DRAFT FINAL REPORT

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Review of Policy Papers Presented to the NATO/CCMS Pilot Study on Research, Development and Evaluation of Remedial Action Technologies for Contaminated Soil and Groundwater. May 1996.

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Report for

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EXECUTIVE SUMMARY

The UK is a member of the NATO/CCMS Pilot Study on "Research, Development, and Evaluation of Remedial Action Technologies which is the third in a series of Pilot Studies exploring contaminated land treatment issues. The intention of the Pilot Study is to act as a focus for sharing information about new approaches to the treatment of contaminated soil and groundwater from a range of countries, and identifying useful ways forward in developing contaminated site treatment capabilities. Its findings will be used widely by participating countries for assessing technologies and as reference information for technical and policy development.

This report is a review of the contaminated land policy issues presented by individual countries at the NATO/CCMS Pilot Study meetings in 1993, 1994, and 1996. It includes the most recent policy developments reported at the Pilot Study and focuses on changes in legislation, regulation policy, and remedial activity on a country by country basis. This document has been prepared by the Centre for Research into the Built Environment, Nottingham Trent University (CRBE) for the UK Department of the Environment, Contaminated Land and Liabilities Branch (CLL) under contract EPG 1/6/7.

Summaries on the following Pilot Study participants are included in this report: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hungary, The Netherlands, New Zealand, Norway, Pakistan, Slovenia, Sweden, Switzerland, Turkey, The United Kingdom, and The United States.

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Review of Policy Papers Presented to the NATO/CCMS Pilot Study on Research, Development and Evaluation of Remedial Action Technologies for Contaminated Soil and Groundwater. May 1996.

1.0 INTRODUCTION

1 This report is a review of the contaminated land policy issues presented by individual countries at the NATO/CCMS[1] Pilot Study meetings in 1993, 1994, and 1996. It is intended to be used for the dissemination of information on the Pilot Study and focuses on changes in legislation, regulation policy, and remedial activity on a country by country basis. It includes the most recent policy developments reported at the Pilot Study, updating information provided in earlier publications [12,13,14,15]. Technical developments reported at the Pilot Study meetings are published in a companion report [47]. This document has been prepared by the Centre for Research into the Built Environment, Nottingham Trent University (CRBE) for the UK Department of the Environment, Contaminated Land and Liabilities Division (CLL) under contract EPG 1/6/7.

2 This report is based on:

- Written material prepared by each speaker for presentation during a Tour de Table session at each of the last three Pilot Study meetings; and

- Supplementary information from the published literature as appropriate and available.

1.1 Background

3 The United Kingdom is a member of the NATO/CCMS Pilot Study on "Research, Development, and Evaluation of Remedial Action Technologies, which is the third in a series of Pilot Studies exploring contaminated land treatment issues [14,15,16]. This Pilot Study has three main goals:

- Evaluation and documentation of leading edge contaminated soil and/or groundwater treatment projects at demonstration or full-scale;

- Examination/identification of emerging technologies that are at bench- or pilot-scale; and

- Development/establishment of a uniform data reporting system to encourage good practice in the presentation of results.

4 The NATO alliance civil structure includes the Committee for Challenges to Modern

[1]Committee for Challenges to Modern Society (see paragraph 4)

Society (CCMS) which was instigated in 1969 on the initiative of US President Nixon. This Committee was one of the earliest demonstrations of environmental concern by any international organisation and is considered to have had a seminal influence on the international development of environmental policy.

5 The principle *modus operandi* of the CCMS is the Pilot Study. These are proposed by member countries at twice yearly plenary sessions of the Committee, which are chaired by the Secretary General. Proposing countries nominate a particular direction for a Pilot Study. Pilot Studies last up to five years and then report their conclusions.

6 The NATO/CCMS budget is relatively small compared with the budget of the NATO Science Committee. Participating projects and national delegates meet their own costs. The UK activities are overseen by the Department of the Environment (DoE) and the Ministry of Defence (MoD) in their capacity as UK CCMS Co-ordinators. They represent the UK at meetings of the full NATO/CCMS and authorise UK applications for CCMS activities. However, input to individual Pilot Studies is made by individual Government departments with specific interests in a particular Pilot Study.

7 A Pilot Study lasts five years. The original Pilot Study was proposed by the USA with Germany and the Netherlands. After successful completion of a first phase of this study (1987-1991)[15,16], a second phase was initiated in November 1992 which will run until 1997. This Phase (II) Pilot Study continues to address field-demonstrated technologies while expanding the original scope from Phase I to include newly emerging approaches.

8 The intention of the Pilot Study is to act as a focus for sharing information about new approaches to the treatment of contaminated soil and groundwater from a range of countries, and identifying useful ways forward in developing contaminated site treatment capabilities. Its findings will be used widely by NATO countries for assessing technologies and as reference information for technical and policy development. Information exchanged includes both practical experience of full-scale applications of new technologies, descriptions of emerging technologies and fundamental under-pinning studies of established approaches.

9 The main work of the Pilot Study is carried out during an annual international meeting which is attended by Country Representatives, technical experts representing each Pilot Study project, and leading experts international experts invited to speak on topics of interest to the Pilot Study. Attendees at the meetings may also include nominated guests of the host country and Pilot Study Fellows (see Section 4.0). To date the second phase of the Pilot Study has held four international meetings (see Table 1).

Table 1: Meetings of the NATO/CCMS Phase II Pilot Study

Budapest, Hungary from October 19th to 22nd, 1992
Québec City, Canada from September 13th to 17th, 1993
Oxford, United Kingdom from September 11th to 16th, 1994

Adelaide, Australia from February 11th to 16th, 1996

10 As first envisaged membership of Pilot Studies was restricted to the NATO countries, however, with the changing political role of the organisation this has been gradually relaxed. Twenty-two nations have now participated in Phase (II) to date including: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Hungary, Italy, The Netherlands, New Zealand, Norway, Portugal, Rumania, Slovak Republic, Slovenia, Sweden, Switzerland, Turkey, United States, and the United Kingdom. In addition, at the recent international meeting held in Adelaide the Pilot Study invited delegates from Asian-Pacific countries including Hong Kong, India, Indonesia, Japan, Malaysia, Pakistan, People's Republic of China, and the Republic of Korea[2].

1.2 Report Organisation

11 This report provides a detailed summary of the policy presentations on a country by country basis at each of the last three Pilot Study meetings (see Table 1), where sufficient written information was provided to delegates. Further information on the Budapest meeting can be found in an earlier publication [15].

2.0 COUNTRY REPORT: AUSTRALIA

Country Representative: L. Emmett (Adelaide meeting), Environment Protection Agency
I. Lambert (Oxford meeting), Environment Protection Agency
I. Hosking (Québec City meeting), Coffey Partners International Pty. Ltd

2.1 Legal and administrative aspects

12 Australia is a federation of six States and two Territories with a Federal Government overseeing specific areas of national policy including trade and commerce, external affairs and defence. The Federal Government does not have *direct* legislative powers on environmental policy but works with State and Territory Government to implement a national strategy. The key national bodies which provide technical guidance for environment and health are the Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) respectively.

13 In September 1995, the State, Territory and Federal Governments established the National Environment Protection Council (NEPC) with the aim of ensuring greater regulatory consistency in implementing national standards for environmental protection.

[2] However only Hong Kong and Pakistan attended the meeting.

The Council consists of one Minister (not necessary the Environment Minister) from each State and Territory Government and is currently chaired by the Commonwealth Minister for the Environment. The Council's principle role is to develop National Environmental Protection Measures (NEPMs) in the form of standards, protocols, goals or guidelines. It was suggested at the Adelaide meeting of the Pilot Study that the NEPC will consider development of guidelines for the assessment of contaminated sites and related issues such as ambient air and water quality.

14 Since each State and Territory Governments implement their own regulatory framework this has lead to many differences between them concerning their arrangements for contaminated sites. For example in the issuing of remediation notices (see Table 2). The usual form of an intervention is for a regulatory agency to direct remediation through the issue of a notice under the appropriate environment protection legislation. As can be seen from the Table, differences exist between States on to whom the notice is served in order of priority.

Table 2: Regulatory differences in the implementation of remediation notices for contaminated sites in Australia. Orders of priority in serving notices

State/ Territory Government	Legislation (To whom the notice is served)
New South Wales	Environmentally Hazardous Chemicals Act (Occupier only) Clean Waters Act (Occupier or polluter)
Victoria	Environment Protection Act (Polluter then occupier where polluter is insolvent or unknown)
Queensland	(Polluter, then site owner, and finally the Local Government where it can be shown its decisions may have contributed to contamination)
South Australia	Environment Protection Act (Polluter, then occupier)
Western Australia	Pollution Abatement Notice (Site owner and/or occupier)

2.2 Framework for ANZECC/NHMRC guidelines

15 Although the NEPC is considering the future development of national assessment procedures for contaminated sites, present guidance has been issued by both the ANZECC and NHMRC entitled *Guidelines for the Assessment and Management of Contaminated Sites* [10].

16 First issued in January 1992, the main purpose of the ANZECC/NHMRC guidelines is to provide a framework for the proper assessment, remediation, and management of contaminated sites. In addition it is intended to ensure that a consistent standard of site assessment and subsequent management is implemented for all contaminated sites in Australia. The guidelines have no formal legal status. The framework outlined in the Guideline document covers such issues as site identification, initial evaluation,

community consultation, occupational health and safety, sampling and chemical analysis, development of site specific guidelines and remedial strategy options. The Guidelines define the goals of site management to be:

- Ensuring a site is acceptable and safe for long term continuation of its existing use;

- Minimising environmental and health risks on- and off-site; and

- Maximising the potential options for future site use.

17 The Guidelines do not recommend remediation of contaminated sites regardless of site specific circumstances since treatment may be either technically difficult to achieve or outweighed by social, economic, and environmental considerations. A site specific assessment which recommends that a restricted site use is the preferred option can be acceptable.

18 The Guidelines are an evolving document which is currently undergoing a major revision by the State, Territory, and Federal environmental agencies. This revision work is due for completion at the end of 1996. A major aim of revising them is to ensure that the document is more responsive to Australian environmental conditions and better reflects the needs of the community and associated industrial sectors through:

- Development of a national health and environmental risk assessment framework for contaminated land;

- Development of national soil quality objectives; and

- Preparation of technical, specific issue guidance for regulatory agencies.

2.3 ANZECC position paper on financial liability

19 In June 1993, ANZECC released a discussion paper for public comment with the aim of developing a consistent, national approach for addressing issues associated with the financial liability of contaminated sites. After submissions to the discussion paper were received, an ANZECC Position paper entitled *Financial Liability for Contaminated Site Remediation* was released in April 1994 to address and respond to particular public comments [11].

20 The Position Paper identified the general principles which ANZECC believed should underpin a liability scheme for contaminated site remediation. These principles included:

- "The polluter pays" except where the polluter or original site owner is insolvent or unknown in which case the current site owner/occupier should be liable;

- The distinction between "risk" and "non-risk" contaminated sites where the

Government should intervene only in cases of the former;

- Strict liability to comply with a direction to take remedial action should apply (although a statutory right to recover costs from the polluter should also exist); and

- Governments (State, Federal etc) should assume responsibility for remedial action in the case of orphan sites.

21 ANZECC recognises that regulatory responsibility lies with individual State and Territory Governments and therefore each Government may adopt the principles which fit within their own administrative and legal frameworks.

2.4 Research and development

22 An estimate at the Québec City meeting of the Pilot Study suggested that there may be as many as 50,000 contaminated sites in Australia. The majority of site management (including both assessment and remediation) is reportedly associated with real estate transactions with most remedial action schemes involving excavation and disposal and/or containment measures. Use of emerging treatment technologies is encouraged by Government agencies and several full scale operations have been implemented [47]. In addition the Environmental Protection Agency (EPA) agreed at the beginning of 1996 to co-sponsor a feasibility study to investigate the prospect of establishing a National Demonstration Sites Program for contaminated land remediation technologies in Australia. This feasibility study is to be undertaken by a team consisting of the Victorian State Government, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and the Australian Academy of Technological Science and Engineering. Further national initiatives of relevance to contaminated land and treatment technological development are outlined in Table 3.

Table 3: Australian national initiatives for research and development of relevance to contaminated land [35]

Appropriate Technologies for the Treatment of Scheduled Wastes	An EPA commissioned review which reports on technologies for the treatment of waste chemicals including PCBs, hexachlorobenzene, and organochlorine pesticides. Four reports are being prepared under this review over a 2 year period. It provides an independent source of information on the current status of treatment technology development and their availability in Australia. Specific issues addressed by the review include applicable waste streams, estimated treatment costs, and information on operational performance and health and safety.

National Environment Industries Database	The Commonwealth Government, through the EPA, is setting up a clearing house for solutions to Australian industries' environmental challenges [35]. Launched in December 1995, the National Environment Industries Database (NEID) is a network of electronic databases, printed materials and information sources on Australia's environmental capabilities. The following databases are available: Database of Environment Management Companies' Capabilities. Collection of comprehensive information on company capability in hard technologies, instrumentation and monitoring equipment, and environmental consultancy and legal services. Database of Research and Development in Waste Management and Pollution Control. Database of links between specific environmental problems to R&D activities in waste management and pollution control in Australia.
National Pollutant Inventory	Provision of community access to information on pollutants entering the environment.
Mining Guidelines	The Commonwealth Government and the mining industry have produced a series of modules concerning best practice for environmental management and ecologically sustainable development.

3.0 COUNTRY REPORT: AUSTRIA

Country Representative: H. Kasamas, Ministry of the Environment

3.1 Legal and administrative aspects: the National Clean-up Programme

23 The Government of Austria operates using a federal system with a National Government supporting the work of nine Provincial Governments. In July 1989, Austria introduced the Federal Clean-up Law (ALSAG) which provides the legislative structure for management of contaminated sites. ALSAG set out a management framework entitled the National Clean-up Programme which includes the following aspects:

- A national uniform structure of registration and assessment for contaminated sites;
- The creation of public funds to support site management;
- A mechanism for the national distribution of public funds to stimulate voluntary activities at contaminated sites (Guidelines for Funding);
- Description of the responsibilities for different regulatory authorities operating within the programme; and
- Statement of liabilities and mechanisms for enforcement (referring to related environmental laws).

24 The National Clean-up Programme is coordinated by the Federal Ministry of the Environment with the Provincial Governments being responsible for the identification of potentially contaminated sites and for enforcing compulsory remedial actions by potential responsible parties in urgent cases. The information provided by the provinces is transferred to the Federal Environment Agency (UBA), which carries out registration, assessment and prioritization of sites according to their level of risk.

25 Financing of remedial actions occurs via a levy on certain waste types with the Federal Ministry of Finance being responsible for its collection. Initial estimates of the required funding for site management were in the order of AS 10 billion (USD 1 billion) over the next decade. However this has been revised upwards in light of experiences in the first years of the National Clean-up Programme. It is proposed to raise levies by as much as 500% to account for increased cost estimates and a significant shortfall in tax collection efficiency. The procedures for collection will also be strengthened.

26 80% of funds generated by levies was intended to finance remedial actions, with 20% for additional risk assessments. The Guidelines for Funding, which came into force in July 1991, specify the required conditions for applicants and are intended to encourage voluntary actions. Every application should include an evaluation of possible treatment options based on ecological, economical and technical considerations. The Guidelines aim to enhance cooperation between potential responsible partners and public authorities, and to encourage the selection of the most effective remedial solutions.

27 By May 1996, 93 applications for financial support had been received for support totalling AS 4.3 billion (USD 430 million). The share of agreed public funds used to support site management is related to the degree of negligence of the potential responsible party. In the past ALSAG has generally covered 70 - 90% of the overall costs for remediation but this has had to be reduced in accordance with Austria's membership of the European Union[3] which began on the January 1st 1995.

3.2 Registration of contaminated sites

28 By May 1996, 24155 potentially contaminated sites had been identified of which 1807 were included on the national register according to one of four catergories of estimated risk level. 94% of registered sites are classified as municipal landfills whereas only 6% are industrial sites. It is suspected that the number of potentially contaminated industrial sites will increase as a programme for their specific identification is fully implemented. 105 of registered sites have been classed as contaminated in terms of ALSAG. Remedial activity has been undertaken at 38 of them.

29 At present the total number of contaminated sites in Austria is estimated to be from 5,000 to 10,000.

3.3 Recent initiatives

30 By 1994 after five years of experience with the National Clean-up Programme several problems in the framework were identified:

- Enforcement of ALSAG has been weakened because of the complexity of different regulations and regulatory agencies in the management process;
- Revenue generated by the waste levy has been only 33% of the amount predicted due to ineffective payment controls at the Federal Ministry of the Environment; and
- The value of applications for remedial action support are currently twice as large as the incoming revenue.

31 It is expected that legislation to amend the National Clean-up Programme to address these weaknesses will be implemented in the short term. This may include changes to enforcement legislation, a simplification of responsibilities, a restructuring of the priority setting system and improvements to industrial cooperation.

3.4 Research and development

[3]Under European Union rules public financial support is limited to a maximum of between 20-40% of overall site remedial costs to avoid imbalances between member countries.

32 ALSAG authorizes the Federal Ministry of the Environment to use public funds to stimulate research projects for remedial technology development. Techniques which are reportedly being investigated and/or are in use include containment, excavation, pump and treat technologies, soil venting, and to a lesser extent bioremediation.

33 Three research areas are currently being promoted: *in situ* bioremediation, solidification and stabilisation studies for soil washing residues, and treatment of gasworks sites (initially studying the impact of leachate on containment materials). In addition, the debate on contaminated land in Austria has recently focused on the standardisation of soil values for risk assessment with a consensus due to be reached by the end of 1996.

4.0 COUNTRY REPORT: BELGIUM [17,48,52]

Country Representative: J. Miller, Institut de Sociologie de l'ULB

4.1 Legal and administrative aspects

34 Interest in contaminated soil and groundwater has been growing in Belgium since the early 1980s when a few highly publicised cases came to the fore, for example the presence of severe arsenic contamination at an abandoned factory at Bocholt in Flanders.

35 Belgium is a Federal State composed of three Communities (Flemish, French, and German) and three Regions (the Flemish Region, the Brussels Capital Region, and the Walloon Region). The Federal Government delegates part of its legislative and executive power to the Communities and the Regions. Communities have responsibility for such matter as culture, education, health and other social affairs. The Regions have responsibility for territorial issues including the environment, employment, transport infrastructure and the production and supply of materials including energy and water. The legal framework for policy on contaminated land issues for each region is summarised below.

4.1.1 The Flemish Region

36 At the end of February 1995 the Flemish Government ratified a new Decree concerning the management of contaminated sites. This law covered five key issues:

- An inventory of contaminated land;
- The difference between historical and new soil contamination;
- The difference between duty and liability for decontamination;
- The soil decontamination procedure; and
- The transfer of land.

37 In the Flemish Region regulatory authorities are now empowered to investigate sites at the time of property transfer or during the closure of certain installations to determine the extent of any contamination which may be present. This information is stored on a regional database under the administration of OVAM (the Public Waste Agency of Flanders) with the dual purposes of supporting policy decision making and as a mechanism to heighten the awareness of potential site purchasers to contamination.

38 In addition to creating an inventory the new legislation defined contamination as either "historical" or "new" depending on whether pollution occurred before after the new Decree came into force. It is a requirement that "new" contamination be remediated as soon as the soil standards (intervention values) for contaminants in soil and groundwater are exceeded. The decision to remediate "historical" contamination is based on a site specific risk assessment approach and due to the limited financial resources available will be subject to prioritisation by the Government. In either case where remediation is required this should be to background levels wherever possible.

39 According to the Decree, responsibility for remediation rests with the user of the land where pollution enters the soil. Therefore in the case where site contamination has arisen from migration of pollutants from off-site then no responsibility rests with site operator. Further, where the operator can prove that either he did not cause the pollution or could have known about the pollution when purchasing the site then he is exempt from an obligation to remediate. The liability for "new" contamination is in accordance with *the polluter pays* principle. In the case of "historic" contamination the owner/user/polluter can be held liable under the rules adopted by the Act of Waste Management (1981).

40 The Decree outlined the soil decontamination procedure which involves four phases:

- Exploratory investigations (similar to a desk study to determine any reason why this site may be contaminated);
- Descriptive Soil Examination (a site investigation to determine the extent and quantity of any contamination present);
- Soil Remediation Plans (design of a remedial strategy); and
- Soil Decontamination Operations (implementation of remediation).

4.1.2 The Brussels Capital Region

41 In this Region the development of a soil protection policy is mainly the responsibility of the Minister of Housing, Environment, Nature Conservation, Water Policy, Historical Monuments and Sites together with the Brussels Institute for Environmental Management (BIM/IBGE). Duties for soil protection are delegated to BIM/IBGE in accordance with the Royal Decree in 1989. Existing legislation for soil protection is limited:

- The National Act on Protection of Groundwater (1971); and

- The Ordonance on Waste Prevention and Management (1991).

42 According to the Ordonance "*any producer or owner of waste has to remove that waste without causing damage to soil, flora, fauna, air and water, and at no risk for the environment and public health*". Therefore the *polluter pays* principle applies in the Region. Where liable parties cannot be found or do not comply with a requirement to take remedial measures then the Government may act to protect human health and the environment.

4.1.3 The Walloon Region

43 In this Region the responsibility for soil protection is shared between a number of regional ministries and semi-public institutions. A distinction is made between land contaminated due to abandoned industrial operations and to waste disposal practices since they are regulated by different authorities. Legislation has been enacted for each type of contaminated site including the Walloon Town and Country Planning Code (1978, amended 1995) and the Walloon Act on Waste Management (1985).

44 It has been estimated that Wallonia has 9,000 ha of derelict land of which more than 50% are related to coal mining [48]. It was for this reason that the Town and Country Planning Code (1978) contained specific regulations concerning site reclamation and alternative economic uses. The principle of these regulations is that the owner of any derelict land is obligated to "bring derelict land back into good condition". The Walloon Region provides assistance to site owners/operators to meet these regulations in form of a subsidy or loan:

- If the owner is a public body then Regional support will meet 50% of the site purchase cost and 100% of the remedial management cost.

- If the owner is in the Private Sector then the Region will provide interest free loans.

45 The 1978 regulations did not include a requirement to investigate and/or control chemical contamination of the soil. However, following concerns raised internationally over the problems of contaminated land the issue of soil contamination was added to the more general derelict land policy. A public body responsible for the reclamation of contaminated sites was created called SPAQUE (Société publique d'aide à la qualité de l'environnement). The main mission of SPAQUE is to assess, set priorities and reclaim former waste disposal sites. As of November 1995 SPAQUE was responsible for 17 priority sites of which 4 subject to on-going remedial action.

4.2 Registration in the Flanders and Walloon Regions

46 At the end of 1995 it was reported that more than 3000 potentially contaminated sites had been placed on the register operated by OVAM for the Flanders Region. Of these sites nearly 43% are characterised as old landfill sites with a further 30% being old industrial sites. OVAM have estimated that up to 9000 potentially contaminated sites will be added to the register over the next few years. As a result, a prioritisation system

has been set up to manage the further site investigation and possible remediation required at many of these sites.

47 In 1989, the Walloon Region initiated a research programme to develop a proactive strategy for contaminated site management. This study was to focus on the early stages of management including identification and preliminary site investigation. As part of this programme a database of all Walloon derelict sites was launched. By 1995 about 2,000 sites had been registered and subjected to an initial risk evaluation (see Table 4).

Table 4: Registered derelict sites in the Walloon Region classified according to comparative risk evaluation [48].

Comparative Risk	Number of Sites (%)
A known risk or a significant probability of high risk	5[#]
A less significant probability of risk	42
Probably present no risk	48
Require further investigation before any judgement can be made	5

[#]Of these 31% are former iron and steel works, 14% are colliery sites, 14% are manufacturing sites, and 11% are former gas works or coking plants.

5.0 COUNTRY REPORT: CANADA

Country Representative: L. Keller (Adelaide meeting), Environment Canada
G. Hill (Québec City and Oxford meetings), Environment Canada

5.1 Legal and administrative aspects

48 Canada is a federal state consisting of a central Federal Government, and ten Provincial and two Territorial Governments. Although there is a Canadian Environmental Protection Act, which covers most environmental issues, the Provincial and Territorial governments are the primary legislative authorities for the environment. The levels of government work extensively together in particular through the Canadian Council of Ministers for the Environment (CCME).

5.2 The NCSRP and the DESRT programmes

49 In October 1989 the CCME initiated the National Contaminated Sites Remediation

Program (NCSRP) in order to provide a consistent national approach for the classification and remediation of polluted sites. The programme's guiding principle is 'the polluter pays'.

50 NCSRP is administered through bilateral agreements between the Federal Government and the Provincial/Territorial governments and focuses on:

- Identification, assessment and remediation of all contaminated sites that form a (potential) risk to human health or the environment;
- Providing a joint government funding for high priority "orphan" sites[4]; and
- Stimulation of the development and demonstration of new and innovative remediation technologies.

51 Two other objectives of the programme are to:

- Define clearly the liabilities of those responsible for contaminating a site, in an effort to encourage pollution prevention; and
- To communicate with stakeholders.

52 A budget of Can$200 million was allocated for orphan site remediation for a period of five years from 1989. By the end of fiscal year 1994-1995, work had commenced on seven new high-risk contaminated orphan sites and had been completed at eleven sites. The total number of orphan sites being addressed by the NCSRP is now 45 at a total cost until March 1995 of nearly Can$80 million.

53 As a custodian for nearly 40% of Canada's land mass, the Federal Government has a significant responsibility to ensure that contaminated sites within its remit are managed effectively. Federal Crown land is put to both Public and Private Sector uses with the responsibility for each site resting with the Government Departments that control its use. In April 1990, through the NCSRP, Environment Canada committed a further Can$25 million over five years to assist Federal Government Departments in identifying, assessing and remediating high-risk contaminated sites within their jurisdictions. Funding is provided on a 50-50 cost-shared basis between Environment Canada and the custodian Department. Until the end of March 1995, a total of 325 Federal sites had been investigated with remediation being initiated at 14 sites.

54 A component of the NCSRP is the Development and Demonstration of Site Remediation Technology (DESRT) programme which has a budget of Can$50 million. The DESRT programme encourages the development and testing of new methods for assessing and treating contaminated sites to eventually bring these new methods to commercial viability. Activity within the DESRT programme in the fiscal years 1993-1995 is outlined in Table 5. The total number of DESRT projects at the end of the

[4]Where no responsible party can be found or is incapable of meeting the costs of remediation.

1994-1995 fiscal year stood at 50 with a total of Can$35 million having been spent by the end of March 1995 (of which Can$14.5 million has come from the Private Sector). The Private Sector contributions are negotiated on an individual project basis depending largely on the nature of the proposed project. It is reported that five companies which have demonstrated remediation technologies under the DESRT programme have been successful at marketing them for commercial use.

Table 5: Activity within the DESRT programme over the fiscal years 1993-1995.

Fiscal Year	Projects Initiated	Projects Completed
1993-94	13	12
1994-95	6	6

55 In addition to the financial resources created under the NCSRP, a general framework was implemented for developing tools for the consistent identification, assessment and remediation of contaminated sites. It includes:

- A National Classification System for Contaminated Sites [20]. This is a technical system designed for screening of contaminated sites to identify priority by assessing relative risks, and to evaluate the need for further measures (site characterization, risk assessment or remediation);

- The Interim Canadian Environmental Quality Criteria for Contaminated Sites [19]. These include assessment and remediation criteria for evaluating the extent of contamination and the need for remediation. Accommodation for various land uses is provided; and

- Remediation objectives. These are site specific treatment goals, that may be either criteria-based or risk-based.

56 To ensure that the updated criteria, which will replace the interim criteria, are derived on a satisfactory scientific basis, a Protocol for the Derivation of Ecological Effects-Based and Human Health-Based Soil Quality Criteria for Contaminated Sites is under development [23]. The Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives [24] sets out the circumstances under which the criteria based or risk based approach should be used to establish remediation objectives.

57 Other guidance documents released recently by the CCME include the contaminated site liability report [21], a guidance manual on sampling, analysis and data management [22], a framework for ecological risk assessment [25], guidelines for conducting bioassays [26], and the Subsurface Assessment Handbook for Contaminated Sites.

5.3 Recent initiatives: Private Sector activities

58 In order to assess the level of Private Sector activity in the contaminated land market the CCME initiated the NCSRP Directory of Contaminated Sites Services Database. The aim is to update the information periodically through the use of a questionnaire. Data submitted for 1993 by 115 companies operating in Canada showed that a total of Can$ 215 M had been spent on assessment and remediation of contaminated sites.

5.4 Remedial methods

59 A breakdown of the on-going and completed DESRT projects is shown in Table 6[5]. In many projects treatment technologies are being used in combination either as a form of process integration or to treat different contaminated media from different areas of the same site.

Table 6: Technical breakdown of treatment technology based DESRT projects until end of the fiscal year 1994-95.

Technology Types[#]	On-going Projects	Completed Projects
Biological	10	14
Chemical	5	4
Physical	7	6
Solidification/Stabilisation	1	1
Thermal	0	5

[#] Broad classes of technology type. In many DESRT projects, technologies are integrated either as a treatment train or as a combined approach and therefore more than one technology type may be used within a specific project. Project numbers in this table will not therefore correspond with the actual number of managed projects initiated in the programme as a whole.

60 Outside the DESRT programme, the application of innovative technologies in the wider NCSRP orphan site programme is limited to approximately 36% of remedial work for sites where a strategy had been decided upon by the end of fiscal year 1994-95 [27]. In over 60% of projects on- and off-site disposal and/or containment measures are reported as the preferred or selected option. In the case of two sites it was concluded that no further remedial action was required.

6.0 COUNTRY REPORT: DENMARK

Country Representative: I.M. Skovgaard, Environmental Protection Agency

6.1 Legal and administrative aspects

61 In Denmark, the national agency responsible for management of contaminated sites is the Environmental Protection Agency (Miljøstyrelsen, DEPA). However in general the responsibility for practical implementation of management strategies and remedial

[5] 8 on-going and completed projects involve development of site assessment test methods and protocols.

work falls on local government (i.e. Regional or County level administration). The DEPA approves the design of remedial actions nationally and compiles a revised national priority list each year based on data supplied by local government. The DEPA provides national guidelines and sets up regulations.

62 Contaminated land is mainly addressed in two pieces of legislation:

- Environmental Protection Act of 1974, amended in 1992, which covers sites contaminated after 1972-74; and

- Danish Contaminated Sites Act 1982, revised in 1990, which covers sites contaminated before 1972-74..

63 A central principle in the Environmental Protection Act is that the polluter should pay. However, according to the statute of limitation of the High Court, the time for bringing such actions expires 20 years after the polluter ceased his activities.

64 Related to the Contaminated Sites Act, a national programme on contaminated sites has been in operation since 1983. The main objective of this programme is whenever possible to make the site fit for reuse without restrictions.

65 In 1993 the Danish Government introduced the Value Loss Act to provide a mechanism for innocent owners of private houses built on a contaminated site to obtain compensation for any loss in value associated with national site registration. It also introduced a mechanism whereby the house owner could apply for immediate remediation of his land for a fee. The cost of this remediation is 60,000 DKr (1993) which represents about 10-15% of average remedial cost is reduced by 4,000 DKr each year. This encourages the homeowner to delay implementation of any remedial action. In 1993 the predicted cost of this system was an estimated 75 million DKr (USD 11 million) per year assuming an implementation period of 15 years [62]. The Act is administered by both local and national government following procedures of the contaminated sites administration.

6.2 Registration of contaminated sites

66 A Statutory Order and an accompanying guideline on registration and deregistration of contaminated sites was introduced in 1993. The order set out the procedural requirements for registration with the need for technical documentation emphasised.

67 Polluted sites are registered by the Official Property Registry. A condition for registration is that there is evidence that the site is contaminated to a level which presents risks to human health and/or the environment through site use and/or water pollution [62]. After registration any change in land use must be authorised in advance by the regional authorities.

68 A prioritization system ranks registered sites according to the actual risks related to the present site use. Sites where there is no conflict with the current land use will not be

remediated within 10 - 15 years. Groundwater protection has a very high priority in Denmark because 99 % of drinking water comes from groundwater sources. The Ministry of the Environment is preparing a "Groundwater Strategy" to speed up the identification and protection of good quality groundwater areas.

69 Under the Contaminated Sites Act, approximately 2,800 sites were included in the national register by January 1994. 53% of these sites are waste disposal sites, 36% industrial sites, 5% gasworks sites and 4% petrol stations. The total number of waste disposal sites is expected to reach 11,000 nationally.

70 A budget of DKr 540 million (USD 80 million) was allocated for registration and management of contaminated sites over the period 1990 - 1993. For 1994, the allocated budget was DKr 310 million (USD 45 million), including DKr 75 million for the 2,200 sites included in the Value Loss Act. A report covering the period 1990-1993 concluded that the total expected cost of cleaning up all identified waste disposal sites is DKr 22 - 24 billion (USD 4 billion) including voluntary actions. It is estimated that remedial actions will take between 30 - 50 years to complete.

71 Approximately half of the remediation projects in Denmark are voluntary, conducted under the guidance and approval of the County authorities. Licenses are normally given on the condition of a limited remedial action [56]. The severity of licence conditions depends on the sensitivity of the proposed future use. Sites that are only partly remediated remain on the register with a licence for restricted land use.

72 Other sites which require remediation include about 10,000 sites occupied or formerly occupied by petrol stations. In 1992 the petroleum and gas industry reached an agreement with regulatory authorities to remediate old petrol station sites under the organisation of an operating company. By the middle of 1993 management had been initiated at 140 sites with remedial actions (mostly by excavation) completed at 66 of them. The cost of remediation is expected to be DKr 50 - 100 million (USD 7 - 15 million) annually over a 10 year period.

6.3 Recent initiatives

73 In 1994 the Ministry of the Environment appointed a national commission (the Contaminated Land Committee) to review the contaminated land situation and to recommend a revised approach for its management. The commission was to consider a proposal for new legislation to produce an integral Contaminated Land Act and to regulate the excavation of soil for re-use or disposal. The final report from the Committee was expected to be available from the end of 1995.

6.4 Remedial methods

74 Excavation and off-site treatment or disposal is the most commonly used technique in Denmark for remedial actions. Emerging technologies are seldom used in publically financed actions. Several reasons for this were reported by Strϕbaek [57]:

- Under the deregistration procedures for sensitive land uses such as for housing removal from the register can only take place when remedial objectives are met. These targets are strict and can only be confidently met by excavation and removal of soil. The threat of economic blight plays an important role in technology selection;

- No general criteria for soil remediation and for disposal of treated soil are available;

- Landfill disposal of contaminated soils is in many cases cheaper than alternative technologies; and

- The average area of individual contaminated sites in Denmark is small which makes the implementation of *in situ* remediation technically difficult and costly.

75 Emerging technologies have been more frequently applied in voluntary clean-ups where there is no requirement for deregistration [29]. The aim of most voluntary actions is to obtain a site licence for a particular land use where the developer/owner can show that there is no conflict between planned use and residual contamination. The site remains on the register. Example technologies which have been used in Denmark include [29]:

- Soil vapour extraction;

- *Ex situ* biological methods, such as landfarming and composting, for treating petroleum oils and BTEX compounds; and

- *In situ* approaches such as soil flushing and bioremediation.

76 As part of a wider review of management priorities initiated in 1992, the DEPA is preparing a strategy for innovative technology development [29]. This report was expected to be available by the middle of 1995.

6.5 Research and development

77 The DEPA has supported various R&D programmes:

- Research in the Landfill Project 1987-92 has included remediation of soil and groundwater contaminated with chlorinated aliphatics.

- The Gasworks Programme has included demonstrations of various technologies at pilot and full scale such as *in situ* biodegradation and soil flushing; composting; electroremediation and thermal treatments.

7.0 COUNTRY REPORT: FRANCE

Country Representative: R. Goubier, ADEME

7.1 Legal and administrative aspects

78 In the 1990s, renewed impetus emerged in France to address the problems of contaminated land, and in particular the setting of a legal and administrative framework and the preparation of technical directives. There is no specific law in France to deal with the problems of contamination arising from industrial activities and/or inappropriate waste disposal. The legal framework is based on the Waste Management Law (1975) and the Industrial Installations Classified for Environmental Protection Law (1976). Additional amendments to the original laws including one in the July 1992 have strengthened parts of the original framework with reference to contaminated land. The four main principles of the overall legislation are:

- The *polluter pays* principle applies where the polluter is the site operator according to the 1976 legislation;
- The obligation of the site vendor to inform potential buyers that certain classified industrial operations have been carried out on-site;
- The obligation of operators of specified industrial activities (including waste disposal) to insure against pollution events and subsequent ground remediation; and
- The obligation that after cessation of industrial activities the site operator reports to the regulatory authority on the state of soil and groundwater at the site.

79 The central regulatory authority in France is the Ministry of the Environment. Within this ministry, the Director of Pollution and Risk Prevention is responsible for the environmental impact of industrial activities including the management of domestic and industrial wastes. As representatives of Government, the Prefects of Departments are responsible for the application of legislation at a local government level. To implement this policy the Prefects are assisted by Inspectors of Classified Installations.

80 Although the *polluter pays* principle is applied in France there remains cases where no responsible party can be found or is incapable of meeting the costs of remediation. Such sites are termed "orphan" sites and are covered by a directive issued by the Ministry of the Environment in 1989. The directive sets out the procedure for management of such sites as follows:

- If a responsible party cannot be found for a specific site then the Prefect may ask the Ministry of the Environment to consider the site "orphan".
- If the Minister agrees then the Prefect is authorised to designate the Agence de l'Environment et de la Maîtrise de l'Energie (Ademe) to carry out any

necessary investigation and remediation work.

- After remedial works are completed, Ademe is authorised to undertake legal action against potential responsible parties to recover costs borne by public funds.

81 From 1989-1994 the funding of the "orphan" management policy has come from Government combined with a voluntary contribution from the EPE (Entreprises pour l'Environnement) which is an association of industrial firms formed in 1992. The EPE agreed to contribute FF 20 million over a five year period for the management of orphan sites in an attempt to avert a new tax on special industrial wastes. However, the combined Government and Private Sector funding of between FF 35 to 40 million per year has proved insufficient to meet the escalating costs of the orphan site programme, and the French Government has therefore implemented the new waste tax. This tax came into force in 1995 as an amendment to the Classified Industrial Establishment Law and is expected to raise an additional FF 65 million in 1995 and FF 100 million in 1998. This is in addition to a tax of FF 20 per tonne for the landfilling of urban wastes

.

7.2 Registration of contaminated sites

82 By October 1994, 669 contaminated sites had been placed on the national inventory of suspected sites. This number does not include certain sites such as gasworks and petrol stations which are registered separately. By 1994 Gaz de France, the main responsible party for gasworks, had identified over 700 such sites.

83 The registration process is carried out by local authorities and is intended to identify those sites which may be suspected of land contamination through former industrial uses. The register is constructed at a local (Regional) and a national level. Regional registers are prepared by specific sub-contractors (e.g. consultancy firms and University Departments) under the supervision of a committee formed by the local authority and the financial institution supporting registration (for example the Ministry of the Environment or the Water Agencies). The collection of information is based on a desk study of historical information and the compilation of any existing lists and registers.

7.3 Recent initiatives

84 The Ministry of the Environment has commissioned the preparation of technical guidance to support the development of national registers and the management of orphan sites. Key pieces of this work programme are outlined in Table 7 along with expert guidance under preparation from Ademe for supporting the use of remedial technologies. The development of these methods and procedures is being carried out with the active participation of a national working group comprising of technical experts, professional unions, and associations for environmental protection.

85 Ademe is currently working with the United Nations Environment Program (UNEP) to

develop technical guidance for the management of contaminated sites which will be available from late 1996. It aims to support developing and newly industrialised countries in their transition to a management framework for contaminated sites which includes site characterisation, prioritisation, selection and implementation of remedial actions, legal and economic aspects, and education and training. The preparation of this guide was based on the results of a survey of 44 countries by the University of Loughborough, Louborough, UK. The majority of respondents indicated that land contamination was a serious issue in their country but that political awareness was variable and generally low.

Table 7: Development of technical guidance and procedures by the Ministry of the Environment to support national policy on contaminated land and by Ademe as technical references.

Guidance	Description
Methodological guide for Regional inventories	Guidance on the preparation of registers for contaminated sites. Published first half of 1996.
Studies of industrial branches	Industrial profiles for contaminated sites including gasworks, chemical plants, and wood preservative sites. To be published during 1996.
Methodological guide for preliminary diagnostic (soil study)	To be available in the first half of 1996.
Methodology for the simplified evaluation of risk prioritisation	Currently undergoing peer review testing.
Methodological guide for impact studies	In preparation
Guide for health and safety for the investigations and works on polluted sites	Available from Ademe
State of the art of the treatment of polluted groundwaters	Available from the Water Agencies
State of the art of sampling and analysis	To be published mid 1996 by Ademe
State of the art of containment measures	To be published mid 1996 by Ademe
State of the art of stabilisation and solidification	To be published mid 1996 by Ademe
State of the art of biological treatment of polluted soils	To be published 1996 by Ademe
State of the art of physico-chemical treatment of polluted soils	To be published 1997 by Ademe
State of the art of thermal treatment of polluted soil	To be published 1997 by Ademe

7.4 Research and development

86 The development of new technical capabilities is encouraged in France. *In situ* bioremediation and soil vapour extraction are commercially available. Soil washing and thermal treatment are at the stage of near market applications. Important developments have been initiated in the area of site characterisation where the use of remote sensing methods such as ground penetrating radar are reportedly a common tool for the initial stages of investigation. Ademe has supported the development of a range of state of the art reviews of emerging treatment technologies (see Table 6). The introduction of a landfill levy on hazardous wastes including soil is expected to increase the cost-competitiveness of alternative remedial approaches.

8.0 COUNTRY REPORT: GERMANY[38,39,43]

Country Representative: V. Franzius, Federal Environmental Protection Agency

8.1 Legal and administrative aspects

87 A second draft of the Federal Soil Protection Act will go before the German Parliament at the end of 1996. It incorporates revisions to the 1992 draft law and aims to harmonize procedures for the identification, registration, assessment and remediation of contaminated sites throughout Germany. At present legislation is passed individually by the 16 Federal States.

88 The 1996 draft law sets out a framework for more detailed regulations to be prepared and issued including various technical guidance on management procedures. Aspects which will be addressed include:

- Risk Assessment and issuing of soil quality criteria;
- Methodology for sampling and analysis;
- Implementation of remedial actions and monitoring requirements; and
- Preventative measures for future soil pollution.

It is intended to pay special attention to the principle of *warding off of danger* and to compare the effectiveness of containment and isolation compared with decontamination measures.

8.2 Registration of contaminated sites

89 The number of suspected contaminated sites registered by December 1995 was approximately 170,000. About 51% of these are former waste disposal sites and 49% are abandoned industrial sites. The identification of contaminated sites is still continuing and estimates for a final total are as high as 240,000.

90 The Soviet Army left German territory in August 1995. By December 1995 nearly 34,000 suspected contaminated sites on former military occupied land had been identified. As a result over 16,000 emergency remedial measures have been initiated on 524 sites, including installation of containment measures and the removal of munitions. An initial assessment of all former Soviet bases in Germany is due for completion by the middle of 1996 at a cost of DM 95 million. Preliminary results report that nearly 35% of sites are within drinking water protection areas and 25% present a significant hazard to water quality.

91 50 years after the end of the Second World War the legacy of armament production still presents significant environmental problems for Germany. The nature of the chemical hazard at these sites is seen as being significantly different from those found at civilian sites. A comprehensive inventory of production sites has been underway since 1990 with 3,200 sites identified to date (of which roughly 50% are considered hazardous).

8.3 Recent initiatives

92 Recent Federal management programmes have been set up for identification and assessment of sites and for initiating immediate measures. The programmes have focused on:

- Military sites (about 2.8% of the area of Germany);
- Armament production particularly those dating from the Second World War;
- Lignite opencast mining sites (about DM 1.5 billion over 1993-97);
- The Wismut uranium mining sites (at a cost of DM 13 billion); and
- Industrial sites owned by Treuhandanstalt in the New Federal States.

93 The Treuhandanstalt is the Federal Agency responsible for the transfer of old industrial operations in the former East Germany into private ownership. Although many of these sites are contaminated, they have considerable economic potential once remedial measures have been implemented. The 'Administrative Agreement on financing the clean-up for contaminated sites' adopted by the Federal Government and the States in December 1992 allocated remediation costs between Government and the States on a 60:40 basis respectively. A total budget of DM 1 billion over 10 years was agreed. The agreement was made on the condition that the New Federal States exempt potential investors from further environmental liability of damage caused prior to July 1990.

94 As part of this agreement several large remedial projects costing in excess of DM 100 million have been implemented. To date 19 projects have been initiated at a cost of over DM 6 billion with costs paid by Government and the New Federal States as 75:25 split.

8.4 Research and development

95 Research on treatment technologies involves optimization of already existing technologies and development of innovative approaches. The VEGAS project is an important initiative to provide a facility for the field scale testing of *in situ* processes (see Box 1).

96 Site assessment methods are being improved and optimized in order to lower the costs necessary to investigate the large numbers of contaminated sites in Germany. Risk assessment projects include:

- Elaboration of toxicological data for 80 common contaminants and 17 priority substances in former armament production sites;

- Effect levels for contaminants; and

- Development and testing of models for risk assessment for contaminated sites (UMS model) and for military and armament production sites (MAGMA model).

Box 1: The VEGAS experimental facility at the University of Stuttgart.

The research facility for subsurface remediation VEGAS (Versuchseinrichtung zur Grundwasser - und Altlastensanierung) at the University of Stuttgart is funded by the Federal Ministry of Research and Technology (BMFT) and the Ministry of the Environment of Baden-Württemberg. The facility became fully operational in the summer of 1995 and is available to industry and research institutions. It provides a link between conventional lab scale studies and field demonstrations through the use of large scale experimental chambers up to 850 m^3 in volume. The objective of using these chambers is to simulate field conditions while also allowing the control and reproducibility associated with lab based studies.

The aim of VEGAS is to test and optimise existing techniques and to develop new techniques for *in situ* remediation of contaminated soil and groundwater. The main research programmes are:

- Optimisation of existing *in situ* pump-and-treat and soil flushing technologies and development of new applications.

- Treatment of non aqueous phase liquids (NAPLs) in the vadose zone.

- *In situ* microbial reductive dechlorination of chlorinated hydrocarbons in soil and groundwater.

- Enhancement of the *in situ* bioremediation of PAH contaminants in soils.

8.5 International cooperation

97 Germany has bilateral agreements to exchange experiences on remedial treatment technologies with the US and with Switzerland. The USA and Germany are leading the new NATO/CCMS pilot study "Environmental aspects of reusing former military sites" [47].

98 Following an International Workshop on Contaminated Sites in the European Union, Germany has lead the initiation of the CARACAS (Concerted Action on Risk Assessment for Contaminated Land) project which started in February 1996 [47].

9.0 COUNTRY REPORT: HUNGARY

Country Representative: Reiniger, R., Hungarian Authority for the Environment
Richter, P., Technical University of Budapest

9.1 Legal and administrative aspects

99 The principal legislation in Hungary is the Environment Law enacted in 1976. In 1990 the Hungarian Ministry of Environment was reorganised and renamed the Ministry of Environment and Regional Policy. The Ministry established the National Authority Network for the Environment which includes the 12 regional Environmental Inspectorates under a single Supervisory Department.

9.2 Environmental problems at former Soviet military sites

100 The legacy of the Red Army is not a problem exclusive to Hungary. Under a bilateral agreement between Hungary and the former Soviet Union, about 100,000 soldiers, 25,000 weapons and 560,000 tonnes of war equipment were withdrawn from Hungarian soil between March 1990 and June 1991. Assessment of the environmental damage caused by the Soviet troops was part of the agreement. The assessment was managed by the Ministry for Environment and Regional Policy and was conducted between 1990 and 1991. The result of this study estimated that nearly US$ 600 million was necessary to remediate the environmental damage left behind.

101 The survey included 171 garrisons, 340 settlements, 6000 major buildings and 46000 hectares of land. The report highlighted:

- Hydrocarbon contamination affecting 2.7 - 3.0 million m^3 of soil and 1.0 - 1.2 million m^3 of groundwater;
- The presence of about 5,500 - 6,500 m^3 of free phase hydrocarbon product on the water table at these sites;
- The presence of between 200000 - 220000 m^3 of mixed waste found at these sites including up to 5% hazardous materials,

The nature of the damage was characterized as follows: 39% of sites had ground and groundwater pollution, 28% had damage to flora and fauna, and 18% were used for inappropriate waste disposal. 20 severely contaminated sites were reported to account for 65% of the total damage.

102 The Hungarian government has allocated US$ 16 million for identification and mapping of soil and groundwater pollution. Site restoration will be undertaken by 10 companies selected by an international tendering process. Addition funding for this work has been provided by Denmark and the USA.

103 To further address these problems a NATO Advanced Research Workshop (ARW) was held in Visegrád, Hungary in June 1994. The workshop focused on identification of

remediation approaches and selection of technologies in the context of the risks of pollution to human health and economic and financial constraints. The workshop also included the presentation of a case study and a tour to the former Soviet Komárom Base Site. Recommendations of the Workshop included:

- Governmental responsibility should primarily be to remediate sites to levels that avoid imminent risks to human health. Additional treatment should be the responsibility of the ultimate landowner;

- Target levels for remedial actions should be based on the proposed land use and should be developed according to established toxicology and risk assessment procedures;

- A more extensive exchange of experiences with the application of effective technologies should be stimulated; remediation technologies which have not been extensively utilized in Central and Eastern Europe should be investigated and demonstrated at appropriate sites; and

- A specific demonstration project for a representative site should be conducted, allowing all interested parties to participate.

9.3 Inventory of groundwater pollution sources in Hungary

104 The PHARE project 121 entitled 'Inventory of Groundwater Pollution Sources' started in February 1992 with the aim to study vulnerable aquifers of importance to drinking water supply in 24 areas of the country. Information on possible sources of groundwater pollution was gathered, processed and transferred to a geographic database. For all 24 areas geomorphological and geohydrological data was collected together with locations and specifications of 1030 public drinking water abstraction wells.

105 Six areas were defined by the Ministry of Environment to be of high priority and have been studied in more detail. Priority setting was carried out on the basis of risk assessment. Risk was defined as the likelihood that pollution of the aquifer had occurred. The risk assessment procedure consisted of two steps:

- determination of possible vertical transport of pollutants through the unsaturated zone; and

- evaluation of possible horizontal transport through the saturated zone to the abstraction well.

106 In most cases chemical analysis for trace contaminants was not carried out. However despite this shortcoming priority ranking was completed for 3,335 possible pollution sources. The top 5% of the highest risk sites were selected for further study. It was reported that a more detailed quantification and mapping of the pollution at various sites would be necessary before remedial options could be considered.

10.0 COUNTRY REPORT: THE NETHERLANDS [1,2,3,4,49,55]

Country Representative: E. Soczo, National Institute for Public Health and Environmental Protection

10.1 Legal and administrative aspects

107 On 10 May 1994, a short bill (known as 'novelle') to amend the Soil Protection Act (SPA) with a regulation on soil clean-up was passed by the Dutch parliament. This constituted a major change in Dutch soil protection. The clean-up regulation, now incorporated in the Soil Protection Act addresses more issues than were regulated in the former Interim Soil Clean-up Act (IBS), especially with regard to voluntary remedial actions [45]. It provided a clear structure for investigation and remediation of sites for all parties involved. The amended Law embodies a shift of emphasis in the following areas [45]:

- Privatisation: the polluter and the owner/ user have been made the primary parties responsible for ensuring the soil quality of a site. They have a duty to initiate investigation and remediation, and also to report any intention to do so to the relevant authorities;

- Decentralisation: the Provinces and the four largest cities have been given more administrative powers. They can issue Clean-up Orders; and

- Uniformity: relevant procedures will be regulated by General Administrative Orders and Ministerial Decrees to provide a uniform system throughout the country. There is an obligation to report cases of soil contamination and of any intention to remediate or remove contaminated soil to the relevant regulatory authority.

108 The amended Soil Protection Act (SPA) will come into force in three phases with the first two phases already implemented:

- Phase 1: regulations replacing the IBS came into force (May 1994);

- Phase 2: encompassing interim policy laid down in the document entitled "Circular on coming into force of the regulation on soil clean-up of the Soil Protection Act" (January 1995); and

- Phase 3: implementation of more detailed regulation left over from the Soil Protection Act.

109 The amended SPA includes provisions for a phased approach to soil remediation and formalises the status of the Service Centre for Soil Treatment (SCG). There is an obligation on the part of those conducting site remediation to consult with SCG on the treatability of excavated soil (see Box 2).

Box 2: The Service Centre for Soil Cleaning (Service Centrum Grondreiniging, SCG).

SCG was founded in 1988 by the Dutch Government to supervise *ex situ* soil treatment in the Netherlands. The role of SCG is to introduce uniformity into the implementation of soil remediation between provinces. From the beginning of 1990 SCG has been responsible for all remediation projects which are financed by the Government. The Private Sector can use SCG to implement remedial action but are not legally obliged to do so. They are however required to consult SCG. SCG also acts as a national broker for contaminated soil by inviting tenders for remedial projects and afterwards selling the treated soil for re-use as building materials.

The main objectives of SCG can be summarised as follows:

- The treatment of polluted soil for re-use as building material.
- The registration of excavated contaminated soil in Dutch remedial projects.

SCG is required to assess the treatment options available for excavated contaminated soil. It can decide whether a soil is treatable using available technology or should be transferred to a temporary storage area.

110 A General Administrative Order will be issued which addresses the central issue of assessment and prioritization of sites. In the interim policy, the concept of 'serious danger' as defined in the IBS has been replaced by the concept of 'serious soil contamination'. Intervention values provide a framework for the determination of serious soil contamination which are laid down in the 'Circular on intervention values'. This came into force in May 1994, replacing the former C-values given in the Soil Protection Guidelines. The application of the new intervention values is not meant to be retrospective and applies only to site assessments completed after May 1994.

111 Intervention values are based on human toxicological and ecotoxicological data which are related to an averaged value over a specific volume of soil and groundwater[6]. In addition soil intervention values are corrected for bulk soil properties such as clay and organic matter content. They indicate the concentration levels of contaminants in soil, sediments and groundwater above which the functional qualities of soil for humans, plant or animals are or will be severely diminished.

112 In the same Circular, target values were also introduced. They replace the former A-values and are intended to indicate a level implying negligible toxicological and ecotoxicological risk. These values are also corrected for soil properties and are used as the basis for remediation objectives.

113 In the Netherlands assessment of soil contamination involves three stages:

- Stage 1: assessment of risk against intervention levels;

[6] for soils the volume is 7m by 7m by 1m depth.

- Stage 2: assessment of actual site specific risk;

- Stage 3: assessment of remediation targets.

114 In the first stage, contaminant levels are compared with intervention values. If these values are exceeded then remediation is required. In stage 2 the actual site specific risk is evaluated to determine the urgency of remedial action. Actual risk is evaluated for three categories: human exposure, animal and plant exposure, and the potential for contaminant migration. If actual risk is unacceptable for one or more of these categories then remediation is considered urgent and one of two options should be implemented [45]:

- Option 1: remediation should take place as soon as possible after the Decree from the responsible authorities, with a maximum time limit of four years;

- Option 2: remediation should be initiated at a moment determined by the responsible authorities, which is at least four years after the Decree.

If the actual risk is acceptable then remedial action is considered not to be urgent. Remediation will still be necessary but can be implemented at a future date. Even if contaminant concentrations do not exceed intervention values the second stage assessment should be conducted since in some cases unacceptable actual risks may be found at soil contaminant concentrations lower than intervention values. Where this occurs the site is categorised as an urgent site.

115 The third stage assessment evaluates the setting of remedial objectives including the decision to remediate according to a "suitable for use" or a multifunctional approach. In the case of the former the effectiveness of isolation, control, and monitoring (ICM) measures should also be evaluated. A special General Administrative Order will address the so called Location Specific Circumstances (LSO), in which total remediation of a site is not feasible. In these situations, ICM measures will have to be taken to prevent exposure to contamination.

10.2 Future policy developments

116 Following the introduction of the SPA it is the intention of the Government to consider future Dutch policy on contaminated land in the context of both an integration of the management process and the aims of the National Environmental Policy Plan (NEPP). The NEPP sets out a number of targets to be achieved by the year 2010:

- All *urgent* sites are to be cleaned up or controlled by containment measures, and/or to be monitored;

- All *non-urgent* sites have to be controlled;

- There is to be a full inventory of contaminated sites for the Netherlands.

The revised management framework will incorporate aspects of a suitable for use approach to assessment, risk-motivated remediation, and an integrated consideration of technical, economic and social issues.

10.3 Registration of contaminated sites

117 Registration of contaminated sites has been conducted for a number of years with the objectives of providing a full inventory of sites found within the Provinces. It is the intention that the registration databases should reside within the Provinces while central Government is responsible for monitoring of remedial actions. A systematic assessment procedure (called FINABO) has been adopted by three of the provinces which involves three types of collected data: site information, project-management information, and financial.

118 The number of suspected contaminated sites in the Netherlands is about 120,000 (mainly sites which are still in use). Total estimated treatment costs are between DFl 50 billion and 200 billion. After 10 years of soil treatment, remedial measures have been taken at about 1,000 sites and investigations have been carried out at about 10,000 sites [40]. In recent years, about DFl 500 million per year has been spent on soil investigations and remediation. For the period 1982 to 1992 the total expenditure is estimated at DFl 2.5 billion.

119 Over the last two years, approximately 1 Mton soil per year is treated in treatment plants. About 200,000 tonnes contaminated soil per year are imported from the Germany. Another 1-2 Mton is disposed in landfills. About 70 % of the disposed soil is potentially cleanable. Reasons for this situation are that costs for disposal of contaminated soil (Dfl. 115 per ton) are only slightly lower than average costs for remediation (Dfl. 135 - 150 per ton). It is expected that this situation will be changed soon, because in the amended SPA it is regulated that cleanable soil should be cleaned. According to the Environmental Management Act 1992 (WMB), the disposal of cleanable soil will be prevented.

10.4 Recent initiatives

120 In October 1992, the Minister of the Environment appointed the Working Group on Soil Clean-up (also known as the Welschen Committee) to translate strategic policy into practice and to recommend solutions to operational problems. The Committee, which consisted of representatives of central, regional and local Government, recommended that [63]:

- Remediation costs should be shared between Government and additional responsible parties for specific sites, such as gasworks;

- Optimisation of current legislation to favour "active management of contaminated land" through a phased remedial approach rather than total clean-up;

- Optimisation of remediation efficiency through enhanced technology effectiveness and a reduction in treatment costs. Most soil treatment in the Netherlands involves either *ex situ* thermal or soil washing technologies. Although these technologies have been improving in recent years only 50% of treated soils meet the Dutch target value due in many cases to residual heavy metal contamination[7].

121 Many of the suspected contaminated sites in the Netherlands are still operational. Based on the report of a joint Committee of industry and Government [28], the Private Sector started a national programme (BSB) for a systematic large scale investigation and remediation operation of its premises in 1993. The BSB scheme is administered by a number of regional bodies, one per Province, and a national steering Committee. A model based approach, which used information from desk studies and the Chambers of Commerce identified about 25,000 sites at which serious soil contamination can be expected [40]. Approval of the Provincial authorities is required for the remedial actions plans of BSB sites.

122 A similar programme has been initiated in the petrochemical retail sector with investigations at a large number of petrol station sites. Where necessary protective measures to prevent pollution migration and site remediation are to be implemented. The SUBAT organisation has been set up to coordinate the post-closure management of petrol stations including site investigations and remediation.

123 In 1994, new Dutch protocols for site investigation in relation to soil contamination were published including:

- A protocol for 'preliminary site investigation';

- A protocol for 'further investigation', part 1 which includes procedures for the assessing the need for remediation according to the SPA.

10.5 Validation and selection of remedial technologies

124 In order to support the role of regulatory authorities in the approval of remedial plans and the selection of remedial technologies two tools have been developed:

- The revised Handbook of Remedial Action Techniques; and

- A Decision Support System for contaminated sites.

125 The Handbook (in Dutch) has been prepared by the RIVM and includes remedial technologies for both contaminated groundwater, soils and sediments. It contains updated technical and validation information on a range of technologies including cost,

[7] Soil exceeding the target value (up to 5 times) can still be reused according to restrictions set by the Regulation on Building materials.

performance, applicability, and experiences with field scale operation.

126 The Decision Support System consists of two main modules: prediction and evaluation. In the prediction module, potentially suitable remedial technologies are selected for a given site and combined to provide a complete remedial option. For each option, key information is calculated for evaluation such as concentration and leaching characteristics of residual contamination, quantity and composition of waste emissions and cost. The evaluation module processes this information in order to recommend one or more remedial alternatives for further consideration. In addition, where data sensitivity and uncertainty are key factors this module will determine the specific parameters which should be improved to increase the confidence of technology selection.

10.6 Research and development

127 Dutch research on contaminated land management has recently been revised in response to changes in national policy. Several major research programmes have been initiated with the aim of conducting more applied research and focusing of resources into overcoming bottlenecks in the application of investigation and remediation procedures. Three of these programmes are described below:

- Integrated research on contaminated land (PGBO);
- *In Situ* Biological Remediation (NOBIS); and
- Treatment Processes for Polluted Sediments (POSW).

128 The PGBO programme has the mission of coordinating Dutch research in contaminated land to ensure the proper dissemination of information and the focusing of research in the acquisition of key areas of knowledge. The programme is financed by the Dutch Government and has a total budget of Dfl 1 million including the provision to fund its own research projects. Example projects which might be funded by this programme are:

- Study of remediation by management tools as opposed to remedial technologies;
- Study on the use of expert systems in contaminated land decision making; and
- Study on the possibilities of reducing information requirements for contaminated land, for example by classifying.

129 The mission of the NOBIS programme is to develop, evaluate, and demonstrate innovative techniques for the process control of *in situ* biotechnology. It is intended to evaluate the potential cost savings afforded by large scale applications of biotreatment and to promote the commercial export of technology and expertise. The programme

is supported by Government to the value of Dfl 25 million with an additional Dfl 12.5 million expected to come from the Private Sector. The programme will run until 1998.

130 The content of the NOBIS research programme will be targeted to the responses of Dutch problem holders in order to pursue research that will develop technologies which will meet market demand. The framework of the programme has been developed from a survey of process bottlenecks (Table 8). The programme aims to pursue an integrated approach to site management which incorporates and optimal balance between risk reduction, environmental benefits, and treatment cost. Research experiences from each project will be shared among other programme participants to encourage information dissemination.

Table 8: Identified bottlenecks in the management of contaminated sites which form a framework for the NOBIS programme.

Bottleneck	Proposed Targeted Research
Identification and monitoring of soil and groundwater contamination: distribution and processes	Characterisation and monitoring techniques and instruments Characterisation and monitoring strategies
Description and modelling of treatment processes	Description for treatment processes: evaluation, integration, simplification and validation of models
Design, realisation and optimisation of treatment processes	Methods for testing treatment processes and their possible simulation Design and dimension principles: "the engineering challenge" Relation between monitoring, control, design, and optimisation
Positioning of *in situ* bioremediation within the overall remediation strategy	Methods for comparing remedial alternatives Evaluation of residual risks and aftercare

131 The POSW programme aims to develop ecologically sound dredging and treatment technologies for contaminated sediments. It is funded by the Ministry of Traffic and Public Works to a value of Dfl 40 million. The programme has been divided into two phases:

- Phase 1: the study of applicability and cost of a number of technologies; and
- Phase 2: further development of promising technologies identified in phase 1 including full scale demonstrations.

Phase 1 was completed in 1991. Phase 2 is to be completed by the end of 1996.

132 POSW research projects are carried out in cooperation with technology vendors,

consulting engineers and research institutes. Aspects of the phase 2 study include:

- *In situ* investigation methods for contaminated dredgings; and
- Use of physical classification (e.g. hydrocyclones), biological and thermal techniques in sediment treatment.

11.0 COUNTRY REPORT: NEW ZEALAND

Country Representative: R. Salter, Ministry for the Environment

11.1 Legal and administrative aspects

133 The issues of contaminated land have only recently come to prominence in New Zealand. Since 1991, problems associated with contaminated sites and their management have become an important part of the environmental agenda in New Zealand, both for regulatory agencies and for industry. Environmental management in New Zealand is divided between three tiers of government: national, regional, and city or district councils.

134 At the national level, the Ministry for the Environment was established to advise central Government. It has two key roles:

- To provide policy advice to the Minister and the Government that promotes sustainable management of the environment; and
- To enable the implementation of sustainable management through the administration of environmental statutes, advocacy, education and advice.

In addition the Ministry also has the ability to develop and promote national environmental standards and to develop policy and legislation on environmental issues. The management of Government owned contaminated sites is the responsibility of individual Government agencies. The Department of Survey and Land Information is the responsible agent where the Government is the liable party on private land.

135 New Zealand has 14 regional councils and 2 unitary authorities. These councils are the primary environmental regulatory agencies with comprehensive responsibilities for management of discharges to air, water, and land. All tiers of local government draw their authority from laws passed by central Government. In the management of contaminated land the principal roles of regional councils are to:

- Gather and maintain information on potential and actual contaminated sites;
- Undertake environmental monitoring;
- Set priorities for specific sites according to their likely adverse effect on the

environment (including human health);

- Regulate site investigation, risk assessment, and remedial actions where required;

- Develop effective management strategies for existing contaminated sites in the region and to prevent new contamination; and

- To ensure public awareness of the issues and to maintain an information support system for all parties affected by contaminated sites.

136 The City or District Councils are responsible for land use planning and control. They address site specific land use controls and issue consents for building construction and provide a wide range of other services including:

- Administration of building controls and restrictions related to sites; and

- Maintenance of land information memoranda relating to the physical characteristics and chemical contamination on each parcel of land.

137 To date, contaminated sites have been largely the responsibility of the regional councils and the major urban city councils. These regulatory agencies have been most affected by the discovery of contaminated sites and have undertaken major initiatives to investigate and characterise such sites.

138 The legal framework for contaminated land in New Zealand is based on the Resources Management Act (RMA), 1991 which integrated a large number of previous environmental statutes into a single all encompassing law. The aim of the Act is to promote sustainable management of natural and physical resources and represents a fundamental shift in focus from previous legislation which emphasised planning activities to regulating the effects of such activities.

139 The RMA sets out a framework of policies and plans, providing processes and mechanisms to allocate resources and to grant consents to minimise adverse environmental effects from industrial activities. There are restrictions on discharge of waste to land, water, and air, with enforcement procedures and liability provisions which are particularly relevant to contaminated sites:

- Liability is to be assigned to the owner/occupier of the site or the polluter;

- Any party may initiate legal action to enforce environmental improvement with liability determined by the acting party[8];

- Increased fines (up to NZ$ 200,000) and imprisonment (up to 2 years) for actions in breach of these regulations; and

[8]This raises considerable uncertainty in assessing liability, in particular due to the lack of any supporting case law.

- Extension of liability of site pollution to company executives.

140 These latter provisions have significantly affected the policies of major companies in New Zealand which are reportedly now carrying out considerable work programmes to assess their own environmental practices and potential liabilities. However, prosecutions are seen as a regulatory action of last resort and fines are generally low in comparison to the overall cost of contaminated site management.

141 Other relevant legislation includes the Health Act and the Toxic Substances Act which contain provisions which could be used to manage contaminated sites. It is unlikely however that they will be used for this purpose since the major initiatives have been taken by the environmental regional agencies rather than the health authorities. New Zealand law does not provide a statutory definition of contaminated land nor are there any statutory threshold levels to define whether a site is contaminated by a specified substance.

11.2 Registration of contaminated sites

142 A broad review of potentially contaminated sites was commissioned in 1992 to identify suspected contaminated sites from historical records of past industrial use. The likelihood and severity of site contamination for each type of industrial site identified was then determined from international experiences of similar industries. Sites were categorised into 3 risk classes:

- High risk sites are expected to pose an actual or imminent significant adverse effect to human health and/or the environment;

- Moderate risk sites are expected to have soil contamination levels above ANZEEC "B" values (see Section 11.3); and

- Low risk sites are considered to be contaminated but not a long term risk unless land use changes to a more sensitive application.

143 A total of 7,800 suspected contaminated sites were identified by this review with petrol stations (2,616), engine works (878) and landfill sites (716) being the largest categories. The study estimated that 23% of these sites were high risk with a time frame for their remediation being around 5-10 years at a cost of NZ$ 620 million. The treatment cost of moderate risk sites was estimated to exceed NZ$ 1 billion and take between 20 and 30 years to complete.

144 Regional councils are currently undertaking a more detailed survey of their regions to assess the validity of the initial study. This has generally resulted in an increase in the number of potentially contaminated sites expected to be identified. The number of small operations with potential contamination has increased significantly with key activities being the use of underground storage tanks in association with petrol stations, stationary boilers, and metal finishing operations. This has not resulted in an increase in expected remedial costs however since the number of large sites requiring remediation have changed little from original estimates.

11.3 Policy developments on contaminated land

145 New Zealand is a party to the Australian and New Zealand Environmental and Conservation Council (ANZEEC) which in conjunction with the National Health and Medical Research Council (NHMRC) has developed Guidelines for the assessment and management of contaminated sites. These guidelines have been adopted as policy and are considered best practice within New Zealand. These ANZEEC guidelines are outlined in more detail in the Australian Country Report (Sections 2.2 and 2.3).

146 Key features of the ANZEEC Guidelines applying to New Zealand in particular are:

- Definition of contaminated land;
- Provision of a methodology for site assessment;
- Provision of a methodology for setting site specific treatment criteria; and
- Reference to the old Dutch A, B, C values where no Australian or New Zealand based value exists.

147 In addition to the ANZEEC Guidelines, the Ministry for the Environment, in conjunction with the Timber Industry Federation, has developed guidelines and standards to address the specific problems of organochlorine chemicals in estuarine sediments. Such contamination is largely derived from the use of preservatives by the timber industry. Guidelines have been prepared which consider the most important and widespread treatment chemicals including pentachlorophenol and compounds of boron, copper, chromium and arsenic. They have been established within the overall framework of the ANZEEC Guidelines and are consistent with its approach. The major components of the timber industry guidelines are:

- Sampling Strategies and Chemical Analysis Protocols;
- Soil Acceptance Criteria;
- Surface and Groundwater Acceptance Criteria; and
- Landfill Disposal.

148 Additional guidelines under development include:

- Management of gasworks sites (expected 1997); and
- Management of hydrocarbon contaminated sites (especially petrol stations) in conjunction with the oil industry (draft March 1996).

149 Recent developments in New Zealand policy have aimed to address three key areas of uncertainty in the initial 1991 legislation:

- Liability;
- Funding of remedial actions for orphan sites; and
- The role of the regulatory agencies and their interaction at district, regional and national levels.

These issues have recently been raised in a discussion document issued in November 1995 [50].

150 As mentioned in Section 11.1 there is considerable uncertainty under current legislation over who is liable for sites contaminated prior to 1991. This is due in the most part to the legislation not being tested under case law. To resolve this uncertainty the Government has agreed to the development of legislation which will be clear regarding its retrospective intent. As a consequence there is an opportunity to establish a clear liability regime for contaminated sites which incorporates the following components:

- The polluter, owner, occupier of a site will all be potentially liable;
- An innocent landowner legal defence; and
- A secured lender defence.

Although Government policy in waste management is to promote the *polluter pays* principle this has not yet been incorporated into statute. Therefore policy has yet to be established on an appropriate regulatory framework to fully address liability at historically polluted sites.

151 At present Government has no specific mechanism to raise funds for management of contaminated sites. In the past Government has appropriated money on an *as required basis* according to the nature of previous Government responsibilities and activities at the site. Funding of the management of orphan sites is a policy issue which has not been fully addressed to date. The size of the orphan site problem has yet to be fully determined although it is expected that this can be estimated once the national review of suspected sites is completed. It is anticipated that the funding of orphan site management will focus on minimising litigation costs; creating incentives for treatment; and keeping overall costs low especially the funding requirement from the tax payer.

152 There is also uncertainty over the interaction between local and national government in contaminated land policy, for example whether regional registers of contaminated sites should conform to a national standard. The most likely timing of legislation to address these and the other issues mentioned above is late 1996 or early 1997.

11.4 Research and development

153 Site remediation work in New Zealand has been rather limited to specific industrial sectors such as the petroleum and timber industries.

154 Underground storage tanks at up to 25% of service stations in New Zealand have been replaced over the last two years. Remediation of contaminated soils at these sites has been either by excavation and landfill disposal or by landfarming. At larger sites, such as refinery and port facilities, *in situ* bioremediation and bioventing have been employed. A bioremediation facility in combination with an engineered landfill has been established specifically to accept and process fuel contaminated soils.

155 Remedial actions at a small number of timber sites have resulted in the temporary storage of contaminated soils until a cost effective treatment method becomes available in New Zealand. In recognition of the importance of this specific problem the Government has initiated two research programmes in this area:

- A review of internationally available organochlorine treatment technologies in order to determine which options might be suitable for a New Zealand application; and

- To investigate organochlorine contamination in the New Zealand environment and to develop a suite of treatment standards.

156 High temperature incineration of contaminated soils and other wastes will not be considered as a treatment option in New Zealand. Here thermal treatment plants are generally restricted to medical and quarantine facilities. As a result some wastes are exported for incineration, for example PCB's are being exported to France.

157 Emerging technologies which are being investigated for use in New Zealand are:

- Bioremediation methods for PCP and dioxins;

- ADOX - Accelerated Decomposition of Organic Halides (a modified chemical dehalogenation technology developed in the USA) for treatment of PCBs and dioxins; and

- Electroremediation for treatment and recovery of metals at cadmium, chromium and arsenic contaminated sites.

158 Although there is limited development of new technologies in New Zealand there is considerable interest from vendors to trial and demonstrate their systems. This can be supported by grants from the Ministry for the Environment's Sustainable Management Fund.

12.0 COUNTRY REPORT: NORWAY

Country Representative: P. Antonsen, State Pollution Control Authority

12.1 Legal and administrative aspects

159 There are two national Government agencies in Norway with an interest in contaminated land: the Ministry of the Environment and the Norwegian State Pollution Control Authority (Statens forurensningstilsyn, NPCA). The role of the NPCA is to implement measures and investigations on behalf of the Ministry. A matter of considerable current debate is the role of local government (through the 19 counties) in enforcing regulations. At present most regulation is carried out at a national level.

160 Political concern over soil pollution has only recently arisen in Norway although the country has moved swiftly to implement management measures. The principal legislation is the Pollution Control Act (1981) where the *polluter pays* principle was introduced. The Act allows the authorities to take measures against pollution and the polluter. If the original polluter can no longer be identified or held responsible then the current landowner may be held liable for the cost of site investigations and remedial actions. Two issues of the current legislation are at present unresolved:

- The problem of pollution existing from before the Act came into force; and
- The simplification of the complex regulatory mechanisms of permits and licences which are required to excavate soil as part of remedial actions.

161 Additional enforcement can be implemented using the Planning and Building Act which requires local government to consider the potential for soil contamination before approving any land redevelopment application. During recent years the national agencies have encouraged local authorities to strengthen their use of this legislation which if applied effectively can prevent costly delays in construction projects where contamination is discovered during on-site work.

12.2 Registration of contaminated sites

162 In 1988 the Norwegian Government commissioned NPCA to draw up a national action plan for landfills and industrially contaminated sites. This plan was completed in 1992 and addressed in particular the problems associated with the most hazardous Norwegian sites identified. The principal goal of the measures proposed is that "the danger of serious pollution problems arising from toxic wastes improperly disposed of in the past shall be reduced to a minimum by the year 2000." The plan also included measures against pollution from mining areas and suggested further investigation of polluted sediments in fjords, harbours and other watercourses.

163 The principal remedial action goals set out in the plan were:

- For groundwater quality: "All large exploitable sources of groundwater shall be protected against pollution. If already polluted, remedial action shall aim at

restoring the source to drinking water quality."

- For soil quality: "Pollution of soil shall be reduced to a level that does not conflict with the type of land use and that ensures the environmental qualities of the area."

- For water quality in watercourses and fjords: "Pollution from landfills, contaminated sites and sediments shall be prevented or reduced to the level necessary to achieve the established water quality criteria or goals for the recipient."

164 As part of the plan, three ambition levels were devised which related remediation targets for each site to factors such as the degree of required remediation, the type of treatment measure employed, and estimated cost. These levels were defined as:

- Ambition level 1: elimination of pollutants to background levels. 90 % of the investigated sites will have to be remediated at an average cost of 5 million US dollars per site;

- Ambition level 2: adjustment of the remediation standard to existing or planned land use and to environmental qualities (flora and fauna of particular value). Here, 70 % of the investigated sites will have to be remediated, with an average cost of 1 million US dollars per site.

- Ambition level 3: remediation to treatment standards adjusted to the actual land use. This will necessitate measures at 50 % of the investigated sites at an average cost of 0.35 million US dollars per site.

Both the Ministry of the Environment and the NPCA concluded that the second ambition level provided an optimal cost effective approach for the national action plan.

165 A national survey of potentially contaminated sites was carried out from 1989 to 1991 to fulfill requirements of the national plan. The survey included municipal and industrial landfills, industrial sites, gasworks, and military sites (including those dating from World War II). Approximately 2,900 potentially contaminated sites were registered (see Table 9) although many more have since been identified during the course of commercial redevelopment. Ranking is based on preliminary risk assessment, taking into account the type of contaminant, the actual land use and the vulnerability of the recipient. A separate survey was conducted for polluted sediments.

166 Applying the criteria set out in the national action plan to the survey data resulted in priority being given to 120 sites where remedial action was to be implemented by 1995. A further 450 sites were identified where additional investigation and remedial measures were to be initiated by the year 2000. The cost of this management programme would be in the range of US$ 300 - 500 million assuming that the financial regime from ambition level 2 was adopted. It was decided that redevelopment of these sites would not be permitted until management measures had been undertaken to assess in detail any health and environmental hazards.

Table 9: Potentially contaminated sites in Norway

Site Type	Classification Category				
	1	2	3	4	Total
Landfills	53	394	1,067	749	2,263
Contaminated land	20	131	355	0	506
Combined landfills and contaminated land	16	54	50	0	120
Sites with toxic waste from WWII	12	20	44	not registered	76
Total	121	599	1,516	749	2,965

Notes
Category 1: sites requiring immediate investigations or measures
Category 2: need for investigation
Category 3: need for investigation in the event of a change in land use
Category 4: no investigation needed

167 At many of the 120 high risk sites the survey identified the potential for serious groundwater pollution of fjords and other water courses. This was due to the location of many industrial operations along the Norwegian coastline. The potential groundwater contamination from these sites was however considered a low risk to actual human health since in Norway only 15-20% of drinking water is derived from groundwater. In many cases, the groundwater catchment areas lay in scarcely populated and poorly industrialised regions of the country. It was concluded therefore that the main hazard to human health from these sites came from human exposure connected to future site land uses.

168 By the end of 1995 the goal of implementing remedial actions at the high risk sites had not been achieved. Of the 120 sites allocated highest priority further site management had been started at 115 of them while remedial measures, where necessary, had been completed at 30 sites. This has been due in part to the considerable regulatory involvement required for sites where contamination was only discovered during redevelopment (140 such sites had been identified by January 1996).

12.3 Recent initiatives

169 Norway has recently established acceptable soil quality criteria for the most sensitive land uses (housing, gardens, childrens' playgrounds). These criteria are used as limit values above which a more comprehensive risk assessment is regarded necessary. Risk assessment should also be carried out if there is a risk of migration to groundwater or other recipients. The current soil quality criteria are based on values from Denmark and the Netherlands and are used as interim criteria. Norway plans to use the proposed Canadian values as soon as these will be published.

12.4 Research and development

170 The Norwegian Research Council (NFR) established in 1994 a separate research programme entitled GRUF to focus on the management of contaminated sites. The goals of the programme are:

- To provide a better understanding of risks connected to contaminated sites;
- To develop and demonstrate cost-effective remedial actions for contaminated sites and landfills; and
- To develop effective methods of monitoring micropollutants from landfills and contaminated sites.

In 1996, the programme will support 15 projects at a cost of US$ 650,000. Although financial support is still uncertain for future years it is likely that the programme will be supported for the next four or five years with an annual budget of US$ 1.6 million (including in-kind contributions to specific projects).

171 The NPCA are developing a database with GIS interface to track all national registered contaminated sites and any management actions supported at these sites. The database which will be completed by the end of 1996 will be used to support the NPCA and local authorities in the reporting and consideration of planning applications.

172 Use of emerging technologies such as bioremediation and soil washing have been applied at a few sites in Norway. An important objective of future studies is to examine the applicability of technologies under Norwegian climatic conditions.

13.0 COUNTRY REPORT: PAKISTAN

Country Representative: M.A. Moten, Ministry of Planning and Development

13.1 Legal and administrative aspects

173 Pakistan has a national Government with four Provincial Governments consisting of the Punjab, Sindh, NWFP, and Balochistan. The principal legislation with regard to contaminated land is the Pakistan Environmental Protection Ordinance (PEPO,1983) and the National Environmental Quality Standard (NEQs, 1983). The PEPO has reportedly been widely criticised in Pakistan for its narrow scope, lack of clarity, and inadequate provisions for law enforcement. As a result the Ministry of the Environment has produced a draft Pakistan Environmental Act (PEA, 1995) which aims to address the perceived shortcomings of PEPO.

13.2 Recent initiatives

174 Pakistan has a reported 88.2 million hectares of land within its borders of which 70% has been surveyed for agricultural land use. Nearly 53% of all land in the Provinces is currently used as pasture and rangelands with only 2% used for urban and industrial purposes.

175 The principal factors affecting soil quality in Pakistan include water and wind erosion, salinity/sodicity, waterlogging, and loss of organic matter. Remedial measures for contaminated land are seen as preventative rather than prescriptive and deal with treatment of hazardous wastes discharged to the sewage system in large cities such as Karachi.

14.0 COUNTRY REPORT: SLOVENIA

Country Representative: B. Družina, Institute of Public Health

14.1 Contamination problems in Slovenia

176 The Republic of Slovenia is a small country of around 2 million inhabitants which was formerly a part of Yugoslavia. There is extensive soil and groundwater contamination resulting from the disposal of municipal and industrial wastes in poorly developed landfill facilities and in many cases in illegal areas such as Karst caves.

177 There has been no systematic review of soil contamination in Slovenia although several indicators have been proposed, including the rising level of contamination in the country's groundwater. The lack of legal facilities for the disposal of hazardous industrial wastes has necessitated it being stored on-site at the factory or dumped illegally which makes the registering of soil contamination difficult. The principal contaminants have been reported to be halogenated hydrocarbons, PCBs, dioxins, pesticides, asbestos, and a range of heavy metals.

178 Although soil and water contamination is reported to be extensive the supply of drinking water to the general population was found to be unaffected by a Government sponsored investigation. The investigators examined 11 important aquifers and 45 groundwater sources across the country from 1990 to 1992. They found no evidence that chemical contamination of these resources had occurred.

15.0 COUNTRY REPORT: SWEDEN [51]

Country Representative: I. Hasselsten, Swedish Environmental Protection Agency

15.1 Legal and administrative aspects

179 The Swedish administration system operates at three levels:

- National government through the Ministry of Environment and the Environmental Protection Agency (Naturvårdsverket, EPA). The Agency is responsible for the national coordination of policy and for prioritisation and management of contaminated sites. It also allocates public funds for the remediation of orphan sites.

- Regional Government through 24 regional environmental authorities or Counties. They are responsible for large scale heavy industries and can intervene in the building planning of local Government if necessary.

- Local Government through 287 municipal environmental and health authorities. They have responsibility over environmental protection related to small-scale industries and the coordination of remedial work in conjunction with building planning and land use.

180 It is the aim of the Agency that within each County and its municipalities there should be a network of remediation experts which meet regularly to share knowledge and to plan and coordinate their work. The regional and local Governments have direct responsibility for the implementation of all practical remediation work.

181 Sweden has no legislation which specifically concerns contaminated land. The current legal framework under which it is considered comes from the Environmental Protection Act (EPA, 1969) which requires an assessment of all activities which are potentially damaging to the environment. Amendments to the EPA have been proposed to provide methods for determining liability and to set-out the obligations for the reporting of contamination, the closure of industrial facilities, and the implementation of remedial actions.

182 The EPA states that the site operator is primarily responsible for remediation of a contaminated site. He is also liable for damages to a third party. The land owners are only deemed liable under certain circumstances. In most cases liability is not retrospectively applied and liability is not generally enforced prior to 1969.

183 Although the basic principle of the EPA is that the polluter pays the Government recognises that a large proportion of remedial costs will have to be funded by the Public Sector. It has been suggested that funding could be raised by changes to the general taxation rate or through introduction of a new waste or environmental tax. This year the Swedish Government in recognition of the job creation opportunities of site remediation allocated US$ 12 million from the unemployment programme to support remedial actions.

15.2 The National Site Remediation Action Plan

184 In 1991 the Environmental Protection Agency initiated a 5 year programme to determine a possible strategy for dealing with contaminated sites in Sweden. The programme covered the framework for addressing the management of contaminated

land including the scope of the problem, financial and legislative requirements, and the methods needed for investigation, risk assessment and remediation. Several full scale demonstration projects were part of this programme, set up to gain practical experience to stimulate and guide remedial activities.

185 In October 1995, the Agency reported its findings to the national Government. It proposed as a long term goal that within 40 years all contaminated sites must be identified, investigated, and if necessary remediated. The focus of the next 5 years should be the 200 most seriously contaminated sites with at least 50% of these remediated by the end of that period. The cost of implementing this work was estimated to be US$ 700 million over 5 years with 50% of the cost being recovered from individually responsible parties.

186 The national action plan made several recommendations to improve the site management process including:

- Clarification of liability within the current legislation;
- Stronger regulatory powers to promote, control, and steer remedial actions;
- Establishment of soil and groundwater guideline values for the most commonly encountered contaminants; and
- Further development of specialist guidelines for specific industries.

The Government is expected to respond to the Agency's plan in the Autumn of 1996.

15.3 Registration of contaminated sites

187 A national inventory of contaminated sites (carried out over 2 years) has provided the basis for the National Site Remediation Action Plan. The inventory which was based and on desk studies, aimed to identify and describe the need for remedial action within different types of industries, to prioritize most urgent sites and to plan remediation for these sites. About 2,000 contaminated sites have been identified and registered in a database at the EPA. Industries with many small facilities still need to be surveyed.

188 A total of about 7,000 contaminated sites is estimated, including 500 military sites and 500 municipal landfills. It is anticipated that about US$ 4 billion will be required for remediation over a minimum 30 year period. At least 50% of these are orphan sites.

189 The distribution of sites reported in 1994[9] according to different industrial sectors indicated that the wood industry accounted for more than 50% of the identified sites. Pulp and paper mills and plants for wood preservation are dominant in this sector. The metal sector covers 20%, whereas the chemical sector holds 17% of the sites. The

[9] in 1994 the total number of sites identified was 1,700.

waste sector represents 8% and the traffic sector 3% of the sites.

15.4 Recent initiatives: risk assessment for contaminated sites

190 A preliminary risk assessment procedure has been developed, which consists of three phases:

- Risk classification;
- Simplified risk assessment;
- Detailed risk assessment.

All of these phases consider: transport and migration of contaminants, exposure and impact on human health and the environment.

191 To provide an initial indication of risks to set priorities for further investigation, sites are classified in four risk categories:

- Class 1: very large degree of risk;
- Class 2: large degree of risk;
- Class 3: moderate degree of risk; and
- Class 4: low degree of risk.

192 The classification reflects the expected seriousness of negative effects for human health and the environment and the probability of these hazards. Most sites are classified in class 2.

193 Simplified risk assessment is based on comparisons with background concentration values for contaminants and the general guide values. Background values are estimated on the sum of contributions from natural sources and diffuse pollution of anthropogenic origin. Detailed risk analyses includes investigation of the presence and behaviour of pollutants, pathways of exposure and impacts of pollutants, for which site specific information on pollutant distribution, environmental and hydrogeological conditions, and ecosystem components (species) is used.

194 Soil quality values are under development for six groups of priority substances and are based on human health and environmental effects. They are intended to protect groundwater as well and focus on "most sensitive" individuals. Two types of land use are considered: "sensitive" (e.g. for housing, but effectively any land use i.e. multi-functionality); and "less sensitive" where the risk of contaminant migration and exposure is limited (e.g. industrial areas and traffic installations).

15.5 Remedial methods

195 The most commonly used treatment method for contaminated land remediation is excavation and disposal to a landfill. Landfilling is very cheap in Sweden. A major barrier to the use of emerging technologies is the lack of treatment facilities, for instance no soil washing plant or controlled biodegradation plant exist, and there is only one high temperature incineration plant. Establishment and development of various treatment methods is a very important and urgent issue. In particular there is an urgent need for treatment methods for combinations of metals and persistent organic contaminants. As transport of soil is expensive due to the large distances in the country, various regional treatment centres are suggested, each providing various types of facilities.

16.0 COUNTRY REPORT: SWITZERLAND [36]

Country Representative: U. Ziegler, Federal Office of Environment, Forests and Landscape

16.1 Legal and administrative aspects

196 In Switzerland, legal reference to soil pollution is made in the Federal Environmental Protection Act of 1983. The Act addresses soil pollution within the broader framework of soil protection with the objective of maintaining soil fertility. The Environmental Protection Act is implemented by a number of Ordinances which allow for assessment and remediation of contaminated sites. The Act is currently being revised to improve the management framework for dealing with soil pollution.

16.2 The Concept for Contaminated Sites

197 The "Concept for the management of contaminated sites in Switzerland" is a development between the Federal Office of Environment, Forests and Landscape and the regional authorities (the Cantons). The concept proposes a management scheme for contaminated sites consisting of four phases:

- Phase 1: Identification;
- Phase 2: Preliminary Investigation;
- Phase 3: Detailed Investigation; and
- Phase 4: Remediation.

Phases 1 and 2 are intended to lead to a legally relevant decision as to whether a site is contaminated or not. More detailed procedures for dealing with contaminated sites is currently in preparation and are based on the Concept framework. These procedures will be given legislative support via a new Federal Ordinance which will be introduced when the revisions of the Environmental Protection Act are completed.

16.3 Registration of contaminated sites

198 A national assessment of contaminated sites, initiated in 1991-92 identified three main site types: waste disposal sites, general industrial sites and places of major accidents. The survey found as many as 40,000 potentially contaminated sites with at least 10,000 requiring further investigation. It has been estimated that the number of actual contaminated sites is in the range of 2,000 - 3,000 with a further 500 to 1,000 needing some form of urgent remedial treatment. By mid 1994 more than SF 250 million had been spent on dealing with urgent site actions.

16.4 Remedial methods

199 The Swiss remedial objectives are based on the principle of multi-functionality. The selection of remedial options is based on both ecological and economical considerations. However, to date most treatment has been based on conventional approaches such as excavation combined with either landfill disposal or incineration. This has reportedly been due to the discovery of contamination during commercial redevelopment and the stringent economic and time constraints that this entails. In some cases soil washing or *in situ* bioremediation has been used.

16.5 Research and development

200 Limited funding is available for R & D on remedial technologies. Projects supported by the Swiss National Foundation have included:

- Assessment of ecological impact of biologically treated soil and their reuse;
- *In situ* bioremediation studies for oil contaminated soil;
- Development of *ex situ* bioreactors; and
- Identification of problematic substances in subsoil.

A key issue which is being addressed is the problems of dealing with residual contamination in treated soils from *ex situ* remedial processes.

17.0 COUNTRY REPORT: TURKEY

Country Representative: R. Apak, University of Istanbul

17.1 Contamination problems in Turkey

201 A Ministry for the Environment was established in Turkey in 1991. This Ministry will hold power of veto over government projects instigated by other Ministries including the Ministry of Housing and Public Works and the Ministry of Tourism and Transport.

202 In 1992 the Turkish Government enacted the Solid Waste Control Act which aimed to regulate the landfill disposal of industrial and municipal waste. The Act prohibits dumping of hazardous solid wastes in the environment and sets limit values for contaminants in stored and disposed wastes. It controls the use of sewage sludge in agriculture and defines terms used in waste management practice. In addition it prohibits co-disposal of dangerous industrial and medical wastes with municipal solid waste. Considerable effort has taken place up to 1996 to implement these measures in the major industrial cities of Istanbul, Izmit, and Izmir. Regular waste collection and controlled disposal has been implemented for both municipal and industrial wastes.

203 Under the Solid Waste Project (SWP) all but one of these illegal dumps has been closed. The SWP work programme has been supported by a grant of DM 80 million from Germany. Remedial work has started at Ümraniye-Hekimbaşi where, in 1993, 27 people died as a result of a landslide of illegally dumped waste caused by a methane gas explosion. This environmental disaster raised public awareness on the dangerous location of these uncontrolled dump sites, often near to inhabited areas. The first stages of remediation involve construction of stone walls capable of preventing the waste mass moving further along the valley. Eventually this waste will be collected and transported for further treatment and proper disposal.

204 A major programme of work has been instigated to treat sewage from Istanbul prior to its entry into the Marmara Sea. At present only 20% of Istanbul's sewage undergoes any form of treatment before discharge. The "Marmara will Survive" and the "Northern Golden Horn" projects represent a considerable investment (over US$ 20 million) in treatment plants and supporting tunnel infrastructure. At least 15 separate plants are required.

205 Over the coming years major efforts are planned to treat land and water in the Istanbul area of Kazlicesme, which has been extensively contaminated by the tanning industry over 500 years. The tanneries have been relocated. In addition wetlands in the Marmara, Aegean, and Inner Anatolian regions are reported to be under severe threat from drying up and the input of industrial pollution.

206 In some rural areas of Inner Anatolia natural asbestos minerals prevalent in local soils have been frequently used to plaster the inner walls of local houses. This has been claimed to be the source of a statistically significant increase of incidences of lung cancer in the region.

18.0 COUNTRY REPORT: THE UNITED KINGDOM

Country Representative: J. Denner, Department of the Environment

18.1 Legal and administrative aspects

207 In 1995 the UK introduced a major piece of legislation which significantly affects the way issues of contaminated land are dealt with. This legislation followed a wide ranging review and consultation exercise of contaminated land and liabilities which resulted in the publication by the Department of the Environment and Welsh Office of the document *Framework for contaminated land* in November 1994 [32,33]. The Environment Act (1995) and specifically Section 57, inserted a new piece of law into the Environmental Protection Act (1990) concerning contaminated land. Section 57 created a new regime for the control of environmental problems associated with contaminated land in accordance with the objective of the Framework document which sought to "establish a modern specific contaminated land power". Now for the first time in UK law there will be a specific definition of contaminated land and dedicated procedures for its control[10].

208 The legal regime will implement the "suitable for use" approach which requires regulatory action only where necessary to deal with unacceptable risks to human health or the environment, taking into account the use of the land in question and its environmental setting. The new controls will complement other regulatory regimes:

- Integrated Pollution Control and the system of waste management licensing which is intended to control and limit future pollution; and

- The planning role of Local Authorities, acting under the direction set out in Planning Policy Guidance Note 23, which will deal with the new risks arising from proposed land redevelopment.

209 Although the contaminated land regime is new, its overall structure and the nature of its controls are broadly similar to more general powers under "statutory nuisance". These other powers will cease to apply to contaminated land.

210 The primary regulatory role under the new regime will rest with Local Government, through the borough and district councils. This reflects their existing powers under "statutory nuisance", and will complement their roles as planning authorities. In outline their role will be to:

- Inspect their areas in order to identify contaminated land;

- Consult on what remediation might be required in any individual case;

- Require remediation to take place through issuing of a formal Remediation Notice if necessary, and with powers to act in default; and

- Record information about remediation carried out under the regime.

211 The identification of any contaminated land will be based on a process of risk

[10] The provisions of the Environment Act (1995) apply only to England, Scotland, and Wales. Northern Ireland will introduce its own equivalent legislation.

assessment. For any land to be identified, the local authority will be required to have found contaminating substances in the land and to have established that they are likely to cause harm to particular "targets"[11]. Under the liability provisions in the legislation, the responsibility for paying for remedial actions follows the *polluter pays* principle. Therefore a person who "caused or knowingly permitted" the contamination will be liable. However, if the polluter cannot be found then liability passes to the current owner or occupier of the site except in the case of water pollution.

212 Section 57 also provided for the creation of the Environment Agency on the 1st April 1996 which is an integration of the functions of the National Rivers Authority, Her Majesty's Inspectorate of Pollution and the local waste regulation authorities. The Agency will build on the role of its predecessor's by protecting and enhancing the environment in line with the Government's commitment to sustainable development. The Agency has four principal roles with respect to contaminated land to:

- Provide site-specific guidance on remediation requirements;
- Act as the regulator for a defined category of "special sites";
- Compile a "national report" on contaminated land; and
- To sponsor technical research while acting as a centre of expertise.

213 The primary legislation sets the principles which will govern the new regime. Within this framework a package of "statutory guidance" will provide the detailed parameters to support professional and technical judgement in specific cases. This itself will be supported by technical guidance from the Department of the Environment's research programme. This will include "standard procedures" and soil guideline values in an advisory, and not statutory role. Secondary legislation, in the form of Regulations, will also be issued to cover the detailed procedural matters. It is the Government's intention to introduce guidance and Regulations only after consultation, and therefore it is likely that these will be implemented towards the end of 1996

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18.2 Registration of contaminated sites

214 Section 143 of the Environmental Protection Act (1990) which contained provision for registers of land which may be contaminated has been repealed by the Environment Act (1995). The Government decided to maintain the 'buyer beware' principle and recommended that the buyer should be better informed. Legislative amendments to common law were not proposed.

215 Recent estimates of the extent of contaminated land in the United Kingdom indicate an area of 50,000 to 250,000 hectares. The amounts of government money spent yearly on redevelopment of contaminated land are approximately £ 200 million.

[11] for example on-site users, drinking water sources, and building materials.

18.3 Recent initiatives

216 The Royal Commission on Environmental Pollution (RCEP) has recently published its findings on a wide ranging review of soils and soil use in the UK [54]. The report emphasised the pressures on soils in the UK as a result of factors including:

- The great intensification of agriculture in the last hundred years;
- Continuing demand for land for building, particularly in areas with fertile soils;
- Increasing amounts of sewage sludge (for which disposal at sea will be banned after 1998);
- Large quantities of other wastes spread onto land or buried in the ground;
- Pollutants reaching soils from the atmosphere; and
- Contamination from industry.

217 The central recommendations of the report were that:

- The Government should draw up and implement a soil protection policy for the UK which takes full account of long-term environmental considerations; and
- The newly formed Environment Agency must take a genuinely integrated view of the environment and give proper attention to safeguarding and remediating soil.

218 The Royal Commission stressed the need to reduce pressure on "green-field" sites by increasing the recycling of derelict and contaminated land. The Royal Commission asked the Government to consider promoting "land banks" of sites for redevelopment which have been treated to remove contamination. They suggested that after a site had been remediated to the standards set by the local regulatory authorities the land owner should be absolved from further liabilities. The Government is expected to respond to the Royal Commission's Report in due course.

219 In May 1995 leading members of UK industry, with the support of the Department of the Environment, formed the Soil and Groundwater Technology Association (SAGTA) [46]. The primary aim of this new Association is share expertise and experience of the technical aspects of dealing with contaminated land and to promote the development of the most-effective management methodologies and remedial technologies. SAGTA will pay particular attention to the introduction of best practice to prevent future land contamination and to deal with historic problems. In February 1996 SAGTA held a major meeting with the general participation of the academic research community. Its objectives were to [18]:

- Bring together research performers from many scientific and engineering

disciplines with interests in contaminated land research;

- Provide problem holders with a clear understanding of the current state of the art in contaminated land management;

- Explain the needs of problem holders to research performers and facilitators; and

- To stimulate the development of multi-disciplinary collaborative links between researchers, funders and problem holders.

220 General conclusions from the meeting included:

- A requirement for research and development investment in many of the areas identified by the four workshops: site assessment, risk assessment, control measures, and measurement and monitoring. Several important issues which were identified including: validation, fundamental understanding of mechanisms affecting the accessibility and availability of contaminants, and dealing with problems of heterogeneity.

- Recommendations were made for: the development of centres of excellence; establishment of larger better targeted projects; and in particular for setting up of field scale sites for research investigations and technology demonstrations.

18.4 Research and development

221 The research programme of the Contaminated Land and Liabilities Branch[12] of the Department of the Environment develops guidance for those involved in the ownership, management, and redevelopment of contaminated land. The programme addresses four key areas: information requirements; risk assessment; remedial methods; and quality assurance. Examples of published reports are listed in Table 10.

Table 10: Selected recent research outputs from the Department of the Environment's contaminated land research programme [34].

Publication	Brief Description
Prioritisation and categorisation procedures for sites which may be contaminated	The report sets out a simple but systematic approach to decide what priority to give to action on a site which may be contaminated.
Information systems for land contamination	Provides guidance on the development and management of systems for holding information on land where contamination is known or suspected.

[12] The Contaminated Land and Liabilities Branch is within the Marine, Land, and Liabilities Division.

Industry Profiles	47 separate documents which deal with individual industries and are intended to provide information on contamination which may be associated with specific industries.
Sampling strategies for contaminated land	The report sets out guidance on formulating sampling strategies at sites where contamination is known or suspected to be present.
Subterranean fires: assessment and control	The report sets out to assist in the selection of remedial approaches to control and extinguish fires, and to examine methodologies to predict site combustibility.
Effects of organic chemicals in contaminated land on building services	This report identifies target chemicals and recommends sampling and analytical methods.
Review of pilot and full scale soil washing plants	The report provides an evaluation of soil washing techniques at pilot, demonstration and commercial scales.
Review of innovative contaminated soil clean-up processes	The report presents a state-of-art review of emerging treatment technologies.

222 The Research Councils support basic and applied research at UK universities and through their own research centres such as the British Geological Survey. Although many research programmes involve generic studies of wider interest to contaminated land several the Research Councils have contributed to the launch of programmes where contaminated soil and groundwater are specifically targeted. These include [18]:

- Biological Treatment of Soil and Water. This programme has a budget of £4.6 million over 5 years and focuses on issues of bioremediation such as the problems of scale-up from laboratory- to field-scale *in situ* approaches.

- Environmental Diagnostics. This programme focuses on the environmental fate, behaviour, and impacts of waste materials generated by human activity.

- Urban Regeneration and the Environment. This programme has recently been approved and will commence in late 1996 or early 1997. The level of funding has not yet been agreed. It will address for areas of research including the shallow sub-surface (soil and sediments), atmospheric dynamics and chemistry, hydrological balances, and urban ecology.

- Waste and Pollution Management . This programme has a budget of £3 million over 5 years and focuses on contaminated land assessment and remediation. The programme is expected to study *in situ* treatment and containment methods.

19.0 COUNTRY REPORT: THE UNITED STATES

Country Representative: S. James, Environmental Protection Agency

19.1 Legal and administrative aspects

223 The USA is a union of over 50 States and Dependencies which delegate some aspects of responsibility to a Federal Government. The issue of contaminated land first rose to prominence in the late 1970s when incidents such as Love Canal and Time Beach sparked national concern. In response to increased public awareness, the US Government passed the Comprehensive Environmental Response and Liability Act (CERCLA) which is commonly known as Superfund [44]. The law created a trust fund for the management of abandoned contaminated sites, principally polluted by waste disposal, from taxes levied against industry. It also introduced strong regulatory powers and responsibilities to State Governments and the newly formed Environmental Protection Agency (EPA).

224 In 1986, CERCLA was amended by the Superfund Amendments and Reauthorisation Act (SARA) to promote the use of permanent solutions to contaminated soil and groundwater problems in preference to containment or excavation and disposal. The trust fund was increased considerably to $8.5 billion over 5 years (with an additional $1.5 billion authorised in 1990). The role of the EPA was broadened to include research and remediation in addition to its regulatory role.

225 The individual State administrations are responsible for the development and implementation of their own contaminated land legislation [6]. Minnesota was the first State to enact remediation legislation in 1989 but many State legislatures are relatively recent. For example, Pennsylvania enacted its own law in 1995 which includes a State requirement to set generic statewide standards for soil and groundwater remediation which take future site use into account. The law also makes provision for State guidance on site investigation, risk assessment, and remediation to be developed. In 1994, a review of the remediation standards set by State legislature (conducted by the Institute for Responsible Management) concluded that no standards were more stringent than those already implemented under CERCLA [6].

19.2 Registration of contaminated sites

226 Under the CERCLA regulations, contaminated sites are assessed and ranked prior to inclusion on a National Priorities List (NPL). By late 1994 1320 sites had been listed with remedial action decisions taken at nearly 885 sites. Over the period from 1990 to 1994 70% of all Record of Decisions (ROD)[13] required remediation of at least some part of the site.

227 In 1992 the Department of Energy (DOE) reviewed monitoring and restoration data from 91 contaminated sites at 18 facilities [30]. The objectives of the review included:

- To identify inorganic and organic contaminants found within soil and groundwater at Department of Energy sites; and

[13] Documents required by CERCLA to support and record contaminated site management decisions.

- To determine their concentration ranges and contaminant associations.

The data from this study would be used to target fundamental research into contaminant subsurface behaviour.

228 The review reported that the most common contaminants found at DOE sites were fuel hydrocarbons, chlorinated solvents, metals, and radionuclides. In most cases contaminants were mixed with two contaminant and three contaminant mixtures found at 64% and 49% of sites respectively. The review highlighted potential problems with the co-disposal of contaminant types with organic solvents capable of mobilising sparingly water soluble compounds such as PCBs being disposed of together at 15 waste sites.

19.3 The use of remedial technologies under Superfund

229 The Superfund Innovative Technology Evaluation (SITE) programme is a major Federal Government initiative to assist in the commercialisation of remediation technologies [44]. SITE primarily conducts full-scale evaluations of technologies developed in the Private Sector. By 1994, over 110 technologies were participating in the field evaluation programme with 70 demonstrations already completed. In addition, a further 70 technologies are being evaluated at the lab-scale [60]. It was reported that the SITE programme plays an important role in raising the awareness of decision-makers about the potential benefits of innovative technologies, and provided necessary information to allow technologies to be selected with confidence.

230 In 1993, the EPA reviewed the characteristics of Superfund sites to determine the current and likely US markets for remediation technologies [58]. The aims of the review were to provide decision support to developers/investors and to encourage the view that site remediation offered opportunities for new companies. It highlighted that the most common contaminants at Superfund sites (for the market in the next 3 to 5 years) are volatile organic compounds (VOCs) and heavy metals which are present on 60% and 53% of sites respectively. The greatest need for new technology was reported to be for *in situ* groundwater treatment and for heavy metal contaminated soils.

231 By 1994 nearly 45% of RODs at Superfund sites involved innovative technologies including *in situ* and *ex situ* bioremediation, soil vapour extraction, thermal desorption, and soil washing. However, only 5% of all Superfund projects involving innovative treatments have been completed which means there is a significant lack of actual field-scale treatment experience and cost-performance data [44].

232 By the end of 1993 nearly 332,000 sites and facilities in the USA had been identified which may require remediation of which 295,000 were underground storage tanks. In a recent initiative the cooperation of Public and Private Sector partnerships has been

promoted for treatment technology at these problem sites[14]. The potential benefits of such partnerships include:

- Technology developers obtain improved credibility for their technology with regulators;
- Technology development is enhanced by additional cost and performance data being available without additional cost to developers;
- The regulators can use such partnerships to develop their treatability tests and technology screening matrices to evaluate technologies prior to ROD;
- The Government agency responsible for the contaminated site has additional expertise made available to solve a site specific problem which may be applicable to similar sites within its remit; and
- Federal Government can use such partnerships to support more cost effective and efficient site remediation and to enhance development of technologies for potential overseas markets.

233 In addition to work sponsored by the EPA, other Federal Agencies have initiated technology development and evaluation programmes at their contaminated sites. The Department of Energy (DOE) has initiated the Integrated Demonstration programme to evaluate remedial actions using individual or combinations of treatment technologies at sites which are representative of others within its remit. At the Savannah River Site technologies such as directional drilling, air sparging, *in situ* bioremediation and radio frequency heating are being investigated [31,60]. The Department of Defense, in partnership with the EPA, has launched the Environmental Technology Demonstration Programme which establishes pilot-scale technology demonstrations at nearly 100 sites across the USA [60].

19.4 Recent initiatives

234 The legislation authorised under SARA expired at the end of 1995. In February 1994, the EPA proposed a number of reforms for CERCLA reauthorisation which included [6]:

- Provision to make significant changes to the liability system in order to eliminate up to 90% of third-party law suits;
- Proposals for a more detailed search for potentially responsible parties (PRPs);
- PRPs to have their share of treatment costs decided by a neutral third-party with incentives to encourage PRPs to use this method rather than legal action;

[14] The Environmental Technology Initiative was originally outlined by President Clinton in his State of the Union message, February 1993.

- Small operations and municipalities would receive some relief from paying fines; and

- Retrospective liability prior to 1986 would be eased.

235 The reauthorisation for CERCLA had not been approved by Congress or the House of Representatives by the end of 1995. A key issue which has delayed its implementation has been retroactive liability which some members of Congress wish to see completely repealed [53].

236 In order to encourage faster redevelopment of Superfund sites the EPA announced in November 1995 that NPL sites could be removed from the list provided that they had been remediated to regulatory standards. The policy was derived from a pilot study for the remediation of military bases where part of the site was turned over for commercial development after the base closed. It received a reportedly mixed response from developers and site owners since many considered that the policy avoided the question of future liability [9].

19.5 Research and development

237 The EPA sponsors research in the area of contaminated land through a number of programmes including:

- SITE programme (see Section 19.3);

- Environmental Technology Initiative (see Section 19.3); and

- Superfund Basic Research Programme (SBR). The SBR programme [7] funds multidisciplinary projects to investigate the relationship between hazardous substances in the environment and human health.

These EPA funded programmes are however facing stringent cuts as a result of Congress and the House of Representatives refusal to endorse the EPA's budget proposals at the end of 1995 [7,8,41].

238 The EPA and the other Federal agencies continue to support the dissemination of information through its published and on-line services. Recent developments have included:

- Release of Vendor Information System for Innovative Treatment Technologies (VISITT) Version 4. This computer database includes technical and vendor information for 325 emerging technologies in the USA (70% of which are commercially available) [61].

- Initiation of the Clean-up Information Bulletin Board (CLU-IN) which provides updated information on treatment technologies and the EPA sponsored research programme [59].

- Publication of the second edition of the *Remediation Technologies Screening Matrix and Reference Guide* [37]. This report provides a detailed procedure for the initial screening selection of remedial technologies for a contaminated site from preliminary investigation data.

239 Both the Department of Energy and the Department of Defense support additional research programmes which include the investigation and remediation of contaminated sites:

- The Environmental Restoration and Waste Management (EM) programme. The aim of this research initiative is to support measures to comply with Federal, State, and local environmental requirements at DOE sites. By March 1994 125 new innovative remediation technologies were being developed through the programme's Innovation Investment Area (IIA) [31].

- The National Environmental Technology Demonstration programme (see Section 19.3).

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241 The summaries contained in this report are based on papers submitted to and presentations made at the Pilot Study. Consequently, the authors of this summary report do not necessarily support the views or conclusions drawn, nor do they verify the accuracy of any data presented.

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21.0 REFERENCES

[1] Anonymous (1994a) *Circulaire interventiewaarden bodemsanering* (Circular on intervention values for soil clean-up), DBO/07494013 of 9 May 1994. In Dutch. Staatscourant 24 May 1994, nr. 95.

[2] Anonymous (1994b) *Circulaire inwerkingtreding saneringsregeling Wet Bodembescherming*' (Circular on coming into force of the regulation on soil clean-up of the Soil Protection Act). In Dutch. Just approved; availability to be checked.

[3] Anonymous (1994c) *Protocol voor het oriënterend onderzoek naar de aard en concentratie van verontreinigende stoffen en de plaats van voorkomen van bodemverontreiniging* (Protocol for preliminary site investigation on the nature and concentration of pollutants and the spatial distribution of soil pollution.). In Dutch. SDU Uitgeverij Koninginnegracht, The Hague, March 1994. ISBN 90 12 08082 7.

[4] Anonymous (1994d) *Protocol voor het nader onderzoek deel 1, naar de aard en concentratie van verontreinigende stoffen en de plaats van voorkomen van bodemverontreiniging* (Protocol for further investigation on the nature and concentration of pollutants and the spatial distribution of soil pollution.). In Dutch. SDU Uitgeverij Koninginnegracht, The Hague, March 1994. ISBN 90 12 08083 5.

[5] Anonymous (1994e) *Federal news*. Environmental Science and Technology 28(4): 172A.

[6] Anonymous (1995a) *States, ASTM developing standards for voluntary clean-ups*. Environmental Science and Technology 29(12): 544A.

[7] Anonymous (1995b) *Superfund research program threatened by Congress, EPA*. Environmental Science and Technology 29(12): 542A.

[8] Anonymous (1995c) *EPA technology initiative thwarted by budget cuts*. Environmental Science and Technology 29(11): 496A-497A.

[9] Anonymous (1996) *Partial delisting of NPL sites approved*. Environmental Science and Technology 30(1): 12A.

[10] Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, January 1992.

[11] Australian and New Zealand Environment and Conservation Council (1994) *Financial Liability for Contaminated Site Remediation. A Position Paper*, April 1994.

[12] Bardos, R.P. (1991) *The NATO/CCMS Pilot Study on Demonstration of Remedial Action Technologies for Contaminated Land and Groundwater, Status June 1989*. Report LR 817 (MR). Warren Spring Laboratory, Gunnels Wood Road, Stevenage, SG1 2BX, UK. ISBN 0856246751.

[13] Bardos, R.P. (1991) *The NATO/CCMS Pilot Study on Demonstration of Remedial Action Technologies for Contaminated Land and Groundwater, Status June 1990*. Report LR 818 (MR). Warren Spring Laboratory, Gunnels Wood Road, Stevenage, SG1 2BX, UK. ISBN 085624676X.

[14] Bardos, R.P. (1993) *The NATO/CCMS Pilot Study on Demonstration of Remedial Actions/Technologies for Contaminated Land and Groundwater, 1988-91, Final Report*. LR 919, Warren Spring Laboratory, Gunnels Wood Road, Stevenage, SG1 2BX, UK. ISBN 0-9282647790.

[15] Bardos, R.P. (1993) *The NATO/CCMS Pilot Study on Research, Development and Evaluation of Remedial Action Technologies for Contaminated Soil and Groundwater, Status May 1993*. Reports LR 986, Warren Spring Laboratory, Gunnels Wood Road, Stevenage SG1 2BX, UK. ISBN 0-856248460.

[16] Bardos, R.P. (1994) *The NATO/CCMS Pilot Study on Research, Development and Evaluation of Technologies for the Treatment of Contaminated Soil and Groundwater*. Presented at the 5th Annual Conference on Contaminated Land, Policy, Risk Management and Technology, 24-25 January, 1994, SAS Portman Hotel, London.

[17] Bardos, R.P., Damigos, E., Goubier, R., Holst, J., Iterbeke, M., van Ommen, H., Vlahoyannis, Y., and von Deylen, H. (1994) *Survey of EU Member States: Contaminated Land: Definitions, Registers, and Priorities of Action. 2 Volumes*. AEA/CS/16419078/LR1001/037(038). Available from AEA Technology, National Environmental Technology Centre, Culham, Abingdon, Oxfordshire OX14 3DB, November 1994.

[18] Bardos, R.P., Laidler, D., and Johnson, S. (in press) *Meeting Report: Contaminated Land Research- The Way Forward*. Seminar and Workshop of the Soil and Groundwater Technology Association held at The Conference Centre, ICI Chemicals and Polymers Ltd, The Heath, Runcorn, February 1st and 2nd 1996. Report compiled of behalf of the Department of the Environment. To be published in Land Contamination and Reclamation.

[19] CCME (1991) *Interim Canadian Environmental Quality Criteria for Contaminated Sites*. Report No CCME EPC-CS34. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[20] CCME (1992) *National Classification System for Contaminated Sites*. Prepared for the CCME Contaminated Sites Task Group. Report No CCME EPC-CS39E. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[21] CCME (1993a) *Contaminated site liability report. Recommended principles for a consistent approach across Canada*. Report No CCME SPC-CGSCL-67E, 25 March 1993. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[22] CCME (1993b) *Guidance manual on sampling, analysis and data management for contaminated sites*. Report No CCME EPC-NCS62E (Volume 1) and CCME EPC-NCS66E (Volume 2), December 1993. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[23] CCME (1994a) *A protocol for the derivation of ecological effects-based and human health-based soil quality criteria for contaminated sites*. Final draft July 1994. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[24] CCME (1994b) *Guidance Manual for Developing Site-Specific Soil Quality Remediation Objectives for Contaminated Sites in Canada*. Final report, July 1994. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[25] CCME (1994c) *Framework for ecological risk assessment at contaminated sites in Canada*. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[26] CCME (1994d) *Review of whole organism bioassays for assessing the quality of soil, freshwater sediment and freshwater in Canada*. Published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[27] CCME (1995) *The National Contaminated Sites Remediation Program*. Draft Annual Report 1994-95. To be published by the Canadian Council of Ministers of the Environment (CCME), Winnepeg, Manitoba, Canada.

[28] Commission on the Soil Clean-up of Operational Industrial Sites. (1991). Final report. In Dutch. SDU Uitgeverij Koninginnegracht, The Hague. ISBN 90 39 901112.

[29] Danish EPA (1995) *Impediments to the development and application of innovative remedial technology in Denmark*. Danish EPA, Danish version in press, English version in preparation.

[30] Department of Energy (1992) *Chemical Contaminants on DOE Lands and Selection of Contaminant Mixtures for Subsurface Science Research*. DOE/ER-0547T. Available from the National Technical Information Service, Department of Commerce, 5285 Port Royal Road, Springfield, Virginia, USA.

[31] Department of Energy (1994) *Innovation Investment Area*. DOE/EM-0146P. Available from the US Department of Commerce, Technology and Administration, National Technical Information Service, Springfield, Virginia.

[32] Department of the Environment and Welsh Office (1994a) *Paying for our Past*. Consultation paper, March 1994.

[33] Department of the Environment and Welsh Office (1994b) *Framework for contaminated*

land. Outcome of the Government's Policy Review and Conclusions from the Consultation Paper Paying or our Past, November 1994.

[34] Department of the Environment (1995) *Contaminated Land Research Programme: Reports and Current Projects*. Published by the Contaminated Land and Liabilities Branch, Department of the Environment, Romney House, 43 Marsham Street, London SW1P 3PY.

[35] Environment Management Industry Association of Australia (1996) *McMullan launches national environment industries database*. EMIAA News 5(1), January/February 1996.

[36] Federal Office of Environment, Forests and Landscape (1994) *Concept for the management of contaminated sites in Switzerland. Objectives and measures*. Federal Office of Environment, Forests and Landscape (BUWAL), Bern, 1994.

[37] Federal Remediation Technologies Roundtable (1994) *Remediation Technologies Screening Matrix and Reference Guide. 2nd Edition*. EPA/542/B-94/013. Published by the Office of Research and Development, United States Environmental Protection Agency, Washington DC.

[38] Franzius V. and Grimski, D. (1994) *Recent developments in contaminated land remediation in the Federal Republic of Germany. Programs and future research*. Federal Environment Agency, Bismarckplatz 1, P.O. Box 330022, D-14193 Berlin, Germany.

[39] Grimski, D. (1994) *Stand der Bodenreinigung bei der Altlastensanierung*. (The present state of soil clean-up for the remediation of contaminated sites). In German. Federal Environment Agency, Bismarckplatz 1, P.O. Box 330022, D-14193 Berlin, Germany.

[40] Holtkamp, A.B. and Gravesteyn, L.J.J. (1993) *Large scale voluntary soil clean-up operation for contaminated industrial sites in the Netherlands now on its way*. In: Arendt, F. et al (eds.): Contaminated Soil '93. Kluwer Academic Publishers, Dordrecht, pp. 27 - 34. ISBN 0 7923 2326 2.

[41] Johnson, J. (1995) *EPA research faces major cuts*. Environmental Science and Technology 29(7): 303A.

[42] Kasamas, H. (1994) *The Austrian Approach to Contaminated Land*. Land Contamination & Reclamation 2(4): 189-191.

[43] Kobus, H., Teutsch, G., Koschitzky, H.P. and Cirpka, O. (1993) *VEGAS: A new facility for large scale physical modelling of in situ remediation of contaminated groundwater and soils*. In: Contaminated Soil '93. Arendt, F., Annokkée, G.J., Bosman R. and Van den Brink, W.J. (eds). Kluwer Academic Publishers, Dordrecht, Boston, London, pp. 1413 - 1415.

[44] Kovalick, W. (1995) *Remediation technologies for US hazardous waste sites*. Chemistry & Industry, 3 July 1995: 500-503.

[45] Krijnen, K. (1994) *De nieuwe wettelijke regeling van de bodemsanering* (New legal regulation on soil clean-up). In Dutch. In: Bodem (Dutch Journal), nr. 4, November 1994, pp. 153 - 157.

[46] Laidler, D. (1995) *Industry forms Soil and Groundwater Technology Associations*. Press Release available from the Association Secretary, Parkman Environment, 19 Queen Annes's Gate, Westminster, London SW1H 9BU.

[47] Martin, I. and Bardos, P. (1996) *Summary Report on the NATO/CCMS Pilot Study on Research, Development and Evaluation of Remedial Action Technologies for Contaminated Soil and Groundwater. Technical Status May 1996*. Available from the Contaminated Land and Liabilities Division, Department of the Environment, Romney House, 43 Marsham Street, London SW1P 3PY.

[48] Miller, J., Geron, G. and Debatty, D. (1995) Wallonia: Remedial Strategies for Urban and Industrial Derelict Land. In Contaminated Soil'95 (Eds W. van den Brink, R. Bosman, and F. Arendt), Proceedings of Contaminated Soil'95, Maastricht, The Netherlands, 30 October - 3 November 1995. pp 1629-1637.

[49] Ministry of Housing, Spatial Planning, and the Environment (1994) *Soil Protection Act 1994* (in English). Available from the Directorate-General for Environment Protection, Department of Soil Protection, Rijnstraat 8, PO Box 30945, 2500 GX, The Hague, The Netherlands.

[50] Ministry for the Environment (1995) *Discussion Document on Contaminated Sites Management*. Available from the Contaminated Sites Group, Ministry for the Environment, PO Box 10362, Wellington, New Zealand.

[51] Norman, F. (1995) *Risk assessment in Sweden*. Paper presented at the second Meeting of the *Ad Hoc* International Working Group on Contaminated Land in Nottingham, United Kingdom, May 1995.

[52] OVAM (1995) *Soil Decontamination in Flanders*. A pamphlet produced by the Public Waste Agency of Flanders. Available from Dr V. De Boeck, Kan. De Deckerstraat 22-26, 2800 Michelen, Belgium.

[53] Renner, R. and Johnson, J. (1995) *Renewed Superfund debate may turn on retroactive liability*. Environmental Science and Technology 29(11): 498A-499A.

[54] Royal Commission on Environmental Pollution (1996) *Nineteenth Report: Sustainable Use of Soil*. Published by HMSO, London, UK. ISBN 0-10-131652-6.

[55] States-General, Second Chamber (1989/1990) *Soil clean-up: ten year planning scenario with specific reference to industrial sites*. States-General, Second Chamber, 1989/1990, 21556.

[56] Strϕbaek, N. (1993) *Lessons learnt from abroad - an evaluation of Denmark's policy on managing contaminated land*. Available from: IBC Technical Services Ltd, Gilmoora

House, 57-61 Mortimer Street, London W1N 7TD.

[57] Strϕbaek, N. (1995) Personal communication, Spring 1995.

[58] United States Environmental Protection Agency (1993a) *Cleaning up the nation's waste sites: markets and technology trends*. PB93140762. Published by the Office of Research and Development, United States Environmental Protection Agency, Washington DC.

[59] United States Environmental Protection Agency (1993b) *Exchanging Technology Information on CLU-IN*. EPA/542/F-93/001. Published by the Office of Research and Development, United States Environmental Protection Agency, Washington DC.

[60] United States Environmental Protection Agency (1994) *The Superfund Innovative Technology Evaluation Programme: Technology Profiles. Seventh Edition*. EPA/540/R-94/526. Published by the Office of Research and Development, United States Environmental Protection Agency, Washington DC.

[61] United States Environmental Protection Agency (1995) *VISITT 4.0 Bulletin*. EPA/542/N-95/008. Published by the Office of Research and Development, United States Environmental Protection Agency, Washington DC.

[62] Welinder, A.S. (1993) *Property value and remedial action: the Danish approach*. In: Contaminated Soil '93. F. Arendt, G.J. Annokkée, R. Bosman and W.J. Van den Brink (eds). Kluwer Academic Publishers, Dordrecht, Boston, London, pp. 63-67.

[63] Werkgroep Bodemsanering (1993) *Saneren zonder stagneren* (Clean-up without stagnation). Final report of the Working Group on Soil Clean-up. In Dutch. The Hague, November 1993.