Appendix A - Abbreviations and Glossary

Abbreviations	**ALARA**	As Low As Reasonably Achievable (Netherlands)
	ANPA	Agenzia Nazionale per la Protezione dell'Ambiente (Italy)
	ASTM	American Society for Testing and Materials
	BAT	Best Available Technology
	BATNEEC	Best Available Technique Not Entailing Excessive Costs
	BEP	Best practice from the perspective of the environment (Finland)
	CARACAS	Concerted Action on Risk Assessment for Contaminated Sites in Europe
	CEN	European Commitee for Standardization
	CHARM	Chemical Hazard Assessment and Risk Management (Norway)
	CLARINET	Contaminated Land Rehabilitation Network for Environmental Technologies
	CLEA	Contaminated Land Exposure Assessment (UK)
	COCs	Contaminants of Concern
	CRBE	Centre for Research into the Built Environment
	CSO	Contaminated Sites Ordinance (Switzerland)
	DEFRA	Department for the Environmental, Food and Rural Affairs (UK)
	EA	Environmental Agency of England and Wales
	EC	Environmental Code (Sweden)
	EMA	Environment Management Act (Netherlands)
	EPA	Environment Protection Agency
	EQS	Environmental Quality Standard
	ESi	Environmental Simulations International
	EUSCLEA	modified version of CLEA software (Basque Country-Spain)
	FEI	Finnish Environment Institute (Finland)
	FIV	Fixed Impact Values (France)
	GAOs	General Administrative Orders (Netherlands)
	GIS	Geographic Information System
	GPZ	Groundwater Protection Zone
	GTS	Generic Test Site
	HESP	Human Exposure to Soil Pollution (Netherlands)
	IARC	International Agency for Research on Cancer
	ICRCL	Interdepartmental Committee on the Redevelopment of Contaminated Land (UK)
	INERIS	Instiut National de l'Environnement Industriel et des Risques (France)
	JAGG	Regneark til risikovurdering af **J**ord, **A**fdampning, **G**as og **G**rundvand (Denmark)
	LNV	Ministry of Agriculture, Nature Management and Fisheries (Netherlands)
	NAPL	Non-Aqueous Phase Liquid (can be Light: LNAPL; or Dense: DNAPL)
	NEPP	National Environmental Policy Plan (Netherlands)
	NICOLE	Network for Industrially Contaminated Land in Europe
	OCRS	Ordinance for Charges for the Remediation of Polluted Sites (Switzerland)
	OEP	Operational Environmental Programme (Greece)
	OVAM	Public Waste Agency of Flanders
	PEC	Predicted Environmental Concentration
	PNEC	Predicted No-Effect Concentrations
	RAM	Risk Assessment Model (UK)
	RBCA	Risk-Based Corrective Action (US)
	RISC	Risk: Integrated Software for Clean-ups (UK)
	RIVM	National Institute of Public Health and the Environment (Netherlands)
	ROME	ReasOnable Maximum Exposure (Italy)
	RTW	Remedial Target Worksheet (UK)
	SCC	Serious Contamination Risk Concentration (Netherlands)
	SEPA	Swedish Environmental Protection Agency (Sweden)
	SFT	Norwegian Pollution Control Authority (Norway)
	SISIM	SIckerwasserSIMulation (Germany)
	SNIFFER	Scotland & Northern Ireland Forum For Environmental Research
	SPA	Soil Protection Act (Netherlands)
	SQG	Soil Quality Guidelines (Norway)
	SRA	Simplified Risk Assessment
	SUS	Sanerings Urgentie Systematiek (Netherlands)
	SYKE	Finnish Environment Institute (Finland)
	UMS	Umwelt Menschen Schadstoffe (= environment-humans-pollutants) (Germany)
	USEPA	U.S. Environmental Protection Agency
	V&W	Ministry of Transport, Public Works and Water Management (Netherlands)
	VCI	Valeurs de constat d'impact (France)
	VDSS	Valeurs de definition de source-soil (France)
	VIEs	Indicative Values for Assessment (Spain)
	VLAREBO	Flemish Regulations on Soil Remediation (Flanders)
	VROM	Ministry of Housing, Spatial Planning and the Environment (Netherlands)
	WHO	World Health Organisation

Appendix A - Abbreviations and Glossary

Modelling Terms	**Risk Assessment System**	A "package" of models used to assess contaminated land risks from multiple pathways.
	Risk Assessment Model	An algorithm or algorithms defined to assess risks from a single exposure pathway.
	Air Mixing Models	Algorithm that represents air mixing within the risk system
	Back Calculations	Risk System calculates a site concentration that will result in a pre-defined risk to the receptor
	Compliance Risk Assessment	Prediction of concentrations of contaminant levels at a receptor point for comparison to compliance criteria
	Ecological Risk Assessment	Risk System considers the risk posed to ecological receptors
	Groundwater Models	Algorithm that predicts the migration and spreading of impacts in groundwater
	Human Health Risk Assessment	Risk System considers the risk posed to human receptors
	Presence of NAPL	Risk System considers the presence of light and dense non-aqueous phase liquids
	Probabilistic Capability	The Risk System allows the input of parameters stochastically. Parameters for either source, physical or exposure parameters are represented by probability density functions instead of single values (deterministic).
	Surface Water Mixing Models	Algorithm to simulate the mixing of groundwater with surface waters within a System
	Vapour Transport Models	Risk System considers transport of vapour within the risk system
Exposure Assessment	**Direct Contact**	Indicates that the exposure pathway is direct from source to receptor, i.e. there is no fate and transport pathway. The source can be soil or groundwater
	Irrigation Model	Uptake of contaminants into vegetables irrigated with contaminated groundwater
	Shower Model	Direct exposure with impacted groundwater used as a source of water in the home.
	Inhalation of Indoor Air	Human inhalation of vapours in indoor air. The vapours originate from a source that is distant from the building. Impacts volatilise and migrate into the indoor airspace where they are inhaled
	Inhalation of Outdoor Air	Human inhalation of vapours in outdoor air. The vapours originate from a source that is distant from the exposure point. Impacts volatilise and migrate to the surface where they are inhaled
	Inhalation of Particulates/Dust	Human inhalation/ingestion of contaminated soil particulates that are small enough to become airborne
	Vegetable Uptake	Uptake of contaminants into vegetable grown on contaminated soil

Appendix B
European Risk System Review

Austria

Legislation

At present there is no specific Austrian Federal Law governing soil conservation or protection. However, it has been declared as a sub-domain of environmental protection in the Federal Constitution (Federal Legal Gazette no. 491/1984).

There is also an emphasis in Austria on preventing groundwater pollution; hence the Austrian Water Act (Federal Legal Gazette No. 215/1959, the Act as amended) is also of relevance.

Two further pieces of legislation are key in assessing the risk of contaminated land. The Industrial Code (Federal Gazette no. 50/1973) aims to protect the interests of neighbours and water bodies. The Waste Management Act (Federal Gazette no. 325/1990) is used to determine when waste collection and treatment is required.

The Act for the Cleanup of Contaminated Sites (Federal Legal Gazette No. 299/1989) is primarily meant to be a means of funding cleanup measures, and obliges the Federal Ministry (for Environment, Youth and Family) to coordinate the investigation, assessment and remedial response to contaminated sites at a national level.

Risk Assessment

Soil

Austrian Standard ONORM S 2088-2 (completed June 2000) provides assessment criteria for soil contamination, specifying that the focus should be on the direct effect of contamination to humans, plants and animals. Intervention values are provided for sensitive land uses such as residential areas, with screening values for other land uses.

Groundwater

Groundwater studies always include an assessment of the geology and hydrogeology of the site and its surroundings with regard to the possible migration of hazardous substances, including identification of relevant pathways and geological barriers. The degree to which a contaminated site causes, or could cause, changes in groundwater quality is assessed by evaluating the dispersal of hazardous substances in groundwater. To assist in the interpretation of chemical analysis results, screening values and intervention values are available, although they are not related to groundwater use.

Contaminants of concern and their likely environmental behaviour are assessed using analytical results from direct sampling. To help evaluate the potential for harm, reference values are provided for leachate concentration, soil gas concentration and 'total' contaminant concentration. These values were derived following a review of specialist literature, and of standards derived elsewhere, and take account of groundwater useage. The values are generally derived from drinking water standards.

Sites with contaminant levels below the screening values are determined not to pose potential risks. Where contaminant levels exceed the screening values the need for further investigation is indicated. These sites usually require the consideration of remedial action.

Reference values are considered to be no more than a support tool for the risk assessment of potentially contaminated sites. Any decision to be made should consider specific site conditions.

Implementation

No specific tools have been developed or recommended for carrying out site specific risk assessment. It was therefore concluded that there was no model available for inclusion in this study.

Belgium

Belgium is divided into the Flemish region, the Walloon region and the Brussels-Capital region, and the responsibility for environmental affairs and policy lies with each region. To date, the only full legislative framework for contaminated sites that has been adopted is in Flanders.

Flanders

Legislation

The "Soil Remediation Decree" came into force in Flanders in October 1995 (and was updated in 1998). Practical implementation of the Decree came into force in 1996 in the "Flemish Regulations on Soil Remediation" (VLAREBO). The regulations have been updated twice, in 2001 and 2002. The regulatory authority is OVAM, the Public Waste Agency of Flanders, which is responsible for soil contamination and remediation issues along with waste management.

The Decree sets out four stages or tiers of investigation that may be required at a contaminated site; preliminary soil investigation, quantitative soil investigation, soil remediation planning and remedial works.

Risk Assessment

The soil remediation regulations incorporate a risk assessment approach. All historical contamination undergoing the descriptive soil investigation are required to be assessed in terms of risk to human, environmental and ecological receptors.

No official documents oblige the use of a tiered approach, however, in practice a tiered approach is adopted.

Formulae used by the Dutch HESP model were adopted to derive soil clean-up values. A clean-up level is defined as the level at which serious harmful effects for humans or the environment may occur. Six land-use scenarios were identified (agricultural, urban, two types of recreational and two types of industrial). For each potential contaminant of concern, exposure calculations were performed, taking into account differing carcinogenic and toxicological effects of contaminants, to produce a tolerable daily intake.

Soil clean-up values for groundwater are represented by drinking water standards.

The methodology for conducting site specific risk assessments originates from the methodology used to derive the soil clean-up level.

Implementation

The risk assessment process determines levels which remediation must achieve. Risk evaluation is split into three sections – risks to human receptors, risks to animals, plants and ecosystems and risk of spreading.

For the assessment of risk to human receptors, an OVAM-recognised exposure system must be utilised. At present VLIER-humaan and CSOIL are the only recognised risk assessment exposure system in Flanders, although the RBCA methodology is under evaluation

There is currently no methodology for assessing risks to animals, plants or ecosystems.

The risk for spreading is covered in a methodology for the calculation of the distribution of pollutants with groundwater. It indicates where models have to be used, and what kind of models can be used. No particular models are recommended. It also indicates which parameters have to be considered in the decision on serious threat. Risk for spreading must also take into account the transport by air and to surface water.

Walloon

To date, no specific legislation for soil remediation exists for the Walloon region. However, contaminated soils are considered as waste and any rehabilitation of a site must be approved by the Minister of the Environment. Guidance on soil remediation is under development.

Brussels-Capital

To date, the existing legislations or guidance for soil contamination for the Brussels-Capital region are as follows:

- Regulation for petrol station (21 January 1999)
- Regulation for contaminated soil (4 July 2002). This is mainly based on the Flemish regulation and Flemish remediation values are considered.

Risk evaluation is split into three sections – risk to human receptors, risks to ecological receptors and risk of spreading. No specific models are recommended. Guidelines are under development.

Denmark

Legislation

The key legislations for addressing contaminated land in Denmark are the Contaminated Sites Act (revised 1996) and the Environmental Protection Act (amended 1996).

In 1998 the Danish EPA issued guideline on the remediation of contaminated sites. The guidelines encompass risk assessment of soil, water and evaporation to air. The Regional Authorities (counties and municipalities) are responsible for registration, investigation and remediation of contaminated sites. The Danish EPA provides guidance for this work.

Risk Assessment

Risk assessment is based on determining contaminant concentrations and comparing them with the quality criteria for soil, groundwater or air. If the concentration of a specific contaminant is found to exceed the relevant criterion the site is considered to present a certain risk to the environment and/or humans.

Groundwater
The estimated groundwater concentration at a distance from the site, within the aquifer, is compared to the groundwater quality criteria. Since nearly all drinking water is derived from groundwater in Denmark, groundwater protection has a very high priority. Standards for groundwater resources that are/or will be used for drinking water are based on drinking water standards.

Soil
The soil contamination at a site is compared with quality criteria, which are based on the land use. The type of land use (ie. very sensitive – residential property with garden or child care centre) also defines the exposure time and depth of utilisation (the vertical extent where the soil has to obtain the quality criteria). There are set 'cut-off' values and soil quality criteria defined for certain compounds.

Air
The vapour pathway is based on contaminant transport by diffusion through pore spaces and into buildings, only indoor air is considered. If the estimated contaminant concentration in indoor air exceeds the air quality criteria, the contamination is considered to present a risk.

Implementation

The Danish risk assessment model (JAGG) produced by the Danish EPA is based on the 1998 guidelines for remediation of contaminated sites. The model calculates the concentration of contaminants within soil, water and air via transport from a soil source through various media to predict receptor point concentrations for comparison to acceptable concentrations.

Finland

Legislation

There is no specific legislation concerning soil protection or the remediation of contaminated soil in Finland. However, Finland's environmental legislation does contain stipulations on soil contamination.

1st January 2000: The Land Use and Building Act came into force, stipulating that the existence of contamination must be known whenever land use is planned.

1st March 2000: The revised Environmental Protection Act, came into force, containing an obligation to notify the environmental authorities on soil contamination, and the duty of the polluter to clean up contaminated soil. The Act also stipulates that when a land area is sold the seller or occupier shall provide the new holder with information on whether soil has been shown to be contaminated or if there are wastes and substances in the soil that may cause contamination. The Act defines more explicitly, and in a more integrated manner, the requirements of environmental permits and the prerequisites for granting a permit. Risk analysis are part of this permit granting process.

Waste legislation (Waste Act and the Waste Management Act) is applied to the liability issues for cleaning up old polluted sites (sites polluted before 1.3.2000). Contaminated soils are defined as waste; hence the waste management legislation is of primary importance. Public health legislation and water legislation are also relevant.

Summer 2001: Finnish Environment Institute (SYKE) guide, recognised that the existing legislation was not clear enough in its definition of who is responsible for cleaning up contaminated sites. It now states that expenses shall be divided among the party causing the contamination, the owner of the real estate, and the local community.

The Finnish environmental administration is divided into the Ministry of the Environment, Regional Environment Centres and municipalities. The Ministry of the Environment is the national authority on environmental issues. It formulates environmental policies and is responsible for preparing legislation. The thirteen Regional Environment Centres among other things grant environmental permits and set the conditions for the cleanup measures. Municipalities supervise activities on their territories.

An act for the assessment of soil contamination and clean up of contaminated sites is in preparation. In this act either guideline values or site specific risk assessment can be used as a decision making tool for soil remediation.

Risk Assessment

Three levels of risk assessment are applied in Finland:

Firstly, a qualitative site risk assessment is completed, often using a site ranking system such as the US Environment Protection Agency Hazard Ranking System.

Secondly, measured concentrations are compared with guideline values for soil contaminants, published in the SAMASE report and mostly based on Dutch values. The "SAMASE" project, was carried out between 1989 and 1993 to examine measures for and develop recommendations on the investigation, categorization and restoration of contaminated sites throughout Finland. The use of risk-based approaches was included as a specific element of the project.

Thirdly, an in-depth risk assessment is undertaken, although few have been completed to date.

Various unnamed computer-based exposure models have been used at this third stage of risk assessment.

Implementation

There is currently no known definitive site specific risk assessment system for inclusion within this study.

France

Legislation

France has no specific legislation concerning contaminated sites. However there are two key policy documents relating to the management and remediation of contaminated soils:

December 1993: Ministerial Directive defining the general policy concerning contaminated sites, including principles of cleaning up soils in a realistic manner, investigation and risk assessment of polluted sites and initial classification of polluted sites.

December 1999: Ministerial Directive blueprint for defining remediation objectives.

Risk Assessment

Simplified Risk Assessment

The objective of the simplified risk assessment is to separate the sites that do not present a threat to human health and the environment from those likely to generate significant harmful effects using simple criteria. Sites are categorised into one of three classes:

Class 1 = Further investigation required
Class 2 = Site to be monitored; and
Class 3 = Low-risk site, suitable for use, may need to restrict future development

The risk assessment should evaluate the risk presented to human health and the environment and must be presented on a site-specific and land-use basis. The procedure for the completion of the simplified risk assessment is presented in the document "*Guide relatif à l'évaluation simplifiée des risques d'un site*" (version 2 - juillet 2000, Editions du BRGM).

The simplified risk assessment is completed using a simple scoring system that that assesses 40 parameters using the Source-Pathway-Receptor model.

As part of the development of version 2 of the Simplified Risk Assessment (SRA) some French Fixed Impact Values (FIV) have been defined. FIV's are presented in "*Management of (potentially) Contaminated Sites*" *(Gestion des sites et sols pollues*), version 2 was issued in March 2000"**.** Two types of values have been developed. VDSS (valeurs de definition de source-sol) are concentrations in soil above which the soil is defined as a source. VCI (valeurs de constat d'impact) are concentrations above which soil and/or groundwater is considered to be impacted. Values are provided for land that has a significant and non-significant usage. The values were developed by the "Public Health " working group in the framework of a national approach to the management and remediation of polluted sites and soils. Foreign guidelines are currently used for some substances, such as solvents, where FIVs have not yet been defined.

Detailed Risk Assessment

Detailed risk assessment is used to aid the decision process to define the strategy for the remediation of sites regarded to have an unacceptable risk to human health and the environment, and is completed after further site investigation. The principal objective being to identify the sites requiring remediation for the proposed future use of the site and those that present a low risk can be returned to there current use without particular action (Class 3 site) or site requiring monitoring (class 2 sites).

The Detailed site investigation should collect the necessary data for a Detailed Risk Assessment, but should also define the extent of pollution and provide an understanding of the migration mechanism to potential receptors. The assessment should consider the risk to potential receptors including human health, water resources and natural and human environment (fauna, flora and property).

The evaluation of potential exposures at the various receptors by the various mediums should take into account the means of transport, the mechanisms of transformation in the environment, which will depend on the characteristics of the substances and the site conditions, the means of transport and the nature and quantity of population, resources or goods likely to be exposed, and all situations at the site (current situation, development at the site, personnel working on the site during work of rehabilitation...).

Implementation

Following contact with INERIS (Institut National de l'Environnement Industriel et des Risques) it has been ascertained that there is no official risk model developed in France, and that there is no national guidance to recommend the use of a particular model.

They use a range of models mainly Dutch and American, selected for use on a site-by-site basis, including RBCA, CSOIL, and Johnson and Ettinger. The most important criteria for selecting a model is that there is information available regarding the algorithms used within the model so that equations can be adapted when required.

It was therefore concluded that there was no French model available for inclusion in this study.

Germany

Legislation

In March 1999 the Federal Soil Protection Act (Bodenschutzgesetz, BbodSchG) came in to force. The associated Ordinance, the Federal Soil Protection and Contaminated Land Regulations (Bundes-Bodenschutz- und Altlastenverordnung, BbodSchV) came into force in July 1999.

The purpose of the Act is to protect soil on a permanent sustainable basis and to facilitate the remediation of historical soil contamination.

The Federal Government shall be authorised to issue regulations, by means of a statutory ordinance and with the consent of the Bundesrat, regarding the requirements for remediation investigations and for the content of remediation plans.

The associated Ordinance, the Federal Soil Protection and Contaminated Land Regulations (Bundes-Bodenschutz- und Altlastenverordnung, BBodSchV), contains regulations for the investigation and evaluation of contaminated sites. Requirements with respect to sampling, analytical methods and quality assurance are regulated in the Ordinance.

Decisions on the need for remedial action are determined by the relationship between background levels of contamination and contamination related to the use of the site.

According to the Basic Law for the Federal Republic of Germany (Articles 30, 83) enforcement for the identification, risk assessment and remediation of soil contamination is the responsibility of the Federal States.

Risk Assessment

Risk assessment is understood to be the whole process of site evaluation, beginning with collecting information that will enable an evaluation of risks to human health and environmental receptors, resulting from contamination present on the site.

The risk assessment process follows a tiered approach:

<u>Orientation Phase</u>

Trigger levels are used to establish whether there is the possibility of contaminants presenting an unacceptable risk. Trigger levels are defined within BBodSchV and are regulated for land use and receptor specific scenarios for the whole of Germany.

<u>Detailed Investigation Phase</u>

Site-specific risk assessment methods are not regulated across Germany; however, the Federal Environment Agency has developed a method for site specific risk assessment covering several exposure pathways using principles that are consistent with those used to derive the trigger values. The UMS (Umwelt Menschen Schadstoffe, “environment”, “humans” and “pollutants” respectively) system evaluates toxicity-based risks via exposure to contaminated soils. The results are estimates of the potential daily intake of hazardous substances, and can be compared with the toxicological tolerable daily intake. Vertical pollutant transfer in the unsaturated zone is also simulated to assess the impacted that contaminated soils have on groundwater. The results are estimates of the concentrations of the contaminants present in the soil and percolating soil water.

Implementation

UMS is a human health risk model developed by the German Federal Environment Agency. The UMS System comprises two modules:

- The UMS model is a methodical tool for assessing the risks to human health via exposure to contaminated soils.

- SISIM (Sickerwassersimulation) simulates the contaminants leaching vertically downwards from the unsaturated zone to the groundwater.

SISIM has not been included within this study as it is not comparable to other systems and does not directly model risk to human health.

Greece

Legislation

No specific legislation, guidelines or standards exist for soil quality in Greece, however, the Greece Environmental Law, 1650/86, which came into force in 1986 was designed to cover all aspects of environmental protection and there are several components in Greek law, which refer directly or indirectly to soil and groundwater contamination.

The Operational Environmental Programme of Greece (OEP) is legislated by 1650/86 and EC environmental regulations and directives. OEP consists of seven sub- programmes; including the development of the infrastructure to respond to the needs of the European Environment Agency to monitor the environment and to comply with environmental standards (funding 47 MECU); the management of the anthropogenic environment and control of atmospheric pollution in Athens (funding 138.2 MECU); and the management and protection of the natural environment (funding 53 MECU).

Risk Assessment

No national guidance on the risk assessment of contaminated land currently exists. Guidance documents have been developed by some organisations but they are not in general force. The risk assessment process is generally site specific and performed according to international (e.g. US Environmental Protection Agency) standards. For assessing the human toxicity of chemicals Greece mainly uses WHO Environmental Health Criteria documents and IARC Monographs for carcinogenic substances.

Implementation

Contaminated land risk assessment is still a developing area in Greek environmental policies. As yet they have no specific methodologies or risk assessment packages and any risk assessments that are carried out use international methods. It was therefore concluded that there was no model available for inclusion in this study.

Ireland

Legislation

There is currently no legislation in Ireland in relation to historic contamination of land. If the contamination will cause, or is liable to cause air, water, waste or any other type of pollution then the relevant legislation dealing with air and/or water and/or waste will apply. The potential for contaminated land to affect water is controlled under the Water Pollution Acts 1977 and 1990. These Acts provide legislative controls for the protection of waters, including groundwater. The Air Pollution Act 1987 also controls Contaminated Land due to its potential to affect air quality.

Contaminated land in certain circumstances could be deemed "waste" under the Waste Management Act, 1996. Under Section 55 of this act a local authority is empowered to serve a notice requiring a person to take specified action to prevent or limit environmental pollution caused, or likely to be caused, by the holding, recovery or disposal of waste within their functional area.

At present, both the Environmental Protection Agency (EPA) and Local Authorities enforce environmental legislation and regulations. Statutory environmental responsibilities of Local Authorities include regulation and control of waste activities, industrial practices, protection of water resources, air and noise pollution.

Risk Assessment

There are no generic clean-up levels for soils in Ireland. Water is compared to the relevant water quality standards, European Quality Standards for surface water, Drinking Water Quality Standards or Dutch Intervention Values.

The Environmental Protection Agency is considering setting non-statutory guidelines for both soil and groundwater, derived from existing risk-based generic guideline values adopted in other European countries, tailored to meet Irish conditions and policies. Where guideline values are exceeded a site-specific risk assessment would be required to determine the actual risks to human health and environmental receptors.

Implementation

There are currently no recommendations on methodologies that should be used to carry out a site specific risk assessment.

Italy

Legislation

In February 1997 the Waste Management Act (*Decreto Legislativo 5 febbraio 1997, n.22*, known as *Decreto Ronchi*) came into force. Article 17 of this Act, was implemented in October 1999 by Ministry Decree n.471 (*Decreto Ministeriale 25 ottobre 1999, n.471*).

Article 17 "Remediation and Environmental Restoration of contaminated land" in the Waste Management Act (*D.Lgs 97/22*) brings into line public and private responsibilities for contaminated land while the Ministry Decree n.471 (*DM 471/99*) provides the technical regulations with the criteria and procedures for contaminated land remediation and reclamation.

According to the Waste Management Act (*DLgs 22/97*) and Ministry Decree n.471 (*DM 471/99*) contaminated sites are prioritised and managed through local authorities (i.e. the regional, provincial and municipal administrations). They are responsible for approving and certifying site remediation projects.

Risk Assessment

Risk analysis is considered an appropriate methodology (*Annex 4*) only if it can be shown that it is economically or technologically unfeasible to remediate any contaminants which are present at concentrations above the legislative acceptable limits.

Risk assessment evaluates the risks presented to human health and the environment and must be presented on a site specific and land use basis. The general procedure for the completion of the risk assessment is reported in DM 471/99 (paragraph II.4 of Annex 4). The adopted risk assessment methodology should define the source of contamination, the exposure pathways, the migration mechanisms and the potential receptors.

Implementation

At the moment two models, based on the American ASTM RBCA methodology are in use, ROME (versions 2.0 and 2.3, released 2003) and GIUDITTA (version 2.0). Currently there is no national guidance to recommend the use of a particular model.

<u>ROME</u>

The ROME (version 2.0) model has been developed by the National Agency for Protection of the Environment (ANPA). The model assumes a risk-based tiered procedure that takes into consideration two types of assessment (generic Tier 1 and site specific Tier 2), derived from the standard ASTM RBCA (Risk-Based Corrective Actions).

At Tier 1 the concentrations encountered on site are compared with calculated risk-based screening levels (*LAG = limiti di accettabilita' generici*) and the acceptable limits reported in DM 471/99 (Annex 1). At Tier 2 site-specific levels are derived taking account of the expected end use, the risks presented to potential receptors are also provided.

In this software the end use of the site, residential/green area or industrial/commercial is considered and it is possible to assess risks to surface waters from impacted soils identified on site.

GIUDITTA

Giuditta is a Windows based software program, developed in Italy by Dames & Moore commissioned by and in cooperation with Milan Province.

Following the most validated methodologies internationally available (ASTM Risk Based Corrective Action, USEPA Soil Screening Guidance) the software is adapted to the Italian Law on contaminated site remediation (D.Lgs. 22/97 and successive modifications and D.M. 471/99).

In this programme the Tier 1 generic risk-based assessment is not considered and the concentrations encountered on site are compared directly with the acceptable limits reported in DM 471/99 (these values are not risk based).

The latest version (Giuditta v2.0) is also able to carry out statistical analysis of the data available for the sites under examination and interfaces with most GIS (Geographic Information System) platforms.

Luxembourg

Information regarding the legislative stance of the Luxembourg authorities in dealing with Contaminated Land and the risk assessment thereof has been difficult to identify. Our lines of enquiry were not finalised in time to be fully entered into this summary Appendix.

Environmental Policy in Luxembourg rests chiefly upon the environmental laws and regulations, which have been heavily influenced by EU directives on the environment and the regulatory approaches of neighbouring countries. Luxembourg has endorsed the "Polluter Pays" and "User Pays" principle, and the regulatory agencies deal with all sites on a site specific basis.

The best practise approach appears to be to use an existing respected methodology and approach in line with neighbouring European countries such as Belgium, or those of the Netherlands, on a site-by-site basis. It should be stressed that EU law applies to Luxembourg and therefore this should be borne in mind when undertaking any risk assessment, for example consideration should be given to the influence of Groundwater Directive or the Habitat's Directive.

From the enquiries we have made and the review of existing literature we have concluded that no defined risk assessment system exists per se and no software development has been undertaken. Therefore the approach in Luxembourg will not be taken further in our comparative study.

Netherlands

Legislation

There are two major pieces of legislation regarding the environment and contaminated land in the Netherlands.

The Soil Protection Act, updated in 1994-5, which regulates the prevention of soil contamination as well as the management and remediation of contaminated land.
If new contamination does occur, then in theory remediation should be undertaken, irrespective of the potential risks posed by the impact. However ALARA ("As Low As Reasonably Achievable") and BATNEEC are recognised principles for use in the assessment of contaminated land.

The Environmental Management Act (EMA), which came into force in 1993, and regulates issues including environmental planning, environmental impact assessment and waste management. New chapters are continually being added to the EMA.

Risk Assessment

A framework has been provided for assessing the potential risks posed by impacts in soil, water and air. Each site is assessed by determining how serious the identified impact on-site is, and how best to carry out any necessary remediation.

<u>The Seriousness of the Contamination</u>
The first stage in the risk assessment procedure follows from the question of how serious any on-site contamination is. A preliminary site investigation is undertaken, followed by a more thorough site investigation if initial suspicions of contamination are confirmed, where groundwater and soil samples are collected.

Two types of screening levels have been developed for the purpose of defining the three groups. Firstly, a target level for the contaminant of concern. Target levels have been produced for around 100 substances in soil and groundwater, and have been conceived based on a percentage of organic matter and clay in the soil. If target values are met, then the soil or groundwater is not considered contaminated. Secondly, an intervention value, which defines the level at which a site is seriously contaminated. Any site lying between theses two levels is considered contaminated, but the site may not need further investigation. This decision lies with the local authorities.

<u>The Urgency of Remediation</u>
The potential risk posed by an impacted site is assessed for three receptors; human health, environmental (groundwater) and ecological.
Sensitive areas are subjected to more stringent intervention values than less sensitive areas.

The seriously contaminated sites requiring urgent remediation are split into three groups, dependent on the exceedances determined during the assessment of remediation urgency:

1. Remediation to begin within four years.
2. Remediation to begin in between four to ten years.
3. Remediation to begin after ten years.

The categories represent the seriousness of the threats posed to human health, groundwater drinking supplies and sensitive ecological areas.

Remedial Objectives

The preferential aim of any remedial works is for soil concentrations to be less than or equal to target levels (or local background concentrations). Newly contaminated sites (during and after 1987) must be cleaned up to target level concentrations. For sites contaminates prior to 1987, if the contamination is considered mobile then it should be removed as far as possible in a cost-effective manner. A land-use-oriented approach is adopted for sites impacted by non-mobile contaminants, with contamination removed to the extent necessary.

Implementation

Two software tools are used in the Netherlands for the purposes of site-specific risk assessment. Firstly, Risc-human is the latest, Windows based, development of the Csoil model developed by the Van Hall Institute. The model requires in-depth data entry and is a sequence of models to be applied on a site specific basis.

The second software tool is SUS (*Sanerings Urgentie Systematiek*), a programme developed to help assess the urgency of remediation and when remediation must begin. It was developed by the Van Hall Institute in cooperation with the Dutch Ministry of Housing, Physical Planning and Environment. SUS uses predefined land-uses with a restricted number of changeable parameters, to position a site within a ranking system of the level of urgency needed. SUS, unlike Risc-Human, is not designed to quantitatively assess risk levels on a site-by-site basis therefore was not considered further in this study.

Norway

Legislation

The Legislation for pollution and management of contaminated land in Norway have been incorporated into the Pollution Control Act, 1981. This provides the government with the authority to regulate pollution dealing with water, air and soil. The Norwegian Pollution Control Authority (SFT) is responsible for the regulation of contaminated sites.

The existing Norwegian policy on risk assessment is based on various Norwegian standards for environmental risk analysis at contaminated sites, developed under the auspices of the Norwegian Pollution Control Authority (SFT), in conjunction with CARACAS. The system encompasses human health and environmental components applied on a three-tiered basis.

Risk Assessment

The risk assessment method comprises three tiers with increasing degree of complexity and detail.

Tier 1 – Simplified Risk Assessment
The maximum identified soil concentration for the contaminant are compared directly to the soil quality guidelines. The soil quality guidelines (SQG) are based on the assumption that humans and the ecosystem are exposed to one chemical substance at a time, that all the exposure pathways act at the same time and that the exposure pathways for a chemical substance are additive. The SQG are derived for a generic site comparing tolerable daily intake (human beings) and tolerable conditions (terrestic ecosystem) with exposure at the site through the a number of exposure pathways.

Tier 2 – Expanded Risk Assessment (exposure calculations)
The Tier 2 assessment is conducted for the current (or planned) use of the site. Consideration is given to the most sensitive land use for the relevant exposure pathways. Taking into account migration and transport and exposure analysis determines the total exposure of the receptors.

Acceptance criteria are defined for each site taking into account health/ecosystem related and migration related conditions. The determined exposure is then compared to the acceptance criteria for the site.

Tier 3 - Expanded Risk Assessment (exposure measurements)
The Tier 3 assessment uses the same risk analysis as Tier 2 but takes into consideration the measured exposure including mobility, adsorbtion and degradation in the different media. This results in expected exposure concentrations, which are compared to the acceptance criteria, as defined in Tier 2.

Other Risk Assessments
In addition the Chemical Hazard Assessment and Risk Management (CHARM) software model has been developed for use in the oil industry. The CHARM model, version 3 (1996) was developed by Norway and the Netherlands for environmental hazard assessment and risk management of offshore chemicals. The model is intended to be used as a tool for the harmonised regulation of the use of chemicals in the offshore industry in the North Sea. The basic principle of the hazard assessment part of the model is that it calculates the discharge of an offshore chemical and the resulting Predicted Environmental Concentrations (PECs) in different environmental compartments. This is then compared with a predicted No-Effect-Concentration (PNEC).

Implementation

A guidance manual for the risk assessment of contaminated sites has been published, containing the equations and assumptions used within the tiered approach (Report 99:06, Guidelines for the Risk Assessment of Contaminated Sites, TA-1691/1999). This can be used to determine the risk posed by the contamination to human health and environmental receptors.

The CHARM model considers offshore contamination and therefore is not considered in this comparison.

Portugal

Legislation

There are no specific laws regulating the management of contaminated sites in Portugal. However, the following national legislations address the issues associated with contaminated land:

Law on the Environment, which came into force on 7th April 1987, defines the basic principles of the Portuguese environmental policy.

Law regarding Waste, Decree Law 239/97, replacing Decree 310/95 establishes the regulatory framework for general waste management, including collecting, storage, transportation, treatment and disposal of waste.

Laws regarding Water, Decree Laws 70/90, 46/94, and 152/97define the rules governing water resource management and impose penalties for uncontrolled discharges to water environments. Discharges to water and standards for drinking water quality are mainly governed by Decree Law 74/90. The Water Institute and Regional Environmental Departments are responsible for implementing this legislation.

Further laws, such as those concerning Environmental Impact Evaluation are also used to achieve the aims of preventing future pollution and reducing historical contamination.

In 1997 The Soil Pollution Development Centre was established (by Decree Law 236/97), integrated in the Waste Institute (Instituto dos Residuos) to define a national methodology for contaminated site management, compiling data from European and North American on contaminated land legislation, methodologies for registering contaminated sites, criteria and risk assessment procedures, procedures for the evaluation of remedial alternatives, risk-based soil screening values

Sufficient information is available in Portugal to make a preliminary identification and characterisation of many sites, namely those related to existing industrial areas and uncontrolled waste deposits.

Risk Assessment

At present Portugal still uses the Canadian criteria as guidance for establishing soil and groundwater cleanup goals, but in the near future intends to develop national procedures for landuse-based assessment and remediation of contaminated sites. Risk assessment methodology will be fundamental to this.

Implementation

Risk assessment methodologies in Portugal are still under development.

Spain

Legislation

There is no specific law relating to contaminated land in Spain. However, the principles established in the Wastes Law should, in the future, form the basis for a specific law about soil protection. The Wastes Law (10/1998), which transposes the fundamental aspects of EU Directive 91/156 relating to wastes into Spanish legislation was approved by the Spanish Parliament in April 1998. Soil contamination is specifically addressed in two articles where the concept of contaminated soil is defined on the basis of risks to human health and ecosystems.

In February 1995 the Central Government approved the National Plan for Contaminated Sites Remediation. The duration of the Plan is to the year 2005. The central Government's Environment Ministry has signed bilateral contracts with the 17 Autonomous Communities to develop the Plan, with each providing 50% of the funding for remediation of publicly owned sites. Responsibility for remediation continues beyond the point when a site is cleaned up to the required level for its anticipated use.

An important aspect of the Wastes Law, included in the Contaminated Soils Remediation Plan, is the requirement to derive screening/guideline values appropriate to the specific soil characteristics of each Autonomous Community rather than using values developed in other countries. Sampling and analytical methods will be standardised through technical guidance.
Under these values the soil is not contaminated and when the soil values are upper, this requires an assessment taking future landuse into account.

Because of regional differences in the characteristics of contaminated soils, some autonomous communities such as the Basque Country, Cataluña, Galicia and Castilla-León have established their own criteria for soil remediation.

Risk Assessment

<u>Basque Country</u>

The Environmental Protection Act of the Basque Country (March 1998) constitutes the legal framework for addressing the problem of contaminated land. It includes a specific chapter concerning soil protection and remediation. The Basque Country takes a 'suitable for use' approach to the management of contaminated sites in which potential land use depends on the degree of contamination. Accordingly, soil quality is defined on the basis of risk assessment for protected targets (human health and the environment) and intended land uses. Two complementary instruments have been developed for risk assessment in order to achieve a cost-effective approach to contaminated site investigation:

Soil screening values known as Indicative Values for Assessment (VIEs) are land use dependent and provide a generic assessment that will allow essentially risk-free soils to be differentiated from soils that pose or could potentially pose risks for the intended use. They are applied in the exploratory phase of an investigation; based on them, the authorities must decide if there is a need for further detailed investigation or, in some cases, if immediate measures are warranted. Three levels have been established. The first, VIE-A, is derived on the basis of concentrations found in soils with little anthropogenic influence and therefore involving no significant risk for any likely soil use. The second, VIE-B, represents the level at which more detailed consideration of risks is required; and the third, VIE-C, is the value at which the risk becomes unacceptable. These values could be used as remediation targets, but this would often be unrealistic because they would be more restrictive than the limits established as a result of site-specific risk assessments.

The Basque country commissioned the assistance of CRBE at Nottingham Trent University, UK to create a modified version of the CLEA software, named EUSCLEA to develop "distribution" based screening values.

Cataluña

The Generalitat of Cataluña has developed provisional criteria for soils quality to be used in this territory. These guidelines include the Cataluña soil quality indication values and a methodology for determination and application. Cataluña soil quality criteria are numeric values of substance concentrations in soil, designed to swiftly evaluate the need for further action.

In Cataluña 94 site specific risk assessments have been carried out using a range of different risk assessment models. In the most of contaminated soils cases (about 70 %) there is no risk assessment, though this percentage is decreasing.

The following table details the number of sites for which various models have been used (information provided by the Junta de Residus, June 2002).

Programs used to Analyse Risk	**TOTAL**
ASR (Avaluació Simplificada de Risc)	**59**
RISC-HUMAN	**8**
RBCA	**9**
SESOIL	**4**
PRG (Preliminary Remediation Goals)	**2**
HESP	**2**
RAGS	**1**
AT123D	**1**
NO ESPECIFIC	**8**
TOTAL	**94**

Galicia

Similar initiatives to those of the Cataluña region are being reviewed and develop in the Galicia region.

Implementation

Whilst the legislation and assessment of contaminated land issues are advancing in Spain, and more specifically in its Autonomous Communities, there are not as yet any widely available or recommended modelling packages for carrying out site specific risk assessments.

The EUSCLEA model exists for the Basque country but has not been included in this study as it is a derivative of the CLEA model.

Sweden

Legislation

A new Environmental Code came into force on 1 January 1999. The Environmental Code is further elaborated and specified in the form of ordinances, regulations issued by public authorities and decisions taken in individual cases. The aim of the Environmental Code is to promote sustainable development that ensures a healthy environmental impact on both the current and future generations. To achieve this aim, the code is to be applied so that:

- human health and the environment will be protected against damage and nuisance, regardless of whether this is caused by pollution or other influences
- valuable natural and cultural environments will be protected and conserved
- biological diversity will be preserved
- land, water and the physical environment will generally be used so as to safeguard long-term good management of resources from an ecological, social, cultural and socio-economic viewpoint

Risk Assessment

When the Environmental Code came into force on 1 January 1999, a new legal instrument, environmental quality standards (EQS), was introduced into Swedish environmental practice. EQS are adopted in order to address actual or potential environmental problems, to achieve environmental objectives and to implement EC directives that prescribe this type of standard.

The assessment criteria are intended to enable classification of risks to health and/or the environment at contaminated sites. In this context, the term “contaminated site” refers to landfill site or area of soil, groundwater or sediments which is so contaminated by a point source that concentrations significantly exceed local or regional background levels

The guideline values are developed for typical Swedish conditions including exposure, geology, and hydrology for three land uses:

- Land with sensitive use, e.g. residential areas, kindergartens, agriculture, together with groundwater abstraction.
- Land with less sensitive use, e.g. offices, industries, roads, car parks, but still with groundwater abstraction.
- Land with less sensitive use as above but with no groundwater abstraction.

For some sites the conditions may be such that the generic guidelines are not applicable, in these cases a site-specific analysis would be carried out.

Implementation

There is currently no ‘official’ risk assessment computer model for Sweden, the formulae presented in Report 4639 (Development of Generic Guideline Values) give the equations and assumptions used to develop the Swedish Generic Guideline Values using risk assessment. However, based on English translation of Report 4639 it is not possible to produce a comprehensive code as equations and assumptions presented in the report are incomplete. It is understood that the SEPA is initiating a project for writing a risk assessment standard code.

Switzerland

Legislation

In Switzerland the management of contaminated sites is legislated by the Federal Environmental Protection Law, brought into force in October 1983 and revised in June 1997, the Ordinance relating to the Remediation of Contaminated Sites (Contaminated Sites Ordinance, CSO), as of 26 August 1998 and the new Ordinance relating to Charges for the remediation of polluted Sites (OCRS, of 5 April 2000).

The purpose of the Environmental Protection Law is to protect persons, animals and plants, and their biological communities and habitats against harmful effects or nuisances and to maintain the fertility of soil. The law is regulated by 26 Cantons (local authorities) across Switzerland.

The CSO is intended to ensure that polluted sites are remediated should they lead to harmful effects or nuisances, or should there be a substantial danger of such effects arising. It is enforced by the Cantons and specifies a procedure as follows.

1. The polluted site should be recorded in the register drawn up by the Canton in which the site is located.

2. An assessment of the need for monitoring and remediation should be undertaken.

3. An assessment of the objectives and urgency of remediation should be undertaken

4. Measures for investigation, monitoring and remediation should be specified.

Risk Assessment

A decision to take remedial action will require a site specific risk analysis based on present and future interactions between the site and the environment, mainly groundwater, surface water, soil and air, taking into account potential for transport and barriers. Intervention values for leachate and air have been derived based on human toxicity consistent with the relevant laws concerning water and soil.

Implementation

A groundwater risk assessment model, TransSim, has been developed for the Swiss Agency for the Environment Forests and Landscapes by BMG Engineering Ltd. TransSim simulates contaminant fate and transport in the unsaturated and saturated zone. It is broadly equivalent with models such as P20 RTW, RAM, ConSim and the groundwater functions within BP RISC, RBCA Toolkit, Risc-human, etc.

European risk systems were reviewed and selected for detailed evaluation in this project before the TransSim model was adopted in Switzerland, and therefore this model was not included in the detailed model evaluation.

United Kingdom

Legislation

For administrative purposes the UK is divided into England, Scotland, Wales and Northern Ireland. In England, Scotland and Wales, the Department for Environment, Food and Rural Affairs (DEFRA) is the Government department with overall responsibility for the environment. Its aim is to protect and improve the environment, and to integrate the environment with other policies across Government and in international forums. Regulation of Environmental Legislation is undertaken by Local Authorities (councils), the Scottish Environment Protection Agency (SEPA), the Environment and Heritage Service (Northern Ireland) and the Environment Agency (EA) in England and Wales. The EA and SEPA were established by the 1995 Environment Act and are Non-Departmental Public Bodies of the DEFRA.

The remainder of this section describes environmental law and regulations that are of direct relevance to this report and that apply to England and Wales.

Both the Town and Country Planning Acts and Part IIA of the Environmental Protection Act 1990 directly apply to contaminated land in England and Wales. Under the former, a planning authority may require investigation before granting planning permission and / or may place conditions on the development including investigation, assessment and remediation.

Part IIA of the Environmental Protection Act 1990 (as inserted by Section 57 of the Environment Act 1995) provides a regime for the control of specific threats to human health or the environment from existing land contamination. Part IIA is intended to complement the planning regime and a number of other regulatory regimes, including:

- Pollution Prevention and Control Act 2001
- Groundwater Regulations 1998
- Part III of the Environmental Protection Act 1990 – Statutory Nuisance Control
- Water Resources Act 1991

The UK regulatory authorities adopt the widely recognised source-pathway-receptor concept for assessing risks from contaminated land. However, the scenarios under which harm may occur are often largely defined by the site conditions and the site sensitivity. The concept of "suitable for use" is adopted to ensure that the risk assessment addresses the site-specific conditions and that any remediation undertaken is to an appropriate level.

Risk Assessment

Risk assessment is considered an appropriate tool in determining the significance of site impacts in terms of harm to receptors and impacts to controlled waters. The source-pathway-receptor concept is used for assessing risks from contaminated land.

There are currently three framework approaches for the assessment of risk with respect to contaminated land in the UK:

- The Contaminated Land Exposure Assessment (CLEA) published jointly by Department of Environment, Food and Rural Affairs (DEFRA) and the Environment Agency, which provides a framework for assessing human health risk from contaminated soils. CLEA is also available as a software tool, see below.

- SNIFFER Method for deriving *site-specific human health risk* from contaminated soils. This methodology was originally published by Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) in 2000. An updated methodology was developed in collaboration with SEPA and the Environment Agency and was published by SNIFFER in May 2003. The updated SNIFFER method has been brought into line with the CLEA guidance. The updated SNIFFER Method is also available as software tools, see below.

- Environment Agency R&D Publication P20, "Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources" is used to assess the risks to groundwater and other controlled waters, as defined by the Water Resources Act 1991.

Implementation

The following risk assessment systems were developed by or on behalf of UK regulatory authorities and are in widespread use:

CLEA
The Contaminated Land Exposure Assessment (CLEA) was developed jointly by DEFRA and the Environment Agency of England and Wales. A spreadsheet model was released in March 2002. The methodology on which the model is based encourages the use of site-specific risk assessment, although the current CLEA software package is limited in its application to the development of generic screening values.

SNIFFER Method
Originally published in 2000, the updated SNIFFER Method was released as software tools in May 2003. Two spreadsheet models are available, one for metals and one for organic contaminants. The models are based on a Microsoft Excel spreadsheet. The main difference between the models is in the number of exposure pathways supported, with additional pathways for inhalation of indoor and outdoor air included in the organics spreadsheet. The SNIFFER models were released after the models had been run and have therefore not been used, however, the capcbilities of this system have been evaluated.

P20-RTW
The Remedial Targets Worksheet (RTW) was developed as a direct consequence of the publication by the Environment Agency of England and Wales of Technical Report P20 "Methodology for the Derivation of Clean-up Targets for Soil and Groundwater to Protect Water Resources" (Environment Agency, 1999). The worksheet is based on a tiered system and does allow the calculation of site specific target levels.

ConSim
ConSim was developed by Golder Associates on behalf of the Environment Agency of England and Wales. The model is a site-specific, probabilistic groundwater risk model that simulates contaminant transport in groundwater in the unsaturated and saturated zones. ConSim was originally released in 1999, and was developed as a tool for assessment of risk from contaminated sites to groundwater. ConSim was not specifically developed to be compliant with the P20 methodology but it can be set up to operate generally to the P20 methodology. ConSim Version 2.0 was due for release in December 2002, but was not available for review at the time of preparing this report in July 2003.