

Management and rehabilitation of contaminated sites: international forums and emerging trends

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Abstract

International cooperation in the field of contaminated site management has increased dramatically in the past decade. The expected benefits of increased cooperation are reduced duplication of effort, including the co-ordination of contaminated site research, improved synergy between various stakeholders and definition of research and industry needs, enhanced policy development for contaminated sites, information dissemination and technology transfer. The paper briefly discusses key collaborations, partnerships and networks throughout the world relating to contaminated site management and remediation. The experience shared within these groups should prove useful to the application of similar environmental problems in regions where cooperation has been less evident, such as in the Asia-Pacific region. The key value of these partnerships lies in connecting and sharing with them. In addition, the work that these organisations are involved with provides a useful indication of important issues in contaminated site remediation at a global level. These issues are: (i) development and demonstration of innovative monitoring technologies for contamination assessment and remediation; (ii) emergence of risk assessment and inclusion of risk communication to the wider communities in which remediation is occurring, and not just regulators, is becoming common practice; (iii) toxicology, bioavailability and ecotoxicity testing of contamination and remediation residuals is increasing though they lack international harmonisation; (iv) increased need for holistic approaches to contaminated site management, e.g. guaranteed remediation programmes and the need for understanding the implications of financing mechanisms.

Key words: collaboration, contaminated sites, contaminated soil, cooperation, management, partnerships, remediation, risk assessment, technology transfer

INTRODUCTION

Cooperation between countries and organisations in the field of contaminated land management has increased in recent years. This is evident at the global, national, regulatory and industrial sector levels, and is a result of the culmination of numerous forces, including increased awareness of pollution and that its impacts can span geographic and socio-political boundaries. The resulting collaborations cut across industries, functions, and disciplines, enhancing exchanges, communi-

cation and co-operative activity between organisations working in the field of contaminated soil and groundwater management. Such collaborations provide an excellent opportunity to leverage resources and experiences so as to accomplish a project more effectively than otherwise might be possible (Bardos 2000; Guerin 2001).

Collaborations can take many different forms. These can include the following types and examples are given in relation to site contamination and remediation:

- government–government e.g. NATO-CCMS, SERDP, FRTR;
- corporate–government e.g. RTDF;
- corporate–corporate e.g. CONCAWE, NICOLE;
- educational institution–government e.g. CRESP, GWRTAC;
- corporate–NGO–government e.g. CL:AIRE.

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Although many of the collaborations discussed have not been in operation for long (<5 years), there is emerging evidence that these have been successful in achieving what they set out to do.

This paper explores the key international collaborations in the site contamination and remediation and fields, highlighting their objectives, key activities and contact points (through their Internet or URL addresses). The collaborations discussed have contaminated land assessment, risk assessment, and remediation as their major focal areas. They also provide a cross-section of the major activities occurring in the contaminated site arena at a global level.

FORUMS BASED IN THE UNITED STATES

The United States has taken a leadership role in technology transfer and collaboration, and the diversity and amount of information transferred, as well as a drive to pursue new technologies reflect this. In the US there has been a large demand for new technologies in the remediation of contaminated sites. Further, there is evidence of substantial government as well as industry funding in their development.

Programmes of the United States Environmental Protection Agency

The US EPA (www.clu-in.org) provides a central location for numerous collaborations and networks. US legislation requiring the remediation of contaminated soil and groundwater at private party sites and clean-up programmes on Federal government lands has been a major driving force for remediation technology development in the US since the early 1980s. The US EPA's Office of Solid Waste and Emergency Response created the Technology Innovation Office (TIO) in 1990 to act as an advocate for new technologies. TIO's mission is to increase the applications of innovative treatment and field analytical characterisation technologies to contaminated sites, soils and groundwater. Within the US EPA, TIO works with other offices to effect policy changes, assist technology demonstrations, analyse trends in technology development and use, identify the supply of technologies and vendors to the marketplace and forecast future demand for technologies. It also charts the cost and performance parameters, and improves the diffusion of technology-related information. TIO has several publications addressing these and other areas relating to site remediation, all of which are available at the www.clu-in.org internet address. Details of contacts, collaborating organisations and reports are also provided at this URL.

The Remediation Technologies Development Forum

The Remediation Technologies Development Forum (RTDF), which is affiliated to the US EPA, encourages collaboration among companies, states and federal agencies in defining, prioritizing and funding new, untried concepts for remediation technologies (Bell *et al.* 1998). By consulting at the earliest stages of technology development, the RTDF seeks to combine the financial and intellectual resources to promote research co-ordination on problems of mutual interest. The forum is composed of the US EPA, the US Departments of Defense (DOD) and Energy (DOE), other Federal agencies, state regulators, technology evaluation and verification entities, and potential end users of these technologies to facilitate independent and expert verification of site characterisation technology performance. The purpose of the RTDF is to identify what government and industry can do together to develop and improve the environmental technologies needed to address their mutual remediation problems in the safest, most cost-effective manner. The RTDF fosters public and private sector partnerships to undertake the research, development, demonstration, and evaluation efforts needed to achieve common remediation goals. There are several Action Teams within the RTDF. These Action Teams address specific interest areas identified by the RTDF including:

- Bioremediation of Chlorinated Solvents Consortium;
- Permeable Reactive Barriers Action Team;
- In-place Inactivation and Natural Ecological Restoration Technologies (IINERT) Soil-Metals Action Team;
- Phytoremediation of Organics Action Team;
- Sediments Remediation Action Team.

An outcome already emerging from the RTDF is the more efficient leverage of resources for technology development and implementation in contaminated site management and the elimination of duplication of effort by member companies. Details of contacts, collaborating organisations and reports are provided online (www.rtdf.org).

The Petroleum Environmental Research Forum

The Petroleum Environmental Research Forum (PERF) is a research and development joint venture between several petroleum companies, formed to provide a stimulus to and a forum for the collection, exchange and analysis of research information relating to the development of technology for health, environment and safety, waste reduction and system security in the petroleum industry. PERF is a non-profit organisa-

tion; its members are corporations engaged in the petroleum industry that recognize the importance of a clean, healthy environment and are committed to supporting cooperative research and development. PERF does not itself participate in research projects but provides a forum for members to collect, exchange, and analyse research information relating to practical and theoretical science and technology concerning the petroleum industry, and a mechanism to establish joint research projects in that field. Details of contacts, collaborating organisations, projects and reports are provided online at www.perf.org.

The Federal Remediation Technologies Roundtable

The Federal Remediation Technologies Roundtable (FRTR) is an interagency working group seeking to build a more collaborative atmosphere among the federal agencies involved in hazardous waste site remediation. By providing such opportunities, the Roundtable aims to identify and publicize more efficient, cost-effective solutions to the Federal Government's hazardous waste challenges. To date, the focus of this group has been on the exchange of information regarding the use and development of innovative hazardous waste characterisation, monitoring and treatment technologies. The exchange synthesizes the technical knowledge that Federal Agencies have compiled and provides a more comprehensive record of performance and cost. Details of contacts, collaborating organisations, projects and reports are provided online at www.frtr.gov.

The North Atlantic Treaty Organisation (NATO)

The NATO Committee on the Challenges of Modern Society (CCMS) provides a forum for the evaluation of demonstrated and emerging technologies for the treatment of contaminated soil and groundwater. The NATO/CCMS forum has been through several phases and is currently in Phase 3. Under this programme, more than 50 different technologies have been demonstrated (Smith *et al.* 1998). Each pilot country is responsible for developing, conducting, and disseminating the results of a pilot study. On completion of a study, a summary report is submitted to the Committee members and then forwarded to the North Atlantic Council. A technical report is usually also published by the pilot group and made available on a world-wide basis to anyone expressing interest, and readers can access its publications online. Details of contacts, collaborating organisations, projects and reports are provided at www.nato.int/ccms.

The Consortium for Risk Evaluation with Stakeholder Participation

The Consortium for Risk Evaluation with Stakeholder

Participation (CRESP) is a university-based US organisation created specifically to develop a credible strategy for providing the information needed for risk-based clean-up of complex contaminated environments, especially those for which the US Department of Energy is responsible. Several universities are involved in this forum.

CRESP, though not a decision maker at DOE sites, has three fundamental commitments: (i) to draw upon stakeholders throughout its work for the refinement of priorities and evaluation of technical data; (ii) to include consideration of social, cultural and economic values in conjunction with human health and ecosystem impacts in a risk-based decision process at each site; and (iii) to work actively with other organisations whose skills and capabilities can contribute to the improved definition, understanding, and reduction of these risks.

CRESP recognizes that the management of radioactive, chemical and physical hazards and restoration of damage at US Department of Energy sites will require a considerable ongoing effort. Thus CRESP's work focuses on the current hazards, long-term impacts and the importance of expeditious decision-making and good timing in implementing restorative action. CRESP also undertakes original research projects on various scientific, technical, occupational, and behavioural aspects of risk-based environmental management (www.cresp.org).

The Strategic Environmental Research and Development Program

The Strategic Environmental Research and Development Program (SERDP) is the Department of Defense's (DoD) corporate environmental research and development (R&D) programme, planned and executed in full partnership with the Department of Energy (DOE) and the Environmental Protection Agency (EPA), with participation by numerous other Federal and non-Federal organisations. Within its broad areas of interest, the programme focuses on clean-up, compliance, conservation, and pollution prevention (P2) technologies. These are described at www.serdp.org. SERDP's environmental research is:

- accelerating cost-effective clean-up of contaminated defense sites;
- facilitating full compliance with environmental laws and regulations;
- enhancing training, testing and operational readiness through conservation measures; and
- reducing defense industrial waste streams through aggressive pollution prevention.

Collaborations on groundwater remediation

GWRTAC, or Groundwater Remediation Technologies Analysis Center, was established in 1995. The centre is operated by Concurrent Technologies Corporation (CTC), in association with the University of Pittsburgh's Environmental Engineering Program, under a Cooperative Agreement with the US Environmental Protection Agency Technology Innovation Office (EPA TIO). GWRTAC is a specialized national environmental technology transfer centre that provides current information concerning innovative groundwater remediation technologies. The intent of GWRTAC is to offer a wide range of information on the state of development of all emerging groundwater remediation activities through its Internet site, searchable case study databases, pertinent technical documents, emails to member subscribers, and a toll-free assistance line. One important mechanism for providing state-of-the-art groundwater technologies is by collecting case study information. This case study information is currently being compiled into databases which provide the means for GWRTAC to prepare status reports for individual technologies or contaminants, or to directly provide GWRTAC customers with information on technology deployment.

GWRTAC focuses on innovative *in situ* groundwater and soil remediation technologies as compared to the pump and treat approach for groundwater, or soil excavation and treatment. Many of the remedial activities summarized by GWRTAC are *in situ* technologies requiring no groundwater extraction. However, means of enhancing pump and treat are also addressed. GWRTAC includes those remediation technologies which, through design and/or application, improve groundwater quality and are integral to groundwater clean-up. The following are technologies that are currently included in GWRTAC's list of technical documents online at the Internet site www.gwrtac.org:

- *in situ* physical/chemical treatment;
- air sparging;
- hydraulic and pneumatic fracturing;
- groundwater recirculation wells;
- *in situ* flushing;
- *in situ* stabilisation/solidification;
- permeable reactive barriers;
- thermal enhancements;
- biological treatment;
- bioslurping;
- intrinsic bioremediation;
- monitored natural attenuation;
- phytoremediation;
- electrokinetics.

Forums focusing on risk-based corrective action

In the past, many countries have set fixed numerical criteria to decide whether remedial actions are necessary. These limits are based on generic assumptions about site conditions such as: soil type, depth to groundwater, geology and hydrogeology, and proximity to potential receptors (e.g. water well, basement and surface water body). Such an approach ignores the fact that contaminated sites vary widely in terms of complexity and the potential risk they may pose to either human health or the environment. As fixed numerical criteria are nearly always set at very low levels to ensure safety, their use has led to the clean-up of more land than may have been necessary. The result is waste of resources (and ultimately added expense to the consumer) by conducting clean-up with no incremental reduction in risk to human health and the environment. As a consequence, the principles of risk-based corrective action (RBCA) have been applied in a number of countries including those in North America where it has been developed principally by the American Society for Testing Materials (ASTM). This follows a flexible approach to decision-making whereby corrective action is appropriately tailored to site-specific conditions and hazards. This leads to more cost-effective solutions, and allows the greatest effort to be applied where it is most beneficial. Readers should consult the US EPA Partnership in RBCA Implementation Program and the American Society for Testing Materials (www.astm.org) for published materials relating to the management of petroleum hydrocarbon contaminated sites.

The Association for the Environmental Health of Soils (AEHS) (www.aehs.com) provides comprehensive documentation on managing hydrocarbon contaminated sites, particularly in relation to RBCA and hosts the Air Force Centre for Environmental Excellence's (AFCEE) protocols for natural attenuation. These documents are now being used widely by remediation practitioners in industry.

The Massachusetts Department of Environmental Protection (www.state.ma.us/dep) also has various publications describing screening values (or levels) for hydrocarbon contaminated soil and water. The American Institute for Petroleum (www.aip.org) also provides publications on RBCA and hydrocarbon contamination.

FORUMS BASED IN THE EUROPEAN UNION

Network for Industrially Contaminated Land in Europe (NICOLE)

NICOLE is a network for the stimulation, dissemination and exchange of knowledge about all aspects of

industrially contaminated land. Its members come from industrial companies (problem holders), service providers/technology developers, universities and independent research organisations (problem solvers) and governmental organisations (policy makers). The network started in February 1996 as a concerted action under the 4th Framework Programme of the European Community. Since February 1999, NICOLE has been self-supporting, financed by the fees of its members. NICOLE is an industry-driven network, which has as one of its aims identifying the research needs from an industry perspective, particularly in the European Union (Kasamas *et al.* 1998a; Bardos 2000; Cortesi *et al.* 2001). Contact www.nicole.org.

Concerted Action on Risk Assessment for Contaminated Sites in the European Union (CARACAS)

CARACAS is an initiative within the Environment and Climate Programme of the European Commission Directorate General (DG) XII (Kasamas *et al.* 1998b). The key areas addressed in the CARACAS programme are as follows:

- the nature of contaminated land site characterisation;
- bioavailability of contaminants in soil and groundwater;
- fitness for use and human health risks;
- ecological risk assessment;
- risk perception and communication;
- remediation technologies and monitoring remediation.

NICOLE's focus is primarily on industrial sites still in use or owned by industry, whereas CARACAS has the broader perspective of governments who have to make decisions within a national contaminated land policy and planning framework. Together the two concerted action networks identified similar areas which would benefit from further research and development initiative. Contact www.caracas.at.

Contaminated Land Rehabilitation Network for Environmental Technologies

The scientific cooperation in Europe successfully established through the CARACAS project has led to the development of another concerted action: CLARINET, the Contaminated Land Rehabilitation Network for Environmental Technologies, which was launched in 1998. The primary objective of CLARINET is to develop technical recommendations for sound decision-making for the rehabilitation of contaminated sites based on current scientific knowledge. CLARINET aims to bring together the combined knowledge

of academics, government experts, consultants, industrial landowners and technology developers. Three particular aspects of contaminated land rehabilitation will be examined within this project: risk assessment; remedial technologies; and decision support issues, including economic, societal and political dimensions. CLARINET aims to elaborate the scientific basis underlying the rational management of contaminated sites. A detailed discussion of CLARINET's activities, including contact information, are described elsewhere (Bardos 2000).

The Common Forum

The Common Forum for Contaminated Sites in the EU is an informal group formed for cooperation between the EU Member States, the European Commission and the European Environment Agency on contaminated land issues (Kasamas *et al.* 1998a). The main objectives of the Common Forum were identified in its initial (1994) workshop as follows:

- to facilitate the understanding of each Member State's approach to tackling the problem of contaminated land;
- to identify with the European Commission thematic areas of transnational interest where an EU-wide cooperation would be beneficial;
- to establish a common forum with delegates from EU Member States to discuss the results of the DG XI study surveys of EU member states' policies on contaminated land and to develop recommendations to identify areas for EU-wide co-operation in relation to contaminated sites.

In this forum, member countries are able to raise issues pertinent to contaminated land management. This is commonly done at the Common Forum meetings. The topics raised reflect the main concerns in contaminated site management and these were identified as follows:

- financing of remediation activities;
- lessons learned from the management of remediation projects;
- monitoring, control and aftercare of contaminated and remediated sites.

The Centre for Exploitation of Science and Technology (CEST)

CEST is a non-profit organisation, registered as a charity, operating for the benefit of its members and for the public good. CEST has approximately 30 members, drawn from:

- industrial manufacturing and service sector corporates;
- research and academic institutions;
- government bodies and agencies.

CEST's mission is to identify new business opportunities for science and technology and to assist their realisation by linking key decision makers in industry, research and government, helping them to identify the best options and to profit through collaborative action. CEST has been operating successfully under this collaborative advantage banner for over ten years, based in London. CEST instigates collaborative programmes, independent research sponsored by CEST members and other initiatives, in areas where science and technology has the capacity to make substantial impacts on the economy and in society. Contact www.cest.org.uk.

CL:AIRE (Contaminated Land: Applications in Real Environments)

CEST has found that the options available for contaminated land remediation were limited by the lack of proven alternative treatment technologies. Where new technologies were developed, their progress (and subsequent adoption by owners of contaminated sites) was often constrained by the absence of an appropriate framework for testing and validation. CL:AIRE is a public/private partnership involving the following stakeholders:

- government policymakers;
- regulators;
- industry;
- research organisations;
- technology developers.

CL:AIRE provides a link between the main organisations in contaminated land remediation in the UK, to catalyse the development of cost-effective methods of investigating and remediating contaminated land in a sustainable way for the benefit of the UK economy and environment. In essence, CL:AIRE provides a vehicle for the practical demonstration of cost-effective remediation technologies. The results of the demonstrations are made available to owners of contaminated land who can utilize this information to extend the clean-up options available to them, reduce the technical risks, and provide realistic cost estimates for full scale remediation. CL:AIRE's objectives are to:

- establish a network of characterized contaminated sites throughout the UK;
- demonstrate the application of remediation technologies which may offer improved site investigation

techniques, monitoring or remedial solutions;

- develop a strategy for remediation technology research in the UK;
- disseminate information from research and technology demonstrations on contaminated land;
- prepare and provide educational materials related to contaminated land for school children and the general public;
- procure funding to support CL:AIRE's activities.

CL:AIRE's ultimate goal is to assist in bringing contaminated land back into beneficial use through the development of both technical solutions and a better understanding of the problems. CL:AIRE aims to establish and co-ordinate a national network of field test sites for the testing of remediation technologies to clean-up contaminated land. It will provide a brokerage service between those seeking solutions to contaminated land problems, the research community and providers of treatment technologies. It is being designed to complement existing public and private sector collaborative programmes in contaminated land remediation and management. Industry has involvement either as a provider of test areas or through research into, or demonstration of, remediation technology. CL:AIRE is envisaged as providing an umbrella across a number of collaborative initiatives, providing consistency and cohesiveness, which should greatly improve the prospects for, and perception of the work. A consortium of UK statutory agencies and major industrial companies is supporting CL:AIRE. This forum can be contacted at www.claire.co.uk.

Scotland and Northern Ireland Forum for Environmental Research

SNIFFER (or Scotland and Northern Ireland Forum for Environmental Research) was established in 1989 as a consortium to direct and manage research funded by contractual subscription. The consortium proved successful in establishing a business-orientated programme of joint research and in building collaborative links with other organisations. In 1994, SNIFFER was reformed as a company limited by guarantee with charitable status (www.sniffer.org.uk). SNIFFER's objectives are to further:

- the protection, conservation and amelioration for the public benefit of the natural environment;
- the promotion of scientific research in areas of water, waste, air and the environment and the subsequent dissemination of the results obtained;
- the advancement of education for the public benefit and in particular the advancement of education in ecological and environmental studies.

Ad hoc International Working Group on Contaminated Land

This forum was established in 1993 and has representatives from governments and environmental agencies from countries, particularly those in the EU. However, the forum is open to all countries. Topics covered are policy issues in contaminated land management, risk assessment, third party financing, registration of contaminated sites and technology selection.

Sensors for Monitoring Water Pollution from Contaminated land, Landfills and Sediments

This forum, also referred to as SENSPOL aims to enhance the development of sensors for practical applications in the abatement of water pollution. SENSPOL commenced in August 2000 and its role is to guide technological development of sensors for environmental pollutants. It aims to accelerate the development of chemical sensors, biosensors and biomimetic systems to provide sensitive and robust devices for monitoring in water, contaminated soil and sediments. Its work is based on a series of European meetings, a centralised information facility and a broad collaboration programme. Its work, described at www.cranfield.ac.uk/biotech/senspol.htm, aims to address the following objectives:

- development of low-cost, durable chemical sensors, biosensors and biomimetic systems for routine application in environmental monitoring;
- development of integrated sensor systems capable of measuring several parameters simultaneously;
- development of biosensors and biomimetic systems capable of measuring new parameters of relevance to the environment;
- assessment of the toxicological risks of complex mixes of pollutants;
- *in situ* monitoring of environmental pollutants to provide early warning of environmental problems and to facilitate optimisation of remediation technologies and natural attenuation processes;
- extending the range of situations where biosensors and biomimetic systems may be applied to monitor the environment under extreme conditions.

Conservation and Clean Air and Water in Europe

Conservation and Clean Air and Water in Europe (CONCAWE) is the oil companies' European organisation for environment, health and safety. Many CONCAWE member companies have been involved with this US-based ASTM activity (described above) but realized that there are a number of differences between the two continents and even within them. CONCAWE has aimed to develop similar techniques for Europe and they have therefore established a task force to carry out

this work and produce a guideline setting out the approach, which could be adapted to the situations prevailing in the various European countries. Details of contacts, collaborating organisations, projects and reports are provided on-line at www.concawe.be.

Countermeasures: Environmental and Socio-Economic Responses

The Countermeasures: Environmental and Socio-economic Responses (CESER) programme was established to deal specifically with the safety and environmental health effects relating to the operation of nuclear reactors and contaminated land resulting from their operation (or malfunction). CESER recognizes that long-term contamination of agricultural land may require measures such as deep ploughing, application of special fertilizers, changes in the feeding of livestock, or changes in land use. The overall objective of this programme is to pursue an approach to nuclear safety, which encompasses all its facets, ranging from the utilisation of nuclear energy to medical applications and other uses of radioactive materials. Research and technology development activities currently underway relate to the following topics:

- exploring new concepts in reactor safety, the management and disposal of long-lived radionuclides, and the risk of diversion of fissile materials;
- to acquire a better understanding of the mechanisms of severe accidents, in order to improve safety measures and prevention (reactor safety);
- safe decommissioning of nuclear plants in order to close the nuclear fuel cycle;
- to improve understanding of the mechanisms of radiation action;
- to address historical liabilities, given the situation in Central and Eastern Europe, which remains a source of concern with regard to nuclear safety.

CESER can be contacted through the University of Stirling's website at www.stir.ac.uk/departments/naturalsciences/envsci/ceser/ceser.htm.

FORUMS BASED IN THE ASIA-PACIFIC REGION

Several collaborations have emerged in the Asia-Pacific region. These collaborations address a wide range of contaminants and issues related to site contamination and remediation. The highly innovative, adaptive and resourceful approach taken by these collaborations, particularly in Australia, reflects the relatively non-prescriptive nature of regulatory authorities in the region, and also the limited funding available for

contaminated site management (Guerin 2000). The key organisations and collaborations are the CSIRO Land and Water Division, which has been hosting an international contaminated sites forum in Australia, since 1999. The Co-operative Research Centre (CRC) for Waste Management and Pollution Control is also an important collaboration between numerous organisations in the Asia Pacific conducting research in the contaminated sites area.

The Australian Contaminated Land Consultants Association (ACLCA) is an organisation comprising environmental consulting companies, also focused on contaminated site issues in Australia with strong linkages to various environmental regulatory bodies in Australia. The ACLCA has a business focus. The Australian oil industry has developed a risk-based approach to the management of contaminated sites. These guidelines are increasingly being used across Australia for site risk assessments where petroleum hydrocarbons are the main contaminants. These collaborations, and others in the region, are described in Table 1.

CONCLUSIONS AND FUTURE DIRECTIONS

Formal collaborations, partnerships and networks focused on contaminated sites and their remediation are emerging globally. The experience shared within these groups should prove useful in application to environmental problems in China and the Asia-Pacific region, where there is currently a great demand for environmental technologies and expertise, but also other developing regions around the world. Future research could review the effectiveness of these collaborations to identify learnings for future efforts in international collaboration.

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Table 1. Examples of organisations and collaborations in site contamination and remediation based in Australia and the Asia-Pacific Region ^(a)

Organisation	Abbreviated name ^(a)	Major activity	Origin	Contact information
Australian Institute of Petroleum	AIP	Co-ordinated the development of the Australian oil industry guidelines for conducting contaminated site risk assessments	Australia	www.aip.com.au
Australian Water Association	AWA	For professionals in water and waste water analysis, assessment, management and treatment. The Australian Water Association is a professional membership organisation formed in 1962 to promote the responsible management of water and its related resources. The AWA has approximately 4000 members across Australia and abroad, including both organisations and individuals. Members come from a broad range of disciplines, including engineers, resource managers and public health professionals. The AWA has a hazardous waste group and organizes a waste management convention every 2-3 years which addresses soil contamination and remediation issues.	Australia	www.awa.asn.au
CRC Waste Management & Pollution Control	CRC WMPC	Key areas of activity are wastewater treatment, technology development and technology transfer to Asia-Pacific countries, R&D. The mission of the CRC WMPC is to return value to members' organisations and to contribute positively to the economic, social, and environmental well being of Australia through focusing pre-eminent research expertise to provide solutions for the environmental industry. The CRC aims to: be recognized as a national and international authority on the scientific and technical management of waste and pollution. It conducts research into environmental monitoring of contaminated sites.	Australia	www.crcwmpc.com.au
CSIRO Land & Water	CLW	CLW organizes a contaminated soil forum recently formed to discuss contaminated sites, particularly those related to industrial facilities. CSIRO Land and Water is a provider of world-class science services specializing in research on soil, water and atmospheric processes essential to the understanding and sustainable management of land and water resources in Australia and internationally.	Australia	www.clw.csiro.au/research/remediation
Australian Contaminated Land Consultants Association	ACLCA	For environmental consultants in Australia with a common focus on contaminated land. The principal aims of ACLCA are the following: to provide a forum for member companies to develop, discuss and respond to issues that affect the responsible management of contaminated lands; establish and maintain a strong working relationship with regulatory authorities and other related agencies that have an interest in the management of contaminated lands; encourage public and private sectors to accept and use ACLCA as the contaminated land consultant industry's peak representative group; promote and encourage the open exchange of information between members and other interested bodies; provide information to outside parties and promote an awareness of the requirement and availability of professional skills in the area of contaminated land management.	Australia	www.ozemail.com.au/~aclcai

Table 1. Examples of organisations and collaborations in site contamination and remediation based in Australia and the Asia-Pacific Region (cont.) ^(a)

Organisation	Abbreviated name ^(a)	Major activity	Origin	Contact information
Environmental Management Industry Association of Australia	EMIAA	EMIAA was founded in 1991 and is the national industry association representing and helping organisations in the business of providing environment management goods, systems and services. It helps members network, access overseas markets, deal with government, and promote policies consistent with sustainable development and supportive of the environment management industry. EMIAA works very closely with Australian Federal and State Government agencies and has 240 corporate members. Members are primarily from the private sector, but also include government agencies.	Australia	www.emiaa.org.au
Strategic Industry Research Foundation	SIRF	Development of a demonstration site for showcasing new environmental technologies, including those related to soil and groundwater clean-up.	Australia	www.sirf.com.au
Australian Centre for Minesite Rehabilitation Research	ACMRR	An industry initiative to carry out environmental research and provide training in environmental management for the mining industry.	Australia	www.acmer.com.au
Environment Industry Development Network	EIDN	The Environment Industry Development Network is an industry development initiative by EMIAA, the Cooperative Research Centre for Waste Management and Pollution Control and the Australian Government's Department of Industry Science and Tourism. EIDN's role is to strengthen the Australian environment management industry and to make it more innovative and internationally competitive. EIDN is an initiative for linking, collaborating, transferring knowledge and technology and for encouraging innovation.	Australia	www.eidn.com.au
Australia and New Zealand Environment Conservation Council	ANZECC	Government initiative between Australia and New Zealand. Several committees addressing hazardous waste management issues in the region. ANZECC provides a forum for member governments to exchange information and experience and develop coordinated policies in relation to national and international environment and conservation issues.	Australia/ New Zealand	www.environment.gov.au/psg/igu/anzecc/index.html
National Environmental Protection Council	NEPC	The National Environment Protection Council has been established to set national environmental goals and standards for Australia, through National Environment Protection Measures. The objectives of the National Environment Protection Council are to ensure that: the people of Australia enjoy the benefit of equivalent protection from air, water or soil pollution and from noise, wherever they live; and decisions of the business community are not distorted, and markets not fragmented, by variations between member governments in relation to the adoption or implementation of major environment protection measures.	Australia	www.nepc.gov.au
Geo-Environmental Protection Center	GEPC	Solving soil and groundwater contamination issues through quality research improvements in countermeasures, evaluation methods and management technologies. To ensure appropriate evaluations of actual conditions at contaminated sites in Japan and the effects of contaminations on the surroundings, as well as to achieve the most efficient remediation of contaminated soil and groundwater. GEPC implements studies related to environmental impact assessments, countermeasure technologies, survey and analysis techniques, management methods and the effective use of decontaminated soil. GEPC supplies technical guidance related to soil contamination to local governments and enterprises.	Japan	www.gepc.or.jp

Table 1. Examples of organisations and collaborations in site contamination and remediation based in Australia and the Asia-Pacific Region (cont.) ^(a)

Organisation	Abbreviated name ^(a)	Major activity	Origin	Contact information
Research Institute for Environmental Technology	RIET	For environmental professionals in Singapore particularly environmental consultants. The mission of RIET is to enhance environmental management and technology awareness, understanding and capability in Asia and to promote international environmental business partnerships and environmentally compatible flow of trade and investment with Asia. Established in 1993 and registered in Singapore as a not-for-profit public company.	Singapore	www.riet.org

(a) Individuals involved in these collaborations can be contacted through the respective homepages.

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