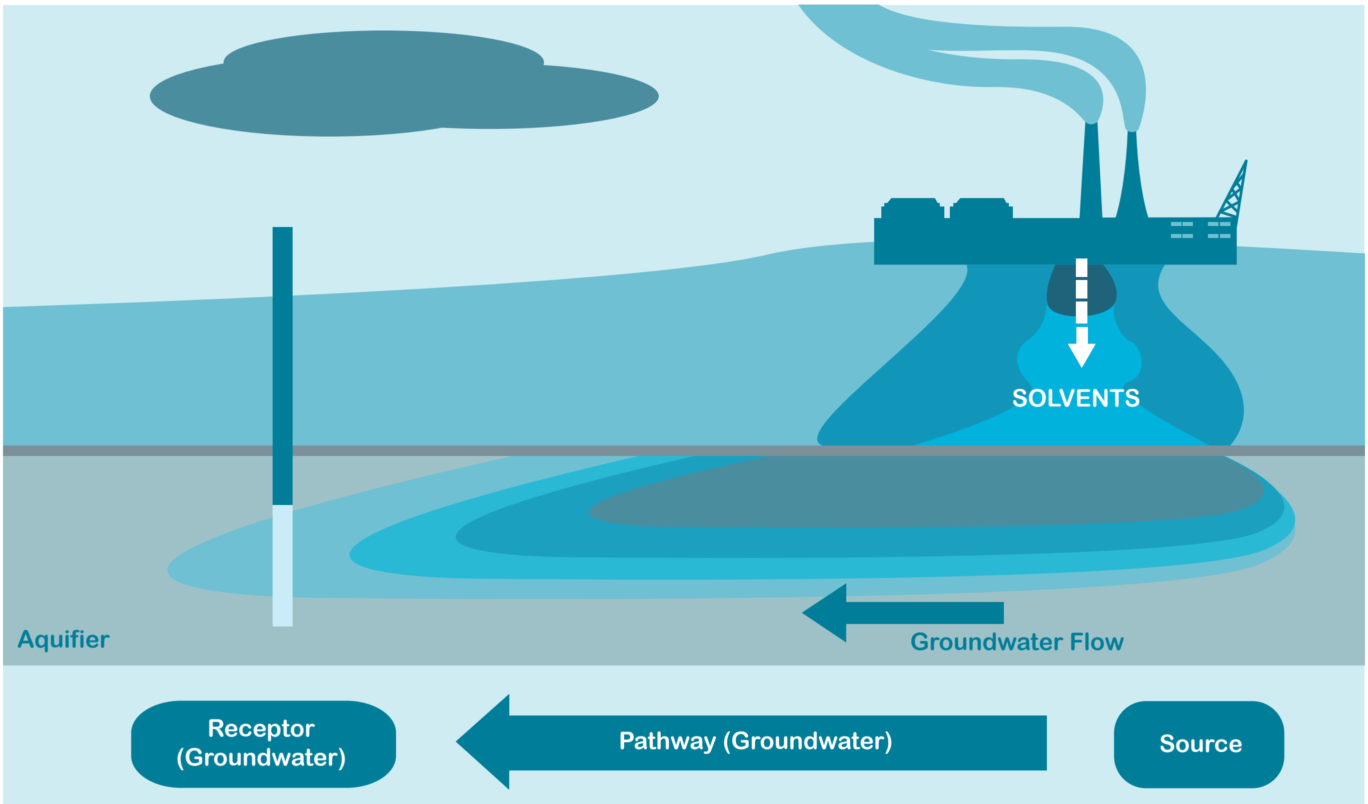
Sustainable remediation

Paul Bardos, **Mark Knight** and **Simon Humphrey** review the history of sustainable remediation and highlight the current issues.

In 1961 the Lower Swansea Valley Project, after many years of campaigning and fund raising, began to investigate how to restore one of the largest areas of post-industrial dereliction in Europe. Today, more than fifty years later, the terms of reference for this project resonate with modern-day themes of sustainable development: "to establish the factors which inhibit the social and economic use of land in the Lower Swansea Valley and to suggest ways in which the area should be used in the future". The entire area has been transformed by the large-scale restoration in the valley from the late 1960s. From a contemporary point of view it is interesting to see mention of the economic and social aspects of sustainability, but no mention of environmental or human health protection. Of course, some of the environmental consequences of the dereliction were plainly visible in the absence of trees and strangely coloured river, and much early effort involved finding out what might be encouraged to grow, and how.

UNDERSTANDING CONTAMINATED LAND PROBLEMS

Developing ideas of what might constitute unacceptable levels of contamination were formulated in the UK from the mid-1970s under the aegis of the Interdepartmental Committee for the Redevelopment of Contaminated Land, as an increasing number of redevelopment projects encountered land-contamination problems. From the late 1970s and early 1980s there was increasing global recognition of the potentially serious consequences of land contamination, triggered by major incidents in several countries where houses were built on former industrial waste disposal sites, such as Lekkerkerk in the Netherlands and Love Canal in the USA. Over the next 20 years there was a substantial international effort to develop the tools necessary to understand the significance of contaminated land problems and deal with them. There was a high degree of international co-operation through collaborative projects funded by the EU, and conferences and exchanges supported by NATO. Two broad concepts emerged: the use of risk assessment to determine the seriousness of the problems, and the use of risk management to mitigate problems found to be significant. For a risk to be present there needs to be a source (of hazardous contamination), a receptor (which could be adversely affected by the contamination) and a pathway (linking the source to the receptor). A receptor might be human health, water resources, a built construction, ecology or the wider environment. In the UK this combination of a source–pathway–receptor is referred to as a pollutant linkage (see **Figure 1**).



▲ **Figure 1: Illustration of a source-pathway-receptor pollution linkage**

Risk assessment focuses on identifying which combinations potentially exist, and if so whether they are likely to be significant (i.e. cause harm). Risk management focuses on breaking the pollutant linkage, either by controlling the source (e.g. extracting the contamination from the subsurface); managing the pathway (e.g. preventing migration of contamination); protecting the receptor (e.g. avoiding sensitive land uses) or some combination of these components. The terms remediation and risk management are now largely synonymous. Around the millennium these broad concepts were crystallised in Europe as risk-based land management by a collaborative European project called CLARINET (Contaminated LAnd Rehabilitation Network for Environmental Technologies), and in the USA as risk-based corrective action by ASTM International (the US equivalent of the BSI).

In terms of sustainable development, contaminated land remediation was generally recognised to be a positive step, almost automatically considered sustainable. It brought land back into use, dealt with pollution problems and reduced development pressures on greenfield sites. In some countries, such as the UK, there was an idea that remediation should not take place without some regard to its costs, and frameworks and tools for cost–benefit analysis (CBA) were developed. However, the broader impact of the remediation process itself on environment, economy and society was not a major factor in decision-making. This broader impact was to some extent epitomised by the question of whether it is really worth expending tens of litres of fossil-fuel equivalent to recover 1 kg of hydrocarbon from a tonne of soil. Of course this is an unfair question, as it depends on the level of risk, but its symbolism is important. A more contentious debate currently taking place is whether it is really sustainable to treat land so that the modelled excess lifetime cancer risk to an individual exposed to contamination over a long period is reduced to, say, one in 1,000,000 by using earth-moving equipment where the risk of worker fatality due to workplace accident is, perhaps, one in 10,000 in a working year. This may not be a true comparison of like with like, but illustrates a real difficulty in identifying what is sustainable, which is that the winners and the losers are not necessarily the same. The issue of voluntary and involuntary risk are also relevant in this analysis, as are the fact that the worker gets a direct benefit (a salary) for attending the remediation job, while the individual resident experiences no direct benefit in return for accepting their potential exposure to residual levels of contaminants in the land.

Sustainability has a real impact. An early casualty of the failure to consider sustainability in sufficient depth was the early Dutch policy of multi-functionality. The idea behind multi-functionality was inter-generational sustainability, in other words, if contaminated land was to be remediated it was most sustainable to treat the site only once. Therefore the remediation work should be sufficient to allow any future land use, so that no future remediation would be needed for that site. The multi-functional policy was largely predicated on the idea that contaminated sites were not numerous, but it soon became clear that the economic resources needed could not be sustained by Dutch society, in a country where as much as 10 per cent of the land surface was suspected to be contaminated. Later on the Netherlands, like other countries, took a functional (fit-for-purpose) approach, treating sites only to the extent needed for the next envisaged land use, so that land intended for an industrial land use did not need the same amount of treatment as a garden where food could be grown. Today nearly all countries with a developed policy take a functional approach to setting remediation targets.

So what is the current situation, and what is sustainable remediation? As for risk management, there is a substantial international collaborative effort to improve the sustainability of the approaches to managing contaminated land, with a range of initiatives in the UK, elsewhere in Europe, North and South America, and Australasia. The debate centres on how sustainability benefits can be assessed and maximised and how negative impacts can be avoided or limited. There is a remarkable degree of consensus across these initiatives about what a vision of sustainable remediation might be. In broad terms concepts of sustainable remediation are based on the achievement of a net benefit overall across a range of environmental, economic and social concerns that are judged to be representative of sustainability.

IS REMEDIATION ALWAYS SUSTAINABLE?

It is clear that remediation is actually not automatically sustainable. The cure should not be worse than the illness. Remediation work can have its own environmental consequences, such as the use of resources and impacts on water and air; its own economic consequences, such as on the viability of businesses or projects; and its own social consequences, such as risks to site workers or impacts on road traffic. Remediation clearly can also have direct benefits, including the reduction of pollutant loadings in the environment; the protection of human health and the enabling of new economic use of land. It can also have wider benefits, including an uplift in surrounding property values, resource recycling or the creation of new public amenity. What is clear is that the balance of consequences is highly site specific and project specific, and also that it is often linked to the project or business goals that require the remediation to take place. For example, for a site regeneration project involving new buildings and new construction, early consideration of sustainability can have a major effect on reducing negative consequences by avoiding unnecessary use of energy and material and financial resources through carefully integrating remediation and regeneration design.

Various international initiatives are developing tools so that sustainability in remediation can be assessed, managed and enhanced. The EU-funded HOMBRE (HOlistic Measurement of Brownfield Regeneration) project has a particular focus on developing synergies between brownfield regeneration and other environmental services, to improve the sustainability of remediation and regeneration. Examples include combining groundwater treatment with in-ground heat storage, or the production of biomass from land areas undergoing rehabilitation. The EU-funded Greenland (gentle remediation of trace element contaminated land) project is investigating how plants and other low-input approaches to remediation can improve sustainability in remediation.

The Sustainable Remediation Forum in the UK (SuRF-UK) has been enormously influential in this debate, and has already produced a framework and tools to support decision-making in a way that ties in well with existing good practice guidance for risk assessment and management. Currently, SuRF-UK is working to extend this by providing case studies and practical guidance for sustainability assessors. The framework advocates a tiered approach to the assessment of sustainability and emphasises that the decision-making effort should be proportionate, with decisions based on the simplest approach that demonstrably provides a robust outcome. .The assessment tiers can range from simple qualitative appraisal, through multi-criteria analysis, to more complex assessments such as monetised CBA.

CBA is a powerful tool that allows the direct comparison of very different impacts using a common denominator that everyone is familiar with – money. However, conventional CBA approaches are limited in that only a few of the key sustainability indicators that should be assessed as part of a sustainability appraisal can be easily monetised. Economic indicators are relatively straightforward and a number of environmental impacts, such as carbon dioxide emissions, groundwater resources and habitats, can be ascribed a range of monetary values. However, the monetisation of other environmental indicators and the majority of the potential social impacts are not usually possible so these are often excluded by practitioners from CBAs.

There is an emerging school of thought that financial quantification can be made, albeit at a high and sometimes crude level, for all social, environmental and economic impacts, and there should be no exclusions from the CBA process (except for factors that are demonstrably irrelevant or unchanged). This theory is based on the application of values rather than direct measurable financial costs. Examples of this have abounded in financial accounting for many decades in measures of goodwill, commonly referred to as brand value and reputation. All of these remain broadly intangible, but are clearly well understood by markets and investors when placing a valuation on a company based on its share value – itself a function of many direct and indirect costs. Potentially the same principles can be applied during CBA for a remediation project to test its sustainability in terms of the value it may create or destroy for participating companies, rather than focusing on a strictly monetised approach. HOMBRE seeks to apply this kind of a wider value-based approach throughout the urban land cycle as a tool for managing sustainable urban development and providing robust and long term solutions to problems of dereliction. **ES**

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