pre-financing of remediation costs and liability regulations. Further major issues regulated in the Decree are:

- the establishment of a register of polluted soils and further identification of pollution;
- protection of the buyer of polluted property;
- mandatory soil investigations when ground transactions are planned;
- possibility of use restrictions at contaminated sites;
- distinction between the person who has the obligation of remediation and the person who has to pay the final burden (=who is liable);
- possibility of official clean-up by the government with recuperation of the money by legal action.

March. 1996 *VLAREBO (Flemish Regulation on Soil Remediation)*
laying down the following issues

- to define polluting activities and investigate them;
- to recognise soil-experts;
- to establish soil standards for remediation including back-ground values;
- to define appealing procedures;
- to establish financial securities.

The Walloon Region
There is no specific legislation concerning contaminated sites. Contaminated sites are addressed indirectly in waste regulations. A new regulation on contaminated sites is under way and has already been agreed by the Walloon Parliament in June 1996.

The Brussels Region
The decree of 30 July 1992 requires that persons who hold a license to operate an industrial facility have to make sure that the facility is not contaminated at the end of exploitation. New legislation concerning contaminated sites is under way.

Responsible bodies
The Flemish Region
OVAM[1], the Public Waste Agency of Flanders is the competent authority for soil remediation.

[1] OVAM = Openbare Vlaamse Maatschappij

The Walloon Region
In Wallonia, as long as no decree on soil remediation has been passed, responsibilities are shared between two administrative bodies, namely

- the Walloon Waste Office, which is the responsible authority for landfills and other sites polluted by waste, and
- the Town and Country Planning Administration, which is responsible for derelict land and brownfield sites.

The SPAQuE (Société Publique d'Aide à la Qualité de l'Environnement), the Public Society for Environmental Quality Improvement was founded in 1992 by the Walloon government; with the objective to manage the clean-up of priority sites.

The Brussels Region
The IBGE (Institut de Brussel pour la Gestion de l'Environment), the Brussel Environmental Protection Agency is responsible for the management of contaminated sites.

Definitions
The Flemish 1995 *Soil Remediation Decree* defines soil contamination in general as *the presence, due to human activity, of substances or of organisms, whether in the soil or in structures, which directly or indirectly produce, or are capable of producing, an adverse effect on the quality of the soil.*

1.2.3. Registers and inventories

Only the Flemish Region maintains an inventory of potentially contaminated sites and a register of identified contaminated grounds (one site can consist of several grounds or 'cadastral lots'). Since 1989, the Walloon Region registers contamination at industrial derelict land and brownfield sites.

The Flemish Region
Entries into the register are based on:

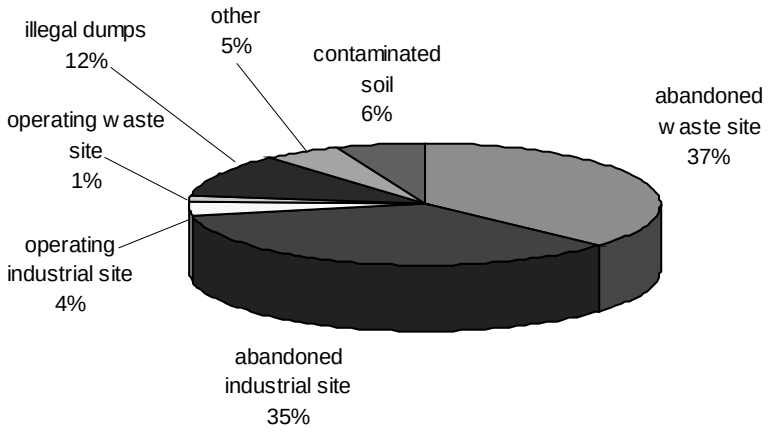
- soil investigations by property transfer and closure of certain installations;
- mandatory soil investigations on a periodical basis for certain exploitations;
- soil investigations of the authorities on soil quality.

The register includes all type of waste sites and military sites and regards military sites where there is pollution. Clear distinctions exist between new and historic pollution generated before October 1995.

1.2.4. Characterised sites

The Flemish Region
By December 1997 the OVAM inventory had 5 528 entries of potentially contaminated sites, and 7 870 contaminated grounds were registered, where soil investigations had been carried out. Figure 1.2-1 shows the split of new and historic pollution, and of industrial and waste sites [214]. More than 50 proposed remediation projects where approved by the OVAM, while more than 150 remediations are already in operation.

Figure 1.2-1: Potentially contaminated sites of the OVAM inventory, according to polluting activities [214]



The Walloon Region
In 1978 an inventory on industrial derelict land and brownfield sites was started, based on specific town and country planning legislation aiming at the redevelopment of the registered sites. In 1989 the Town and Country Planning Administration launched a specific programme with the objective to assess the risk of contamination at registered sites. The risk assessment consists of a preliminary risk assessment with four risk classes. The resulting database serves for policy decisions, to select priorities for detailed site investigations, and for remediation plans if proven necessary.

A more elaborated hazard ranking system has been developed for waste sites by the SPAQuE, under the supervision of the Walloon Waste Office. The ranking is performed on the basis of a check-list and considers contamination sources, transport mechanisms (vectors) and risk groups.

In 1998 the number of potentially contaminated sites was estimated to amount to approximately 5 000, of which 2 200 were already identified, classified and registered in the Town&Country Planning Data base. 150 sites (status Feb.99) have been assigned with a very high risk factor and have been subject of detailed investigations. Some of these sites are currently remediated. Sites with a lower risk factor are only investigated in more detail when a land redevelopment strategy is planned, whether by public or private operators. Besides that, the SPAQuE assessed 17 heavily polluted priority sites, all of which are former waste sites. Four of these are currently remediated [289].

The Brussels Region
In the scope of real estate transfers industrial sites are investigated. At the end of exploitation of an industrial activity the licensee is obliged to conduct a study in order to prove that the site is not contaminated. In case the study reveals negative results the licensee has to carry out a second study in accordance with the BIRGM with the objective to decontaminate the site. By April 1997 the BIM registered about 130 files on ongoing and completed decontamination [203].

Concerning waste sites the Brussels region compiled an inventory on so called ‘point noir’, being abandoned waste sites and preliminarily municipal waste sites. At present there are no operating waste sites within the Brussels Region [203].

1.2.5. Site identification methodologies

The Flemish Region
Site investigations with the purpose to identify contamination take place

- in connection with property transfer,
- whenever an industrial facility is closed down,
- on a periodical basis (every 5, 10 or 20 years) depending on the type of exploitation,
- but also within soil quality investigations of the public authorities. [156].

If the owner of a real estate property wants to sell his 'land' he has to get a 'soil-certificate' from the OVAM. In case the property has been used or is still used for certain potentially polluting activities the OVAM will demand that a preliminary study according to defined guidelines is carried out in order to issue a 'soil-certificate'. If the results of the preliminary study reveal that the site is likely to be contaminated the site will be included in the Flemish register of contaminated grounds.

Preliminary survey (inventory)
Major objective is to prove whether or not a defined site is likely to be seriously contaminated. This is done by collecting and assessing:

- administrative data (like localisation, present ownership, use, provisions regarding buildings on the site and the surroundings);
- historical data (former uses and organisation, accidents, earlier permissions, results of prior conducted investigations, etc.), and
- (hydro)geological data based on books and archives of regional geology and hydrogeology with special regard to the site and the surroundings (level of groundwater table, soil structure, existence of aquifers, sewage systems, etc.).

The preliminary study is terminated by a site visit, possibly including a meeting with the owner or operator of the site. In connection with the site visit observations on the size of the site, the function of different parts of the site are conducted, and sensory impressions are noted. It is also possible to carry out one or more dwellings in order to support the sensory impressions.

The evaluation includes an assessment of whether or not serious contamination is likely to exist. In addition the possible spacious distribution of the contamination is described, indicating homogeneous or heterogeneous distribution.

Preliminary investigation (registration)
The Flemish Region has issued a guideline [224] recommending four possible sampling strategies, depending on

- the distribution of the contamination (homogeneous, heterogeneous), and
- the knowledge of the contamination, e.g. whether investigations or prior remediations have been carried out.

The number of samples depends on the selected sampling strategy and on the size of the site (sampling area).

Analysis of soil or/and groundwater is carried out according to a standard package of parameters and can possibly be extended due to actual knowledge or founded suspicion of contamination.

Guidelines of how to carry out sampling and analysis are described in the VLAREBO Waste Analysing Compendium published by OVAM [156].

If the concentration of one or more of the measured parameters is 80 %or above the remediation values for farming and country-like residences the site will be included in the register of contaminated grounds. There are differences in the administration of historic and new contamination; the criteria for inclusion of new contamination are more stringent than for historic contamination.

Main site investigation
If the preliminary investigation reveals a need for remediation a detailed investigation has to be carried out to describe the risk, followed by an assessment of different remediation possibilities. The criteria are more stringent for new pollution than for historical pollution. In addition, to environmental and technical factors, financial feasibility and planning aspects are considered.

The Walloon Region
The SPAQuE has elaborated a criteria scheme for the evaluation of contaminated sites (in the Walloon context waste sites). Based on this scheme, a software called AUDISITE has been developed.

The principle of the Walloon Scheme regards two steps.

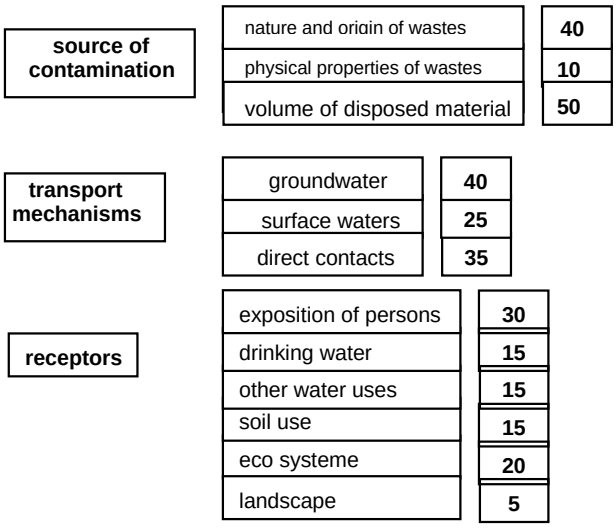
In a preliminary evaluation, a first screening is carried out. This stage of evaluation does not include expensive investigations.

In a second step a detailed evaluation is carried out, by conducting a comprehensive site investigation.

The evaluation scheme distinguishes between three major tasks, being source of contamination, transport mechanisms and receptors. Each task regards a variety of environmental factors, which are assigned with points, in dependence of how much they apply (see Figure 1.2-2). Two final scores are calculated:

- The risk level
- The quality of information

Figure 1.2-2: Scoring scheme of the Walloon site evaluation system [200]



The two obtained scores are used to classify the site in question. In total there are 5 classification categories:

Table 1.2-3: Site Classification Scheme applied in the Walloon Region [200]

Category	Description
A	measures are necessary
B	periodical monitoring is necessary, measures are possible
C	measures are not necessary but observation on a regular basis is required.
D	the site does not need any further measures
E	more information is needed to assign a category

1.2.6. Funding and liability

The Flemish Region
Clear distinctions are made between new and historic pollution. For new pollution the polluter-pays-principle is strictly applied. For historic pollution (generated before October 1995) liability is regulated according to contemporary law.

In any case the clean-up obligation rests with the operator of a site (or on the owner in case there is no operator) and is valid automatically in case of new pollution and by governmental order in case of historic pollution. The operator has to pre-finance and carry out the clean-up. This is to make sure that remediation efforts are as cost effective and as correct as possible. After the realisation of the clean-up the operator or owner can try to recover his expenses from the liable parties [201].

The law excludes innocent landowners in case they can prove that they did not cause the pollution. In case of orphan sites, public means are used to finance the clean-up.

The Flemish Region disposes over an environmental fund, retrieving money from various sources:
- waste disposal and waste incineration;
- waste water discharges (industry and household);
- real estate transactions (1 000 BF/ 25 EURO per action);
- eventual reimbursements of the liable parties, in case of an official clean-up.

On a year-by-year basis the government decides the individual shares to be allocated to the different environmental issues. In 1996 the annual budget for official clean-up activities (where the polluter failed to cover any costs) amounted to approximately 1,500 million BF (36 MEURO)

The Walloon Region
There is no specific funding system. Along the redevelopment of brownfield sites and industrial derelict land limited funds are also available for clean-up measures at such sites. These funds are provided by through the town and country administration. The remediation of orphan sites is funded by the Walloon government and allocated by the SPAQuE. Up to 1996 approximately 1.2 billion BF (30 MECU) have been spent on sites remediation 1992 and 1996, of which approximately 400 million BF (10 MECU) in 1996 [96].

The Brussels Region
The Brussels region does not use a clean-up fund or any other means to finance site remediations.

1.2.7. Scale of the problem

9 000 sites after completion. Total clean-up costs were estimated to make up approximately 280 billion BF (6,9 billion ECU). About one third of this amount will be pre-financed by the

OVAM, the other share has to be covered by the liable parties according to the soil remediation decree of 1995 [214].

The Walloon Region, according to the Town and Country Planning Administration, estimates the number of potentially contaminated sites to amount to 5 000. This figure considers only industrial sites [289].

1.2.8. References

Exchange rates: 100 BF (Belgium Francs) = 2,5 EURO (as of November 1999).

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1.3. Denmark

1.3.1. Country characteristics

In Denmark, contaminated sites became an issue of major national concern in the late 1970s. Systematic characterisation of contaminated sites started in 1982. Initially, investigations only concerned waste deposits containing chemical waste. Later on, industrial activities were included and, since 1990, all types of waste disposals and petrol stations are systematically investigated.

Methodologies for site investigation and risk assessment are highly developed. Public funding for remediation of contaminated sites is targeted to meet the requirements of current land use and groundwater protection regulations.

In the 1980s, the problem was considered to be under control. Ten years later, it was clear that the extent and the impacts of the contamination had been underestimated and that existing legislation was insufficient. Consequently, the legislation was revised in order to include all relevant types of contaminants and contamination resulting from airborne and other diffuse sources. The Soil Contamination Act was adopted in 1999. It covers all contamination in soils, with no limitations in terms of time (also past contamination is included) and location, with the exception of agricultural soils treated with sewage sludge, fertilisers, pesticides, etc., which are not covered.

The Kingdom of Denmark is composed by 14 counties and two municipalities (Copenhagen and Frederiksberg). Statistical data (Table 1.3-1, Table 1.3-2) show that:

- extent of agricultural areas is very high (about14 %higher than the EU average value), whereas extent of wooded area is very low (less than the half of the EU average value);
- water use intensity is considerably lower than the EU average value (only 9 %compared to 18 %);
- population increase between 1950 and 1990 has been moderate (20 %).

Table 1.3-1: Some selected geographical statistics of Denmark in comparison with total and average EU-values; (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Denmark	43 090	1.3	27 880	64.7	4 930	11.4	4 225	9.8	13 000	9	98
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.3-2: Some selected population statistics of Denmark in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Denmark	5 140	1.4	119	20.0	72.2	77.9
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.3.2. Legal background

Major legislation addressing contaminated sites in Denmark is the *Soil Contamination Act*, enforced in 2000.The act replaces previous legislation (Act on Contaminated Sites, also called Waste Deposit Act, and the Act on Value Loss) and the parts of the Environmental Protection Law dealing with soil.

The act includes a system for mapping of contaminated soils, defines the priority areas for public financed remediation and establishes a system for management of excavated soil.

Responsible bodies
Regional authorities (the 14 counties and the 2 municipalities) are responsible for registration and investigation of contaminated sites
The national Environment Protection Agency (Miljøstyrelsen) provides guidance to regional and local authorities and supports R&D activities.

Definitions
The Danish contaminated sites policy includes all types of contamination, provided that the concentrations of harmful substances are higher than the defined quality criteria [193]. A site is considered to be contaminated when it is proved and documented that there is a high probability that the site is affected by soil contamination of a type and degree that may have harmful impacts on humans and the environment. [76].

1.3.3. Registers and inventories

The Soil Contamination Act introduces a new system for mapping of contaminated sites. The new system will replace the old register, established in 1990. As before, the information on the mapped sites will be entered into the Land Register. Each entry in the new register will be linked to a digital map covering the whole area of the site. Digitalisation is expected to be completed by December 2000.

The objective of the register is to better manage the use of land by:
- avoiding that land is sold or bought in ignorance of contamination;
- controlling changes in land use, especially in those cases where a change to a more vulnerable land use is requested;
- avoiding that excavated soil creates problems when reused.

The new register will include sites regarded as contaminated (mapped at level 2) or potentially contaminated (mapped at level 1).

Prioritisation
According to the Soil Contamination Act, publicly financed remediation will mainly take place on sites which are likely to have:

- harmful impacts on the groundwater within the designated areas with special drinking water interest;
- harmful impacts on the groundwater in the water abstraction area of a common water supply plant; or
- harmful impacts on human health in areas with housing, children's institutions, or public playgrounds.

Sites belonging to these groups are designated as 'areas for special public efforts'.

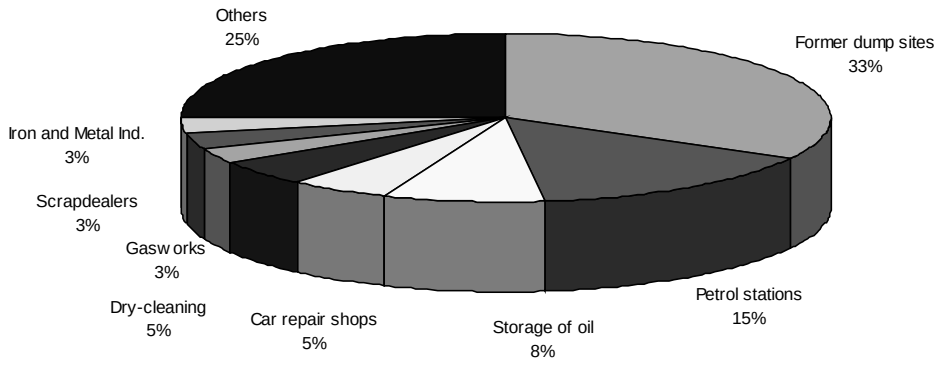
In those sites where contamination is likely to have harmful impacts on human health, remediation with usually only take place if the soil quality criteria are exceeded 10 times, corresponding to the level of the so-called 'cut-off value'. In slightly contaminated areas, exposure to contaminated soil is reduced to an acceptable level by reducing contact with soil.

1.3.4. Characterised sites

Potentially contaminated sites
The total number of potentially contaminated sites (mapped at level 1) affected by contamination from point sources is estimated to 30000 sites (as of 1999). In addition, an area of 200 km^2 is expected to be mapped at level 1 because of contamination deriving from diffuse sources as e.g. airborne pollution from traffic, etc. Due to the establishment of the new register, the total number of sites mapped at level 1 (potentially contaminated) will not be assessed before December 2000 [189].

Contaminated sites
The Danish old register of contaminated sites includes 4 520 sites (as of December 1998) [211]. Main sources of contamination are former dump sites, not in operation, (33%) and petrol stations (15%) (Fig. 1.3-1).

Figure 1.3-1: Source of contamination at contaminated sites, according to the Danish EPA



In total 14000 sites are estimated to be contaminated, of which 3400 will probably be part of the special public effort [189]. In particular:

2300 sites	are expected to pose a risk to the groundwater in areas designated as particularly valuable water abstraction areas:
200 sites	are expected to pose a risk for the groundwater in water abstraction areas of a common water supply plant;
900 sites	are expected to pose a risk on human health on areas used for housing, children institutions, or public playgrounds.

Moreover, an area of 20 $km^{2,}$ used for housing or other relevant uses, is estimated to be slightly contaminated by diffuse sources. Public financed remediation will be necessary in 200 cases.
In another 200 sites, where contamination derives from oil tanks used for domestic heating, remediation is expected to be included in the special public efforts scheme [189].

Remediated sites
As of December 1998, more than 1400 sites that are or were once included in the inventory have been remediated. About one third of the clean-ups has been funded by public money and about another third has been funded as part of an agreement between the petrol industry, the Danish EPA and the regional authorities [211].

In addition to the remediation of sites included in the inventory, remediation of 'new' contamination emerged after mid 1970s has taken place in Denmark. However, it can only be quantified from 1996. In the period 1996 -1998, approximately 1600 new contaminated sites were identified, of which more than two thirds were remediated. The majority of the 'new' contamination is caused by oil spills, mainly deriving from private oil tanks used for domestic heating [211].

Moreover, approximately 1000 petrol stations have been investigated and/or remediated as part of an agreement with the petrol industry.

1.3.5. Site identification methodologies

The Danish approach to identify and investigate potential contaminated sites starts with the mapping of potentially polluting activities. The first mapping of contaminated sites was carried out in 1982; it covered landfills and other sites where there was a suspicion that oil or chemical waste had been buried. The mapping was limited to contamination that had taken place before mid-70s. In 1988 the mapping continued to include industrial sites; in 2000 the process has been extended to sites contaminated after mid-70s and to contaminated areas from diffuse sources.

Preliminary survey
The preliminary study of potential contaminated sites includes the gathering of data on:

- localisation;
- current and past activities (e.g. type of operation, operation period, tanks, use of chemicals, accidents);
- characteristics of the site (e.g. size, owner, present use, future use, geological and hydro-geological conditions).

At this early stage, a preliminary risk assessment is carried out; available data are assessed in order to define whether the suspicion of contamination shall be further supported or not. If there are activities on the site or in other areas which may be sources of soil contamination on the site, the site itself will be designated at level 1 and a notification included in the Land Register.

Preliminary investigation
If the site, as result of the preliminary survey, is mapped at level 1, and the site is regarded as 'area for special public efforts', a preliminary investigation will be carried out. The owner of a site used for housing can also ask the competent regional authority that a preliminary investigation is carried out within a period of two years after the site is mapped at level 1.

The investigation will include the following tasks:

- historical investigation, going in further details including e.g. aerial photos;
- site visit, where former employees or neighbours will be interviewed;
- limited technical investigation, in order to confirm the presence (and extent) of contamination.

The number of sampling points will be limited, depending on the size of the site. A risk assessment will be carried out considering both the current and the possible future land use. Guideline values for soil (based on the most sensitive land use) and on groundwater (based on drinking water values) are applied as orientation values.

In addition, a site-specific risk assessment will be conducted to assess the probability of leaching of contaminants to the groundwater, since soil guideline values do not take into account such effects.

Where documentation has been obtained which renders it highly probable that the site contains soil contamination of a type and concentration that may have harmful impact on humans and the environment, the site will be mapped at level 2 with a notification in the Land Register. Sites which are considered to pose a risk for the present land use or for drinking water resources have the highest priority and will continue into the next step of the process [188].

Main site investigation

Main site investigations will be carried out in those sites that were assigned a high priority in the preliminary investigation. Major objective of this step is to assess the need for remediation [190], [192].

The number of samples of soil and groundwater depends on the specific case. A guide to the sampling and analysis of contaminated sites provides instructions [192].

1.3.6. Funding and liability

In principle, the polluter is liable for cleaning-up and bearing the costs of the operation. However, this applies only to cases where the soil pollution entirely or partially took place within the last 20 years, since the polluter's liability generally expires after 20 years. The innocent owner of a property is not held liable [2], [74].

The Soil Contamination Act introduces strict liability. Regarding the power of the authorities to order investigation and notices of enforcement to this effect, strict liability can be applied to contamination which has occurred after 1991. In relation to orders to carry out remediation, strict liability can only be applied for contamination taking place after January 1, 2001.

A special provision has been introduced for owners of oil tanks used for domestic heating, with a capacity below 6000 litres. Strict liability in these cases only applies to contamination which has occurred after March 1, 2000. These more strict rules on the responsibility of owners of private oil tanks are combined with a compulsory insurance programme. All the oil companies supplying heating oil have established a joint insurance scheme. All owners of oil tanks used for domestic heating with a capacity below 6 000 litres are automatically covered by the insurance scheme [189].

Orphan sites

The government is held liable for orphan sites covered by the Soil Contamination Act. Remediation on these sites is fully funded by the public authorities if the site is designated as 'area for special public effort' and remediation is considered necessary.

Public funding
A special clean-up system for landowners was introduced in late 1993 with the Act on Economic Damage to Family Housing on Contaminated Land (The Loss of Value Act). After the enforcement of the Soil Contamination Act, this system is continued within the Act under the title 'The Loss of Value Scheme'. By paying a minor contribution, the landowner can initiate publicly financed clean-up. Under the Loss of Value Scheme, the protection of the *innocent* landowner is considered very important. This implies that the owner who has caused the contamination, for example by operating a small business on the premises, is not entitled to receive public support. The same applies if the owner knew about the pollution at the time of purchase and therefore purchased the property at a reduced price. In 1998 the budget under this scheme was about 6,7 MEURO (49 MDKK) [211].

In 1992 the petrol industry established a fund, expected to cover the clean up costs of some 10000 filling stations over a period of 10 years. The budget is estimated to range between approximately 1 and 2 MEUR (6.8 and 13.6 MDKK) per year, and it is funded from the petrol sales at a rate of 0.007 EURO (0.05 DKK) per litre [2].

In 1998 the annual public budget spent on contaminated sites, including investigations and remediation actions, amounted to 43 MEURO (315 MDKK). The amount of the budget spent by the private sector is not known in detail. Nevertheless, it can be mentioned that the fund for the remediation of petrol stations has a yearly budget of approximately 17 MEURO (125 MDKK), the Danish Railways and the Ministry of Defence dispose of a yearly budget of approximately 2 MEURO (15-16 MDKK) each. [211]

1.3.7. Scale of the problem

Approximately 200 km^2 in Denmark is estimated to be affected by diffuse contamination due to atmospheric deposition of pollutants from e.g. burning of fossil fuel and traffic sources.

Estimates on the cost of the total public effort including mapping, investigation and remediation amount approximately to 480 MEUR (4300 MDKK).

1.3.8. References

Exchange rates: 100 DKK (Danish Kroner) = 13.45 EURO (as of November 1999).

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1.4. Finland

1.4.1. Country characteristics

Activities to overcome the problems raised by contaminated sites started with the investigation of hazardous waste landfills in the early 1980s. Since then Finland developed a national strategy towards contaminated sites. Between 1989 and 1993 the Finnish environmental administration conducted a national project, the SAMASE project, with the major objective to assess R&D needs, to develop soil guidelines and to quantify the problems posed by contaminated sites.

The hydro-geological conditions in Finland differ significantly from most other EU countries. Small-featured geology with thin soil layers, 7 meters on the average, are predominant characteristics. Acidity and nutrient deficiency are natural soil properties throughout the country. Also the harsh and variable climatic conditions, such as periods with frozen soil and snow cover, have to be considered whenever actions at contaminated soils are planned.

Groundwater is the major drinking water resource. Hence emphasis has been put on groundwaters when assessing risks of contaminated soils. Groundwater resources are mainly located in very permeable esker formations. Otherwise the most common soil type in Finland is moraine, which has a relatively low permeability.

The Republic of Finland is divided in 5 Provinces and the autonomous community of Åland; statistical data reveal that (Table 1.4-1, Table 1.4-2):

- Finland has the lowest population density within EU. Transportation distances are usually very long;
- the water use intensity is very low;
- the share of wooded area is very high, being about twice as much as the EU average.

Table 1.4-1: Some selected geographical statistics of Finland in comparison with EC average values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Finland	338 130	10.4	25 580	7.6	232 220	68.7	8 073	2.4	108 000	3	76
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.4-2: Some selected population statistics of Finland in comparison with EC average values; [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Finland	4 982	1.4	15	24	71	79
EU15 Total	368 641					
EU15 Av.			145	26	73	79

1.4.2. Legal background

Finland has no separate soil clean-up legislation. Problems raised by soil contamination are addressed in [30]

- the 1978 Waste Management Act 673 and
- the 1994 Waste Act 1072

Soil protection is addressed in the 1994 Waste Act, which also refers to soil contamination generated before January 1994 and gives definitions related to soil contamination, prevention of soil pollution, responsibilities of real-estate owners and other issues.

The policy objective towards contaminated soils defines the protection of soil quality in order to allow unrestricted use.

Between 1989 and 1993 the SAMASE project, a national action programme on contaminated sites, was conducted, major activities of the project were:

- the assessment of R&D needs;
- the investigation and development of risk analysis methods;
- the proposal for guideline values of contaminated concentrations in soil;
- the identification of potentially contaminated sites;
- the evaluation of volumes of contaminated soils;
- the estimation of decontamination costs;
- the assessment of capacity requirements for remediation measures and technology;
- the assessment of development needs of land use planning related to soil contamination;
- the investigation of legal and economic problems and problem identification, and
- the initiation of extensive information transfer activities.

Responsible bodies
The Ministry of the Environment is the national environmental authority and is responsible for the realisation of legal requirements and the allocation of public funding.

The 13 Regional Environment Centres have the primary responsibility for data collection and are partly responsible for the allocation of public funding. Furthermore they give permits and set provisions for all clean-up measures.

The Ministry of Defence has the primary responsibility for soil contamination at military sites.

Definitions
Soil contamination is indirectly defined in the Waste Act as 'excess content of harmful substances in the soil causing significant acute or long-term hazard to human health or the environment' [150]. In the beginning of the SAMASE project soil contamination was expressed as 'harmful substances in the soil causing significant acute or long-term hazards to human health or environment' [193].

1.4.3. Registers and inventories

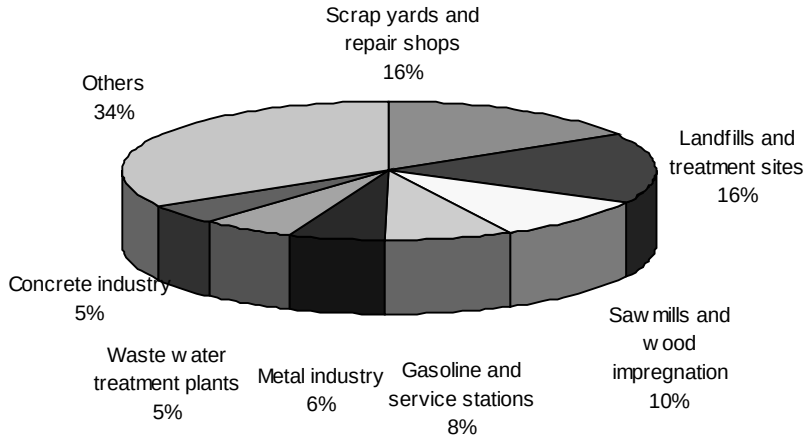
Between 1990 and 1992 a list of potentially contaminated sites was compiled under the SAMASE project. The data on potentially contaminated sites were entered in a database and are continuously updated. The 13 regional environment centres are responsible for collecting the information from the 452 municipalities (NUTS5). The statistics about contaminated sites cover the mainland Finland (NUTS1, excluding Åland).

Potentially contaminated sites are classified in 4 so called Risk Classes; in 1993 the total number of potentially contaminated sites was reported to be 10 396 (see Table 1.4-3). The register includes industrial activities, landfills and mine tailings. Military sites are handled in a separate information system, which is under the responsibility of the Ministry of Defence.

1.4.4. Characterised sites

Of the 10 396 potentially contaminated sites, pollution turned out to derive most frequently from 1) scrap yards and repair shops and 2) landfills and treatment sites with both resulting in a percentage of 16 %of the total amount of potentially contaminated sites identified.

Figure 1.4-1: Share of polluting activities assigned to potentially contaminated sites [150]



Prioritisation
The Finish classification of potentially contaminated sites was the following criteria:

01...contamination estimated to be insignificant;
02...minor contamination possible, contaminant migration not probable;
03...significant contamination and contaminant migration suspected;
04…significant contamination and contaminant migration verified by investigations.

Table 1.4-3: Risk classes and vulnerable land uses of potentially polluted sites, as defined within the 1992 SAMASE project [150]

	Risk Class				
Location of Site	1	2	3	4	Totals
GW Area	27	940	381	102	**1,450**
Residential Area	28	610	338	113	**1,089**
GW and Residential Area	17	375	168	36	**596**
Other	177	5 430	1 252	402	**7 261**
Total	**249**	**7 355**	**2 139**	**653**	**10 396**

1.4.5. Site identification methodologies

The starting point of the Finnish site identification programme was the compilation of potentially contaminated sites under the SAMASE project from 1989-93 [131]. The identification of sites was based on permits, announcements, reports on chemical accidents, on oil accidents, industrial registers, and other documents on polluting activities and events. The major part of information was retrieved from public authorities, but also from unofficial sources such as old catalogues, registers, maps, interviews etc.

Finland has published technical guidance on how to identify and investigate sites (in Finnish with English abstracts) [132], [133].

Preliminary survey
In a preliminary study information on the past and present land use of the site in question, on soil stratification and on hydrogeology is collected.

Preliminary investigation
Preliminary investigations are carried out since 1994. They include a field investigation and a minimum of samples, which are supposed to focus on the spots of contamination only.

Main site investigation
If serious contamination is revealed, more investigations are carried out. A sampling strategy is set up primarily based on ISO/DIS 10381-1 1995, soil and groundwater samples are taken. The number of sampling points depends on the size of the site and for soil samples whether the contamination affects the topsoil or the sub soil.

With the obtained results a risk assessment is conducted either based on comparison with guideline values or by applying site-specific criteria. In general guideline values are not stringently applied but are usually used to support cleanup decisions. Based on the results of the risk assessment a remediation plan is set-up.

1.4.6. Funding and liability

The SAMASE project included the estimation of clean-up costs of priority sites. First estimates on the overall costs were calculated for a 20-year period. The calculated total costs shall be shared between the government, regional authorities and real-estate owners with 25 %, 25 %and 50 %respectively [234].

In 1996 enterprises and responsible public bodies signed an agreement on the clean-up of service stations. The programme was called SOIL I. It is a programme of the petroleum industry with the objective to fund the remediation of polluted decommissioned service station sites by oil companies and the remediation of old abandoned sites by the 'Oil Pollution Compensation Fund', which is a national fund under the Ministry of the Environment.

In general the 'polluter pays' principle is applied. In those cases were the polluter cannot be assigned clean-up costs are shared between the government and the local authorities. The state budget provides monetary equipment for development and demonstration projects, in order to support special cases of site contamination and for employment programmes.

A waste tax was introduced in September 1996. The revenues of this tax are not directly dedicated to finance site remediation. However, the Finish parliament stated that sufficient financial allocations would be devoted from the annual state budget to that purpose [108].

1.4.7. Scale of the problem

In 1996 the Ministry of the Environment referred to annual public expenditures of approximately 6 MEURO (32 million FIM), spent exclusively on remediation development and action [108].

Results from the SAMASE project calculate the total volume of contaminated soil to be over 10 million m^3 and the total costs to be approximately 5.5 billion FIM (900 MEURO) respectively (see Table 1.4-4). It is proposed that contaminated sites shall be restored within the next 20 years, with an annual contribution of public authorities (both state and municipalities) of about 110 million FIM (55 MEURO).

Table 1.4-4: An estimate of the number of contaminated sites to be remediated and respective costs of soil-clean-up during 20 years [150]

Site type	Number of sites	Estimated cumulative costs		Share
		[billion FIM]	[MEURO]	[%]
Industrial Sites	808	3.0	500	27
Landfill Sites	334	1.1	200	57
Mining waste sites	35	1.4	200	54
Total	*1 177*	*5.5*	*900*	*100*

1.4.8. References

Exchange rates: 100 FIM (Finnish Marks) = 16.8 EURO (as of November 1999).

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1.5. France

1.5.1. Country characteristics

Initial action towards contaminated sites was taken in 1978, when two national inventories were carried out. Up to the beginning of the 1990s contaminated sites were not of major concern in France. Since then public attention and political concern have been growing continuously. Most remarkable incidents of current developments were:

- the endeavour to work out a comprehensive national inventory including operating industrial sites and abandoned sites;
- the enforcement of a law on regulating the funding of the remediation of orphan-sites, by levying the treatment of hazardous wastes;
- the elaboration of national technical guidance documents on historical site investigation, simplified risk-assessment and detailed risk-assessment.

The Republic of France consists of 99 administrative units (départements), distributed over 25 regions. Each department has one representative of the central government (le préfet de département). Statistical data (Table 1.5-1, Table 1.5-2) reveal that

- France has experienced a major population increase between 1950 and 1990, being significantly higher than the EU average value;
- agriculture plays a major role for France's economy and is about 15 %higher than the EU mean value.

Table 1.5-1: Some selected geographical statistics of France in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
France	551 500	17.0	305 810	55.5	148 110	26.9	47 787	8.7	198 000	19	68
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.5-2: Some selected population statistics of France in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male female	
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
France	57 980	15.7	103	35.0	73.4	81.8
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.5.2. Legal background

France has no specific legislation concerning contaminated sites. National policy and national measures to be applied are defined in circulars of the Minister of the Environment to the heads of the French departments. A key document is the circular letter of the Minister of the Environment from 3 December 1996, defining major features of a national policy towards contaminated sites.

Circular letters

Dec. 1993 Minister of the Environment to the heads of departments
the document defines *the general policy towards contaminated sites* [50].
Major tasks of this document are:
(1) principles of a realistic soil clean-up policy
(2) measures and tools to realise this policy
- investigation of polluted soils and sites
- evaluation of risks and vulnerability of those sites
- establishment of a concerted information network at a regional level
- establishment of a national inventory of contaminated industrial sites
(3) initial classification of contaminated sites.

April 1996 in two circular letters the Minister of the Environment instructs the department heads of how *to select priority branches in order to conduct initial evaluations* (diagnostics initiaux) and simplified risk assessments of priority branches.

June 1996 the Ministry of Environment forwards to heads of the departments *definitions of the administrative and legal instructions for contaminated sites remediation*, and in particular, for orphan sites. [51]

Framework laws

Other important regulatory documents that address contaminated sites [195]:

Law of July 19th 1976, on *environmental permits for industrial sites (IC-law)*
The law on environmental permits covers all environmental aspects of industrial activities including waste management tasks, and requires large-scale facilities to be authorised (currently 68 000 sites) and smaller facilities to be declared (currently 500 000 sites). Furthermore it covers legal provisions for closing down industrial facilities and the discovery of contamination next to industrial plants.

Law of July 15th 1975 on the *elimination of waste and recovery materials*

Law of July 13th 1992 on *management of domestic waste*
Major objective of the law is to reduce direct land filling of waste that cannot be further treated by for instance thermal valorisation or compost. The law includes a tax on direct land filling and regulates the selling of land for those facilities that operate under authorisation of the IC law (see above). In this case the vendor is obliged to inform the purchaser about

possible soil contamination to avoid the purchasing of land in ignorance of existing contamination.

Law of February 2nd 1995 on the *funding of orphan sites*
The law regulates the funding of orphan sites by applying a levy on the treatment of special hazardous wastes.

Responsible bodies
Although there is a recent tendency towards some regionalisation, France remains a centralised country. For the environment, like for other subjects, laws are discussed and voted by the parliament and regulations are enacted by the Government and have a national validity.

The Ministry of the Environment
At the central level the section in charge is the *Direction de la Prévention des Pollutions et des Risques* (DPPR) of the Ministry of National Land Planning and the Environment.

The Departments
At the local level the basic geographical administrative unit is the *département*. In total there are 99 French départments, their heads are the so-called *préfets de département*.

Regional directories of industry, research and environment
In the particular case of contaminated sites, the department head is assisted by the Inspectors of the registered installations who control industrial activities and who are in almost all cases members of the Regional Direction of Industry, Research and Environment, *les Directions Régionales de l'Industrie, de la Recherche et de l'Environment* (DRIRE).

Definitions
In general two main categories of land pollution are considered, being diffuse contamination and contamination from point sources [195]:

1. The pollution of agricultural land that is extensive and derives mainly from agricultural activities e.g. application of fertilisers or pesticides. The most frequent consequence is groundwater pollution due to nitrogen and pesticides. In that case legal and technical approaches are connected with water quality problems (protection of water resources).
2. The pollution resulting from the management of effluents, domestic and industrial solid wastes and more widely, of polluting industrial activities (chronic or accidental pollution).

In 1997 a definition for contaminated sites has been established in the glossary of a guideline on contaminated sites [134].

1.5.3. Registers and inventories

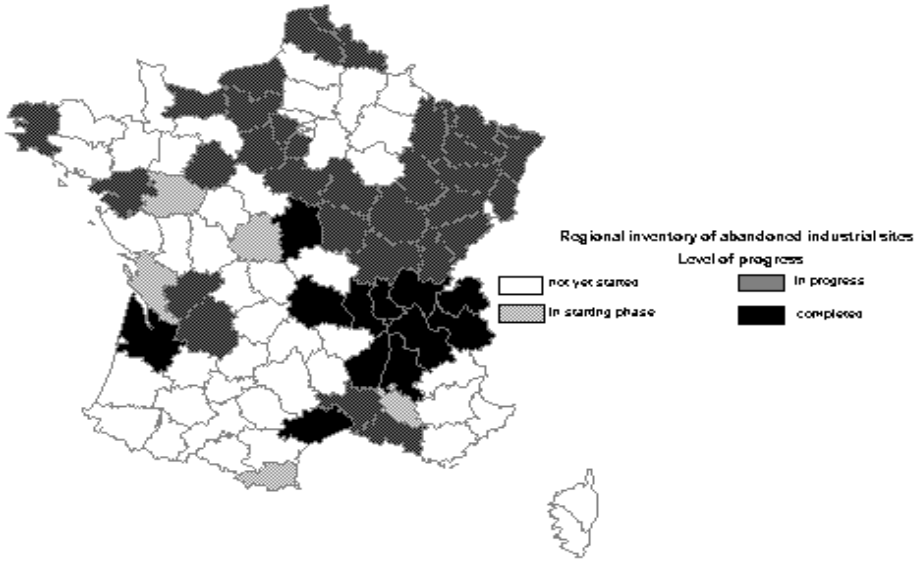
Although France was probably one of the first countries to carry out some kind of inventory of polluted sites, limited attention has been given to the problems of land pollution until the beginning of the nineties. Apart from the initial national surveys on contaminated sites conducted in 1978, new activities have been taken recently [51], [169], [196].

National register
Since 1993 the Ministry of the Environment runs a national register. The national register refers to sites that have been reported by the local authorities and are considered as polluted. The sites are entered into a database. Periodically the Ministry of the Environment issues public reports on the current situation. In December 1994, 669 sites were reported to be in the register, by December 1997 the register referred to 896 contaminated sites and 125 sites that have already been restored with or without any limitation in land use.

Inventory of abandoned sites
Apart from the investigation of operating sites the Ministry of the Environment conducts a systematic national survey on old abandoned industrial sites. These inventories are managed on a regional scale. By the end of 1997 40 departments had initiated such inventories. It is expected that 200 000 to 300 000 former industrial sites will be identified at the end of the studies.

Along with the above activities 467 abandoned gas works, which still belong to the national gasworks company Gaz de France, will be investigated. The sites were selected according to a scoring system, which was approved by the Ministry of the Environment. Depending on the results of the preliminary diagnosis, Gaz de France is committed to investigating and to implementing the needed clean-up measures.

Figure 1.5-1: Level of progress of the regional inventory of abandoned industrial sites (BRGM, 1998)



Inventory of active industrial sites
In April 1996 the Ministry of the Environment instructed the heads of the departments to in a first step draw up a list of priority sites, in order to further investigate these sites. A preliminary classification of priorities is given in the annex of the circular letter (see Table 1.5-3). Within 5 years it is previewed that some 1 600 sites assigned with priority 1 will have to conduct soil studies and a simplified risk assessment, and if necessary the appropriate clean-up measures.

Table 1.5-3: Priority branches according to the circular letter of the Minister of the Environment, from April 3 1996 [49], [145]

Priority	Branches
1	Special industrial waste treatment and waste recycling facilities. Production and storage facilities of the following industries: chemical, petrochemical, carbochemical, pharmaceutical, pesticides, gas works, coke plants and oil refineries. Hydrocarbon tanks and stocks. Iron and steel industry, including processing of non-ferrous metals and surface processing. Tanning and wood treatment facilities. Crystal- and ceramic processing industries.

2	Thermal power plants. Secondary steel industry (blast furnaces), transformation of steel, mechanical industries including repairing and maintenance.
3	Other industries.

Registration of incidents
Contaminated sites discovered by chance and accidents are also registered and treated under the provisions of the IC law or water law.

1.5.4. Characterised sites

The inventory of identified contaminated sites included 669 sites in 1994, not including gasworks, petrol stations, and other suspected radioactive locations (included in a specific inventory). 896 sites have been registered in 1996.

1.5.5. Sites investigation methodologies

The methodology of how to identify and investigate sites is a tiring process, consisting of three major steps [62] – [64].

Preliminary survey
The preliminary survey aims to prioritise sites for investigations. The inventories of old abandoned sites and active industrial sites are used; sites are selected by using easily accessible documentary information. Criteria for the selection are (1) the type of the activity, (2) vulnerability of the water resources (groundwater and superficial water) currently used as drinking water, and (3) for old abandoned sites the current land use [130].

Preliminary investigation
This step includes the so-called initial diagnosis or soil study and the simplified risk assessment (SRA). It aims to identify potentially sources of pollution, and to briefly evaluate potential impacts on human health and the environment.

Part A of the so-called soil study (études des sols, étape A) is a documentary study (a historical review and a vulnerability study) based on available and accessible data, and it is completed with a site visit. The historical review includes a description of the sequences of activities that have taken place in the course of time, their precise locations and any associated environmental practices that may have been carried out. The vulnerability study includes an investigation of the parameters (geology etc.) that could have relevance for the fate and transport of the contaminants and the potential targets (human health water supply, water supply etc.) likely to be affected.

During the site visit the data deriving from the documentation study should be verified and additional data acquired. An evaluation and identification of existing and potential impacts takes place and a further investigation programme is prepared.

The conditional Part B of the initial diagnosis includes the collection of data, which have not been available within the previous study but are needed for the simplified risk assessment. In practise, Part B consists of a site investigation with special emphasis to soil and water sampling, in order to evaluate the actual impact on these media. The initial diagnosis does not determine spatial distribution, or transport mechanisms of contaminants. The decision making process within the SRA is supported by defined guideline values (only for water and soils) so called 'Valeurs de Constat d'Impact' (VCI) related to media uses.

Based on the results of the soil study, a simplified risk assessment is conducted according to a scoring system and the site in question is classified in one of 3 groups [134]:

- sites needing further investigation and detailed risk assessment;
- sites for which monitoring systems should be applied;
- sites that can be used for specific purposes without further investigations or implementation of measures.

In-depth investigation and detailed risk assessment
The results of the preliminary investigation define the need for conducting a detailed risk assessment. The detailed risk assessment is supposed to evaluate the impact on human beings and the environment (e.g. flora and fauna, natural resources like groundwater, surface waters and buildings) and the need for treatment to reduce or eliminate these risks. The technical guidance document on the in-depth diagnosis is under development and the completion is foreseen for the year 1999 [52].

1.5.6. Funding and liability

Wherever the generator of pollution is at hand the polluter-pays-principle is strictly applied.

Voluntary agreements of industry
In 1992 French industry founded the 'French Organisation of Enterprises for the Environment' EPE. The organisation signed a 5-year agreement with the French Agency for Environment and Energy Control (ADEME) for the clean-up of contaminated sites. Industry created a fund with an annual budget of approximately 15 million French Francs (2.3 MEURO). Under the surveillance of the ADEME remediation projects were funded where responsible parties were not at hand or were insolvent. The system worked rather efficiently until the end of 1994, when it was evident that the budget was not sufficient to overcome the actual needs. As a consequence the waste tax was introduced in February 1995.[197].

Tax system
The remediation of orphan sites is funded by a tax, introduced in February 1995. The tax regards hazardous chemical wastes. The monetary resources retrieved from this tax are allocated to investigations and clean-ups. It is foreseen that the tax will be progressively increased; from the initially 25 FF (3.8 EURO) per ton industrial waste to 40 FF (6.1 EURO) from 1998 on. The tax is progressive, in the first year the income of the new tax amounted to approximately 69MFF (10.5 MEURO) and is supposed to increase to up to 100MFF (15.3 MEURO) in 1998. A National Committee is responsible for the management of the waste tax and has agreed to 37 interventions at orphan sites, at total costs of approximately 200 million FF (30.5 MEURO) [54], [195]. The system will be modified in the year 1999.

Grant and loan system
France has six Water Agencies (Agences de l Èau), of which the two most important have decided to provide grants and/or low-interest loans for site investigations and clean-ups within their next working period (1997 to 2000). The loans are supposed to amount to approximately 50 percent of the total costs [195], including studies and remediation works. The real amount of grants or loans depends on the Water Agency and range from 30 to 70 %according to the water resource areas.

1.5.7. Scale of the problem

At present no efforts have been undertaken to estimate the scale of the problem at the national level. First results from the regional surveys estimate the total number of potentially contaminated sites as listed below:

abandoned sites	200 000 to 300 000
authorised active industrial sites	~ 68 000
smaller active industrial sites	~ 500 000

1.5.8. References

Exchange rates: 100 FF (French Francs) = 15.2 EURO (as of November 1999).

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1.6. Germany

This chapter was prepared in cooperation with the German Federal Environment Agency (UBA). Special thanks are due to Dr. Karin Freier and the German Federal States for providing the relevant data.

1.6.1. Country characteristics

The Federal Republic of Germany consists of 14 Federal States (Länder) and 2 Free Trading Cities (Hansestädte) each having a high degree of autonomy. Each of them has developed its own strategy towards the problems posed by contaminated sites, including individual registration systems, evaluation systems, prioritisation procedures and risk assessment methodologies. The comparability and aggregation of data represents a major problem, which has become even bigger after the reunion in 1990. In the five new Federal States systematic regional surveys in order to compile comprehensive registers on waste sites and industrial sites were set up soon after the reunion.

For the time being it is almost impossible to present data at a national level. As a consequence, data are presented on a state-by-state basis. Comments are added where necessary in order to call attention to data dissimilarities.

Statistical data (see Table 1.6-1, and Table 1.6-2) reveal that:

- Germany is among the most densely populated countries in the EU;
- the water use intensity of renewable water sources is considerably high, and
- the population increase between 1950 and 1990 was very low compared to other Member States, being about half of the average.

Table 1.6-1: Some selected geographical statistics of Germany in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Germany	356 910	11.0	180 320	50.5	103 930	29.1	49 540	13.9	171 000	34	86
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU 15 Av.				50.5		28.0		7.1		18	75

Table 1.6-2: Some selected population statistics of Germany in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Germany	79 365	21.7	222	16.0	72.0	78.6
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.6.2. Legal background

Federal Soil Conservation Act, 1998
The Federal Soil Conservation Act was ratified in February 1998. Major objectives of the new law are the restoration and maintenance of inherent soil functions to be achieved by (a) pollution prevention and (b) remediation. The new law defines contaminated sites as abandoned sites, being mainly waste sites and industrial sites and explicitly excludes contamination due to radioactive substances and due to war agents [115].

The legal instruments for contaminated sites management are now harmonised among the German Federal States in order to be more efficient. The new Federal Soil Conservation Act creates a legal framework to address the problems at existing contaminated sites and to prevent future soil contamination. The Federal Soil Conservation Act will come into force in March 1999.

Ordinance on Soil Conservation and Existing Contaminated Sites (inpreparation)
An associated Ordinance on Soil Conservation and Existing Contaminated Sites is still under parliamentary discussion and is supposed to come into force at the same time as the Act. Both the Act and the planned Ordinance on Soil Conservation and Existing Contaminated Sites define requirements for the investigation, assessment and remediation of contaminated sites.

By means of this Act the multiplicity of legal requirements and standards for soil remediation in different parts of Germany will be replaced by national uniform criteria for risk assessment and clean-up.

The special regulations in the Act concerning contaminated sites management are consistent with current regulations in the Federal States and are listed beneath.

Responsible bodies
According to the German Constitution, Art. 30, 83 the Federal States are responsible for registration, inventory, risk assessment and remediation of contaminated sites. Germany has a distinct federal structure. The general management approaches can be based on state-specific standards as well as on countrywide uniform regulations.

Environmental Ministries in the Federal States
The Environmental Ministries in the Federal States are responsible for regulations and allocation of money. The Environmental Agencies in the Federal States are responsible for execution and supervision, compiling of registers, development of guidelines etc.

The Federal Environment Authorities
Competent Federal State authorities are responsible for the official registration, investigation and the risk assessment of all abandoned sites, which are suspected to be contaminated. The authorities have the right to recover the investigation costs from the liable persons by means of:

- uniform soil screening levels (trigger values) the responsible authorities decide whether or not a site needs to be further investigated, or whether immediate remedial measures need to be implemented;
- uniform action levels are prescribed provided there is a good scientific justification. Action levels indicate a certain degree of hazard, which has to be addressed immediately without the need for further site investigations;
- decisions on the type and extent of remedial measures are made on a case-by-case basis depending on the current and future land use and on the relevant receptors (sensible environments).

Federal Ministry of Defence
According to the general responsibilities for military bases the Federal Ministry of Defence, the Federal Ministry for Urban and Regional Planning and Construction and the Federal Ministry of Finance are dealing with the management of military bases owned by the Federal Ministries.

In line with the 'polluter-pays-principle', the person causing the contamination is held responsible. Besides the polluter, the owner or occupier of the site is responsible as well. For orphan sites the Federal States are liable for risk assessment and clean-up.

Definitions
According to the Act, and in consistence with current practise, contaminated sites and potentially contaminated sites are defined as indicated beneath.

Potentially contaminated sites are defined as:
- abandoned waste disposal sites being either closed-down waste disposal facilities or other sites where wastes have been treated, stored or disposed;
- abandoned industrial sites being closed-down facilities or other sites where environmentally hazardous substances have been handled during operation;
- and in general as sites where there are concrete reasons to suspect harmful changes in the soil or other hazards to individuals or the general public.

Contaminated sites are defined as:
- abandoned waste disposal sites;
- abandoned industrial sites, and
- where there are sound reasons for suspecting harmful changes in the soil or other hazards for individuals or the general public.

The German Federal States have the freedom to regulate the registration and identification of contaminated sites. The Federal Soil Protection Act does not cover these aspects. The following tables (see Table 1.6-3, Table 1.6-4) indicate the different specifications and criteria for abandoned industrial sites and abandoned waste sites of the German Federal States. The tables indicate the general trends in line with definitions in individual Federal States; Deviations are possible.

Table 1.6-3: Definition of abandoned industrial sites in the Federal States [226]

Federal states	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Baden-Württemberg	■														■
Bavaria	■	■	■		■	■				■	■				■
Berlin	■	■	■			■		■					■		■
Brandenburg	■		■			■		■		■					■
Bremen			■	■										■	■
Hamburg	■	■	■			■		■					■		■
Hesse	■				■	■	■		■	■					■
Meckl.W.Pomerania	■		■		■	■									■
Lower Saxony	■					■		■			■	■			■
Northrhine-Westphalia	■		■			■		■		■					■
Rhineland-Palatinate	■									■					■
Saarland	■	■	■										■		■
Saxony	■	■	■										■		■
Saxony-Anhalt	■	■	■	■	■	■		■		■	■	■	■		■
Schleswig-Holstein	■		■			■	■	■							■
Thuringia	■				■	■	■								

1) Land/areas occupied by decommissioned installations
2) Ancillary facilities
3) Other land/areas/operating sites
4) Former industrial and commercial sites
5) Industrial plants/activity/enterprise
6) Commercial facilities/activity/enterprise/purpose
7) Other facilities/economic enterprises
8) Public institutions
9) Jurisdictional purposes
10) Former military sites
11) Decommissioned military installations (handling of warfare agents)
12) Mining sector
13) Pipeline and sewerage systems (abandoned/decommissioned/no longer in use)
14) Fortification with contaminated building materials
15) Handling of dangerous/environmentally hazardous substances

Table 1.6-4: Definition of contaminated sites in the Federal States [226]

Federal State	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Baden-Württemberg					■										
Bavaria	■	■	■		■										
Berlin		■								■					
Brandenburg	■		■												
Bremen													■	■	
Hamburg											■				
Hesse		■			■							■		■	■
Meckl.W.Pomerania	■	■	■		■										
Lower Saxony			■						■						
Northrhine-Westphalia	■		■												
Rhineland-Palatinate						■	■								
Saarland	■		■												
Saxony						■	■								
Saxony-Anhalt						■	■								
Schleswig-Holstein				■				■							
Thuringia					■										

1) Based on a risk assessment/investigation and evaluation
2) Remedial action required/need for remedial action identified
3) Threat to public safety and order
4) (Other) threats or individuals of the public at large
5) Safeguarding of common weal/Common weal found to be impaired
6) Hazards to the environment/air, water and soil
7) Hazards to human health (in particular)
8) Harmful changes to environmental media
9) Long-term and detrimental changes to soil, a body of water, air
10) Contamination or detrimental change to a water body by substances constituting a hazard to waters
11) Presence of harmful soil contaminants
12) Existing contamination
13) Contamination if soil, groundwater or surface water
14) Conflict with/consideration of existing or planned uses
15) Substantial

Military contaminated sites
This category refers to sites that pose a risk to the environment and human health due to former military operations (i.e. decommissioned military installations for conducting trials, facilities for testing military equipment or for performing other military activities).

Former armament production sites
This category refers to sites that pose a risk to man and the environment due to chemical armament production. Substances causing contamination are in particular chemical warfare agents, propulsive agents, chemicals added to warfare agents for tactical purposes, preliminary products, waste products arising during production and residues arising from the destruction of conventional and chemical warfare agents. As a matter of principle the following facilities are suspected to be contaminated:

- former production facilities;
- ammunition depots;
- weapons neutralisation grounds;
- bomb-disposal grounds and shooting ranges;
- delaboration works and
- facilities for intermediate or final storage of chemical warfare agents.

1.6.3. Registers and inventories

With respect to registration the German Federal States have designed their own approaches. The Federal Soil Protection Act does not regulate the registration and identification process. Although the individual approaches vary in detail depending on the administrative structures and responsibilities in each Federal State, the general procedure is very similar and can be characterised as such.

Step I:	Identification and registration
Step II:	Investigation and risk assessment
Step III:	Remediation and/or monitoring

All Federal States compile data on potentially contaminated sites, regarding the four major categories as indicated previously. The registration of abandoned waste sites started very early and is up to now more or less completed in all Federal States. The registration of abandoned industrial sites is still an ongoing process in most Federal States. The registration of military sites and former armament production sites is the most recent approach.

It has to be taken into account that up to 1989 industrial and agricultural activities of the new Federal States were remarkably different to those of the old Federal States. Due to the planned economy, agriculture was organised in considerably larger scales. Agrochemical

centres and airstrips/airfields in agricultural areas were common installations in the former German Democratic Republic (GDR), and are now regarded as potentially polluted sites.

In addition numerous military bases, most of them being abandoned in recent years, pose a major problem to all Federal States. On the one hand the new Federal States face the problems of the military bases of the West Group Troupe (WGT) of the former USSR and on the other hand the old Federal Countries those of the military bases of the allied forces. Former armament production sites have been investigated by national surveys in 1993 and 1995.

1.6.4. Characterised sites

All Federal States compile data on abandoned waste sites and abandoned industrial sites. In addition most Federal States register military sites and former military production sites. The figures as indicated in Table 1.6-5 include any site that is likely to pose a risk to human health and the environment. For the time being the share of those sites, which are of concern, can only be estimated roughly.

Table 1.6-5: Summary of potentially contaminated sites, source: see Table 1.6-6, Table 1.6-7, and Table 1.6-8

Type of site	No of sites
Potentially contaminated abandoned waste sites	90 517
Potentially contaminated abandoned industrial sites	112 368
Potentially contaminated abandoned former armament production sites	202 885
Potentially contaminated abandoned military sites	3 240
Potentially contaminated military sites owned by the Government	No official data

Abandoned waste sites

Inventories of abandoned waste sites are more or less completed throughout the country. Based on recent data provided by the Federal Environment Agencies the total number of abandoned waste sites makes up almost 90 517. Further analysis of the data reveals that procedures for data entry are heterogeneous:

- Some Federal States apply restrictions to data entry in order to avoid the management of superfluous data. Other Federal States include the pure existence of any former waste site. In the new Federal States not only abandoned waste sites are regarded but also sites, which are still operating;
- the provided data gives no further information on the risks posed by these sites.

Table 1.6-6: Number of potentially contaminated waste sites in 1998; *source: UBA 1998*

Federal State	No. potentially contaminated waste sites
Baden-Württemberg	5 362[1)]
Bavaria	9 725
Berlin	673
Brandenburg	5 585
Bremen	105
Hamburg	460
Hesse	198[2)]
Lower Saxony	8 957
Mecklenburg – West Pomerania	4 332
Northrhine – Westphalia	17 155
Rhineland – Palatinate	10 578
Saarland	1 801
Saxony – Anhalt	6 936
Saxony	9 382
Schleswig-Holstein	3 076

Federal State	No. potentially contaminated waste sites
Thuringia	6 192
Total	*90 517*

[1] 90 %of the regional survey is completed, including military bases
[2] sites with proven contamination

Abandoned industrial sites

Inventories of abandoned industrial sites are only partly completed. Again it is noteworthy that figures on the total number of sites provide no further information on the threats posed to the environment. The procedure of data entry is just as heterogeneous as for abandoned waste sites.

Table 1.6-7: Potentially contaminated industrial sites in Germany in 1997; source: UBA

Federal State	Potentially contaminated industrial sites
Baden-Württemberg	2 057[1]
Bavaria	3 194
Berlin	5 541
Brandenburg	8 580
Bremen	about 4 000
Hamburg	1 701
Hesse	160[2]
Lower Saxony	- [3]
Mecklenburg – West Pomerania	7 462
Northrhine – Westphalia	14 874
Rhineland – Palatinate	- [3]
Saarland	2 442
Saxony – Anhalt	13 295
Saxony	22 197[4]
Schleswig-Holstein	14 497
Thuringia	12 368
Total	112 368

[1] 90 %of the regional survey is completed, including military bases
[2] the figure represents registered sites with proven contamination
[3] at present no official data
[4] figure is about 80 %of the total

Former armament production sites

Former armament production sites were investigated in national surveys in 1992 and 1995 and coordinated by the Federal Environmental Agency. The total number of contaminated sites was reported to be 3,240 (UBA 1995). Apart from the national survey, the Federal States run their own monitoring programmes and hence have their own statistics, which are indicated in Table 1.6-8.

Table 1.6-8: Former armament production sites source: UBA 1995; the Federal States 1998

Federal State	UBA 1995	1998 update by the Federal States
Baden-Württemberg	412	410
Bavaria	337	275
Berlin	80	-
Brandenburg	336	238[1)]
Bremen	11	-
Hamburg	60	-
Hesse	109	395
Lower Saxony	277	188
Mecklenb.W.Pomerania	196	196
Northrhine – Westphalia	321	382
Rhineland – Palatinate	210	393
Saarland	13	-
Saxony – Anhalt	270	825[2)]
Saxony	278	718[2)]
Schleswig-Holstein	107	159
Thuringia	223	252
Total	3 240	No official data

[1)] after a review the total number was reduced to 238 sites, of which 41 were classified with high risk, 111 sites with medium risk, 71 sites with low risk and 15 sites which cold not be classified

[2)] military and former armament sites in total

Abandoned military sites

Military contaminated sites are former locations used for military operation, i.e. sites containing decommissioned military installations for conducting trials and for use of military equipment items or for performing other military activities.

Until 1990, an area of approximately 960 000 ha was used for military purposes in Germany (see Table 1.6-9).

Table 1.6-9: Abandoned military sites up to 1990; source UBA 1997

Operator	Total Area	Number of Bases
The German Federal Armed Forces	Approx. 253 000 ha	Approx. 7 000 bases
The Western Allies	Approx. 200 000 ha	
The National People's Army of the former GDR	Approx. 240 000 ha	Approx. 3 300 bases
WGT bases (bases of the former Soviet Armed forces in the former GDR)	Approx. 250 000 ha	Approx. 1 026 bases sites

Between 1991 and 1995 the Federal Ministry of Finance financed a programme for the registration and preliminary assessment of the former WGT properties. As a result of this comprehensive survey, coordinated by the Federal Environmental Agency 33 738 potentially contaminated sites, covering approximately 256 000 ha, were registered and a first evaluation was undertaken (UBA 1995).

Table 1.6-10: First evaluation of registered potentially contaminated sites at former WGT properties; source: UBA 1995

Number of sites	Classification after First Evaluation
18 920	Not environmentally relevant
10 808	Require further, medium-term investigation
4 010	Require immediate action (approx. 12 %)

Contamination profiles indicate the following major categories: mineral oil products, metal wastes, mineral wastes, residential wastes, organic chemicals, and explosives (munitions, respectively).

Military sites owned by the Federal Government
As mentioned previously military bases are under the responsibility of the Federal Ministries of Defence, for Urban and Regional Planning and Construction, and of Finance. At present the Federal Government owns an area of about 380 000 ha.

To ensure consistent management procedures and assessment criteria for these sites, the regional finance office of Hannover was appointed as lead-finance office. By August 1997 the office reported the registration of 22 513 potentially contaminated sites at 2 021 bases. The progress of investigations at these bases is specified in Table 1.6-11 [157].

Table 1.6-11: Level of progress at 2 021 military bases owned by the German government; source: UBA 1997

Number of bases	Classification after First Evaluation
697	Under preliminary investigation (34 %)
221	Under detailed investigation (11 %)
37	Under remedial investigation (2 %)
55	Under remedial action (3 %) now

About 22 513 potentially contaminated sites were registered at 2 021 bases, covering an area of approximately 380 000 ha.

Level of progress
Table 1.6-12: Data availability according to first evaluation (FE) and risk assessment (RA)

Federal State	waste sites		industr. sites		former arm't prod. Sites		military sites		ref.
	FE	RA	FE	RA	FE	RA	FE	RA	
Baden-Württemberg									[89]
Bavaria									[84]
Berlin									[116], [155]
Brandenburg									[88]
Bremen									[122]
Hamburg									[129]
Hesse									[122]
Lower Saxony									[122]
Mecklenburg – West Pomerania									[33]
Northrhine – Westphalia									[122]
Rhineland – Palatinate									[118]
Saarland									[119]
Saxony – Anhalt									[128]
Saxony									[42]
Schleswig-Holstein									[120]
Thuringia									[122]

Apart from mere registration of potentially contaminated sites all Federal States work on further evaluation of these sites. The level of progress is different from state to state, and highly depends on economic pressures, historic land use and availability of monetary resources. Some Federal States publish data on site investigations on a regular basis.

Table 1.6-12 indicates which Federal States provide data on the number of sites subjected to first evaluation (FE) and risk assessment (RA).

1.6.5. Site identification methodologies

In connection with the proposed Soil Act (see 1.6-2) uniform standards and guidelines shall be published. Besides that the definition of uniform soil screening levels and action levels is projected. At present most Federal States operate under individually defined guidelines [80]. Although the various systems in the Federal States vary in detail, depending on the structure of the administration and responsibilities in the states, the methods for site identification and investigation can in general be described as a stepwise approach of two main steps that each can be sub divided.

1. The first step includes a preliminary identification of sites leading to the identification of potential contamination with the objective to include such sites in a list of potentially contaminated sites (Verdachtsflächen).

2. As a second step a technical investigation is carried out and the concentration of contaminants in soil and groundwater is compared to soil and groundwater screening levels, for the purpose of making a comparative evaluation and setting priorities. On the basis of this evaluation the relevant sites will be deemed contaminated and included in the federal lists of contaminated sites [215].

In the following the identification process of some selected Federal States is described.

Hesse
Major guidelines with regard to site identification and investigation published by the Hesse Landesanstalt für Umwelt are:

- a general guideline on the investigation of contaminated sites describes the investigation and assessment of soil, soil gas and water [165];
- a guideline on the analysis of particular substances [166],

As military sites are considered as a special problem specific guidance has been published in this field:

- a guideline on the historical investigation of military sites [163];
- a guideline describing the possible organisation at former military production sites and the chemicals possibly handled at these sites [164].

Other publications regarding identification and investigation of contaminated sites are planned or under preparation.

In the following the identification process valid for abandoned industrial sites is described. The identification of contaminated military sites is in many aspects in line with industrial sites.

Preliminary survey; the following procedure applies to industrial sites and to some extent to military sites. Potentially contaminated sites are systematically identified. As a first step trade registers at the level of municipalities are evaluated.

First hints are the branch of industry, localisation and the period of operation. Subsequently a short ‘negative list’ is applied to sort out cases of minor importance. Data of the remaining cases are registered and reported to the Federal Environment Agency, the branch of industry is assigned with a code. Based on the historical use sites are divided in 5 different hazard classes.

The registered data are evaluated, data are unified in case more than one industrial operation has taken place at the same site. Evaluated data and corresponding references are sent to the municipality in order to complete submitted information and better control present and future land use. The completed data are returned to the Federal Environment Agencies, which assess whether or not a site should be considered as potentially contaminated. Sites are subsequently classified in different priority groups.

Preliminary investigation; to further prove the suspected contamination technical site investigations is carried out.

Main site investigation; detailed investigations are conducted with the purpose to define the need for remediation.

Baden Württemberg
The Landesanstalt für Umweltschutz of Baden-Württemberg has published a series of guidelines regarding the identification and investigation of contaminated sites, including both detailed technical and more general issues. The latter series includes:

- a guideline on historical investigation of potentially contaminated sites [169];
- a basic guideline on site investigation describing how to step-wise assess potentially contaminated sites, how to characterise the most important hydrogeological features and how to select and apply the most reasonable investigation methods [170], and
- a guideline on the investigation of groundwater investigations, describing methodologies on groundwater investigation, including the assessment of water use, and the applicability, and the costs involved for each method [171].

Baden Württemberg follows a stepwise site identification approach. At each level of investigation it is possible to sort out those sites which are of minor importance.

Preliminary survey; with respect to historical investigations, distinctions are made between 'area-covering' (fläckendeckende) historical investigations and a site- specific investigations. Area-covering historical investigations are the first step to systematically assess sites within a defined region. The goal of this type of investigation is to ensure a registration of all sites, which are possibly contaminated (sites that possibly pose a hazard to human beings and the environment.).

The first minimum data set includes: the identification and localisation of the site, indication of possible contamination by determining the type of industry, the expected contaminants, the operation period, the number of employees, etc, and the characterisation of the present use of the site. No technical investigations are carried out at this level.

Subsequently a 'preliminary classification' (Vorklassifizierung) is made, revealing whether there is a necessity to conduct a site-specific historical investigation.

Site-specific investigations are carried out according to the priority of urgency; the data collection is based on available data.

Preliminary investigation; this step includes a preliminary technical investigation. Sites are treated in order of urgency according to the results of the site-specific historical investigation.

Main Site investigation; the need for remediation and the implementation of safety measures are assessed within this step.

Niedersachsen
Niedersachsen has published

- a guideline concerning abandoned landfill sites including methods for site-identification and investigation [124].

A guideline dealing with abandoned potentially hazardous sites will be published during 1997. The programme for the identification and investigation of contaminated sites follows the idea that a certain central management combined with a scientific technical advice service is necessary to achieve a homogeneous treatment of abandoned sites. This scientific advice is carried out by a regional assessment committee, which represents the regional authorities responsible for water and waste issues. In the following the organisation of the investigation of abandoned waste sites is described. The procedures regarding abandoned industrial sites have not been finalised yet.

Preliminary Survey; identification of potentially contaminated sites. Data are collected by the federal authorities for ecology and soil research in the so-called federal working group of contaminated sites (LAA = Landesarbeitsgruppe Altlasten). At this step existing information from different archives, e.g., descriptions of the site, and its operation, photos, maps and general knowledge of geology etc. at the site and the surroundings are collected.

A preliminary assessment (Erstbewertung) of the data is carried out by the LLA with assistance from the regional assessment committee, which proposes the need for action. Dependent on the result of the assessment the site is either included in a regional 'waiting list' or in a regional 'priority list'.

Preliminary Investigation; at this level technical investigations are carried out and more detailed historical information is included, e.g. geophysical investigations, dwellings and analysis of the samples and assessment of aerial photos.

On the basis of the investigations a risk assessment is carried out, and the regional assessment committee assesses the need for further action. Possible decisions are (1) no need for further action unless alarming news emerges, (2) need for control, or (3) detailed investigation is needed.

Main site investigation; results of the detailed investigation are supposed to lead to one of the following decisions (1) remediation necessary, (2) additional investigation necessary, and (3) control measures to be implemented.

Lower Saxony
The following relevant documents have been published:

- a guideline on site identification, step by step investigation and risk assessment of abandoned land fills;
- a review of scientific and technical methods and approaches for site investigation. Furthermore two special volumes concerning geological investigations, steady state groundwater flows and transient contaminant transport modelling;
- a guide on how to identify abandoned industrial sites including instructions on database software;
- a final report on risk assessment results concerning former armament production sites and other abandoned military sites. The report also mentions unpublished but available specialised basic studies;
- further information via internet. Http://www.nlfb.de/n4hydro/altf00.htm.

A preliminary assessment was carried out with the assistance of the regional assessment committees. As a result of the administration reform the assessment committees do not exist any longer.

1.6.6. Funding and liability

The Federal States apply the polluter-pays-principle, wherever the polluter can be identified. If the polluter is insolvent or funding of the clean-up would make him go bankrupt, special support may be available in some Federal States.

Special liability regulations in the new federal states

1990 Environment Act: Liability Exemption for Environmental Damage
The Liability Exemption regulates liability of real-estate owners concerning environmental damage due to former activities on land properties. The law was enforced in the interim period between the breakdown of the GDR and the adhesion to the Federal Republic of Germany and maintained after the unification in order to support economic prosperity. The crucial date is 1 July 1990. Real estate owners can hence file an application for liability exemption in case the contamination was caused before this date. If the application meets the requirements, the public authorities cover site investigations and necessary clean-up costs.

Orphan sites
The Federal states in general are liable for the clean-up of orphan sites. In the new Federal States a lot of sites are handled like orphan sites due to the Liability Exemption regulation.

Public funding
Some Federal States have established special funds or tax systems mainly in order to finance orphan sites, insolvent polluters or sites which belong to public authorities. In 1998 it was realised that the existing tax systems were not in line with the constitution and were hence abandoned.

Baden Württemberg
In 1987 the Federal Government and the local authorities have established a joint fund in order to support investigations and remedial action at public sites and at orphan sites. Between 1988 and 1996 total expenditures were about 600 million DM (300 MEURO), of which 61 million (30,5 MEURO) were spent in 1996 [115].

Up to 1998 a waste tax was used as a contaminated sites funding tool, which has recently been declared as not being conform to the constitution. New support systems are under discussion.

Bavaria
The Society for the Clean-Up of Contaminated Sites in Bavaria was founded in 1989 in order to support clean-ups at orphan sites. The annual budget of the society amounts to some 6 million DM (3 MEURO) and will be doubled in 1998 on. The fund is dedicated to industrial orphan sites [84].

The State Ministry for State Development and Environmental Affairs has recently set up a 100 million DM fund (50 MEURO) for contaminated sites, which is financed through revenues from the state's privatisation programme. Low-interest loans have been available from mid-1997 to private companies which cannot fully cover remediation costs [113].

Berlin
For the years 1995 and 1996 annual budgets for public funding were previewed with 70 million DM (35 MEURO) for the years 1995 and 1996.

Public funding is available for public sites, orphan sites and most sites of the former GDR.

Brandenburg
From 1992 to 1996 the Ministry of the Environment allocated some 11.3 million DM to the clean-up of former military production sites, being approximately 2,3 million DM on an annual basis [88].

'Orphan sites': on average 3,5 MDM/per year were provided from the Federal budget.

Bremen
Bremen has a waste tax; revenues from this tax are to some extent used to support clean-up measures. Between 1992 and 1995 total clean-up expenditures amounted to 61,4 million DM (30,7 MEURO). Public funding derived from different sources being the waste tax, the land development programme, and the budget of the environment department, their shares amounted to 10%, 2 %and 15 %respectively.

In 1998 the existing funding system based on a waste tax was declared as being not in conformity with the constitution. New support systems are under discussion. For the period 1994 – 2004 Bremen is provided with a remediation budget of over 200 million DM (100 MEURO) of the land development programme.

Hamburg
Hamburg has no special arrangements as regards public funding, public expenditures were though considerably high. In the period of 1993 to 1995 expenditures from the public budget amounted some 177 million DM (88,5 MEURO), spent exclusively on sites investigations and remediation measures. The remediation of the waste site Georgswerder consumed almost 40 %of this amount. For the years to come annual budgets are calculated with 55 to 60 million Dm (27,5 to 30 MEURO) [129].

Hesse
Based on a Funding Regulation the State Government supports local authorities, funding rates range between 70 and 90%. Between 1991 and 1995 expenditures ranged between 14 and 28 million DM (7 and 14 MEURO). The funding is exclusively dedicated to public property and orphan sites [43].

Industrial sites, where the polluter cannot be held liable are financed by the Hesse Industrial Waste Society, funded by the federal budget and to some extent from the revenues a tax on hazardous wastes. Between 1991 and 1995 annual expenditures ranged between 11,21 and 44,5 million DM (5,6 and 22,2 MEURO) [122].

Annual expenditures on military production sites ranged between 17,6 and 36,8 million DM (8,8 and 18,4 MEURO) for the same period.

Lower Saxony
Public expenditures are covered by a levy on water exploitation [117]. Annual expenditures and budgets have not been published so far.

Mecklenburg-Western Pomerania
Up to now annual budgets and expenditures have not been published. In 1996 some 35 million DM (17,5 MEURO) were planned to be spent on urgent measures concerning four major cases, according to the Federal Environment Agency [122].

Northrhine-Westphalia
The country has a variety of funding systems [114]:
1) The State Government supports local authorities; an average funding rates range between 40 and 50 %;
2) the Northrhine-Westphalia property fund supports land development project;
3) the Waste and Contaminated Sites Society to some extent takes over the clean-up duties of the local authorities.

In 1998 the existing funding system based on a waste tax was declared as being not in conformity with the constitution. New support systems are under discussion.

Rhineland-Palatinate
From 1989 to 1993 Rhineland-Palatinate disposed over some 30 million DM (15 MEURO). In order to finance the clean-up of urgent cases, only former hazardous waste dumps where a liable polluter was not at hand. The budget was based on an agreement between the industry and public authorities and was not prolonged after 1993. For 1995 annual expenditures for soil remediation were estimated to amount 11 million DM [122]. In 1998 the agreement between the industry and public authority was renewed. The new budget amounts to 3,5 million DM (1,7 MEURO) per year for a 10 year period.

Saarland
Saarland neither disposes of a special fund nor has a waste tax. Annual budgets and public expenditures have not been published up to now.

Saxony-Anhalt
The remediation of seven large-scale sites was estimated to need 2 to 2,6 billion DM (1 to 1,3 billion EURO) in the years to come. Expenditures from recent years have not been published.

Saxony
Based on the liability exemption regulations annual expenditures on clean-up measures amounted 48,7 million DM (23 MEURO) in 1997. Additionally some 55 million DM (27,5 MEURO) were spent on large-scale projects. In 1997 15,7 million DM for remediation were spent by the Saxony Funding system.

Schleswig Holstein
In 1998 the funding system based on waste tax was declared as being not in conformity with the constitution. New support systems are under discussion.

Thuringia
19,5 million EURO from KONVER, EU programme to support the conversion of abandoned military sites.

Based on the funding system for remediation of contaminated sites 80 projects were managed with a total budget of 24 million DM since 1995. Part of them 32 remedial projects with a budget of 6,8 million DM were carried out in 1998.

1.6.7. Scale of the problem

The listed cost calculations regard costs and trends at the point in time they where generated. Many figures are probably out of date, however they represent a first step towards quantification of the scale of the problem. In 1993 the scale of the problem has been calculated for the old Federal States. It was estimated that some 23 600 sites were in need of further action and that the required budgets would range from 184 to 925 billion DM (92 to 462 billion EURO) depending on the applied remediation technology [245].

Baden-Württemberg
In 1992 the Ministry of the Environment estimated the total clean-up costs up to the year 2000 with 2 billion DM (1 billion EURO) up to the year 2000 [34].

Berlin
In October 1995 clean-up costs over a period of 10 to 15 years were estimated to range from 4 to 5 billion DM (2 – 2,5 billion EURO) [116], total future clean-up costs were calculated to amount to approximately 10 billion DM (5 billion EURO) [34].

Bavaria
The State Ministry for State Development and Environmental Affairs estimated total clean-up costs for Bavaria to amount to some 5 billion DM (2.5 billion EURO) [84].

Rheinland-Pfalz
In 1993 total clean-up costs for the entire Federal State were calculate to range between 2,5 to 5 billion DM (1,2 to 2,5 billion DM).

Saarland
In 1993 total clean-up costs were estimated to amount to 600 million DM (300 MEURO) not including mining sites and sites of the steel industry. In addition the costs for 2 major mining sites were calculated to need some 250 MDM (125 MEURO) in addition.

Saxony-Anhalt
Total clean-up costs were calculated for those sites, which are considered to be of major risk to human health and the environment. Each being a large scale clean-up. Calculated expenditures range from 1.6 to 2.6 billion DM (0.8 to 1.3 billion EURO) [122].

Schleswig-Holstein
For the years to come the local authorities claim some 200 million DM (100 MEURO) in order to cover the costs of 26 imminent sites [122].

1.6.8. References

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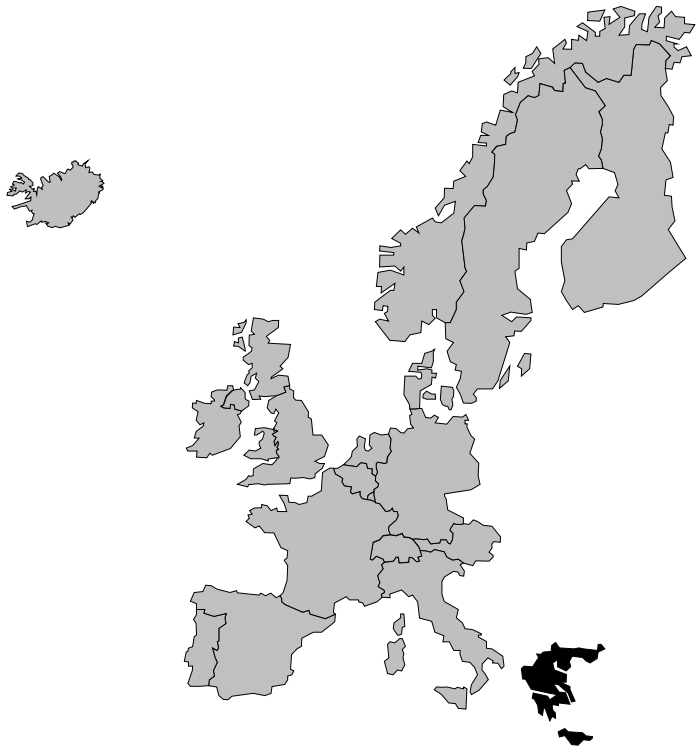
1.7. Greece

1.7.1. Country characteristics



The country character in Greece has changed since 1951 from mainly agricultural into more urban. The greater area of Athens, with a population of more than 3.5 million inhabitants, has one of the highest rates of population increase among the European countries. Not only Athens but also the surroundings of other Greek cities (i.e. Thessaloniki, Patras, Kavala) have experienced a significant population increase. The economic progress was accompanied by a rapid urban and industrial development, with resulting impact on the Greek environment [276].

Major environmental problems range from air pollution, to water pollution, solid wastes disposal, land degradation, forest fires, threat to biological diversity and natural reserves, and noise problems. Some of these are only local and of low intensity [277]. Future development and environmental protection represent a great conflict, and will hence be a major challenge for policy makers.

In recent years great efforts have been made to establish a comprehensive waste management policy. In line with this goal the remediation of some large-scale waste sites has been initiated.

The Republic of Greece consists of 13 regions divided into 51 administrative units; statistical data reveal (see Table 1.7-1, Table 1.7-2) that:

- the share of agricultural area is very high, being almost 20 %above the EU average;
- population density at an average level is very low, whereas the population increase between 1950 and 1990 was considerably higher than the EU average;
- the water use intensity is moderate.

Table 1.7-1: Some selected geographical statistics of Greece in comparison with total and average EU-values (WWTP= waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Greece	131 957	4.1	91 627	69.4	29 378	19.8	1 037	0.8	58 650	12	-
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.7-2: Some selected population statistics of Greece in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Greece	10 454	2.7	79.2	38.2	74.6	79.4
EU15 Total	368 641	100.0				
EU 15 Av.			145	26.0	73.0	79.0

1.7.2. Legal background

Greece has no specific clean-up legislation. Contaminated sites are addressed in the general environmental protection legislation, and in waste legislation.

Law 1650/1986 Protection of the Environment
A frame-law, covering all environmental fields and aspects. Specific provisions for soil protection from the disposal of municipal and industrial wastes are mentioned.

Law 69728/1996 Waste Management Act
The Act defines that local authorities are responsible to make waste management plans. Waste management and waste disposal have to be performed in such a way that any environmental pollution risk (in soil, waster, and air), arising from these activities, be prevented or limited [278].

Law 19396/1997 Hazardous Waste Management Act
defines hazardous wastes and refers, among others, to the duties of the producer and the holders of hazardous wastes [278].

Responsible bodies
The Solid Waste Division of the Ministry of Environment, Physical Planning and Public Works (YPEHODE) is responsible for overseeing the management of contaminated land in Greece. With respect to municipal waste sites the obligation rests with the local authorities, as laid down in the Waste management Act [278].

Definitions
There is no specific definition for contaminated sites.

1.7.3. Registers and inventories

Up to now there are no registers on contaminated sites, neither on a national basis nor at a regional level. Site investigations are usually isolated cases.

1.7.4. Characterised sites

Results from a national survey of 1988 on municipal waste disposal sites revealed that about 3 500 out of 5 000 facilities were operating without any environmental protection measures. Research carried out by Universities and Research Institutes has identified a number of industrially contaminated sites. The relevant projects involve collection of historical data relating to a site, geological and hydrogeological data, chemical and physical measurements of soils or liquids (surface or groundwater, leachates etc).

Contaminated sites are more related to improper dumping of household and industrial wastes, to mining areas and tailing ponds and to petroleum refining and storage sites.

1.7.5. Funding and liability

Article 29 of the Law on Protection of the Environment refers to the polluter-pays-principle [3].

Most emphasis is put on the remediation of large-scale waste sites in the area of Athens, Saloniki, Sakynthos and Heraklion [208], [207]. Generally remediation projects are financed with grants from the 2nd Community Support Framework (projects included in the Operational Environmental programme of Greece), through the Cohesion fund and, using national resources exclusively, through the 'Special Fund for the Implementation of Structural and Urban Plans'. The total budget of the current projects amounts to 14 billion Drs.

The Greek government disposes over an environmental fund that retrieves money from fines for violating environmental law.

1.7.6. Scale of the problem

Up to now no systematic efforts have been undertaken to quantify the problems posed by contaminated sites. However, given the fact that Greece is less industrialised than most Western European countries it can be expected that the scale of the problem is also less serious.

1.7.7. References

Exchange rates: 1,000 Dr (Greek Drachmae) = 3.0 EURO (as of November 1999).

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1.8. Ireland

1.8.1. Country characteristics

Ireland's relatively late arrival into the industrial age means that contaminated land problems in Ireland are significantly smaller than those of most other European Countries. However, in 1992 the Environmental Protection Agency Act was passed and the Irish Environmental Protection Agency (EPA) was established to improve environmental protection and pollution control in Ireland. Under this Act EPA has important statutory duties and powers in relation to integrated pollution control (IPC) licensing of major industries. New activities applying for an IPC licence or licensed activities are now required to identify, assess and, where necessary, remediate contaminated soil and/or groundwater.

More recently emphasis has been put on establishing and implementing a comprehensive framework for waste management which includes addressing the management and remediation of sites used for the disposal and recovery of waste. In July 1996 the Waste Management Act came into force conferring a wide range of statutory duties and powers to EPA and Local Government providing for the prevention, management and control of waste.

The Republic of Ireland is composed of 26 counties covering 4 provinces. Statistical data (Table 1.8-1 and Table 1.8-2) reveal that:

- the intensity of exploitation of renewable water-resources is very low;
- the population increase between 1950 and 1990 was remarkably low compared to the EU average;
- the population density is very low, and
- Ireland has a very high proportion of agricultural land within the EU Member States.

Table 1.8-1: Some selected geographical statistics of Ireland in comparison with total and average EU-values (WWTP = waste water treatment plant) [36], [282], [283]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Ireland	70 282	2.2	47 862	68.1	5 622	8.0	7 000	9.96	50 000	2	68
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.8-2: Some selected population statistics of Ireland in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Ireland	3 571	1.0	50	18.0	72.0	77.7
EU15 Total	368 641					
EU15 Av.			145	26.0	73	79

1.8.2. Legal background

Ireland lacks specific contaminated land legislation. However, existing legislation provides considerable powers for dealing with contaminated land. Existing legislation of particular importance includes [90]:

The Waste Management Act, 1996;
the Environmental Protection Agency Act, 1992, and
the Local Government (Water Pollution) Acts, 1977-1990.

Waste Management Act, 1996
The Waste Management Act confers powers on both the EPA and Local Government to deal with contaminated land arising as a result of waste disposal and recovery activities. With regard to waste management the EPA is responsible for amongst other things the licensing of waste disposal and recovery activities and the preparation of a national hazardous waste management plan. The Agency cannot grant a waste licence if an activity contravenes any relevant standard for land or soil when operated in accordance with the licence conditions. Historical contamination and its remediation particularly at existing sites, is dealt with within the scope of a waste licence by specifying conditions attached to the waste licence.

EPA is currently preparing proposals for a National Hazardous Waste Management Plan and following a period of public consultation the plan will be adopted in early 1999. This plan will establish a framework for the identification of sites that have been used in the past for disposal of hazardous waste.

Local authorities are required under the Waste Management Act to prepare waste management plans for their functional areas, implement recommendations made under the National Hazardous Waste Management Plan and identify, remediate or cause to remediate where necessary, sites where waste disposal and recovery activities have occurred.

The Environmental Protection Agency Act, 1992 [280]
EPA has a wide range of statutory duties and powers in relation to the licensing and regulation of large industrial and other processes. These activities are licensed on the basis of integrated pollution control (IPC) and the application of best available technology not entailing excessive cost (BATNEEC). As part of this licensing process details of emissions made to ground and an assessment of their impacts is required. Details on all known historical pollution incidents which have occurred on-sites must be provided along with any proposals for remediation.

Local Government (Water Pollution) Acts 1977-1990 [281], [282]
These Acts deal specifically with water, however, contaminated soils, which have the potential to pollute surface water and/or groundwater, can be controlled under these Acts and associated regulations. Powers are available to both the local authorities and EPA under this legislation.

Responsible bodies

The Department of the Environment and Local Government
is responsible for policy development and legislation in relation to environmental protection. EPA and local authorities are generally responsible for the implementation of legislation arising from government policy.

The Environmental Protection Agency
was established in July 1993 and is responsible for the licensing and regulations of large industrial processes, the licensing of waste recovery and disposal activities, the monitoring of environmental quality and advising and assisting public authorities in respect of their environmental protection functions.

Local authorities
are primarily responsible for pollution control from industrial activities not subject to the Agency's integrated pollution control licensing system and for the preparation of waste management plans within their functional areas. As part of this process, local authorities must identify sites where waste disposal or recovery activities have occurred, undertake a risk assessment of the sites and carry out or cause to carry out remediation of these sites where appropriate. They must also adopt and implement measures specified in the National Hazardous Waste Management Plan in relation to the management of hazardous waste within their functional areas.

Definitions
A national definition for contaminated sites or land does not exist.

1.8.3. Registers and inventories

To date no specific national survey has been carried out to identify and register contaminated sites in Ireland. However under EPA Act, 1992 and the Waste Management Act, 1996 the identification of contaminated industrial and waste disposal or recovery sites, which fall under the licensing system, is occurring. In 1996, EPA compiled and published a 'National Waste Database Report, 1995' which provides an inventory of disposal and recovery facilities. This report will be updated as required and will provide information on the number of potentially contaminated waste disposal and/or recovery sites [94].

It has been proposed to compile a register on historical land uses, putting emphasis to those activities which are known to result in contamination problems in order to better manage land development, to aid potential land buyers and to identify sites where risk assessment may be required in order to carry out appropriate remedial measures taking into account fitness for use. [91].

1.8.4. Characterised sites

Activities which give rise to particular concern in an Irish context are [93]:
- old gas work sites
- petroleum storage sites
- landfill sites
- mining sites and tailings ponds
- military sites
- dockyards
- chemical industries
- tanneries
- timber treatment facilities
- pesticide usage in agriculture and horticulture
- scrap yards and fragmentation plants
- railway lands especially depots

1.8.5. Site identification methodologies

At present no national guidance has been established of how to identify contaminated sites. Large complex industries and waste disposal or recovery activities are required under the licensing system operated by EPA to identify sites where contamination has occurred. Where contamination has been identified, a site-specific risk assessment will be required to identify the risk to humans and the environment. On completion of site investigations and assessment, appropriate actions can be taken to remediate the site taking into account proposal for future use. EPA is also required during the preparation of the National Hazardous Waste Management Plan to provide for the identification of waste disposal sites for hazardous waste, the assessment of the risk of environmental pollution and advise on appropriate remedial measures for such sites taking into account the cost effectiveness of available remediation techniques.

Local Authorities are also required under section 22 of the Waste Management Act to identify sites where waste disposal or recovery activities have occurred. Once identified the following steps are required to be taken [198]:

- the assessment of any risk of environmental pollution arising as a result of such activities;
- the taking or recommendation of measures in order to prevent or limit any such environmental pollution;
- the identification of necessary remediation measures in respect of such sites, and
- the recommendation of such measures to be taken to achieve such remediation, having regard to the cost-effectiveness of available remediation techniques.

1.8.6. Funding and liability

In general the polluter-pays-principle is applied. Concerning contaminated sites there are no special funding systems.

1.8.7. Scale of the problem

The extent of contamination is believed to be limited compared to other European countries. EPA has recently carried out a preliminary assessment of the number of activities that may give rise to contamination of soil and groundwater. For historical sites, the estimate is based on the number of sites at which activities likely to give rise to soil or groundwater contamination took place, such as old gasworks and mining sites. For existing activities, the estimate is based on existing knowledge of land contamination in industrial and waste management activities licensed or due to be licensed by EPA. It is estimated that there are currently between 1 900 to 2 300 industrial sites which may pose a risk to soil or groundwater in Ireland [93].

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1.9. Italy

1.9.1. Country characteristics

The clean-up of contaminated sites is a problem that started only recently to be assessed and tackled in Italy [11].

In 1989 the government made first attempts by starting a regional plan on contaminated sites and obliging the Italian regions to in-detail survey their territories. Major objective of the plan was to quantify the problems posed by contaminated sites. The regions complied hesitantly; it took almost 8 years until compiled data were suitable to be published.

In 1994 a National Environment Agency was founded (ANPA, Agenzia Nazionale per la Protezione dell'Ambiente) with the responsibility to proactively support environmental legislation.

The Republic of Italy consists of 20 regions, including 103 provinces; the Regional Governments operate with a certain degree of autonomy. The region of Toscana has passed its own clean-up law in 1993. Likewise Lombardia and Piedmont have elaborated regional systems to overcome the problems posed by contaminated sites. [8], [9], [12].

Legislation toward contaminated sites has been changed recently: by the beginning of 1997 a new law was promulgated regarding waste and contaminated sites assessment and management aspects, demanding the development of use-oriented limit values for soil, groundwater and surface waters and obliging local authorities to compile registers on contaminated sites.

Statistical data (Table 1.9-1, Table 1.9-2) in comparison with other EU Member States reveal that Italy

- has a very high use of renewable water resources;
- is very densely populated, though the increase in population between 1950 and 1990 was very moderate compared to the EU average value.

Table 1.9-1: Some selected geographical statistics of Italy in comparison with total and average EU-values; (WWTP = waste waster treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Italy	301 270	9.3	168 500	55.9	67 510	22.4	13 006	4.3	175 000	32	61
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.9-2: Some selected population statistics of Italy in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Italy	57 661	15.8	191	21.0	73.6	80.4
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.9.2. Legal background

In 1989 '*The Regional Contaminated Sites Plan*' (based on the law 441/87) was established.

The plan required regions to draw up a management plan, regarding four tiers:

- Tier A identification of potentially contaminated sites
- Tier B evaluation of the level of contamination by analysis
- Tier C definition of priority sites to be contaminated on a short-term basis
- Tier D definition of priority sites to be contaminated on a mid-term basis

Within eight years most of the Italian regions complied with 'The Regional Contaminated Sites Plan' and submitted their data. In February 1997 the results were summarised and presented at a conference by the Ministry of the Environment in Ravenna. It was concluded that the existing legislation was insufficient, and that there was a great need to manage the problems posed by contaminated sites more efficiently in the future.

In February 1997 a *new waste regulation* was promulgated [60]
Article 17 is dedicated to contaminated sites. The major objectives are:

- the definition of use dependant limit values for soil, surface water and groundwater;
- the definition of site assessment and sample analysis procedures;
- the definition of clean-up, safety, and environmental restoration criteria;
- site polluter obligations;
- shared liability in case of unknown polluter (community, region);
- the necessity to compile a register of contaminated and potentially contaminated sites;
- the implementation of legal consequences by non-compliance.

Decree 471/99 issued in December 1999 has regulated these technical issues. In this piece of legislation limit values for soil (two land uses) and groundwater concentrations for roughly 100 substances are defined. Procedures for assessment and remediation project design and approval protocols by local authorities, together with monitoring tasks, are established [272].

Different remediation solutions are outlined:
- clean-up,
- clean-up with safety measures,
- emergency and permanent safety actions.

Clean-up with safety measures is envisaged for those contaminated sites where limit values cannot be reached according to best available technologies at affordable costs. Residual concentrations, different from limit values, can be justified on the basis of a site-specific risk assessment.

Previously law 426/98 of December 1998 listed a number of contaminated 'sites of national interest', deserving particular attention, responsibility and funding from national government authorities [273].

Responsible bodies
Ministry of the Environment
The 'Ministero dell'Ambiente' publishes environmental policy, outlines general trends, and coordinates regional action at a national level.

Environment Agency
In 1994 a national environment agency, ANPA (Agenzia Nazionale per la Protezione dell'Ambiente), was approved by the Italian government. One of ANPA's main functions is to make the implementation of Italy's environmental policy less centralised. The law foresees that Italy's regions set up local agencies to work alongside the ANPA. To date (January 1999) 14 Regional Agencies (ARPAs) and 2 Provincial Agencies (APPAs) have been established [58]. Major responsibilities are above all:

- to promote environment legislation;
- to establish technical standards;
- to collect environmental impact data nation-wide;
- to promote research on pollution;
- to provide central and regional administrations with advice on environmental issues.

ANPA, together with the relevant regional environment agency (ARPAs) and other national competent institutions, is consulted by the Ministry for the Environment for approving assessment and remediation projects on the sites on national interest [272, 273].

Regional Governments
The 'Assessorati all'Ambiente' (regional environment departments) are responsible for the development and the implementation of the environmental policy at the regional level. Regional soil remediation and reclamation directives are most frequently included within regional waste policies on waste disposal and groundwater [48], [59].

Regions are responsible for updating the census of potentially contaminated sites, and compiling the inventory of contaminated sites, which will be completed, according to Decree 471/99, within December 2000. Regions provide planning and priority setting for actions on contaminated sites.

Together with individual municipalities, the regions authorize characterization and remediation projects on contaminated sites [272].

Definitions
Decree 471/99 defines a site polluted where contamination levels or chemical, physical, biological degradation of soil, ground or surface water determines hazards to public health, natural or built environment. For legal purposes a site is defined as polluted when even a single substance in soil or water, exceeds concentration limits values established in the same decree.

Clean up with safety measures is defined as the different actions needed to reduce site contamination to concentration levels exceeding acceptable legal limits when these cannot be reached, according EU principles, by best available technologies at affordable costs. In these cases reuse of the site implies safety measures, monitoring, control and use limitations [272].

1.9.3. Registers and inventories

Results from a preliminary national survey have recently been summarised and published. [148] The submitted data of 11 regions have been completely approved by the Ministry of the Environment.

Table 1.9-3: Regional surveys on contaminated sites provided by the Italian regions; source [148]

	Surveys on contaminated sites		
Region	Level of completion	Approved on a regional basis	Approved by the ministry
Abruzzo	Completed	Yes	Yes
Basilicata	Completed	Yes	Yes
Calabria	Not provided		
Campania	Not provided		
Emilia Romagna	Completed	Yes	Yes
Friuli V.G.	Completed	Yes	Yes
Lazio	Not provided		
Liguria	Completed	Yes	Yes
Lombardia	Completed	Yes	Yes
Marche	Completed		
Molise	Completed	Yes	Yes
Piemonte	Completed	Yes	Yes
Puglia	Completed	Yes	
Sardegna	Completed		Yes
Sicilia	Completed		
Toscana	Completed	Yes	Yes
Trentino-Alto Adige: Bolzano Trento	 Completed Completed	 Yes Yes	Yes
Umbria	Completed	Yes	Yes
Valle d'Aosta	Not provided		
Veneto	Not provided		

1.9.4. Characterised sites

According to the provided regional plans, some 8 873 potentially contaminated sites were identified. It is noteworthy to mention that the total number of potentially contaminated sites is likely to exceed some 10 000. The regions which have not provided any data cover approximately one third of the Italian population. The results include waste sites and industrial sites, abandoned as well as still operating sites (Table 1.9-4).

Results from an earlier survey on landfills, carried out in 1992, mentioned that only 16 %of 340 investigated landfills complied with actual requirements. [10]

Table 1.9-4: Number of potentially contaminated sites per region according to the regional surveys; source [148]

Region	Number of potentially contaminated sites
Abruzzo	120
Basilicata	411
Calabria	Data not provided
Campania	Data not provided
Emilia Romagna	3 182
Friuli V.G.	151
Lazio	Data not provided
Liguria	85

Region	Number of potentially contaminated sites
Lombardia	2 120
Marche	210
Molise	30
Piemonte	311
Puglia	1 212
Sardegna	391
Sicilia	110
Toscana	428
Umbria	112
Valle d'Aosta	Data not provided
Veneto	Data not provided
Total	*8 873*

The regions defined priority sites according to tier C, and tier D of the national plan. Two priority categories were defined: remediation measures are necessary on a short-term basis and on a mid-term basis.

Priority class	Number of sites
On a short term basis	321
On a mid-term basis	930

In total 1 251 sites were reported to need clean-up. 68 %were reported to be waste sites and only 32 %to be industrial sites.

1.9.5. Site identification methodologies

The preliminary inventories submitted by the regions include abandoned and active waste disposal sites and industrial sites. Each region ranked the sites according to relative risk criteria. The ranking methods were not homogeneous, but generally quite similar. Regional directives and remediation plans are in some cases associated to technical guidelines that define clean-up objectives based on comparison to international standards and to local background data.

The recent waste and contaminated sites legislation appoints ANPA for the definition of a ranking criterion according to a comparative risk assessment approach.

Approaches to risk assessment
Technical approaches to Risk Assessment have been described in documents prepared by UNICHIM (1996) and ANPA (1997) [59]. [According to decree 471/99 comparative risk assessment criteria will be devised by the ANPA, to define priorities for actions on contaminated sites of regional inventories. According to Law 426/98 ANPA will also define relative risk criteria for priority actions on sites of national interest.

Site specific risk assessment, for clean up actions with safety measures, will be carried out according to internationally validated approaches [272].

The scientific approach to site specific risk assessment, according to ASTM RBCA standards and USEPA guidelines, has been described by ANPA (1997) on the basis of a project originally shared with the regional environment agencies. Elements of the approach have been recently implemented inside different software tools.

1.9.6. Funding and liability

The polluter-pays-principle is applied as far as possible. The new Waste Regulation defines the liability for those sites where a polluter cannot be identified. In those cases the Environment Agency, communities and regions are jointly held liable and are responsible for the implementation of appropriate safety measures. The regions have the freedom to establish appropriate funds with the purpose to finance clean-ups. [60]

1.9.7. Scale of the problem

Remediation costs were calculated for clean-up measures deemed necessary on a short-term basis and on a mid-term basis. The individual cost calculations provided by the regions are very heterogeneous and are hence only a first estimate of the future costs. The compiled calculations estimate costs on a short-term basis at approximately 340 MEURO (321 sites), and on a mid-term basis at more than 200 MEURO (939 sites). [148].

Table 1.9-5: Regional clean-up costs on a short-term basis and on a mid term basis, in million Lira and million EURO. Source [148]

	Short term basis			Mid-term basis		
	No. sites	ML	MEURO	No. sites	ML	MEURO
Abruzzo	4	12 586	7	8	12 678	7
Basilicata	23	22 728	12	72	1 296	1
Calabria			0			
Campania			0			
Emilia Romagna	66	85 360	44	91	67 160	35
Friuli V.G.	10	23 570	12	139	15 183	8
Lazio						
Liguria	5	50 354	26	7	2 795	1
Lombardia	25	98 705	51	70	288 600	150
Marche	15	81 166	42	131	1 135	1
Molise	12	20 185	10	18	7 596	4
Piemonte	26	124 443	65	266	5 238	3
Puglia	12	20 575	11	11	25 555	13
Sardegna	80	22 527	12			
Sicilia	4	14 604	8	9		
Toscana	37	65 962	34	105	3 150	2
Trentino-Alto Adige						
Umbria	2	13 243	7	3	622	
Valle d'Aosta						
Veneto						
Totals	***321***	***656 008***	***341***	***930***	***>400 000***	***>207***

1.9.8. References

Exchange rate: 1 000 L = 0.52 EURO; (as of November 1999).

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1.10. Luxembourg

1.10.1. Country characteristics

In recent years the problems posed by contaminated sites have gained more and more concern. In 1994, new waste management legislation was enforced, which also includes provisions for contaminated sites. According to the new regime a land register of contaminated sites shall be established within five years in order to draw up annual clean-up plans for urgent cases.

The regime of the new policy is underway and the register of contaminated sites will be established within 1997. Up to now site investigations and clean-ups have taken place wherever they deemed to be necessary.

In the past the economy has been dominated by the metal industry. In the near future some high furnaces will be shut down and as a consequence a redevelopment project for the affected mining areas will be initiated.

Contaminated sites of major concern are abandoned scrap yards and waste sites. Statistical data (Table 1.10-1, Table 1.10-2) reveal that Luxembourg:

- has world-wide one of the highest GDP(gross domestic product) per capita rates, and is hence one of the richest countries [107];
- has abundant renewable water resources .

Table 1.10-1: Some selected geographical statistics of Luxembourg in relation to average values of the EU Member States (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Luxembg	2 586	0.1	1 264	48.9	886	34.3	8	0.3	5 000	1	90
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.10-2: Some selected population statistics of Luxembourg related to average values of the EU Member States; source: [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Luxembourg	382	0.1	148	29.0	72.1	78.6
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79

1.10.2. Legal background

There is no specific legislation on contaminated sites. In June 1994 a General Waste Management Act was enforced which addresses waste sites and abandoned waste sites.

1994 Waste Management Act '*Loi du 17 juin 1994 relative à la prévention et à la gestion des déchets*', The law addresses the various aspects of waste management in general. Contaminated sites due to waste disposal are explicitly addressed in article 15 and 16. The following issues are regulated:

- the establishment of an inventory of waste sites *'cadastre des sites de décharge de déchets'* to be realised in a 5 year period;
- the remediation of those sites;
- public authorities have to cover the necessary clean-up costs, in case the polluter can not be detected, is insolvent or has no appropriate assurance at hand.

Responsible bodies
The Environment Agency (Administration de l'Environnement) is the national authority, being responsible for environmental concerns in general. The Waste Department (Division des Déchets) is a subdivision of the Environment Agency and is the body in charge of wastes and contaminated sites.

1.10.3. Registers and inventories

The Waste Management Act of 1994 requires operating and abandoned waste sites to be inventoried within 5 years. According to the Waste Department the inventory shall be set up within the year 1997, including priority lists and costs calculation of the most urgent sites.

1.10.4. Characterised sites

In 1995 a programme to identify abandoned waste sites was initiated. The number of potentially sites amounts up to 616. About one third has been investigated in more detail, and as a result 175 abandoned waste sites were defined. The investigations will continue in the years to come. Sites, which have been investigated in detail, are entered into a database within the Life Programme.

Table 1.10-3: Some concrete incidents of soil contamination in Luxembourg, source: [109], [110]

I = industrial sitea = abandonedr.c. = remediation completed
W = waste site, o = operatingr.p. remediation planed

site				type of contamination	location
I	a	Gas work		PAHs	Ettelbruck
I	a	Tear factory	r.c.	Tar layers	Gasperich
I	a	Derelict site	r.c.	Tar layers	Gasperich
I	a	Petrol stock		Leakages from subsoil tanks	Esch sûr Alzette
I	a	Scrap yard		PCB, heavy metals, hydrocarbons	Mensdorf
I	a	Scrap yard		Hydrocarbons and heavy metal found in the subsoil	Sandweiler
I	a	Scrap yard		PCBs and heavy metals found in the subsoil	Reckange
I	o	Industrial site		PCB contamination due to transformer reparations	Walferdange
I	o	Industrial site		Hydrocarbon contamination in the subsoil;	Windhof
W	a	Municipal waste site		Cadmium, traces of dioxin	Wiltz
W	a	Illegal deposit of used oils		Hydrocarbons and heavy metal found in the subsoil	Seilwescht
W	a	Waste site	r.p.		Ronnebierg

Clean-up costs of the site in Gasperich were about 810 million FLUX (approx. 20.2 MEURO).

1.10.5. Funding and liability

Major liability principles are laid down in the 1994 Waste Management Act [111].
The polluter-pays-principle is applied wherever the polluter is at hand (Article 15).
In case the polluter cannot be detected or is insolvent or not covered by appropriate financial assurance public authorities are held liable and have to bear the necessary costs (Article 16)

Public funding
There are no funds, which are exclusively dedicated to contaminated sites. Up to now public support is negotiated on a case-by-case basis. It is noteworthy to mention that the principle of retroactive liability is not fully applied. If the polluter can prove that his past activities were handled in full compliance with existing law he will have the opportunity to receive public funding.

1.10.6. Scale of the problem

Up to now no attempts to quantify the problems posed by contaminated sites have been undertaken. In the future results from the land register will be used to calculate clean-up costs of priority sites on an annual basis.

1.10.7. References

Exchange rates: 100 FLUX (Franc Luxembourgois) = 2.5 EURO (as of November 1999).

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1.11. The Netherlands

1.11.1. Country characteristics

The Netherlands has a long history of land appreciation. Problems raised by contaminated sites were realised early mainly due to the coincidence of various soil related problems such as very densely populated areas, shallow ground-water tables, high extent of groundwater exploitation, intensive agricultural and industrial use. Public concern was stimulated due to several incidents in the late 1970s, Lekkerkerk being the most prominent. Chemical waste was found in the subsoil of a new housing development.

The development of soil protection and remediation policy over the past decade has been rapid and has resulted in a number of acts along with related rules and regulations. As early as 1976 the Dutch government decided to include soil protection in the national environment policy.

Concerning technical guidance on soil pollution the widely known Dutch list has been developed in the 1980s and has been followed by many European countries. The Dutch list has been completely reviewed in 1994 along with the amendment of the *Soil Protection Act*. Up to now the problems posed by contaminated sites have several times been quantified and up-dated [1], [2], [206].

Apart from national legislation voluntary agreements between industry and public authorities came into being, the covenant system being the most remarkable (see funding)

The Kingdom of the Netherlands consists of 12 Provinces, each having a high degree of autonomy, statistical data (Table 1.11-1, Table 1.11-2) reveal that the Netherlands have

- experienced a remarkable increase in population between 1950 and 1990, being almost twice as much as the EU average value;
- the highest population density among the European Member States;
- a high share of agricultural area along with about 600 000 registered industrial activities.

Table 1.11-1: Some selected geographical statistics of The Netherlands in comparison with total and average EU-values; (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Netherlds	37 330	1.2	20 060	53.7	3 000	8.0	3 550	9.5	91 000	16	93
EU-Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
Av.-Val.				50.5		28.0		7.1		18	75

Table 1.11-2: Some selected population statistics of The Netherlands in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Netherlands	14 952	4.1	401	48.0	73.9	80.3
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.11.2. Legal background

A number of acts, circulars and General Administrative Orders have been enforced, issued and amended in recent years. The overriding legislation is the *Soil Protection Act*, which was first enforced as an Interim Act in 1983 and amended in 1987 and in 1994 respectively. It regulates the prevention of new pollution and liability concerning costs raised by contaminated sites. In 1983 the Ministry of Housing, Spatial Planning and Environment (VROM[2]) issued a guidance document on soil remediation, which is supposed to support the objectives of the Soil Clean-up Interim Act [2], [79].

Milestones of Dutch legislation regarding contaminated sites:

1989 *National Environmental Policy Plan*
defines the following goals:

- environmental policy has to be quality, effect and cause oriented
- the objectives of the environmental policy have to be coordinated
- public awareness shall be stimulated
- the principle of sustainable development shall be regarded
- the multi-functionality of soil shall be conserved by
  a) restoration means and
  b) pollution prevention
- the described goals shall be achieved within one generation

1994 Amended *Soil Protection Act*
regulates soil pollution deriving from the following sources:

- application of fertilisers: cattle manure, organic fertiliser
- disposal of solid and liquid waste
- storage of petrochemicals in underground tanks
- seepage of surface waters
- the reuse of cleaned soil as building material (see funding/SCG)
- lays down the role of the Soil Clean-up Centre (SCG)

As a result of the 1994 Amended *Soil Protection Act* a variety of Circulars and General Administrative Orders were and are still elaborated. Among them a circular which almost relaces the 1983 Soil-Clean-up Guidance document.

1995 *Regulation on the Disposal of Contaminated Soils*
the regulation requires a certificate, to be issued by the Soil Clean-up Centre (SCG), in order to facilitate disposing of contaminated soils.

[2] VROM = Ministerie Volkshiusvesting, Ruimtelijke Ordening en Milieubeheer

Responsible bodies
Regulatory Responsibilities are divided between the Central Government, the 12 Provinces (+ 'larger cities') and the local authorities. In recent years some of the responsibilities to conduct the necessary clean-ups have been transferred to the Provinces and Local Authorities.

The Central Government
The central government is now responsible for the legal framework and its supervision, whereas provinces and local authorities in detail regulate soil and groundwater protection.

Provinces
are obliged to :
- compile inventories using data retrieved from the local authorities;
- have to approve changes in land use according to the Spatial Planning Act;
- are obliged to annually draw up an investigation and remediation programme covering the following five years. The programmes have to include priorities and anticipated clean-up details.

Local Authorities
report to the provincial governments about historical investigations, site investigations, incidents, clean-ups, etc.

Definitions
A **contaminated site** is defined by the 1994 Amended *Soil Protection Act* as a site where the soil is, or threatens to be, contaminated in relation to territories that, on account of said contamination, the cause or the consequences thereof, are connected with each other in a technical, organisational or planning sense.

A **seriously contaminated site** is defined as a site where the soil is or threatens to be contaminated so that the functional properties which the soil has for man, flora and fauna have been, or are in danger of being seriously reduced.

1.11.3. Registers and inventories

Registers are compiled by two major groups, the provincial governments and by industry along with the covenant agreement. The central government does not dispose over a unique national inventory or priority list, for both aspects provinces have their own lists [202].

Provincial Governments
Data are compiled since 1982 and are retrieved from local authorities and are updated on an annual basis. Major data sources are local archives, data from site investigations due to property transactions and permit applications for emissions and effluents.

BSB[3] inventory
Along with the BSB covenant (see funding) industry compiles data on **operating industrial sites**. Potentially contaminated sites are identified according to business activities. Within the first years of the BSB covenant an action programme was set up, with the objective to compile an inventory of potentially contaminated sites. In the starting phase it was estimated that more than 100 000 sites will need to be surveyed [2].

[3] BSB: Bodemsanering van in gebruik zijnde bedrijfsterreinen, clean-up of present industrial sites

SUBAT[4] inventory
Since the beginning of the 1990s the petrol industry compiles data on out-of-service petrol stations. 6 200 petrol-stations are involved [2].

SCG[5] inventory
SCG maintains a register of the contaminated soils reported to it and coordinates the data with the provincial governments. SCG also informs the Ministry of Housing, Spatial Planning and the Environment (VROM) of the contents of the register in aggregate form [2].

Prioritisation
On an annual basis Provinces submit priority lists to the central government. The order of priority assigned to a site specifies who will have to clean-up his site and when. On the basis of the priority lists, clean-up costs are calculated and the shares of the national budget are allocated in proportion to the funds required.

1.11.4. Characterised sites

In 1990 a preliminary report on the number of potentially contaminated sites was presented to the Parliament, concluding that some 110 000 sites were potentially to be contaminated. The sites were assigned to the corresponding polluting activities indicated in Table 1.11-3.

Table 1.11-3: Number of potentially contaminated sites according to polluting activities; [57], [146]

Activity / Type of Site	No. of sites
Abandoned gasworks	234
Municipal waste disposals	3 300
Abandoned industrial sites	80 000
Operating industrial sites	25 000
Out-of-service petrol stations	6 200
Military sites	2 500
Others (waste disposals, diffuse sources, leakage in sewing systems and underground tanks	
Total (estimated)	*110 000 – 120 000*

1.11.5. Site identification methodologies

The Dutch approach of site identification and investigation consists of the following major parts:

- the **preliminary survey**; has the purpose to substantiate the suspect of serious contamination. In case a sound suspicion already exists this part is not carried out and the preliminary investigation will be the first step;
- the **preliminary investigation** has the goal to prove contamination;
- the **main site investigation** has the objective to assess the urgency of remediation and the type of remediation.

[4] SUBAT = Stichting Uitfoering Bodemsanering Amovering Tankstations, Voluntary fund created by the petrol industry for the clean-up of out-of-service stations.
[5] SCG = Service Centrum Grondreinigung, Soil Clean-up Service Centre

The approach is based on a classification of sites according to two different conditions:
1) a classification in one of the two groups
   - 'land soil' and
   - 'water soil', being soils over-layered with water sediments, and
2) a classification according to the distribution of the contamination
   - homogenous distributed contamination;
   - heterogeneous distributed contamination, where the location of the point source is known;
   - heterogeneous distributed contamination, where the location of the point source is unknown;
   - where there is no reason to believe that the site is contaminated.

Soil quality criteria are defined in the 1994 amended *Soil Protection Act*. There are three major soil quality objectives, of which each can be defined for the compartments soil, water and air [56]. The strategic goal of soil remediation in the Netherlands is to reach the target values. These values represent multifunctional soil quality [78].

Table 1.11-4: Environmental quality objectives used in the Netherlands; [56]

Quality Objective	Definition
Target values	indicate the level of a substance where risk for human beings, plants, animals and ecosystems is negligible. They represent a 'clean and multifunctional environment'
Limit values	can be formulated in case the present quality of a part of the environment does not meet the quality of the target values. They display the environmental quality that should be reached within a certain plan period. They impose an obligation to reach a certain result*
Intervention values	represent a level where action is needed because impermissible risks may occur. It depends on site-specific factors if action should take place immediately.

* sometimes it is not possible to give an indication of the result that can be reached. In such cases guide values instead of limit values can be used. Guide values impose an obligation to make a particular effort.

Preliminary survey
The preliminary survey [172] has the goal to localise the source of contamination and to quantify the affected area. This step includes the collection of information on the prior and the present land use. The minimum data set for land soil, and adapted to the conditions for water soil are as following:

- localisation of the site in question and the relevant surroundings;
- identification of possible wells, disposals, storage sites, tap systems, leakages (e.g. underground tanks), end of transport systems;
- information on potentially polluting activities including production, handling, storage and where these possibly have taken place;
- data on used cables and wires;
- information on the activities of the adjacent sites, e.g. investigation of contamination that has taken place in the neighbourhood; prior users of the site, etc.;
- information on the soil and the hydrogeological situation, including an assessment of the geology, the level of the groundwater table, the expected horizontal and vertical direction of the water flow; localisation of rivers and other surface water (also if they are hidden in pipes); usability of groundwater wells and abstractions; existence of brackish water and salt water; results from prior investigations of the site or the neighbour area.

The preliminary survey includes sampling and analysis of soil and water samples. The number of samples is dependent of the expected spatial distribution of the contamination. Based on a visit of the site and on the collected information a hypothesis regarding the distribution of the contamination is set up. If it is demonstrated that the concentrations are higher than

$$\frac{I+T}{2}$$ I = intervention value
T = target value

for more than one or more substances it is assumed that there may be a serious soil contamination and further investigations will be undertaken.

Preliminary investigation
At this level of contamination the spacious distribution of the contamination is further investigated. The number of samples taken is substantially higher compared to the preliminary survey.

If it is demonstrated that the concentrations are higher than (I+T)/2 for more than one of the substances the hypothesis of a serious contamination is confirmed. The site can still be included in the subsequent investigation when the concentrations are below (I+T)/2 if the concentrations of one or more substances are exceeding the target value (T), but there is no direct demand to proceed the investigation process.

Main site investigation
The detailed investigation is subdivided in two parts. Part one has the goal to more precisely investigate the concentration levels and distribution of contamination. Part two regards an assessment of possible distribution- and exposure possibilities [173].

The investigation of 'soil sites' will at this level include field observations, investigations of (hydro)geology, chemical and physical investigations of the soil samples. The 'historic transport' of the contamination will be evaluated (an evaluation of how the transport of the contaminants has taken place until today). If the area of the site exceeds 1 000 m^2 the investigation of the site will be divided in sub-areas.

On the basis of the results of part 1 of the extended investigations it is decided whether it is necessary to carry out part 2 of the detailed investigations.

The goal of part 2 is to in-detail assess the distribution of contamination and the possible exposure. The investigation includes the examination of receiving environments, e.g. indoor air, drinking water. The results obtained are used for a final assessment in order to define the urgency of remediation and the suitable technology.

1.11.6. Funding and liability

In principle the polluter-pays-principle is applied. In the case of insolvency of the persons responsible for the clean-up, public funding may be available, which represents an advance payment, which has to be recovered.

Orphan sites
Clean-up costs of orphan sites are covered by public funding.

SCG Soil Clean-up Centre
The Soil Clean-up Centre (SCG) was founded as a public company in 1989 and acts as an intermediary organisation for soil remediation requirements. The SCG was founded in order to have an unbiased organisation at hand and to achieve clean-up goals at reasonable costs. The SCG is a self-financing company, it charges a fee of 0.23 EURO (0.5 NLG) per tonne treated soil and risk premium of 1.8 EURO (3.8 NLG) respectively [2].

The SCG takes care of the following tasks:

flows of contaminated soils are registered
the feasibility of soil cleaning is assessed
decisions on the necessity of immediate soil clean-up are made
the reuse of recycled soil as building material is organised
certificates on soil characteristics and future use are issued

The BSB covenant

In 1991 the government and industry signed an agreement: industry agreed on carrying out clean-ups on its own and the government agreed on not intervening within a period of 25 years. The agreement includes some 120 000 industrial sites which need to be investigated, prioritised and if necessary cleaned up. Companies participate by subscribing to the covenant, those who do not subscribe are reported to the provincial governments and risk to be obliged to undertake site investigation measures at any time [2].

The SUBAT covenant

The SUBAT covenant is a voluntary agreement of the petrol industry. Major objective of the agreement is to fund remediation of out-of-service petrol stations. The remediation costs are covered by a fund which retrieves money from a fee included in the petrol price. In 1995 the fee was about 0.005 EURO (0.01 NLG) [2].

1.11.7. Scale of the problem

Efforts to estimate the scale of the problem posed by contaminated sites have been made several times. The most recent estimate refers to a presentation of the Minister of the Environment in May 1997. The scale of the problem was outlined as following: about 100 000 sites are suspected to be contaminated not including diffuse contamination and contaminated sediments in rivers and canals. Total remediation costs are roughly estimated to amount to 50 billion U$ (44billion EURO). The Minister referred to annual expenditure of about 0.5 billion U$ (400 MEURO) of which about 70 %are provided by the government [206].

In 1994 annual expenditures assigned to contaminated sites were about 680 MEURO, about equally divided between industry and public authorities (see Table 1.11-5). Expenditures on soil made up about 11 %of the national environment budget (see Table 1.11-6) [77].

Table 1.11-5: Dutch environmental protection expenditures on soil in 1993 and 1994 [77]

Sector	1993 MEURO	1994 MEURO
Central government	34.5	30.82
Provincial governments	152.72	198.26
Water boards	0	0
Municipal governments	69.46	80.96
Intermunicipal authorities*	3.22	4.6
Industry	245.18	277.84
Households	0	0
Transport services	49.22	86.94
Total	554.30	679.42

* Municipal environmental authorities comprising several small municipalities unable to sustain an individual authority

Table 1.11-6: Dutch environmental protection expenditures on water, air, waste, and soil in 1993 and 1994; [77]

	1993		1994	
	MEURO	%	MEURO	%
Water	1 660.6	29%	1 767.78	28
Air	851	15%	965.08	15
Soil	554.76	10%	679.42	11
Waste	1 631.62	29%	1 812.86	29
Misc.	934.26	17%	1 008.32	16
Total	5 632.24	100%	6 233.00	100

1.11.8. References

Exchange rates: 100 NLG (Dutch Guilders) = 45.4 EURO (as of November 1999).

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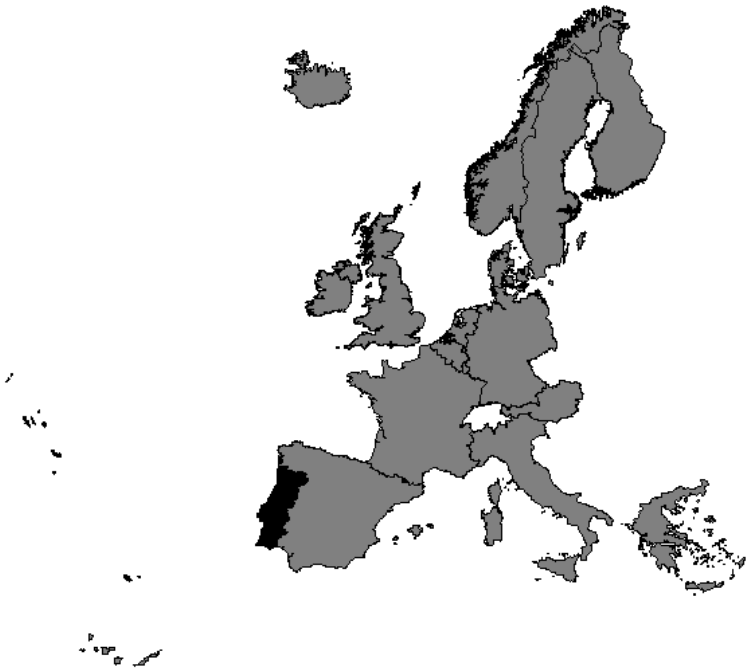
1.12. Portugal



1.12.1. Country characteristics

The development of a specific policy framework for contaminated sites is in the planning phase. In recent years most emphasis has been put on the development of a comprehensive waste management policy. In 1996 the Waste Institute (Instituto dos Resíduos) of the Ministry of the Environment was established. The Waste Insitute is responsible for the execution of national Waste Policy, its structure also includes a Soil Pollution Development Centre. It is planned to develop a contaminated soil policy, including new legislation, contaminated soil registers, and technical guidance on risk assessment.

For the time being contaminated sites are investigated on a case-by-case basis, major cases are the land development project of the Expo98 area and the remediation of a facility of the chemical industry in Estarreja, [209].

Compared to other countries in the EU and EFTA Portugal shows the lowest sectoral changes between 1984 and 1994 [210]. The Republic of Portugal consists in total of 18 mainland districts and 4 island districts, statistical data (see Table 1.12-1, Table 1.12-2) show that:

- the population increase between 1950 and 1990 was very and the population density is on average very low;
- the population share connected to waste water treatment is very low compared to the EU average;
- the water use intensity is very moderate in the context of the EU countries.

Table 1.12-1: Some selected geographical statistics of Portugal in comparison with total and average EU-values; (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Portugal	92 390	2.9	40 110	43.4	29 680	32.1	4 536	4.9	73 000	10	21
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.12-2: Some selected population statistics of Portugal in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Portugal	9 868	2.7	107	17.0	70.1	77.3
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.12.2. Legal background

There is no specific legislation on contaminated sites. At present national legislation on waste, water quality and environmental protection address the problems related to contaminated sites. In addition laws on environmental impact evaluation and land planning refer to soil contamination issues.

Framework Law on the Environment of April 7 1987 (Lei de Bases do Ambiente)
The law in general defines the basic orientation for the environmental policy, introducing

- the polluter-pays-principle;
- the obligation to all governmental departments to promote and control better life and environmental quality;
- for all citizens the right to a clean environment and the obligation to protect it, and
- the obligation that law-breakers have to remove infractions and restore the former situation.

Legislation on *Water Protection*
The Decree 70/90 of March 2nd 1990 lays down disciplinary rules for the management of hydrological resources and imposes penalties for uncontrolled water emissions.

The Decree 74/90 of March 7th 1990 gives authorities the power to control and prevent water pollution and sets standards for drinking water and other water uses.

Waste Legislation
The Decree 239/97 of September 9 1997 refers to a new waste regime, including a strategic plan for the management of municipal solid waste as well as industrial waste.

Responsible body
The authority in charge of contaminated land is the Waste Institute (Instituto dos Residuos), which works in cooperation with the Regional Environment Departments and, when necessary seeks advice from scientific institutes and universities.

Definitions
Portugal has no official definition for contaminated sites. The Waste Institute refers to *'Soil polluted due to added substances which on a short or on a long term basis cause negative effects, and pose a potential risk to humans and the environment.'* [242]

1.12.3. Registers and inventories

It is intended to develop a methodology for the registration of contaminated sites. With regard to industrial and urban waste sites information on preliminary identifications is available [242].

1.12.4. Characterised sites

In 1987 the Portuguese Directorate General conducted a survey on hazardous waste generation, treatment and disposal. Results revealed that only about 18 %of the generated hazardous waste was disposed or incinerated in an environmental sound way [212].

Subsequently, the need for a new regime to tackle the hazardous waste problem was recognised.

Portugal has recently published an action plan with the objective to apply safety measures for open dumpsites. Up to now some 300 uncontrolled open dumpsites have been identified. A monitoring system in order to control and classify these sites is in the implementation phase [242].

Contaminated sites are investigated as isolated cases; of major importance are the following:
- an oil refining facility at the Expo 98 area;
- a chemical facility in Estarreja.

1.12.5. Funding and liability

In line with the Framework Law on the Environment the polluter is held liable for the clean-up of soil contamination.

Portugal has no specific funds dedicated to remediation measures. Investigation of contaminated sites are funded by general environmental programmes.

1.12.6. Scale of the problem

In line with the initiation of new actions towards contaminated sites it is planned to estimate the remedial costs involved [209].

1.12.7. References

Exchange rates: 1 000 Esc (Portugese Escudos) = 5.0 EURO (as of November 1999).

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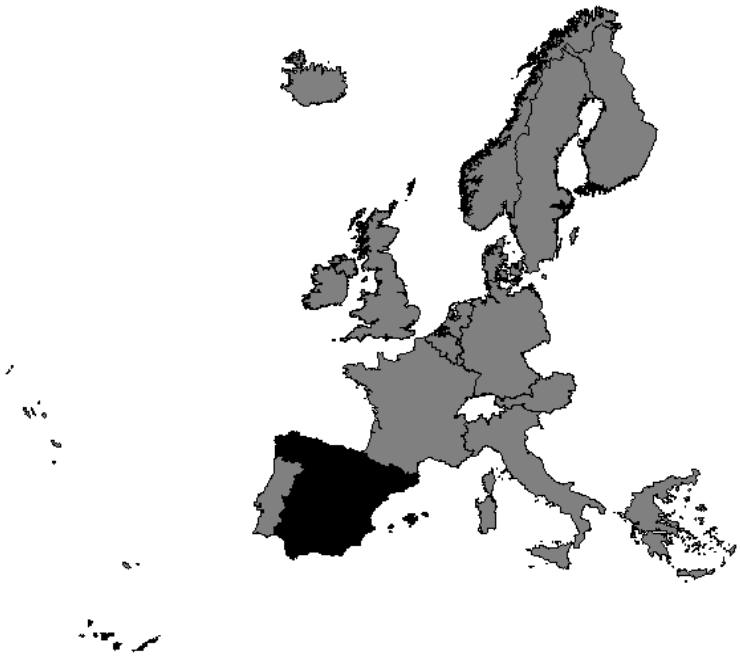
1.13. Spain



1.13.1. Country characteristics

Since 1990 Spain has experienced major changes as regards contaminated sites. Between 1990 and 1993 first attempts to quantify the number of potentially contaminated sites were undertaken, and a database on contaminated soils (Inventario de Suelos Contaminados; ISC) was established. In 1996, as a consequence, 394 priority sites were selected for immediate action. For the period 1996 to 2005 a remediation action plan was drawn up by the MOPTMA (Ministerio de Obras, Transportes y Medio Ambiente). These competencies were taken over by the current Ministry of the Environment (Ministerio de Medio Ambiente). Foreseen actions are the remediation of the selected priority sites, further up-date of the inventory of potentially contaminated sites, setting up basic methodological guidelines applicable for the whole country, further investigations, control and monitoring at the potentially contaminated sites and the allocation of the required funds.

The Kingdom of Spain consists of 17 autonomous regions (Comunidades Autónomas), which have their own local governments. The degree of autonomy and legislative power varies within the autonomous regions, but these regions have the same level of environmental competencies.

Statistical data reveal that (Table 1.13-1, Table 1.13-2):

- the share of agricultural area is much above average compared to other EU countries;
- likewise the water use intensity is considerably high, and that
- Spain has experienced a major population increase between 1950 and 1990 being about 50 %higher than the EU average value.

Table 1.13-1: Some selected geographical statistics of Spain in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Spain	504 780	15.6	304 720	60.4	158 070	31.3	35 111	7.0	117 000	32	53
EU15 Total	3 239 464	100.0	1 483 194	45.8	1 120 606	34.6	247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.13-2: Some selected population statistics of Spain in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Spain	38 959	10.7	77	39.0	73.4	80.5
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.13.2. Legal background

In the period 1990 to 1995 first action was taken by the Ministry, and a first National Action Plan was conducted with the following objectives.

1990 – 1995 National Plan for the Remediation of Contaminated Soils

- to identify polluted sites which were contaminated by industrial waste;
- to create a database;
- to develop a risk assessment methodology;
- to calculate the cost of the actions that must be carried out;
- to propose a programme of action at short, medium and long terms;
- to evaluate remediation costs;
- to consider a legal framework.

1995 – 2005 National Plan for the Remediation of Contaminated Soils

National policy concerning contaminated sites is defined in the *National Plan for the Remediation of Contaminated Soils* (El Plàn Nacional de Recuperaciòn de Suelos Contaminados, 1995 – 2005) which was approved in 1995 [68]. The plan is supposed to be realised between 1995 and 2005. The major objectives of the national plan are:

- the prevention of further contamination;
- to continue the identification of polluted sites;
- to carry out more investigations at potentially contaminated sites: on-another 1,650 sites;
- to remediate contaminated sites: clean-up of 274 priority sites;
- to develop clean-up technologies;
- to lay down specific national legislation and technical regulations.

In 1995 as a consequence the MOPTMA published the National Plan for the Remediation of Contaminated Soils (Plàn Nacional de Recuperaciòn de Suelos Contaminados). The plan initially foresaw the allocation of 805 MEURO for the clean-up and prevention of contaminated sites over eleven years.

Responsible bodies

- In July 1996 the **Ministry of the Environment** (Ministerio de Medio Ambiente) was founded, with the aim to centralise environmental functions, previously held by several other ministries. The Ministry of the Environment has taken over the environmental functions of the former Ministry of Public Works, Transport and the Environment (MOPTMA, Ministerio de Obras Publicas, Transportes y Medio Ambiente) and some responsibilities of the Ministry of Agriculture [70]. The Ministry of the Environment has the competence to lay down environment legislation and to coordinate the regional governments.

- **Regional Governments**: Each regional government has executive environmental competences in its territory. Within their territories they are responsible for the execution of the National Plan for the Remediation of Contaminated Soils.

Definitions
The National Plan for the Remediation of Contaminated Soils includes a definition for contaminated areas in the broad sense: 'An area is considered contaminated when its natural condition has been altered by the presence of toxic and hazardous elements of anthropological origin with the subsequent imbalance in the function of the soil itself'.

The Code of Practice of the Basque Country's Master Plan [67] includes a definition for contaminated soil: 'In general the Master Plan for Soil Protection defines as contaminated soil all soil which has suffered changes in its chemical, physical or biological characteristics which by nature, scale or duration are incompatible with its functional properties or which pose a serious threat to public health or the environment. For the purpose of practical quantification a soil is considered as contaminated when concentration of pollutants exceeds the reference level (VIE-A) or the local background level'.

1.13.3. Registers and inventories

From 1991 to 1995 the MOPTMA worked on establishing a National Inventory on Contaminated Sites. The objectives were as described:

- identification of potentially contaminated sites;
- characterisation of identified sites;
- preliminary risk assessment;
- alternative remediation proposals and cost evaluation;
- remediation proposals of the Autonomous Regions ;
- action proposal at the national level.

1.13.4. Characterised sites

Investigations between 1990 and 1995 revealed first data on the quantity of potentially contaminated sites. During this period the database for contaminated soils (Inventario de Suelos Contaminados; ISC) has been established.

Up to date about 18 000 industrial sites are regarded as potentially polluting activities, of which 4 902 are included in the national inventory. Up to June 1997 some 370 sites were identified as contaminated (Table 1.13-3). The National Inventory was conducted in two steps.

Table 1.13-3: Number of potentially contaminated sites regarding the 1st and 2nd step of the National Inventory; [69]

Type of site	No. of sites
Potentially polluting industrial activities	18 142
Potentially contaminated sites	4 902
Characterised sites	370

394 sites were selected for preliminary risk assessment and categorised in 3 prioritisation categories: remediation action necessary (see Table 1.13-4)

- 1/ in the short term;
- 2/ in the medium term and
- 3/ in the long term.

Table 1.13-4: Number of prioritised contaminated sites in Spain; source: [68]

Priority of remediation action	1st step	2nd step	Total
1/ in the short term	61	52	113
2/ in the medium term	85	37	122
3/ in the long term	128	31	159
Total	274	120	394

1.13.5. Site identification methodologies

The Basque country, Catalonia, and Galicia have already published methodological guidelines aimed at unifying the criteria to investigate contaminated sites at a regional level. Furthermore, a guideline of the autonomous region Castilla Leon is under way.

The Ministry of the Environment is also elaborating a basic guideline, in order to harmonise regional data investigations, priority setting and remediation performance.

The Basque Country
The general approach of contaminated sites management was firstly defined in 1994 in the proposal for a 'Soil Protection Master Plan' [65], [66]. In the following the guidelines of the Basque Country are briefly described. The Basque Country has published a series of methodological guidelines aimed to unify the criteria applied to the investigation of soil contamination. Guidance is given on historical studies and sampling design [186], sampling techniques [184], chemical analysis [185], and risk analysis [187].

When 'potentially contaminated soil' is identified, which could happen as a result of e.g. environmental appraisal, during a land purchase deal, during inspection when land is to be developed, the site is included in the 'Inventory of Potentially Contaminated Sites'. The investigation strategy (in the Basque country for the sites included in this inventory) is divided in three steps.

Preliminary survey
The preliminary survey [67] aims to confirm the suspicion of soil contamination and to gather basic information for designing the subsequent fieldwork. The preliminary survey includes:

- historical investigation (compiling data from maps, photographs, archives, interviews and other sources);
- field inspection visit (confirmation of the information compiled, inspect the present state of the site);
- the analysis of the physical environment (regional and local geology, geomorphology, etc.).

If the suspicion of contamination is supported by the preliminary survey the investigation process is continued.

Preliminary investigation
The preliminary investigation aims to confirm the presence of contamination. On the basis of the results from the preliminary survey a sampling and analytical strategy is designed and the investigation is carried out. Comparison of the analytical results with three levels of guideline values (reference values, indicative value for assessment, and maximum tolerable risk) decides whether the site should be considered:

- as uncontaminated;
- to present a risk for the envisaged land use and thus only should be monitored over time, or
- as seriously polluted and thus be maintained in the investigation process.

Main site investigation

The main site investigation aims to characterise a site, by defining the extent of the contamination and the risk involved. The sampling design will build on the results of the preliminary investigation. The results of the investigations and the risk analysis (comparison with guideline values) defines whether it is sufficient to apply preservative measures or whether remedial measures have to be applied.

Catalonia and Galicia
The Autonomous Community of Catalonia has drafted a guideline for soil quality assessment under the title 'Soil quality criteria for site assessment in Catalonia'. Along with the regional policy of soil protection and remediation some provisional soil quality criteria have been developed, suitable for the specific conditions in Catalonia {235], [236]. The evaluation of soil quality addresses human toxicity, ecotoxicity, and the risk of potential ground water contamination. The assessment of soil quality at a site is based on the definition of background levels in combination with considering the future land use at the site.

The Autonomous Community of Galicia has also established characteristic background values for heavy metals.

1.13.6. Funding and liability

Wherever the polluter is at hand the polluter-pays-principle (caveat emptor) is applied.

Remedial action for public properties, properties where the owner can not be identified or where the owner is insolvent are jointly funded by the Ministry of the Environment and the Regional Governments, except for Navarra and the Basque Country where 100 %of the costs are covered by the Regional Authorities.

If the remediation action results in an economic benefit, local authorities take the opportunity to recover invested money from beneficial returns [71].

1.13.7. Scale of the problem

Within the first step of the National Action Plan total costs to meet the proposed actions were calculated to be approximately 805 MEURO. The National Inventory was continued and revealed that the initial calculation considerably underestimated the situation. Recent calculations of remediation costs of 370 priority sites were calculated to amount 1 849 MEURO (Table 1.13-5).

Table 1.13-5: Previewed funding of priority sites in Spain for the period 1995 and 2005; source: [35], [68]

Region	Potentially contaminated industrial activities	Potentially contaminated sites	Characterised places	Funding MEURO
Andalucia	1 396	683	43	418.90
Aragon	717	356	7	43.52
Asturias	394	160	17	33.09
Baleares	303	13	4	13.80
Canarias	396	245	12	32.97
Cantabria	238	81	8	71.28
Castilla-La Mancha	287	415	15	41.37
Castilla y Leon	811	438	29	33.90
Cataluna	4 913	611	60	398.85
Ceuta-Melilla	22	5	1	-
Extremadura	183	44	6	3.42
Galicia	860	543	26	34.54
La Rioja	153	40	5	7.16
Madrid	2 277	248	25	57.86
Murcia	469	84	14	145.66
Navarra	334	40	9	29.71
Pais Vasco	2 059	556	45	400.65
Valencia	2 330	340	44	82.65
Total	***18 142***	***4 902***	***370***	***1 849.33***

Half of the total costs shall be jointly funded by contributions from the Ministry of the Environment and the European Union Cohesion Fund [35], [68].

1.13.8. References

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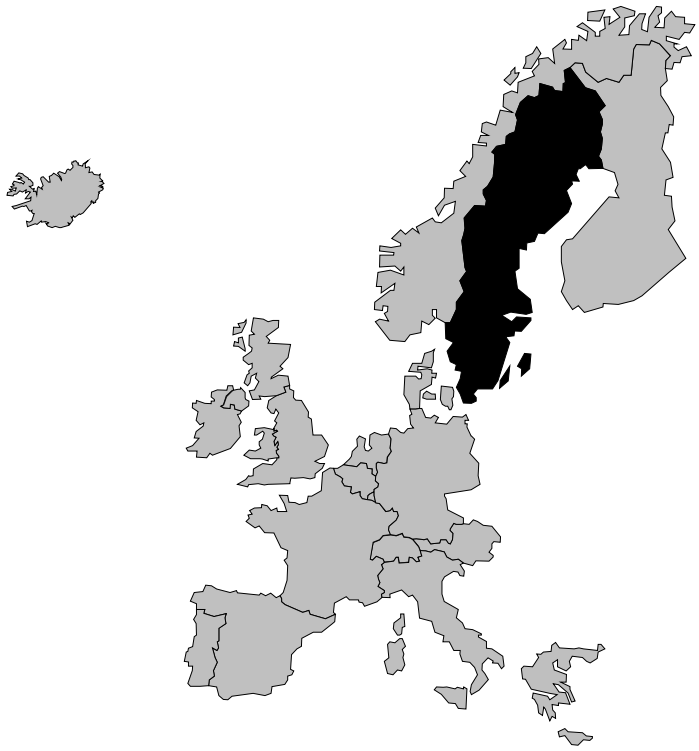
1.14. Sweden



1.14.1. Country characteristics

The first systematic mapping of potentially contaminated sites was carried out in the early 1990s. In 1995 a new regime towards contaminated sites was proposed; the Swedish Environmental Protection Agency issued a remediation action plan with the objective to comprehensively identify and investigate the contaminated sites in Sweden and carry out remediation work where necessary. The action plan proposed the clean-up of 200 most urgent sites within the first 5 years. In addition it was realised that there was an urgent necessity to enforce specific national clean-up legislation and to establish funding tools like a waste tax or voluntary agreements with industry [47].

In 1996, the Swedish EPA doubted whether the objectives of the action plan have been too ambitious, however in parts it has already been realised [151].

The dominating contaminants are metals, petrol products, chlorinated and polyaromatic hydrocarbons [16].

The Kingdom of Sweden consists of 24 Provinces, each having a representative of the Government, the 'Landshövding', and its own parliament. Statistical data (see Table 1.14-1, Table 1.14-2) reveal that:

- forestry plays a major role in Sweden's economy, since 62 %of the county's area are wooded, which is almost the double of the EU average value;
- renewable water resources are abundant, the intensity of water exploitation from renewable water resources is only 2%, the EU average value is 16%;
- population density is very low in Sweden. The share of the country area makes 12 %of the EU total whereas the share of the population makes only 2,3%.

Table 1.14-1: Some selected geographical statistics of Sweden in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Sweden	449 960	13.9	34 010	7.6	280 200	62.3	17 584	3.9	168 000	2	95
EU15 Total	3 239 464	100.0	1 483 194		1 120 606		247 773		1 452 150		
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.14-2: Some selected population statistics of Sweden in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Sweden	8 566	2.3	19	39.0	74.8	80.8
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.14.2. Legal background

From January 1999 Sweden will have a new environmental law, the Environmental Code. The law will include:

- an obligation to report and make public any detected contamination of land or water;
- the possibility to register and impose restrictions on land use;
- rules on liability for the investigation and remediation of contaminated land.

The liability rests in the first place with the person who caused the pollution and then with the person who owns the contaminated land.

Responsible bodies
The Swedish Environmental Protection Agency (Naturvårdsverket)
is responsible for the central coordination, the overall planning, the prioritisation, and the allocation of general funds for investigations, inventories and remediation.

Local authorities
The County Administrative Boards and the Municipalities have the responsibility to carry out the practical work.

Definitions
According to the Swedish EPA a contaminated site is defined as *'any land, water, building or installation which is contaminated to the extent that it can pose a risk for health or the environment '.*

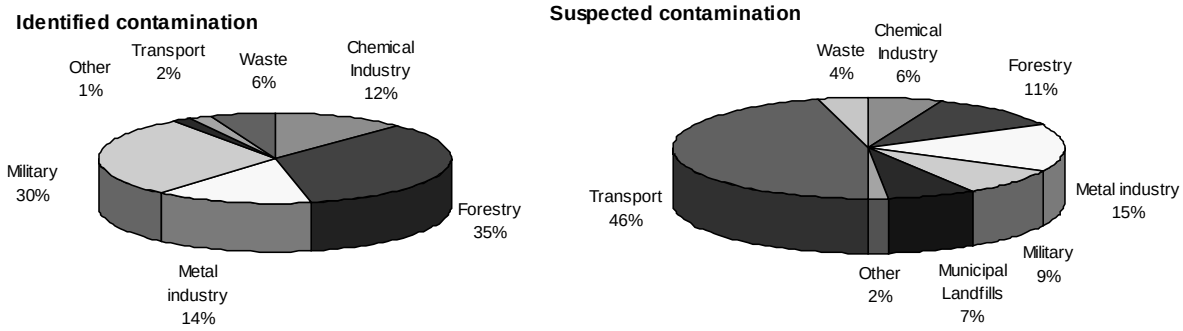
1.14.3. Registers and inventories

The national register regards industrial sites, waste sites and military sites. Sweden has a national priority list regarding four risk classes, being very high, medium/high, low risk, and very low risk.

1.14.4. Characterised sites

By the end of 1996 more than 2,000 sites have been proven to be contaminated and some 7,000 were identified as potentially contaminated (Figure 1.14-1).

Figure 1.14-1: Shares of industrial branches assigned to 2,046 identified contaminated sites and 7,005 potentially contaminated sites [16]



1.14.5. Site identification methodologies

Between 1992 – 1994 Sweden carried out a systematic mapping of 60 prioritised industries and industrial activities (Branchkartlägningen = BKL). The first mapping was based on information retrieved from the Swedish EPA, from regional, and from local authorities. The BKL is the basis for the Swedish identification and investigation programme [176]. The first data set from the BKL is completed with information on industrial branches and activities. The process of site identification and site investigation is described below. On the basis of the available publications it has not been possible to judge which information level corresponds to the level of potential contamination and which to the level of verified contamination.

Preliminary survey
As a first step after the very first identification of sites, a risk classification is carried out, based on available information that can be collected from public and private archives, also including geological and geochemical maps. The data will include:

- administrative data (e.g. localisation, type of industry, owner);
- a description of industrial activities, (e.g. operation period, description of processes, buildings, which chemicals have been handled, deposits etc.);
- a description of the contamination;
- a description of the site and the surroundings (e.g. distance to residential areas, soil type).

The risk classification is an evaluation of the toxicity of contaminants, their concentrations, the potential for further migration to the surroundings and the sensitivity and the protective value of the surroundings. The risk classes are called:

- risk class 1: very high risk
- risk class 2: high risk
- risk class 3: moderate risk
- risk class 4: low risk.

Only those sites classified in group 1, 2 and 3 continue in the investigation process.

Preliminary investigation
The preliminary investigation starts with the setting up of sampling plan. The purpose of the sampling plan is to verify the presence and the possible dispersion of contamination and to get a dimension of the level of the local background concentrations. At this level the number of samples should as a minimum include at least three sampling points for each of the media soil, groundwater and sediments. In most cases the sampling of surface waters can be reduced to two points of measuring: one upstream and one downstream of the contamination. At this

level of investigation a basic programme and an additional programme are feasible both including physical, chemical and biological tests.

The basic investigation programme include a list of basic compounds and properties which always should be included in the investigation supplemented by the contaminants that are particular relevant for the industrial activity on the investigated site. In case of suspicion of a contaminant that can bio-accumulate in the environment the additional programme is used.

When the investigations are carried out the risk of the site is evaluated by assigning one of the four risk categories, being the same as in the preliminary study. The contamination level and the potential for dispersal of contamination are included in this evaluation. The level of contamination is compared with guideline values if they exist for the relevant contaminants. The sites are grouped according to their relative size compared to the guideline values. In case corresponding guideline values do not exist, background values are used for comparison.

As in the preliminary study only those sites assigned to the risk groups 1 to 3 are further investigated.

Main site investigation
The next step in the process is the main site investigation of a site. Sweden has developed guidelines that offer different possibilities [179], [180] of which sampling strategy to apply, and how to take a sample, how to analyse, etc. In addition, the Swedish EPA has defined generic guideline values [178] and models how to apply them [177].

On the basis of the investigations it is decided whether and how remediations should be carried out.

1.14.6. Funding and liability

The polluter-pays-principle is applied as far as possible. In many cases, though, it is not possible to identify a potential polluter or to oblige the polluter to completely cover the necessary remediation measures. As a consequence a great share of the planned remediation work will have to be financed by public means.

The implementation of a waste tax is in discussion, and a proposal has been passed to the Swedish Commission of Inquiry. The new tax is expected to achieve annual revenues of 1 to 1.5 billion SEK (115 to 173 MEURO) during the first 10 years of implementation [16].

In Sweden remedial work is recognised as job creating sector. Great hopes are therefore placed in funding deriving the national employment programme [151].

There is a voluntary agreement of the petrol industry, similar to those systems already existing in Denmark and the Netherlands. The agreement is supposed to regard the investigation and if necessary the remediation of some 6,000 petrol stations. To achieve this goal a levy will be added to the petrol price. Over a period of 10 years a budget of 1,500 SEK (173 MEURO) shall be generated and allocated to the clean-up of petrol stations [151].

1.14.7. Scale of the problem

In 1998 total potentially contaminated sites were estimated to amount to 22,000 sites, and total clean-up costs were calculated to make up 4 billion U$ (3.5 BEURO).

In January 1996 the National Remediation Action Plan foresaw a budget of 4.5 billion SEK (520 MEURO) to meet the short-term objectives of the first five years, including investigations, remedial action, maintenance of inventories, and R&D support. The public share of this budget is calculated to make up more than the half, being about 2.5 billion SEK (288 MEURO). The annual budget for the first year was calculated with 200 million SEK (23 MEURO) and to increase progressively over the next years, but already in 1997 representatives of the EPA announced that the scheduled budget is not likely meet complete approval [16], [47], [151].

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1.15. United Kingdom

1.15.1. Country characteristics

The United Kingdom has experienced a major restructuring process in recent years. Heavy industry has been dramatically reduced and many sites have been abandoned. At the same time the service sector exploded and now dominates the economy. Within EU Member States the UK is among the leaders in the service sector, which amounts to more than 70 %of the gross domestic product (in Germany only 65 %) [107], [210].

Industrialisation started very early in the UK. Many industrial regions of the UK are among the oldest in the world and have experienced intense activities of heavy industry. Of major concern are above all coal carbonisation, petroleum refining, asbestos manufacturing, metal processing, waste treatment and disposal.

Due to several severe incidents the problems raised by contaminated sites were realised as early as the 1960s. Among them the case of the Lower Swansea valley which was contaminated by metalliferous industries and the village of Shipham which was contaminated by mining activities [2].

Contaminated land policy has been a subject of intense debate for about ten years now. First measures were taken with the approval of the 1990 Environment Act, allowing local authorities to operate under the statutory nuisance provisions in order to take measures against soil pollution.

Recent developments concerning contaminated sites are above all the amendment of the Environment Act in 1995. A new part (Part IIA) was inserted, addressing exclusively contaminated sites. The act provides a completely new regime for the control of specific threats to health or the environment from existing land contamination. Local authorities are obliged to inspect their territories in order to identify ‘land that may be contaminated’. The amended Environment Act is up to now not enforced since statutory guidance to the local authorities and to the Environment Agencies needs to be approved and issued [105].

The United Kingdom consists of four Constituent Countries, namely England, Wales, Scotland and Northern Ireland. Among the Constituent Countries, England is the largest in size covering more than 50 %of the national area and the biggest in population, holding a share of more than 80 percent. Hence population density in England is the highest compared to the other countries, being on average about 367 persons per square kilometre.

Statistical data (Table 1.15-1, Table 1.15-2) reveal that

- the share of area used for agricultural purposes is about one third higher than the EU average value;
- the share of nationally protected areas is very high, being almost three times the EU average value;
- the UK is one of the most densely populated EU Member States and has on average the same population density as Germany, and
- the population increase between 1950 and 1990 was very low being about half of the EU average value.

Table 1.15-1: Some selected geographical statistics of the United Kingdom in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[%]*	*[%]*	*[%]*
UK	244 880	7.6	178 370	72.8	24 000	9.8	46 391	18.9	120 000	-	87
EU15 Total	3 239 464		1 483 194		1 120 606		247 773		1 452 150		
EU15 Av..				50.5		28.0		7.1		18	75

Table 1.15-2: Some selected population statistics of the United Kingdom in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
UK	57 411	15.7	234	14.0	73.0	78.7
EU15 Total	368 641	100.0				
EU15 Av.			145	26.0	73.0	79.0

1.15.2. Legal background

Legislation concerning contaminated sites is addressed in the Environment Act, which has been amended recently. The amended version is not fully enforced by now. Responsible bodies hence keep working under the requirements of the old version. The provisions of the Environment Act apply to England, Wales and Scotland. Northern Ireland will introduce its own legislation [105].

The Government's final strategy is to be advisory and not statutory; intending to look whenever possible for non-regulatory approaches to deliver its objectives, including market-based instruments [72], [106].

1990 Environment Act,
Contaminated land is only broadly addressed. Part III includes the statutory nuisance provisions, which allow local authorities to operate and to take measures against land contamination.

1995 Amendment of the Environment Act,
In 1995 the Environment Act was revised and Part IIA was incorporated, which explicitly addresses the management of contaminated 'land'. Part IIA is not yet in operation, since statutory guidance to the local authorities and the Environment Agency needs to be issued.

1996 Draft Statutory Guidance on Contaminated Land [102], [104], [105]
The statutory guidance will play a crucial role under the new regime. Its approval will fully enforce the amendment of the Environment Act. The statutory guidance in turn will be supported by advisory technical guidance from DoE's and the Environment Agency's research programme.

The layered approach of legislation, statutory guidance and advisory technical guidance is intended to allow the necessary flexibility for delivering the 'suitable for use' approach

Responsible bodies
Local authorities
The primary regulatory role rests with the local authorities, being borough councils, district councils, the City of London, the Temples or councils for local government areas. Local authorities operate under the provisions of the 1990 Environment Act, i.e. under the statutory nuisance provisions. Future responsibilities under the new regime of the amended Environment Act will be as follows [101]:

- the duty to inspect land in order to identify contaminated land;
- the identification of responsible parties;
- to oblige responsible parties to take measures and to bear the costs of remedial action.

Ministries
The governments of the Constituent Countries each have their own Environment Ministries, being

- the Department of the Environment (DoE)
- the Welsh Office
- the Scottish Office
- the Department of the Environment Northern Ireland

The Environment ministries take the leading role in policy development and technical support. Likewise they are responsible for the allocation of money, i.e. from the budgets of the Constituent Countries to the local authorities [102], [104].

Environment Agencies
The regime of the Environment Act of 1995 includes the provision to establish Environment Agencies in England, Wales and Scotland, each incorporating the functions of Her Majesty's Inspectorate of Pollution, National Rivers Authority and local Waste Regulation Authorities.

The Environment Agencies were established in April 1996
- the Environment Agency for England and Wales
- the Scottish Environment Protection Agency

With respect to contaminated 'land' major responsibilities of the Environment Agencies are [55]:

- to provide site-specific guidance to local authorities when appropriate;
- to act as the regulatory authority for any land designated as a 'special site';
- to publish periodic reports on contaminated land;
- to act as a centre of expertise, and to manage a programme of technical research.

Definitions
UK legislation and official documents always refer to contaminated 'land'. In accordance with the provisions of Part IIA of the Environment Act and the Statutory Guidance Document, land is only contaminated where it *'appears to the local authority, in whose area it is situated to be in such a condition, by reasons of substances, in or under the land, that (a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) pollution of controlled waters is being, or is likely to be caused…' [19], [104].*

1.15.3. Registers and inventories

In 1991 the UK government planned to oblige local authorities to compile registers on 'contaminated land' available for public inspection. One year later the government reversed its plans. The issue was not re-addressed until 1995 when the New Environment Act was enforced. The act provides a new regime for the control of specific threats to health or the environment from existing land contamination. Local authorities are obliged to inspect their territories in order to identify 'land that may be contaminated' [2], [20], [22].

Results obtained from the requirements of the New Environment Act are to be expected from the periodic reports on contaminated 'land' to be published by the UK Environment Agencies.

1.15.4. Characterised sites

Up to now compiled data on potentially contaminated sites and verified contaminated sites are not available. Some surveys on potentially contaminated sites have been conducted between 1989 and 1991 (see Table 1.15-3), the information is very incomplete though and does not reflect the actual situation.

Table 1.15-3: Information on potentially contaminated sites in the UK; source: [3]

No. of sites	Size	Land use / type of sites	Area	Ref. year	Source
	40 495 ha	Derelict land	England / Wales	1989	DoE
749	3 900 ha	Potentially contaminated sites excluding operating sites, and sites smaller than 0,5 ha	Wales	1988	Welsh Office
2 551	8 297 ha	Derelict land	Scotland	1992	Scottish Office
1 577		Waste sites	County of Cheshire	1990	DoE
68		Gasworks	London	1991	Friends of the Earth

The Department of the Environment estimates the total number of potentially contaminated sites to be some 200 000 hectares or 100 000 sites respectively, of which about 10 %are believed to be seriously contaminated. Further specifications to these figures are given by Ulrici (see Table 1.15-4).

Table 1.15-4: Estimated share of potentially contaminated sites according to land use activities; source: [2]

Number of sites	Type of site
20 000 – 25 000	Abandoned waste disposal sites
3 000 – 5,000	Communal sites of gasworks
Some hundred	Steelworks sites
Several 10 000	Petrol filling stations

Prioritisation

The suitable use approach is applied in order to classify a site as contaminated. The new Guidance on Contaminated 'Land' refers to the source-pathway-receptor linkage approach to be used as a tool to aid prioritisation.

1.15.5. Site identification methodologies

The Department of Environment has published a series of publications regarding contaminated sites and more are under preparation. Guidance on basic principles and sources when researching the history of contaminated sites [183], preliminary site inspection [144, 145], sampling strategies [182], and for a two step assessment approach for assessing the impact on groundwater and surface water [142, 143]:

A **qualitative assessment** to determine whether contamination at a site has the potential for polluting either ground or surface water. This step requires a desk study and a site visit both specially designed as part of this process.

A **quantitative assessment**, including modelling techniques where appropriate, to establish the extent and severity of any contamination that may be present. This step requires a detailed and specially designed site investigation.

Guidance [181] has also been given to deciding what priority to give to action on a site that may be contaminated. The guideline gives no information on what information level are considered to correspond to contaminated site level.

The basic principle of the guidance is that a site is assessed under the following headings:

- development (humans, plants and the built environment)
- surface waters
- groundwater

Preliminary survey
The objective of the first part of the process is to provide a preliminary prioritisation into groups for procession into part 2 of the preliminary study.

The following information should be collected:

- regarding development: boundary of site, national grid reference, presence of buildings on the site, type of land use near the site.
- regarding surface waters: surface water feature on the site or within 500 m of the boundary, direction of water run off on basis of maps.
- regarding groundwater: on basis of protection plans and vulnerability maps.

As a result data are assessed and assigned to categories (A to C).

In part II of the process available site investigation data and other information is collected and examined (e.g. applications/decisions concerning planning, licenses and reports, geological and hydogeological maps, knowledge on accidents, fires, significant spillages on the site.

The site is visited to confirm for instance the nature of any new development, to identify any differences from information obtained from maps, or historical records, and to identify significant surface features.

A more detailed assessment is carried out. The likelihood of the presence of contaminants, the potential migration pathways and the potential risk to man and the environment are assessed and grouped into one out of four priority categories. If possible it is assessed whether the contamination exceeds guideline values, e.g. for assessment under the heading development: the action values for soil.

Preliminary investigation
The purpose of the preliminary investigation (exploratory study) is to help to determine whether there is evident contamination present and whether a main site investigation shall be carried out. Based on the preliminary study the investigation should be designed to target areas of likely maximum concentrations. Number of samples is dependent on the size of the site and the sampling depth of the mobility of the substances and the use of the site.

1.15.6. Funding and liability

Whereever a polluter can be detected the *polluter-pays-principle* is strictly applied. If the polluter cannot be found the landowner is held liable. In addition the principle of *caveat emptor* or 'let the buyer beware' is applied to sales of land in the UK [103].

Under the regime of the New Environment Act Local Authorities will be liable for orphan sites.

Public funding
There is no specific government grant for remediation of contaminated land but there are a number of mechanisms for funding restoration or other remedial action. In order to do so the Department of the Environment, the Welsh Agency, and the Department of the Environment Northern Ireland have limited budgets at their disposal.

DETR: Supplementary Credit Approval Scheme for Contaminated Land
In England the Department of the Environment, Transport and the Regions administers the Supplementary Credit Approval Scheme for Contaminated Land, a loan scheme for local authorities to remediate closed landfill sites. The system allows local authorities to borrow finance for action on specific site. This applies where the local authorities are responsible for investigation and remediation of contaminated land and where they cannot immediately recover the costs from those responsible. In recent years the annual budget allocated to contaminated land ranged between 12 to 14 million £ (approx. 17 to 20 MEURO). [2], [103].

English Partnerships
The English Partnerships, founded in 1994, are a public body, with an annual programme of some 260 million £ (approx. 369 MEURO). Budgets are calculated annually to include three development programmes, all of which may include activity on contaminated sites. The English partnerships promote economic regeneration in the areas of greatest need through the redevelopment of vacant, derelict, and contaminated land and buildings. Support is available for local authorities and private owners. Within England English Partnerships manages the Land Reclamation Programme, the main objective is to secure regeneration of land in England, which [95], [103]

- is vacant or underused;
- is situated in an urban area, being underused or in-effectively used;
- is or likely to become contaminated, derelict, neglected, or unsightly.

Welsh Development Agency and Scottish Enterprise
Wales and Scotland have agencies, whose responsibilities are similar to those of the English Partnerships.

In Wales, the Welsh Development Agency spends about 35 million £ (approx. 50 MEURO) per annum on land reclamation. Around 40 %of the budget is directed to sites having a need for some treatment of contamination.

In Scotland, Scottish Enterprise takes care of funding land development.

1.15.7. Scale of the problem

In 1992 the Centre for the Exploitation of Science and Technology estimated total clean-up costs to range between 13 and 39 billion EURO. The calculation refers to 10 000 ha contaminated land and to treatment costs ranging between 130 000 and 390 000 EURO per hectare [3].

1.15.8. References

Exchange rates: 1 £ (Pound Sterling) = 1.6 EURO (as of November 1999).

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1.16. Iceland

1.16.1. Country characteristics

Soil pollution is only a minor issue in Iceland. There are only very few heavy industry facilities spread over a very sparsely populated country. The problems posed by abandoned industrial sites are in general unknown, since all sites are still operating. Iceland is among the top seafood exploiting countries (the world's number fourteen). The economy is dominated by the fishing industry and secondly by the production of aluminium [107].

Statistical data of the Republic of Iceland reveal that

- renewable water resources are abundant;
- the population density is among the lowest world-wide, 90 %of the population live in urban areas, and
- the population increase between 1950 and 1990 has been three times the EU average value.

Table 1.16-1: Some selected geographical statistics of Iceland in relation to average values of the EU Member States (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Iceland	103 000	3.2	22 820	22.2	1 200	1.2	9 159	8.9	168 000	<1	6
EU 15 Av.				50.5		28.0		7.1		18	75

Table 1.16-2: Some selected population statistics of Iceland related to average values of the EU Member States, source: [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Iceland	260 000		2.5	78.0	75.6	77.9
EU15 Av.			145.4	26.5	72.7	79.3

1.16.2. Legal background

Up to now there is no specific legislation, which addresses contaminated sites. Likewise there is no definition. Soil pollution is addressed in the

- *Act on Public Health and Pollution Control*
- *Regulation on Pollution Control*

which aims, among other issues, to reduce waste generation and specifies the rules for waste disposal in order to minimise the risk of soil and groundwater contamination.

Responsible bodies
The Environment and Food Agency in Reykjavík is responsible for the compilation.

1.16.3. Registers and inventories

To some extent data on sites that are suspected to be contaminated and sites that are known to be contaminated are compiled by regional authorities and submitted to the Environment and Food Agency. Information is compiled systematically based in regional surveys and also by occurring incidents [112].

1.16.4. Characterised sites

Up to now only very few sites have been proven to be contaminated [112].

Military sites
There is only one military site in Iceland, being a NATO military base. Soil pollution incidents on this site have been handled according to US legislation, since this site belongs to the US forces. Soil and groundwater pollution have been detected at this site deriving from de-icing agents which had been applied at the NATO air strip.

Industrial sites
There are no abandoned industrial sites in Iceland, all sites are still operating. The same is true for the Iceland airports. (In case one of these sites will be shut down, soil pollution is likely to be detected in the future).

At one metal recycling facility soil pollution due to PCBs and heavy metals has been detected. The site is situated next to the coast; it has been proven that groundwater was not affected.

Several incidents are known, where the replacement of old transformers caused some soil pollution.

Waste Sites
Iceland has a variety of small and very small waste sites, which are used to dispose municipal waste and to some extent hazardous waste. Up to now incidents of soil pollution and groundwater pollution due to these sites are not known. The Environment and Food Agency states that one should be aware that such incidents are likely to occur in the future.

There is only one large-scale waste site in the Greater Reykjavík area that has been abandoned in recent years. Municipal and hazardous wastes have been disposed in a small sea bay. Surveys of the eco-system have not proven any negative effects on plants or animals in this area.

1.16.5. Site identification methodologies

A working group has been established in the Environment and Food Agency in order to discuss standards and guideline values [112].

1.16.6. Funding and liability

The polluter-pays-principle is applied [199].

Public funding
There are no specific public funds for contaminated sites.

1.16.7. Scale of the problem

Up to now no attempts have been made to quantify the problems posed by contaminated sites.

1.16.8. References

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1.17. Norway

1.17.1. Country characteristics

Political concern about the problems posed by contaminated sites emerged in the late 1980s. From 1987 to 1990 the first national survey on hazardous waste was initiated. In 1989 existing approaches in some counties were investigated in order to set an initial step for a future soil protection policy. In 1992 a list of polluted industrial sites, waste sites and military sites was compiled by the SFT[6] (State Pollution Control Agency). As a result a clean-up plan for some 450 sites was out-lined.

In addition to the common problems posed by waste sites, contaminated sediments in fjords and mining areas are of major concern [2].

Norway retrieves about 85 % of its drinking water needs from surface water. The protection of ground water is hence of minor importance. Typical climatic conditions are low temperatures, high precipitation, and heavy snow-melting during the spring-period.. Typical pollutants are heavy metals from the smelter and metal finishing industry, hydrocarbons from the petroleum industry, and PAHs[7] from gasworks respectively [97]. In most fjords, harbour areas, shipyards, and military sites PCBs[8] are the main contaminants.

The pollution of fjords and rivers represents a particular problem, since heavy industries are usually situated along coasts. Soil erosion caused by agriculture and low exchange of water with the open sea facilitate the accumulation of polluted sediments in the fjords. In certain fjords the sale and consumption of seafood is already subject to official restriction [2].

The Kingdom of Norway consists of 19 counties. Statistical data (Table 1.17-1, Table 1.17-2) reveal that:

- the Norwegian population density is among the lowest in Europe;
- renewable water resources are abundant compared to other European countries;
- agriculture is of minor importance.

Table 1.17-1: Some selected geographical statistics of Norway in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Norway	323 900	10.0	9 760	3.0	83 300	25.7	4 536	1.4	392 000	1	57
EU15 Av.				50.5		28.0		7.1		18	75

[6] SFT = Statens forurensningstilsyn (State Pollution Control Agency)
[7] PAHs = Poly-Aromatic Hydrocarbons
[8] PCBs = Poly-Chlorine Biphenyls

Table 1.17-2: Some selected population statistics of Norway in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Norway	4 246	1.2	13	30.0	73.4	80.0
EU15 -Av.			145.4	26.5	72.7	79.3

1.17.2. Legal background

Norway has no specific legislation on soil pollution. However soil pollution is addressed in the National Pollution Control Act.

The *Pollution Control Act*, enforced in 1981
regulates environmental protection in general. Major objective is the protection of the environment in its own right, even if public health and use are not directly impaired. In the mean time the act has been amended four times in April 1983, in May 1986, in March 1989, and in June 1989 respectively.

National Standard on Risk Assessment, Norsk Standard 1991
contains the requirements for risk analysis to include: definitions, a description of the planning phase and the procedure used in risk assessment.

Responsible body
The SFT (State Pollution Control Agency) is responsible for the registration of potentially contaminated sites into the national database. In addition the SFT takes charge of cases requiring urgent clean-up.

Definitions
The Pollution Control Act defines pollution in general as *'discharge of solid matter, fluid or gas into air, water or ground, which cause or may cause damage or disamenity to the environment'*.

1.17.3. Registers and inventories

The national register regards waste sites, industrial sites and partly military sites [100]. Local authorities are obliged to collect data on potentially contaminated sites and report these sites to the county governments. The SFT retrieves data from all county governments and takes charge of the data entry into the national database.

1.17.4. Characterised sites

As a result from a survey which was completed in 1991, there are approximately 2 500 potentially contaminated sites in Norway. Unless there is a change in land use at the sites, less than 1 000 sites are considered to be in need of further investigations. In March 1996 the SFT registered 272 sites with ongoing investigations or clean-ups, 77 completed sites, being either remediated or isolated [99], [152].

The registration of potentially contaminated sites is based on data collection via interviews with present and former polluters and with local authorities. Sites are ranked into four categories (see Table 1.17-3). The ranking represents a preliminary risk assessment based on information concerning the type of contamination, land use and the vulnerability of possible receptors. At this stage of the procedure no sampling is performed.

Table 1.17-3: Priority ranking of potentially contaminated sites [152]

Priority	Description
1	Sites where immediate investigations or measures are required
2	Sites where there is a need for investigation
3	Sites where there is a need for investigation in event of change of land use
4	Sites where no investigation is needed

Table 1.17-4: Status of registered potentially contaminated sites, by March 1996 [152]

Status	No. of sites	Priority
Suspected contaminated sites to be handled in the future	1 300	3
Sites where investigations are needed	472	2
Investigations and/or measures are carried out	202	1, 2
Investigations and/or measures are carried out	70	3
Sites cleaned up or isolated	53	1, 2
Sites cleaned up or isolated	24	3
Total	***2 121***	

1.17.5. Site identification methodologies

The general procedures for contaminated land management have been published in a generic guideline [225]. Local authorities conduct regional surveys and systematically collect data on contaminated sites. The results are reported to the SFT which maintains the national register. Besides that accidents and suddenly arising incidents are also included in the register. Major objective of the system is to hand over the responsibility for site identifications and investigations to the responsible parties under the supervision of the authorities. Within the scope of the regional surveys easy accessible information is regarded; i.e. address, map coordinates, activities at the site and current land use, distance to settlements, primary recipients, dominating soil conditions, type of industry (or deposit), present and possible future conflicts [137].

Preliminary study
Sites registered in the national register are prioritised. Authorities oblige owners of priority sites to carry out a preliminary study. These are based on the evaluation of data including:

- historical data, maps, photo investigations, and interviews;
- description of the contamination; i.e. type, amounts and localisation of contamination, and hazard identification;
- distribution of contaminants (pathways, measures to prevent distribution, main processes);
- effects (present land use, plan for future land use, function and use of groundwater/other recipes).

Based on the results obtained the authorities decide whether investigations are to be continued or not.

Preliminary investigation
The goal of this step is to assess the extent of the contamination and the need for applying measures [137]. The investigations are dedicated to the characterisation of

- the contaminated source i.e. area of distribution, potential for mobilisation, and chemical-physical properties of the area in question;
- possible distribution pathways;
- possible effects.

This is usually done by measuring the level of contamination in the top soil, in the soil gas, in the groundwater, and in possible recipients, and by measuring and calculating concentrations in the indoor environment and the size of the affected aquifer.

There is no strict guidance for what has to be included in the preliminary investigation. SFT has published a guideline [138] that recommends basing the sampling on the expected distribution of the contamination, distinguishing between homogeneously and heterogeneously distributed contamination and the existence of a point source.

The setting of sampling points depends also on the geology and hydrogeology, and on the contaminants and their chemical and physical properties. Apart from sampling within the affected area, it is also recommended to take samples in the vicinity in order to define reference values. The ISO standard ISO/DP 10381-1 (89) is recommended in case of very complex hydrogeological conditions where the localisation of the source of contamination is critical.

A risk analysis is carried out either by comparing the contamination level with guideline values or by carrying out a site specific risk analysis. The guideline values are based on the most sensible land use (residential housing, etc.) and can be deviated for other types of land use by carrying out a site-specific risk assessment.

The preliminary investigation is the basis to decide whether or not a main site investigation shall be carried out and whether clean-up measures shall be necessary [98].

1.17.6. Funding and liability

The polluter-pays-principle is applied at sites where the contamination emerged after 1981, and hence after the national Pollution Act was enforced.

For pollution, emerging earlier than 1981 the owner and the occupier are held liable.
Costs which cannot be covered by liable parties are covered by the SFT, which receives an annual budget from the Ministry of Environment. In recent years the budget has been fixed to about 9 million NKr (1.1 MEURO).

The SFT provides financial support for the implementation of new technologies, and provided a budget of approximately 4 million NKr (0.5 MEURO) in 1996.

1.17.7. Scale of the problem

During the National Survey of 1992 overall clean-up costs of priority sites were calculated. Of 450 selected sites, which were believed to pose an acute risk to human health, the total clean-up costs were calculated to range between 2 to 3 billion NKr (250 to 375 MEURO), of which 85 %amount remediation measures and 15 %site investigation respectively [152].

By 1997 the SFTP issued new results on national clean-up calculations, remediation costs for some 700 selected priority sites were calculated to range between 3 to 4 billion NKr (375 to 500) MEURO.

1.17.8. References

Exchange rates: 100 NOK (Norwegian Crowns) = 12.1 EURO (as of November 1999).

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1.18. Switzerland

Special thanks to Dr. Christoph Wenger of the (BUWAL) who kindly prepared this chapter.

1.18.1. Country characteristics

About two thirds of Switzerland consist of sparsely populated mountainous regions. The majority of the population lives or works in the urban areas of the lowland. Most landfills and industries are hence located in these densely populated centres, which are often situated above large groundwater resources.

Switzerland has a strong federal structure, being organised and divided into 23 states, called Cantons, each having a high level of independence. The Swiss states vary significantly in terms of surface area, population, economy, industrialisation, scientific background but also in the extent of environmental impacts.

First attempts towards systematic assessment and remediation of contaminated sites were made by the local authorities in 1985. The initial incident for these activities was the leakage of the large hazardous waste landfill of Kölliken; the containment of this site will cost more than 150 MEURO. In 1991 the Federal Government started to develop a national policy for the management of contaminated sites and in 1994 a first concept was published [284]. In 1995 the legislation on environmental protection was revised and the major objectives of the concept were integrated in the relevant contaminated sites management part.

Statistical data (Table 1.18-1, Table 1.18-2) reveal that

- of all surveyed countries Switzerland has one of the highest figures for population increase between 1950 and 1990;
- the use intensity of renewable water resources is very low, and
- the connection of sewing systems to water treatment plants is above average.

Table 1.18-1: Some selected geographical statistics of Switzerland in comparison with total and average EU-values (WWTP = waste water treatment plant) [36]

	Total Areas		Agricultural Areas		Wooded Areas		Nationally Protected Areas		Renewable Water Resources	Water Use Intensity	Population served by WWTP
	[km²]	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[km²]*	*[%]*	*[Mio m³/yr]*	*[%]*	*[%]*
Switzerl.	41 290		20 212	48.9	10 520	25.0	1 112	2.7	54 000	2	90
EU15 Av.				50.5		28.0		7.1		18	75

Table 1.18-2: Some selected population statistics of Switzerland in comparison with total and average EU values [36]

	Population		Population density	Population increase 1950-1990	Life expectancy at birth male	female
	[1000]	*[%]*	*[per km²]*	*[%]*	*[years]*	*[years]*
Switzerland	6 712		163.0	43.0	74.0	81.0
EU15 -Av.			145.4	26.5	72.7	79.3

1.18.2. Legal background

Federal legislation concerning environmental protection is divided into the Federal Law relating to the Protection of the Environment and the Federal Law relating to the Protection of Waters.

Federal Law of 1991 relating to the Protection of Waters
The Swiss Water Protection Law and the Ordinance relating to the Protection of Waters define the general obligation for precautionary measures and the quality standards for surface water and groundwater. In the case of water pollution, these regulations are referring to the specific ordinances concerning contaminated sites, soil protection and others.

Federal Law of 1983 relating to the Protection of the Environment (revised 1995)
With respect to contaminated sites the following issues are regulated:

- the obligation to register and remediate polluted sites;
- the financing of remediation measures in line with the 'polluter-pays-principle'; the owner of a site can be exempted under certain circumstances, the authority may decide about the division of the remediation costs, and
- a levy on landfills in order to finance remediation projects (1) when liable parties cannot be identified or are insolvent and (2) of domestic landfills.

Soil protection policy and contaminated sites remediation measures are dealt with in separate ordinances.

Federal Ordinance of 1998 on Soil Pollution
Soil pollution is defined as the physical, chemical and biological modification of the natural composition of the soil, while soil means the unsealed top layer of land where plants can grow. The protection of soil quality underlies the precautionary principle with the long-term view to preserve soil fertility. The technical measures are mainly implemented at the source of emission. Besides that the ordinance sets soil guideline and clean-up values.

Federal Ordinance 1998 relating to the remediation of polluted sites
This document defines:

- the registration of polluted sites (landfills, industrial sites, sites of accident) by the Cantons in a register open to the public until 2003;
- use-dependent clean-up criteria for surface water, groundwater and soil air, including intervention values and analytical methods;
- use-dependent remediation objectives and criteria for the urgency of clean-up;
- the obligation to carry out a remediation project (including long-term feasibility, eco audit of the measures, cost-effectiveness, distribution of costs).

Responsible bodies
The Ministry of Environment, Traffic, Energy and Communication
is politically responsible towards the Parliament, the Cantons, the economy and foreign ministries.

The Swiss Agency for Environment, Forests and Landscape (BUWAL)
is responsible towards the Parliament and the public for the preparation of laws, ordinances and other regulations, for research and development, and maintains the international contacts.

The Cantonal Environment Agencies
are responsible for the execution of the Federal policy; in total there are 26 Cantonal Environment Agencies.

Definitions
According to the Federal Ordinance of 1998 relating to the remediation of polluted sites contaminated sites are defined as 'polluted sites, if they result in harmful effects or cause a nuisance to the environment or if there is a danger that such effects may arise'.

1.18.3. Registers and inventories

In the mid-eighties the Cantons started to register landfills and soil contamination due to accidents. Later in the early nineties the registration process was extended to industrial sites. With the revision of the Environment Protection Law the Cantons are now obliged to register all types of polluted sites (landfills, industrial sites, accidents) in a register which is open to the public. Three quarters of the Cantons are using the Federal computer programme for site registration, called 'EVA' [288]. Military sites are registered separately by the Ministry of Defence and railway sites and polluted airports are registered by the Ministry of Environment, Traffic, Energy and Communication.

1.18.4. Characterised sites

Potentially contaminated sites
By the end of 1996 about 36 000 potentially contaminated sites have been registered by the Cantons and the Ministry of Defence. This value is estimated to correspond to approximately 75 %of the total.

The registered sites are split into the following groups:

- landfills
- industrial sites
- accidents

Contaminated sites:
By the end of 1998 about 1 000 sites have been investigated, of which nearly 200 have been object of a remediation project. In total more than 100 contaminated sites have been cleaned up.

In 80 %of the cases remediation costs were less than 1 MEURO, only a few cases were in the range of 50-100 MEURO.

1.18.5. Site identification methodologies

Before the Ordinance on Soil pollution came into force site identification methods varied among the Cantons. Great efforts have been undertaken by the Swiss Environment Agency in

order to streamline the different criteria for site identification, investigation, risk assessment and clean-up. Furthermore, a comprehensive German-French-Italian Contaminated Sites Glossary has been issued in 1995 [286]. The new Ordinance relating to the remediation of polluted sites defines a uniform federal approach and is very detailed.

The Swiss approach is based on the following principles. The main goal is to stop sources of pollution that lead to, or have the potential to result in, hazardous and therefore unacceptable emissions in a legally protected medium, such as groundwater, surface water, soil, air, humans, etc. The remediation criteria and the remediation goals are entirely use-dependent and defined as

- zero-immissions for drinking water-wells;
- precautionary protection for usable groundwater, surface water, indoor-air and sensitive soils (agriculture, horticulture, children playgrounds);
- minimum protection for non-usable groundwater and non-sensitive soils.

For the quantification of the site hazard (potential) a set of intervention values for an aqueous phase (mg/L) and a set of intervention values for a gaseous phase (ppm) have been defined. The proposed intervention values are compound-specific. For the aqueous phase intervention values have been defined for 17 inorganic and 54 organic compounds, and for total petroleum hydrocarbons. In most cases the numerical values correspond to drinking water values. Otherwise, the values have been toxicologically derived from the unit risk approach according to the U.S. EPA. The underlying assumption is that leachate or pore water infiltrating into groundwater should not exceed drinking water limit values for any individual compound [287].

If a site is classified as a 'contaminated site' based on the initial field investigation the required actions are a detailed site investigation, risk assessment and possibly a feasibility study for remediation options. Based on these investigations the urgency and extent of remedial measures are defined. The goal of the remediation measure(s) is simply defined as the correction of the situation that initially led to the classification of the site as a 'contaminated site'. All types of remedial measures – decontamination, containment, monitoring (e.g. intrinsic bioremediation) and restricted site use – are acceptable, provided that a long-term and sustainable solution can be achieved.

The approach outlined above will provide a uniform technical and legal framework for the assessment and remediation of contaminated sites in Switzerland. At the same time it does, however, also ensure the flexibility needed to design optimal, case-specific remedial schemes; 'as much remediation as needed, not as much remediation as possible'.

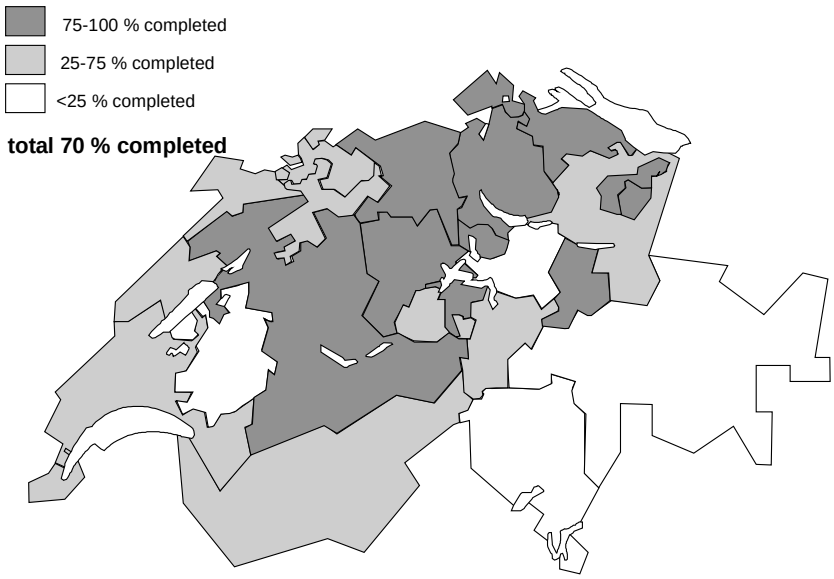
The Swiss approach of contaminated sites management is defined as a tiring approach comprising four phases.

Swiss terminology	Corresponds to
Phase 1: Registration	Preliminary survey
Phase 2: Preliminary Investigation	Preliminary investigation
Phase 3: Detailed Investigation	Main site investigation
Phase 4: Remediation Project	Implementation of clean-up measures

Preliminary survey
This step corresponds to Phase 1 of the Swiss approach. It does not include technical investigations and is supposed to give a first clue on potential contamination based on easy available information such as historic maps, aerial photographs, interviews of relevant parties and on-site visits.

Systematic regional surveys according to the preliminary survey are carried out by all Cantons, about half of the Cantons is close to completion.

Figure 1.18-1: Systematic regional surveys on potentially contaminated sites and their level of completion at the Canton level [285]



Major objective is to obtain information on the geographical details (coordinates), licenses, owners and liable parties, former and current use, type and quantity of wastes and substances handled and disposed at the facility, accidents, sensible environments next to the site, already implemented environment protection measures and other.
Sites are ranked according to their environmental impact potential.

Preliminary investigation
This step corresponds to Phase 2 of the Swiss approach and includes a historical and technical investigation. Source pathway relationships are preliminarily assessed and impacts on receiving environments are evaluated. Objective is to preliminarily assess the potential of migration and spreading of substances into sensitive environments.

A decision is made whether or not the site needs to be cleaned up or only a continuous surveillance.

Main site investigation
This step corresponds to Phase 3 of the Swiss approach. Detailed technical investigations are supposed to clarify the extent of contamination and the possible or already existing impacts on sensitive environments. It is defined which pathways of substance migration are relevant and hence need to be interrupted. A decision is made concerning the remediation goals and the urgency for remediation.

Implementation of clean-up measures
Phase 4 of the Swiss approach includes the clean-up design, the remediation and an after-care phase.

1.18.6. Funding and liability

Remediation financing is in general regulated along the polluter-pays-principle. The owner of a site is exempted from liability provided he or she did not know and benefit of the contamination and will not gain after the remediation. The authorities decide on the division of costs.

For the year 2000 a new Ordinance on clean-up financing is scheduled based on the following background. Art. 32e of the Environment Protection Law gives the Federal Council the authority to introduce a tax to finance remediations. The tax is supposed to be levied on waste disposal; the rate is limited to a maximum of 20 %of average deposition costs in Switzerland. The revenue is exclusively dedicated to the purpose of site remediation and goes to the Cantons in order to financially support the remediation of sites where the polluter cannot be identified or is insolvent, and for the remediation of domestic waste sites. The amount of the compensation is limited to 40 %of the countable remediation costs; at least 60 %of the remediation costs have to be borne by the Cantons.

1.18.7. Scale of the problem

According to the actual experience the BUWAL estimates a total of 50'000 potentially contaminated sites with a sectoral split of 50 %industrial sites, 46 %landfills and 4 %sites of accident. The final number of effective polluted sites are not known yet. About 3,000 are contaminated and therefore need remediation measures. The total time for the contaminated land management should not exceed 25-30 years. The total costs are estimated to be more than 3 000 MEURO.

1.18.8. References

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2. Review of terminology

In this part of the report, a review of existing terminology on contaminated sites is presented and two definitions are proposed.

2.1. Methodology

The methodology used to prepare this review was as follows:

2.1.1. Pre-selection of keywords

A pre-selection of keywords was done taking into account the information available in different sources such as:

- The International Standard Organisation Technical Committee 190 (ISO/TC 190) [220]
- Analysis of the Vienna and Amsterdam questionnaires [4]
- The Scoping Study for the European Topic Centre on Soil prepared by GEUS [193]
- The Bridging Study for the European Topic Centre on Soil prepared by GEUS [222]
- Proceedings from CARACAS meetings [48]
- Proceedings from NICOLE meetings [221]
- Proceedings from Common Forum meetings
- Proceedings from meetings of the Ad-hoc Group
- Waste 92 report [3]
- International Experience in Remediation of Contaminated Sites 'Ulrici Report' [2]
- Contaminated Soils 95 Congress [223]
- Information already existing at the national levels was also considered as well.

2.1.2. Screening of pre-selected keywords

Following the collection of the information available and after an overall analysis and discussion a screening of the pre-selected keywords was carried out and a limited number was selected in order to establish common definitions of specific terms.

2.1.3. Coverage: EU and EFTA countries

A survey of the definitions used in EEA countries was carried out using the information available from the above sources [223].

For most EU countries only the definition for the term 'contaminated land' or 'contaminated site' appears to exist. No specific definitions for the rest of the selected terms exist.

The different definitions of the term 'contaminated site' applied in the EU and EFTA Member States will be listed and a common definition for this term will be proposed.

2.1.4. Definitions for 'contaminated sites' and synonyms

Keywords that are similar to the term 'contaminated sites' are pre-selected and screened and finally common definitions for these keywords are given. It is not intended to propose a subjective definition for each term and, as far as possible, definitions already established by other working groups, particularly the 'ISO TC/190 SG 1 WG2', were adopted. This was done to avoid an ambiguous definition for the same term which could lead to misunderstandings in the future.

2.2. Definitions

2.2.1. Survey in EU and EFTA countries

At present harmonised definitions do not exist. Some countries appear to have their own national definitions but, in most cases, only the term 'contaminated site' appears to be clearly defined. To start with, terms such as 'contaminated site', 'contaminated soil' and 'contaminated land' or 'polluted site', 'polluted soil' and 'polluted land' are frequently used as synonyms. Obviously these expressions do not really have the same meaning, moreover, they may have different connotations for different people and there are difficulties in properly translating them into all EU languages [3].

Not only are different expressions used when considering the same subject but also the definitions for a particular term, such as **contaminated site** vary among the surveyed countries. Several definitions for this term are given in the above-mentioned report [223]. These definitions are clearly different, some of them being more quantitative such as those of Belgium-Flanders, Denmark and the Netherlands while others are more qualitative, for instance those of France, Finland, Sweden or Spain.

In accordance with the sources and reports listed above the definitions for the term 'contaminated site' and related terms in the EU countries are:

Austria
According to the 1989 Act on Clean-up of Contaminated Sites, the definition contaminated sites refers to 'waste sites and industrial sites, including the consequently polluted soils and aquifers, that pose a considerable threat to human health and the environment, – according to the results of a Risk Assessment' [37].

Belgium-Flanders
The Flemish 1995 *Soil Remediation Decree* defines soil contamination in general as the presence, due to human activity, of substances or of organisms, whether in the soil or in structures, which directly or indirectly produce, or are capable of producing, an adverse effect on the quality of the soil [201].

Denmark
The Danish contaminated sites policy regards all types of contamination, provided that substance concentrations are higher than the defined quality criteria [193]. Sites are considered as contaminated if there is a threat to human health and/or the environment (groundwater, surface waters, flora, fauna) [73].

The Act on Waste Disposal Sites defines contaminated sites with regard to waste disposal and the date of pollution emerging:

- sites contaminated with oil and oily wastes before 1972;
- sites contaminated with chemicals and chemical waste before 1976;
- former landfill sites put into operation before 1974 and closed down before 1990.

Finland
Soil contamination is indirectly defined in the Waste Act as 'excess content of harmful substances in the soil causing significant acute or long-term hazard to human health or the environment' [150].

In the beginning of the SAMASE project soil contamination was expressed as 'harmful substances in the soil causing significant acute or long-term hazards to human health or environment' [193].

France
In general two main categories of land pollution are considered, namely diffuse contamination and contamination from point sources [195]:

1. The pollution of agricultural land which is extensive and mainly due to agricultural activities (e.g. application of fertilisers or pesticides). The most frequent consequence is the pollution of the groundwater due to input of nitrogen. In that case legal and technical approaches are connected with water quality problems (protection of water resources);
2. the pollution resulting from the management of effluents, domestic and industrial solid wastes and more widely, of polluting industrial activities (chronic or accidental pollution).

Germany
There is no national definition for contaminated sites. Most Federal States consider the following major categories: abandoned waste sites, abandoned industrial sites, military sites and abandoned military production sites [115].

The Netherlands
A **contaminated site** is defined by the 1994 Amended *Soil Protection Act* [56] as a site where the soil is or endangers to be contaminated in relation to territories that on account of said contamination, the cause or the consequences thereof are connected with each other in a technical, organisational or planning sense.

A **seriously contaminated site** is defined as a site where the soil is or endangers to be contaminated so that the functional properties which the soil has for man, flora and fauna have been, or are in danger of being seriously reduced.

Spain
The National Plan for the Remediation of Contaminated Soils [68] includes a definition for contaminated areas in the broad sense: 'An area is considered contaminated when its natural condition has been altered by the presence of toxic and hazardous elements of anthropological origin with the subsequent imbalance in the function of the soil itself'.

The Code of Practice of the Basque Country's Master Plan [67] includes a definition for contaminated soil: 'In general the Master Plan for Soil Protection defines as contaminated soil all soil which has suffered changes in its chemical, physical or biological characteristics which by nature, scale or duration are incompatible with its functional properties or which pose a serious threat to public health or the environment. For the purpose of practical quantification, soil is considered as contaminated when concentration of pollutants exceeds the reference level (VIE-A) or the local background level'.

Sweden
According to the Swedish EPA a contaminated site 'is an area, landfill, land, groundwater or sediment which has been contaminated intentionally or unintentionally, through industrial or other activities. Based on the assessed short or long term risks of negative impacts on health and the environment, the sites are classified into four risk classes, being class1 – very high risk, class2 – medium / high risk, class3 – low risk, class4 – very low risk' [47].

United Kingdom
UK legislation and official documents always refer to contaminated 'land'. In accordance with the provisions of Part IIA of the Environment Act and the Statutory Guidance Document, land is only contaminated where it 'appears to the local authority, in whose area it is situated to be in such a condition, by reasons of substances, in or under the land, that

a) significant harm is being caused or there is a significant possibility of such harm being caused or
b) pollution of controlled waters is being, or is likely to be caused...' [19], [104].

Norway
The Pollution Control Act defines pollution in general as 'discharge of solid matter, fluid or gas into air, water or ground, which cause or may cause damage or disamenity to the environment' [2].

As in Norway, other countries such as the EU countries Greece, Ireland, Italy, Luxembourg or Portugal or the EEA associated countries Iceland or Liechtenstein do not have a specific definition for contaminated sites, although contaminated sites may be included in existing related definitions like 'pollution' in Greece (Law 1650/86 on the Protection of Environment), Portugal (Law on the Environment April, 1987) and Luxembourg (1994 Waste Management Act), and 'derelict land' in Ireland (1990 Derelict Sites Act) or some specific regulations in some Italian regions like Tuscany, Piedmont and Lombardy.

2.2.2. Proposed definition for the term 'contaminated site'

After a preliminary analysis of the different definitions for the term 'contaminated site' it is obvious that different approaches are used. Some definitions have a more quantitative or absolute character, while others are more conceptual or qualitative. Taking into account the diversity of geographical and geological variation in the background levels, the heterogeneity of natural soils and the differing perceptions of the concept 'danger to the environment' in the surveyed countries, a general conceptual definition is proposed. However, the word contamination infers the impression of harm in several European languages and it may not be appropriate to use the term 'contaminated site' to define a site where the input of substances has not caused an unacceptable threat to human health or the environment. Therefore two different approaches of how to define 'potentially contaminated sites' and 'contaminated sites' are presented.

	Qualitative definition	Quantitative definition
Potentially contaminated site	In the case that an unacceptable hazard to health and environment might exist	a location where as a result of human activity, waste and/or harmful substances with an anthropogenic origin and suspected to be dangerous to human health and/or the environment are present in, on or under the soil, and/or in nearby controlled groundwaters and surface waters resources
Contaminated site	In the case that an unacceptable hazard does exist	is a potentially contaminated site in which the quantities and/or concentrations of waste or harmful substances are such that – on the basis of the results of risk assessment- they constitute danger to human health and/or the environment

2.3. Terminology

2.3.1. Background and overall approach

Several terms related to the subject 'contaminated sites' are frequently used in the literature with rather different meanings.

The International Standards Organisation (ISO) includes a Technical Committee (TC190) with interests in soil quality and a Subcommittee SC1, the secretariat of which resides with AFNOR, where terminological work is carried out. The Committee Drafts ISO/CD 11074-4 and ISO/CD 11074-1 (1996 E/F/R) which are currently under vote, define a list of terms frequently used in the rehabilitation of soils and sites.

For the sake of compatibility and harmonisation the definitions proposed for the selected and screened keywords are, as far as possible, the same as stated in ISO/CD 11074 reports [220]. For those terms for which the ISO/TC 190 does not propose a definition other sources of information will be taken into account, particularly the Analysis of the Vienna Questionnaire.

2.3.2. Definitions for terms:

The definitions for the selected terms are listed below.

Soil is the upper layer of the Earth's crust composed of mineral particles, organic matter, water, air and organisms [220].

Groundwater is the water contained in the interconnected pores, situated below the water table in an unconfined aquifer, or situated in a confined aquifer [4].

Hazardous substance is a solid, liquid or gaseous substance, with the potential to have a negative impact on human health and the environment in general [275].

Pollution refers to concentrations of hazardous substances above background levels normally experienced in soils, leading to damage of soil functions [4].

Contamination refers to elevated levels of hazardous substances in the soil, due to the activities of man that are not necessarily harmful [4].

Polluters-pays-principle is the principle that the polluter is responsible for correcting or remediating a site, whatever environmental degradation their actions have caused [4].

Inventory involves compiling contaminated site registers to create a basis for rational and consistent policy for management of potentially and proven contaminated sites [3].

Prioritisation involves raking various environmental concerns together with economic and social consideration [3].

Soil protection are measures for long-term maintenance of restoration of soils and soil functions [220].

Assessment criteria are concentrations of chemical substances (values) in soil or groundwater which can be used to assess site conditions in terms of potential need for remediation. Where conditions do not exceed assessment criteria, there is no need for further investigation or remediation [4].

Background concentration geogeneous or pedogeneous average concentration of a substance in a examined soil [220].

Contaminant is any chemical substance whose concentration exceeds background concentrations or which is not naturally occurring in the environment [4].

Guideline value is a value recommended by an authoritative body without legal obligation [220].

Legally binding value is a value binding through legislation [220].

Sensitive site is a site whose soil properties or functions are readily or excessively affected by changes in external influences [220].

Problem site is a site shown to be probably hazardous to the environment especially to human health [220].

Orphan site is a site for which no owner or other responsible party can be identified [220].

Abandoned suspected hazardous site Abandoned site, the history of which, leads to a suspicion that it may be hazardous [220].

Hazardous site Site which, by reason of the substances or agents present, is judged to be hazardous to human health or safety, or to the environment [220].

Derelict site a site so damaged by human activity as to be incapable of beneficial use without treatment. Damage may be to the aesthetic, physical, engineering, environmental or contamination aspects of the site [220].

Risk assessment assessment of damaging effects of a polluted site on man and the environment with respect to their natural extent and probability occurrence [220].

Risk management is the process of evaluating, selecting and carrying out remedial actions in response to risk assessments [4].

Effects assessment is the identification and quantification of the potential adverse effects of chemicals on individuals, population or ecosystems by means of laboratory testing or field observations, example of endpoints: death, reproductive failure or reduction of species diversity [4].

Exposure assessment is the estimation of exposure of target organisms resulting from release, transport and fate of a chemical in the environment; examples of endpoints: environmental concentrations, intake per unit body weight [4].

Hazard assessment integration of the effect and exposure assessment to determine the probable nature and magnitude of a hazard resulting from the release of all chemical into the environment; examples of endpoints: comparison of predicted environmental concentration with no-effect concentration [4].

Decontamination removal or partial removal of hazardous substances in the soil, with the aim of restoring soil functions and reclaiming the soil for intended usage [220].

Remediation the management of a contaminant at a site so as to prevent, minimise, or mitigate damage to human health or the environment. Remediation is a broader term than cleanup in so far as remediation option can include physical actions, such as removal,

destruction and containment, as well as the use of institutional controls such as zoning designations or orders (Environment Canada, 1991). In the United States, remediation is differently defined under different laws. The general scope of the definitions refers to all measures that reduce the risk to humans and the environment. There is no formal definition of cleanup in the United States [4].

Remedial investigation is an investigation to collect all information necessary to design and execute remediation strategy [220].

Remedial design (Remedial strategy) is a a combination of remediation methods and associated measures that will meet specified remedial standards and other objectives, and overcome site-specific constraints [220].

Remediation objectives is a generic term for any objective, including those related to technical (e.g.: residual contamination concentrations, engineering performance), administrative and legal requirements [220].

Remediation values indication of the performance to be achieved by remediation usually defined as 'contamination-related objectives' in terms of a 'residual concentration' [220].

Residual contamination is the amount or concentration of contaminants remaining in specific media following remediation [220].

Remediation criteria is the concentration of substances in soil or groundwater which are intended as general guidance to protect and maintain specified uses of soil and water at contaminated sites. At concentrations ascending these criteria, the need for remediation is indicated [4].

Post-treatment management (Aftercare) measures applied on completion of remedial measure, or as an integral part of a containment strategy, to ensure continued effectiveness over the long-term [220].

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3. Review of site identification and investigation methodologies

In this part site identification and investigation methodologies are reviewed by comparing existing guidelines and standards. In addition, the types of sites, which are covered by the individual systems, are listed as well as the currently available data on the number of potentially and definitely contaminated sites.

3.1. Objective

The objective of describing the methodologies for site identification and investigation is to present the level of information among EU and EFTA Member States that forms the basis for classification of sites as contaminated or potentially contaminated. It is outside the scope of this section to compare the risk levels that are used in the individual approaches. It is planned that this subject will be dealt with in follow-up work.

The present study is a desk study. A detailed comparison of the reviewed methods would demand concrete implementation in the field in the case of site investigation and testing at the strategic and regulatory level in the case of site identification.

3.2. Introduction

Twelve of the surveyed countries have issued guidelines at a national or regional level to support the process of identification and investigation of (suspected) contaminated sites. The guidelines describe how the identification process has to be carried out and which procedures and tools are to be used. In general most emphasis is put on guidelines issued at the national level. In some cases guidelines issued at the sub-national level have been taken into account. This was the case for Germany, Belgium and Spain. Table 3.3-1 gives an overview of those countries and regions that are covered by this study and indicates the references of their current guidelines. The following survey gives an overview on guidelines regarding site identification and investigation at the regional level. The survey is not complete as for instance some of the German Länder covered that have issued guidelines are not covered.

Table 3.2-1: Overview of the countries and regions included in this survey

Country	National	Reference	Regional	Name of region
Austria	●	[204], [205]		
Belgium			●	Flanders [156], [220]
Denmark	●	[190], [192]		
Finland	●	[157-159]		
France	●	[160]		
Germany			●	Baden Württemberg [169-171] Hessen [163-167] Niedersachsen [124] Sachsen-Anhalt [161], [162]
The Netherlands	●	[172]		
Spain			●	The Basque country [66], [67]
Sweden	●	[179], [180]		
Switzerland	●	[288]		
United Kingdom	●	[144], [145], [182], [183]		
Norway	●	[174], [175]		

Also at the international level initiatives have been taken to work out guidelines for site identification and investigation. The International Standardisation Organisation's (ISO) sub-committee ISO/TC 190/ SC 2 elaborated some standard proposals of which especially the following draft standards are of relevance for this survey 'design of sampling programmes' [217], and 'procedure for the investigation of urban and Industrial sites with regard to soil contamination' [218]. The Nordic countries have jointly worked out a guideline [219] 'Nordic guidelines for chemical analysis of contaminated soil samples' that gives a proposal on chemical analysis and sampling procedures.

3.3. Basic principles for identification and investigation of contaminated sites

Among EU and EFTA Member States a variety of different factors have been taken into account for the design of a contaminated sites policy. Although the countries have much in common and contamination in many cases is likely to involve similar problems, there are important differences among the individual country approaches.

The history of industrial development of a country, population density, and the availability of water resources are only some of the range of factors that have determined the shape of policy on contaminated sites and thus the methodologies for site identification and investigation. Apart from differences in procedures basic information may differ in type and quality and technical investigations may be based on different methods and assumptions.

In line with this, the following questions describe the most important issues relevant for the outcome of the process of site investigation and identification and for the country comparison of total figures on the number of sites considered to be (potentially) contaminated.

1) How does the preliminary identification take place: systematic approach or ad hoc?
2) Which sites are included in the process, e.g., type of industry, types of hazard, types of present use, are small sites excluded? Is contamination that has taken place before or after a certain date excluded?
3) Which targets are considered relevant (land use, groundwater, surface water, buildings)?
4) At which step in the process may a site be considered to be potentially contaminated and at which step may it be considered to be contaminated?
5) Which types of contamination are relevant (chemical, biological, radioactive)?
6) Which types of effects are relevant (human toxicological, ecotoxicological, radioactive effects, physicochemical)?
7) What information is considered sufficient at the different steps (i.e. site identification, site investigation etc.)?
8) When is risk unacceptable (concentration of contamination/relation to land use) and when are sites regarded as (potentially) contaminated?

Most emphasis is put on addressing the problems related to the points 1, 2, 4, and 7, whereas the remaining issues will be handled in follow-up work.

3.3.1. Systematic or ad hoc identification process?

Major distinctions have to be made between the number of sites obtained by a systematic identification process compared to those obtained by an 'ad hoc' approach, where sites are only included if they show up as a result of sudden discovery of contamination, for instance in connection with building activities or contamination of drinking water.

In most of the countries with elaborated guidelines for site identification and investigation of (potentially) contaminated sites a systematic identification process has been initiated and in some countries also completed. The progress of systematic identification can vary among the Federal States but also among the regions of a country. The starting point of the identification process will most often be the identification of former or still operating industries which are

known to be potential sources of contamination. In the Flemish Region a special form of systematic identification is carried out. Identification is initiated by purchasing of land and ceasure of certain industrial activities. The authorities approve the sale of such properties only under the provision that minimum historical investigations are carried out.

Types of sites included in the process

Not all countries carry out systematic investigations of all activities that may possibly have caused contamination. Waste disposal and Industry are the two most important groups of potential sources for contamination. In the majority of EU and EFTA Member States both industrial sites and waste deposits are included in the systematic identification process. In some countries sites that are still in operation (both industrial sites and waste disposals) are excluded. Not all countries include former military sites in the systematic identification process. Table 3.3-1 shows which type of site is included by which country in a systematic identification process.

Table 3.3-1: Use of systematic methods for the identification of abandoned and operating waste disposals, industrial sites and military sites as of August 1999

	Industrial Sites		Waste disposals		Military Sites
	Abandoned	Operating	Abandoned	Operating	
Austria	●	●	●	●	●
Belgium[1]	●	●	●	●	●
Denmark[2]	●	●	●		●
Finland	●	●	●	●	●
France	●	●	●	●	●
Germany	●	●	●		●
Greece					
Ireland	●	●	●	●	
Italy	●	●	●	●	
Luxembourg			●	●	
The Netherlands	●	●	●	●	●
Portugal					
Spain	●	●	●	●	
Sweden	●	●	●	●	●
Switzerland	●	●	●	●	●
United Kingdom					
Iceland			●		
Liechtenstein					
Norway	●	●	●	●	●

[1] refers only to the Flemish region. And to contamination generated before 1994

[2] refers to contamination generated before the mid 1970's

3.3.2. How far has the identification process progressed?

When comparing the number of (potentially) contaminated sites it is relevant to consider how far the countries have progressed. For some countries figures on suspected and contaminated sites are available and in some cases figures on estimated totals are indicated. These data are presented in Table 3.3-2.

Table 3.3-2: Number of potentially and definitely contaminated sites in EU and EFTA countries as of August 1999 according to identified sites and estimated totals

	Potentially contaminated		Contaminated sites	
	Identified	Estimated total	Identified	estim. total
Austria	28 000	~80 000	135	~1 500
Belgium[1]	7 728	~14 000	8 020	n.i.
Denmark[2]	37 000	~40 000	3 673	~14 000
Finland	10 396	25 000	1 200	n.i.
France	n.i.	700 000-800 000	896	n.i.
Germany[3]	202 880	~240 000	n.i.	n.i.
Greece	n.i.	n.i.	n.i.	n.i.
Iceland	n.i.	300-400	2	n.i.
Ireland	n.i.	~2 000	n.i.	n.i.
Italy	8 873	n.i.	1 251	n.i.
Luxembourg	616	n.i.	175	n.i.
Netherlands	n.i.	110 000-120 000	n.i.	n.i.
Norway	2 121	n.i.	n.i.	n.i.
Portugal	n.i.	n.i.	n.i.	n.i.
Spain	4 902	n.i.	370	n.i.
Sweden	7 000	n.i.	2 000	n.i.
Switzerland	35 000	50 000	~3 500	n.i.
UK	n.i.	~100 000	n.i.	~10 000

n.i. = no information available

[1] PCS identified: 5 528/Flamish Region + 2 200/Walloon Region, PCS estimated: 9 000/Flamish region + 5000/Walloon Region, CS identified: 7 870/Flamish region + 150/Walloon Region. Figures of the Flamish Region regard contamination generated before 1994 and refer to grounds, one site can consist of several grounds.

[2] includes contamination generated before the mid 1970's,

[3] military sites are not included in this figure

A comparison of the number of identified sites to the estimated total clearly shows that most of the countries are in the beginning phase of the identification process.

3.3.3. Which types of hazards are included in the identification process?

The most common targets considered in connection with contaminated sites are land use, groundwater and surface water contamination. These targets are considered by those countries that have elaborated guidelines for site identification and investigation. Also building material is mentioned as a potential target in some countries (United Kingdom and Austria). On the basis of the available material it has not been possible to assess how prioritisation is carried out within and among the individual targets.

The following issues need to be clarified country-wise within the future work

- when is a site regarded as (potentially) contaminated (also when it does not constitute a risk at the present use)
- land use in relation to the quality of groundwater and surface waters

3.3.4. Level of information for the assessment of sites

As described in the following section 3.4 the identification process can be divided into a number of steps. There will be differences as to what information level the countries or regions may consider as sufficient for regarding a site as (potentially) contaminated.
Some countries do not define potentially contaminated sites at all. Mainly because of the fear that unfounded suspicions could lead to drawbacks such as the loss of value of a site. The United Kingdom and Denmark do not inventory individual sites as suspected sites. This does not mean that these countries do not carry out investigations in order to confirm a suspicion but that there is no official decision or declaration of individual sites at this level.

Comparability of information and assessment at each of the information levels
Irrespective of whether the assessment is based on historic information or on technical information the result will always depend on the content and the quality of the interpreted material.

Some of the important questions related to historical information would be:

- to what extent has information been filed and what are the possibilities of its access?
- were there industrial pollution control measures available and to what extent have they been implemented?
- to what extent and how detailed is the mapping of geological and hydrogeological conditions in the area?
- how often have aerial photos been taken?

Important parameters for the assessment of technical investigations are (1) sampling and (2) analysis of the contamination. Soil is a difficult medium to sample and analyse because in most cases it is very heterogeneous and the binding of contaminants to soil depends both on the type of contaminants and the inherent soil properties including soil type, redox condition, water saturation, etc.

Important issues related to technical investigations are:

- design of the sampling programme;
- choice of the sampling technique;
- how storage and treatment of samples are carried out;
- choice of analytical methods (which substances and parameters are covered by the investigation and which investigation methods are used).

ISO has taken initiative to establish standards for all these four issues but till now the coverage of specific investigation methods has been very limited. The Nordic Countries have jointly issued recommendations on soil analysis. However, not all the methods included have been validated yet.

3.4. The main steps of site identification and investigation

It is a common characteristic of the systematic approaches that they are subdivided into a number of steps. A stepwise approach ensures that the economic resources are used as efficiently as possible. In addition 'large scale' benefits can be gained by investigating a great number of sites with the same characteristics (for instance sites of the same industrial branch operated in comparable ways, and/or being located in the same geographical area and thus to a large extent having similar geological and hydrogeological conditions).

Corresponding to the first two work units 'suspicion' and 'investigation of evidence' as defined in section 1 of this report the corresponding structures are as follows:

It applies to all countries or regions that have issued general guidelines on site identification and site investigation that the first identification is followed by a stepwise approach including the following elements and in the following order:

1) historical surveys of the potential contamination;
2) limited technical investigation of the possible contamination;
3) detailed investigation with the aim of deciding on remedial treatment.

The international standardisation organisation ISO has prepared a draft standard that gives guidance on the investigation of urban and industrial sites with regard to soil contamination (ISO 10381, part 5). The draft standard is divided into three main steps:

1) Preliminary survey
2) Preliminary site investigation
3) Main site investigation

The content of the three main steps of the draft standard corresponds to the countries' approach to identification and investigation of contaminated sites as presented above. The standard does not deal with the preceding process on how the first identification of potentially contaminated sites takes place. The terminology from the draft ISO standard has been used in the following description of the identification and investigation process and for the description of the methodologies for site identification in the country profiles of this report (see Part3).

The individual country approaches do not completely correspond to these three main steps. In some cases these steps are additionally sub-divided, or a few technical investigations are already carried out in connection with the preliminary survey.

3.4.1. Preliminary survey

On the basis of available information the preliminary survey has the goal of assessing whether potentially polluting activities have taken place and whether contamination can be suspected. The results of the preliminary survey will in most cases classify a site as a suspected contaminated site.

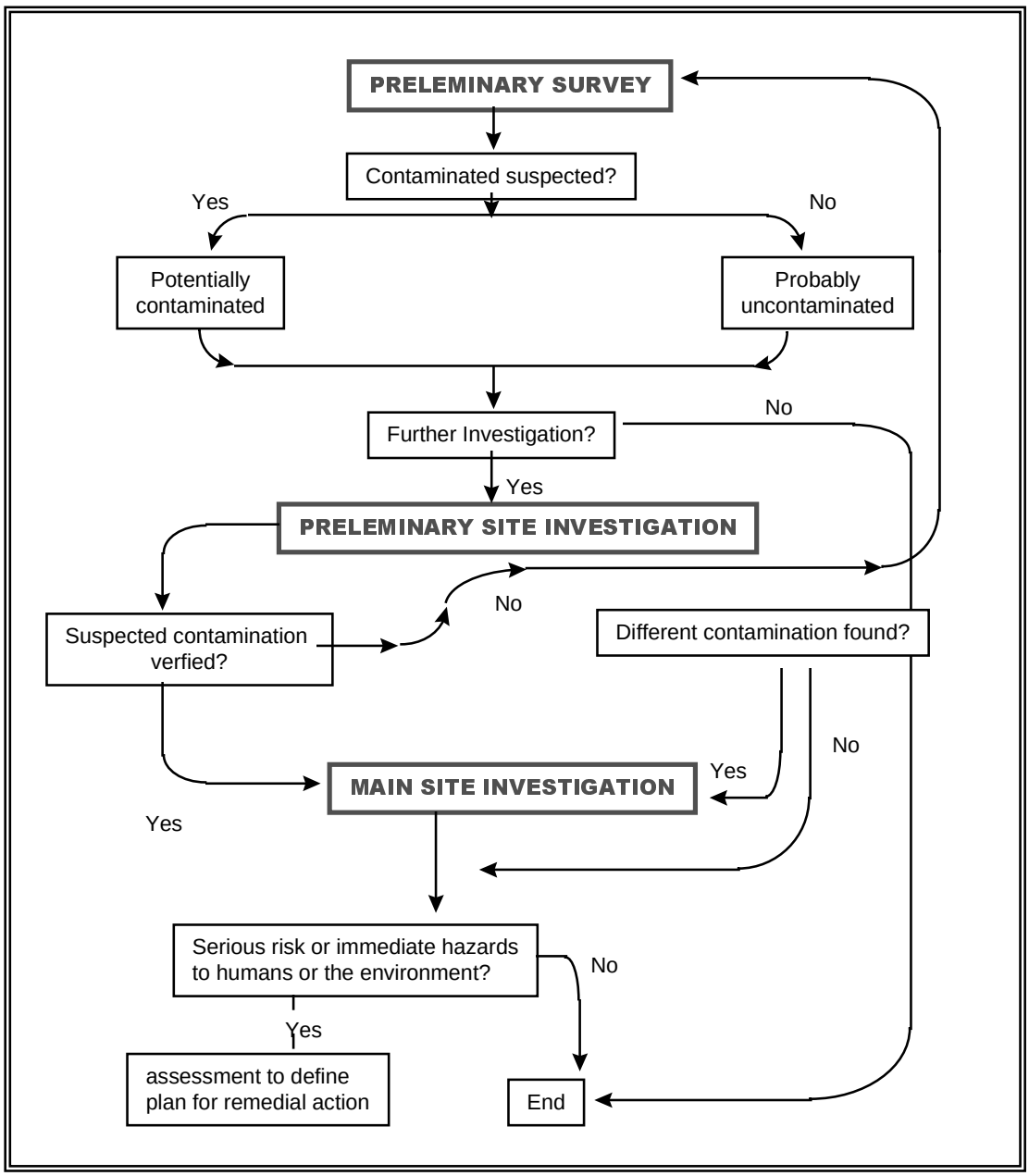
Draft ISO standard
According to the draft standard (ISO 10381, part 5) the aim of the preliminary survey is to determine the type and location of polluting substances. It includes the following basic steps:

- examination of the relevant history of the site;
- formulation of a hypothesis on spatial distribution, possible extent and type of contamination;
- conclusions with regard to further investigations.

The information on the history of the site should include data on past and present land use of the site, soil stratification and hydrogeology. The information should be obtained by: visiting the site (field observations), the use of detailed maps, detailed examination of public and private archives, interviewing current or former workers, neighbours, environmental activist groups, water companies and water authorities, and by evaluating old and recent aerial photographs.

On the basis of the collected information a hypothesis of the nature and distribution of the contaminants on the site should be proposed and lead to one of the following assessments:
- Hypothesis of a 'probably uncontaminated site';
- Hypothesis of a 'potentially contaminated site with a homogeneously distributed contamination';
- Hypothesis of a 'potentially contaminated site with a heterogeneously distributed contamination, where point-sources can be localised'
- Hypothesis of a 'potentially contaminated site, with a heterogeneously distributed contamination, where point-sources can not be localised'.

Figure 3.4-1: The major step in the identification process. From the draft standard ISO 10381, part 5



In case of a potentially contaminated site the possible contaminants should be determined. In some cases the spatial distribution of the contamination might vary from one part of a site to the other. Consequently a different hypothesis must be made for the individual parts of a site.

National guidelines

The preliminary survey is the first study to examine material of individual sites. The study will in most cases include a prioritisation process in order to decide which sites most urgently need to be investigated in detail. It is a general characteristic of all the guidelines for site identification and investigation that the preliminary study is supposed to be based on already available and accessible information.

In most cases the procedures for waste deposits and industrial sites vary remarkably. The identification of waste deposits will be based primarily on aerial photos, whereas the

evaluation of industrial sites will generally be based on records of buildings, approval of operating processes, accidents, etc. Table 3.4-1 includes an overview of those elements recommended in the guidelines. In some countries the preliminary survey is divided into two parts. After part one a first evaluation is carried out in order to eliminate the negligible cases. For these countries the different steps are indicated in Table 3.4-2 by '1' (first step in the preliminary study) and '2' (second step in the preliminary study) respectively.

The terms applied in the individual country guidelines do not completely correspond to those indicated in Table 3.4-1. In some countries the guidance for collection of information is very specific and outlines different types of parameters that should (as far as possible) be included. In other guidelines more general expressions are used. To simplify the matter the terms indicated in Table 3.4-1 are general terms.

Annex 1 contains a description of the content of the different headings in Table 3.4-1.

There are many similarities between the types of information included in the preliminary survey. In contrast to other countries, the Netherlands and France already include the possibility of technical site investigations at this level. Regarding these two countries and Sweden it has not been possible to judge whether the preliminary survey forms the basis for the classification of sites as potentially contaminated sites.

Although there is a striking degree of comparability between the information included in the preliminary surveys, it should be emphasised that Table 3.4-1 only provides an overview of the included information categories. Not only among countries but also within countries great variations in the quality and the amount of available information are found.

Whether the preliminary survey in general corresponds to the definition of suspected contamination or whether sites are automatically regarded (and counted) as 'potentially contaminated sites' from the moment they are included in the identification process remains unclear.

Finally it is not clear whether the classification of sites as 'suspected contaminated' automatically applies to all sites that are considered in this process.

In many countries (e.g. Sweden, France, Germany) prioritisation procedures are used to assess the obtained results. Prioritisation is mostly based on knowledge about the type of industry and the quality of performance during operation, the handled substances, present land use at the site, and the geological and hydrogeological conditions of the site and its surroundings. Some countries, such as the Netherlands apply limit values at this step of the procedure provided that information on contamination is available.

3.4.2. Preliminary investigation

Preliminary investigations are carried out to confirm the existence of contamination. In most cases the results of the preliminary investigation form the basis to definitely classify sites as contaminated.

A variety of issues will influence the results of the preliminary investigation, the major issues being:

- sampling patterns;
- number and type of samples;
- depth of the boreholes;
- quantity of the samples;
- transport and storage of samples;

- selection of substances to be analysed;
- treatment of samples.

In the following, different approaches have been compared and evaluated by focusing on selected issues such as the sampling patterns, number and type of samples, depth of the boreholes and recommendations to use mixed samples.

Draft ISO standard

According to the draft standard (ISO 10381, part 5) the preliminary site investigation aims to verify the presence of contaminated soil, including the identification of polluting substances, their distribution, their concentration levels and the location of such substances in the soil profile.

The preliminary investigation consists of the following basic steps:

1) design of a strategy to test the hypothesis as made in the preliminary survey;
2) carrying out the investigations including the necessary fieldwork;
3) determining the validity of the hypothesis (accept or reject);
4) drawing conclusions with regard to further investigations.

The recommendations on how to carry out the investigation depend on the hypothesis of the spatial distribution of contaminants. The standard provides guidance as to which substances shall be selected for chemical analysis, the depths of boreholes, selection of soil layers to be sampled, sampling patterns, number of samples and when mixed samples may be used. It is recommended to subdivide the site into sampling areas according to the expected spatial distribution of contamination.

If the site is considered to be 'probably uncontaminated' it is recommended to carry out systematic sampling and analysis for a fixed set of substances. A systematic sampling grid is preferred. Different soil layers should be investigated separately. Soil sampling should be conducted at a standard interval of 0.5 m in the vertical dimension and not exceed one metre. The number of sample spots to be chosen is not fixed but should be proportional to the total surface area of the site and at least four samples are to be taken of the vertical soil profile.

Table 3.4-1: Information included in the preliminary survey pr. country based on available national or regional guidelines for site identification and investigation

	Austria	Belgium: FL	Denmark	Finland	France	Germany: BW	Germany: HES	Germany: S-A	Germany: N-S	The Netherlands	Spain: BASQ	Sweden	United Kingdom	Norway
1. Localisation	●	●	●	●	●[1]	●[1]	●[1]	●[1]	●	●	●	●	●	●[1]
2. Industry:					●[1]									
- type	●	●	●	●	●[1]	●[1]	●[1]	●[1]	n.a.	●	●	●	●	●[1]
- operation period	●	●	●	●	●[1]	●[1]	●[1]	●[1]	●	●	●	●	●	●[2]
- size of site	●	●	●	n.a.	●[1]	●[1]	●[2]	●[1]	●	●	●	●	●	●[1]
- buildings/facilities	●	●	●	n.a.	●[1]	●[2]	●[2]	●[1]	●	●	●	●	●	●[1]
- processes	●	●	●	●	●[2]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
- production volume	●	●		●	●[2]	●[1]	●[2]	●[2]	●	●	●	●	●	●[1]
3. Legal conditions														
- owner	●	●	●	●	●[1]	?	●[2]	●[1]	●	●	●	●	●	●[1]
- permissions, etc.	●	●	●	●	●[2]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
4. Potential contaminants.		●												
- types	●	●	●	●	●[1]	●[1]	(●[1])	●[1]	●	●	●	●	●	●[2]
- amounts	●	n.a.		●	●[2]	●[2]	●[2]	●[2]	n.a.	●	●	●	●	●[2]
5. Site characteristics:														
- geology	●	●	●	●	●[2]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
- hydrogeology	●	●	●	●	●[2]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
6. Present land use														
- site	●	●	●	●	●[1]	●[1]	●[1]	●[1]	●	●	●	●	●	●[1]
- surroundings	●	●	●	●	●[1]	●[1]	●[1]	●[1]	●	●	●	●	●	●[1]
7. Targets at risk:														
- groundwater	●	●	●	●	●[1]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
- surface waters	●	●	●	●	●[1]	●[2]	●[2]	●[2]	●	●	●	●	●	●[1]
8. Former investigations	●	●	●	●	●[2]	●[2]	●[2]	●[2]	n.a.	●	●	●	●	●[2]
9. Accidents	●	●	●	●	●[2]	●[2]	●[2]	●[2]	n.a	●	●	●	●	●[2]
10. Site visit	●	●		n.a.	●[2]	●[2]	●[2]	●[2]	n.a.	●	●	●	●	●[2]
11. Limited technical investigation	No	Possible	No	●	No	No	No	No	No	Possible	No	No	No	No
12. Aerial photos	●	n.a.		n.a.	●[2]	●[2]	?	●[2]	n.a.	n.a.	●	n.a.	n.a.	●[2]
Information level ≈ Suspected contaminated site	●	●	(●)[3]	●	?	●	●	●	●	?	●	?	No[3]	●

[1, 2] The identification level corresponding to the preliminary survey is in some countries divided into step 1 (●[1]) and step 2 (●[2]).

[3] Denmark and the United Kingdom do not inventory suspected sites

n.a: available data did not enable the authors to see whether or not the information was included in the preliminary survey.

If groundwater is available in the sub soil sampling should be carried out for as many water carrying layers as can be recognised. In case a deep-water body is involved, consideration should be given to the collection of samples at different depths within the water column.

In addition it is described how to extend the sampling area by taking mixed samples. The caution to be taken and the possible drawbacks of such sampling, i.e. dilution of contamination, are specified.

The investigation strategy for a 'potentially contaminated site' should focus on the expected contaminants at the site in question and their potential locations. In general the number of samples should be in proportion to the surface area.

- Homogeneously distributed contamination: systematic sampling of the complete area. Confirmation of contamination may be achieved with relatively few samples. Sampling of each soil layer plus any material of interest observed at each sampling location. Mixed samples are not recommended for soil or for groundwater. If the samples of soil layers from different locations appear similar the number of samples analysed can be reduced.
- Heterogeneously distributed contamination, known locations of hot spots: systematic sampling of the potentially contaminated locations. A minimum of four points should be sampled as near as possible to each suspected hot spot.
- Heterogeneously distributed contamination, where the source of contamination is unknown: Sampling procedures as for homogeneously distributed contamination, but the majority of samples will require analysis.

It is recommended to take groundwater samples both 'upstream' and 'downstream' of those locations that are suspected to be contaminated, the majority of samples being taken downstream.

National guidelines
Most of the national guidelines recommend starting the preliminary investigation by setting up a hypothesis for the expected distribution of contamination. The hypothesis should be used as the basis for developing a sampling strategy. There are differences among the guidelines with respect to the recommended point in time for making a hypothesis; some establish such a hypothesis as final step of the preliminary survey and some as the first step of the preliminary investigation. The preliminary survey may be based on a suspicion regarding the actual type of contamination, leading to a strategy for analysis of the contamination. Some guidelines (e.g. the French) emphasise the use of cheap field methods, since in France confirmation of the concentration **level** is of primary importance at this step in the process.

The Finnish [158, 159], French [160] and Norwegian [175] guidelines for setting up sampling programmes give very general recommendations on how to set up sampling programmes, and refer to the principles of the draft ISO standard 10381, part 1 (Guidance on design of sampling programmes).

The guidelines issued by the German Federal States [161, 165, 170] and Austria [205] give guidance on how to apply different grids considering the type and distribution of the expected contamination. None of these guidelines gives specific recommendations on the number of soil samples to be taken. Sampling should be carried out to a depth that would cover the extension of the contamination. Provided that investigations are exclusively dedicated to examine direct soil exposure, the Austrian guideline recommends taking surface samples to a maximum depth of 1 meter.

With regard to groundwater sampling all guidelines demand sampling up-stream and down-stream of the expected contamination. Most of the guidelines refer to one sample up-stream and 1-2 samples downstream.

The Flemish Region [224], Denmark [192], the Netherlands [172], and the Basque country [186] relate the number of samples to be taken to the expected distribution, the knowledge of the contamination and the size of the site. The sampling strategies are based on different principles and are thus not readily comparable.

The Netherlands and the Basque country classify sites in three groups which are, to a large extent, in line with the draft ISO standard (ISO 10381, part 5) and in agreement with the standard consider a fourth group, namely a strategy for sites that are not expected to be contaminated.

The Nordic countries have jointly issued a guideline on sampling and analysis of contaminated sites. The strategy is mainly based on part 1 and 5 of the draft ISO standard as described in the review of the standard under paragraph 3.4.1. However, on some issues the guideline gives more specific guidance, e.g. on the number of samples to be taken.

Table 3.4-2, Table 3.4-3, Table 3.4-4, and Table 3.4-5 give an overview of major sampling programme features of those countries that have further specified sampling procedures. The sampling programmes are divided into four main hypotheses for the spatial distribution of contamination and are presented together with the corresponding recommendations included in ISO 10381, part 5 (draft) and the Nordic guideline.

Table 3.4-2 addresses methodology for sites that are expected to be uncontaminated. Nearly all national guidelines agree on the use of systematic sampling patterns and on the depth of sampling. In the draft ISO standard and the Nordic guideline the sample depth is not given specifically, but it is recommended that topsoil, subsoil and underground is sampled until the bedrock has been reached. Concerning the number of samples there are great differences among the countries. In this respect only the Dutch and the Danish guidelines are comparable. The guidelines of the Flemish Region and especially of the Basque country recommend relatively few samples.

The guidelines of the countries and regions do not advise against using mixed samples. Both ISO 10381 (part 5) and the Nordic guideline allow the possibility to take mixed samples, although they stress the disadvantages involved of such techniques.

The guideline of the Flemish Region is the only one that gives advice on the number of groundwater samples to be taken.

Table 3.4-2: Methodology for sampling at sites that are not expected to be contaminated. Only countries that give specific guidance on sampling are included

	Sampling pattern	Number of soil samples (number analysed)	Depth of sampling (m)	Analysis of mixed soil samples	Number of Groundwater samples
ISO 10381, part 5	Systematic	-		Yes	-
Nordic Guideline	Systematic	-		Possible (max. 10 samples)	-
Flanders	Systematic	9 (6) per ha	0.5 -2 meter	No	1 ha: 3
Denmark	Systematic	400 m^2: 5-10	1 meter (special conditions also exceeding 1m)	Yes	-
The Netherlands		20 per 1.000 m^2	2.5 – 3 meter	?	Not determined
The Basque country	Regular (Herringbone grid)	20 per ha	?	No	?

Table 3.4-3 gives an overview of the sampling strategies for investigation of homogeneously contaminated sites. The ISO standard and the Nordic guideline recommend a systematic grid whereas the Basque country recommends a regular sampling grid.

With regard to the number of samples there is agreement among the guidelines from the Flemish Region, the Netherlands and the Basque country in connection with preliminary site investigation. As a practical limit the Nordic Guideline suggests the use of spatial units with a (maximum) size of 1 000 m^3. In case of a sampling depth of 1 meter this would correspond to a maximum sampling area of 1 000 m^2 compared to the size of bigger sampling areas in the national guidelines. Only the Dutch and Danish guidelines give specific recommendation on the sampling depth whereas the other guidelines refer to the expected extension of the contamination.

The Flemish Region and the Netherlands are the only ones, which give recommendations with regard to the number of groundwater samples. The Flemish Region is in line with Finland, France, the German Federal States, Austria, Sweden and Norway in recommending 2-3 samples up and down stream of the contamination, whereas the Netherlands recommend to take 6 groundwater samples.

Table 3.4-3: Methodology for sampling of sites expected to be homogeneously contaminated. Only countries that gave specific guidance on sampling are included

	Sampling pattern	Number of samples (number analysed)	Depth of sampling (m)	Analysis of mixed samples	Number of Groundwater samples
ISO 10381, part 5	Systematic	Proportional to size of site	Through full depth of site or to natural ground	No	-
Nordic Guideline	Systematic	Min.5 per max. 1,000 m^2.(if the sampling depht is 1 meter)	The part expected to be contaminated	No	Up and down stream of contamination
Flandern		<200 m^2: 4 1 ha: 6 (4)		Yes	<200 m^2: 2 1 ha: 3
Denmark		400 m^2 : 4 40,000 m^2: 12	0,05 – 0,2 m (diffuse cont. Areas)		
The Netherlands		1 ha: 6	0.5 – 2		6
The Basque country	Regular (Herringbone)	1 ha: 6	The part expected to be contaminated		

Table 3.4-4 addresses methodology for sites where the contamination is heterogeneous and the source localised. In contrast to sites with homogeneously distributed contamination the sampling strategy focuses on areas that are expected to contain hot spots of contamination and hence demands less intensive sampling for the other parts of the site.

Nearly all countries agree on a systematic sampling pattern, and the Basque country recommends that the sampling takes place along the direction of the expected maximum concentration. There is an agreement between Denmark, the Netherlands, the Basque country and the Nordic Guideline to take a minimum of 4 samples per point source, whereas the Flemish Region recommends 1-3 samples per hot spot. As for homogeneously distributed contamination only the Netherlands gives specific advice on the sampling depth.

Table 3.4-4: Methodology for sampling of sites where the contamination is expected to be heterogeneously distributed and the source can be localised. Only countries that give specific guidance on sampling are included.

	Sampling pattern	Number of soil samples (number analysed)	Depth of soil sampling (m)	Analysis of mixed samples soil	Number of groundwater samples
ISO 10381, part 5	Systematic	Proportional with size of site	To the full depth of site or to natural ground	No	-
Nordic Guideline	Systematic	min 4 near each hot spot. If more than one hot spot min. 1 per hot spot	The part expected to be contaminated.	No	min. 4
Flanders	Systematic	1-3 per point source			1
Denmark	Systematic	4-5 (covering 25 m^2)	Dependent on contamination and target at risk.	No	_
The Netherlands		≥4	2.5 – 3 meter		3-5
The Basque country	Along direction of max. conc. of expected contamination	>4 per point source		No	?

Finally Table 3.4-5 includes an overview of guidance for sampling at sites with a heterogeneously distributed contamination where the location of the source is unknown. The probability of finding a hot spot of which the location is unknown depends on the size of the contamination. The guidelines from the Netherlands, the Basque country and the Nordic Guideline base the sampling strategy on the expected size of the contamination.

The Dutch guideline describes a sampling strategy that can be applied to sites of which not more than 5 – 10 %are contaminated. The Basque guideline refers to a formula to calculate the number of samples. Assuming a relative size of contamination at 5 and 10 %and a site size of 1,000 m^2 the number of samples corresponds to the number of samples recommended in the Dutch guideline.

The Nordic guideline distinguishes between significant and not significant contamination. A contamination is defined as significant if the volume of the contamination exceeds 25 m^3. If the contamination is considered to be significant a minimum of 4 samples is recommended. If the maximum spatial unit (1 000 m^3) defined in the Nordic Guideline is used, it will result in a clearly less intensive sampling than the Dutch and the Basque guidelines. When determining the number of required samples the guidelines from Denmark and the Flemish Region do not refer to an assumed relative area of contamination. The Danish guideline is in line with the Dutch and the Basque guidelines, whereas the number of samples recommended by the Flemish Region is in between the Nordic Guidelines and the other guidelines.

If a non-mobile contamination according to the Nordic Guideline is considered to be insignificant (less than 25 m^3), the contamination is treated like a homogeneously distributed contamination. Mobile substances regarded as insignificant are to be investigated indirectly by investigation of groundwater. The Dutch guideline treats sites of a size not exceeding 100 m^2 as homogeneously distributed contamination where the locations of the hot spots are known.

Table 3.4-5: Methodology for sampling of sites where the contamination is expected to be heterogeneously distributed and the location of the source is unknown. Only countries that give specific guidance on sampling are included.

	Sampling pattern	Number of soil samples (number analysed)	Depth of sampling (m)	Analysis of mixed soil samples	Number of Groundwater samples
ISO 10381, part 5	Systematic	-	to full depth of site or to natural ground	No	-
Nordic Guideline	Systematic	s: min 4 samples is: groundwater/ ≈probably uncontaminated			
Flanders	Systematic	<200 m^2: 5 10 – 20,000 m^2: 8	Suspected contaminants: max. 1 meter not suspected contaminants min. 0.5 meter	No	<200 m^2: 2 1-2 ha: 3
Denmark	Systematic, concentrated in areas that have high probability of contamination	10-25 per 400 m^2	Dependent on contamination and target at risk.	No	_
The Netherlands		1,000 m^2: (5%[b]): 24 (10%[b]): 14	2.5 – 3 meter		Not used
The Basque country	Regular	Number = 4 + A/ a	To the expected distribution of the contamination	No	?

s: significant contamination;
is: insignificant contamination;
A: size of site;
a: expected size of contamination,
b: relative size of contamination compared to the size of the site

Likewise, guidance on the content of the analytical programme varies from country to country. Some countries demand a basic set of analyses to be carried out, whereas others recommend that the analytical programme be set up in view of the expected contamination. The majority of countries restrict their recommendations to the investigation of soil parameters, hydrogeological and geological investigation and chemical analysis of soil and groundwater. The Swedish guideline is the only one that includes biological testing in the standard analytical programme intended for specific sites.

Finally it can be concluded that already at the level of strategic planning there are similarities but also differences. More differences are likely to occur at the level of technical investigations. However to sum up it can be said that all countries have some important features in common, for example:

- sites are classified as contaminated on the basis of technical investigations;
- sampling strategies are set-up on the basis of the expected distribution of the contamination.

3.4.3. Main site investigations

The next step in the process is the main site investigation provided that the contamination has been confirmed.

According to the national guidelines for site identification and investigation the goal of the main investigation is to determine the need for remediation or other measures to eliminate or reduce the exposure to the contamination. In line with this principle the draft ISO standard (ISO 10381, part 5) describes the two major goals of main site investigation:

- to define the extent of the contaminated area and the degree of contamination;
- to assess the risk s of the involved hazards.

Most of the countries give detailed guidance on specific methods regarding particular conditions.

The investigation process will thus be intensified leading to relatively detailed sampling both horizontally and vertically.

The review of main site investigations will be part of the follow-up study.

3.5. Conclusions

Twelve of the 18 surveyed countries have started a systematic identification process covering industrial sites and/or waste deposits. In 9 of the countries military sites are also included in the process. Most of the approaches include both abandoned sites and sites in operation. Germany and Denmark exclude waste deposits in operation. It has not been possible within this review to assess which types of industries are included in the identification process. An evaluation of this issue may reveal further differences in the coverage of the identification process.

11 of the 12 countries that carry out systematic investigations on contaminated sites have issued guidelines either at a national or at a regional level with the objective to support the identification process. The present review is primarily based on these guidelines and the draft standard ISO 10381, part 5 ‘procedures for investigation of urban and industrial sites with regard to soil contamination'.

It has not been possible to obtain information describing how far the identification process has proceeded in all countries. However, the information available reveals that the individual countries are at different levels of progress within this process. Consequently figures on the number of suspected or contaminated sites do not represent the scale of the problem but only give a picture of how much efforts have already been made in this area.

Although the main procedures for identification and investigation of contaminated sites in the reviewed countries follow the same general line, there are significant differences.

Almost all countries regard land use, groundwater and surface waters as potential targets for contamination. On the basis of the available information it has not been possible to assess whether only certain types of current land use are considered or also possible future land uses. With regard to groundwater, it is not clear whether the risk for groundwater contamination is restricted to certain areas only, e.g. specific drinking water areas.

The process of site identification and investigation follows a stepwise procedure including the following elements in the following order:

- **Preliminary survey**: Historical survey of the potential contamination. In most cases sites are defined as potentially contaminated sites;
- **Preliminary site investigation**: Limited technical investigation of the possible contamination. In most cases this step defines sites as contaminated;
- **Main site investigation**: Detailed investigation with the purpose of deciding on remedial treatment.

There is much agreement as to which pieces of information should be included in the **preliminary survey**. However, the quality, exact type and amount of information varies significantly from country to country and even within countries. The classification of sites as potentially contaminated sites also differs significantly among countries. Regarding some particular countries it was not possible to judge whether sites included in the identification process are automatically classified as potentially contaminated sites or not. In other countries limited technical investigations are already included at this level.

The main principles and intentions for the **preliminary investigation** are in general very similar. For most countries the investigation level is described as a very limited investigation where only a few samples are analysed with the main aim of confirming the presence of contamination. In all countries the investigation is based on the expected spatial distribution of the contamination.

Several countries give only general guidance on sampling patterns whereas others give more specific guidance, e.g. on the number of samples to be taken. The comparison of the latter revealed similar sampling intensities in the majority of cases.

All countries base the decision to define a site as contaminated on the results of technical investigations. However, within this study it has not been possible to compare the content of these investigations.

Furthermore, an evaluation of the different approaches of the step **main site investigation** or of the items covered by risk assessment that are relevant for site identification have not been part of this study.

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4. Conclusions

The existence and availability of data on contaminated sites have been investigated within the survey presented in this report. In line with expectations the obtained data are very heterogeneous. However, the survey gives an overview of the currently applied systems and the available data and will facilitate the establishment of a European framework for data collection and assessment.

Soil and land development are subject to the subsidiarity principle. This fact is very well reflected by the obtained results. A common European contaminated sites policy does not exist, although interest around this issue is increasing. This fact influences the establishment of a European data collection framework in the way that it:

- will need to respect the national differences, and
- can only be based on voluntary commitments.

The major goal of the future follow-up work is to give a comprehensive overview of the problems posed by contaminated sites by establishing a European data collection and assessment system in line with the current policy background.

The results from the first survey will be reviewed and completed. The definition of contaminated sites indicators will be the central issue of the future work, and furthermore, the testing of such indicators in volunteering European regions. The monitoring of contaminated sites is a demanding process; many countries have only recently started to set up monitoring systems. In order to be able to describe in detail the problems posed by contaminated sites at a European level it will be necessary to find solutions for these data gaps. Methods to better estimate the contaminated sites situation will also be needed.

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Annex 1 Explanation of data categories included in the preliminary survey

In the aim of comparing the types of data/information countries include in the preliminary survey, 12 categories are set up:

1. Localisation:
   A geographical identification of the site takes place either in the form of identifying the address and/or by identifying map projections coordinates as for instance UTM.

2. Industry:
   From a historical viewpoint information is collected on all present or historical industrial activities at the site:
   - type: the branch of industry;
   - operation period;
   - size of site: including the area limitations of the different industries that have been operating at the site;
   - buildings/facilities: where are or have buildings, technical equipment, installations, tanks, etc. been situated;
   - processes: which types of processes have been used at the site, details about the production process, which substances/products were used, production of waste, handling, storage;
   - production volume: may be measured in many ways e.g. as the size of the production or number of employees.

3. Legal conditions:
   - owners: information on owners, users, etc. in the course of time;
   - permissions, etc.: could be permissions from authorities for certain industrial activities.

4. Potential contaminants:
   - types: information on materials, substances, products either used in the processes or waste products derived from the activities. The information could either be collected from the individual industrial firms or as general knowledge based on the type of industry;
   - amounts: could either be indirectly based on the size of the industry, or on the information from the accounts of the industry.

5. Site characteristics:
   - geology: will often be based on regional soil maps and other regional information and seldom on data from the individual site;
   - hydrogeology: will often be based on regional maps of the hydrogeological conditions, level of groundwater table, etc.

6. Present land use
   - site: land use at the site;
   - surroundings: land use in the neighbouring area.

7. Targets at risk:
   - groundwater: information on present or planned use for drinking water, general information on the quality;
   - surface waters: existence of nearby surface waters.

8. Former investigations:
   - investigation of the site, or of its neighbourhood.

9. Accidents:
   - knowledge about accidents that have taken place at the site.

10. Site visit:
    - a visit of the site with the purpose of confirming collected information on buildings, etc. and giving an impression of the conditions on the site, vegetation damages, etc.

11. Limited technical investigations:
    - field test or possibly a few samples for chemical analysis.

12. Aerial photos:
    - use of aerial photos, present and historical.