ASSESSING THE WIDER ENVIRONMENTAL VALUE OF REMEDIATING LAND CONTAMINATION

R.P. Bardos[1], T.E. Kearney[2], C.P. Nathanail[3], A. Weenk[4], I.D. Martin[2]

[1]r[3] Environmental Technology Ltd
P.O. Box 58, Ware, SG12 9UJ, UK
[2]Environment Agency, National Groundwater and Contaminated Land Centre
Olton Court, 10 Warwick Road, Olton, Solihull, B92 7HX, UK
[3]School of Chemical, Env. and Mining Engineering, University of Nottingham
Nottingham NG7 2RD, UK
[4]Novem b.v.
P.O. Box 8242, NL-3503 RE Utrecht, The Netherlands (work carried out at TNO MEP, Appeldoorn, The Netherlands

Key words: brownfields, contaminated sites, decision making, decision support, environmental impact, industrial sites, remediation, remediation efficiency, sustainability

Summary

The aim of this paper is to consider qualitative and quantitative approaches for assessing the wider environmental value of remediating land contamination. In terms of the environmental element of sustainable development, a remediation project's overall environmental performance is the sum of the environmental elements of the core and non-core aims of a remediation project. The core aims are those fixed by the primary drivers and constraints of the project. Non-core performance is related to wider environmental, economic and social impacts and benefits. Wider environmental effects might include a variety of components within categories such as: aggravation factors, air and atmosphere; water function, ground function; legacy; resource and energy utilisation; and conservation.

1 Introduction

In the UK the goals for sustainable development have been described by Government (DETR 1998 and 1999) as:

- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources; and
- Maintenance of high and stable levels of economic growth and employment.

Underpinning these objectives are three basic *elements* to sustainable development: economic, environmental and social. Any overall sustainability appraisal must consider the economic, environmental and social elements of a project together (UK Round Table 1997).

Remediation of contaminated sites is carried out to enable redevelopment and to reduce risks to human health, surface and groundwaters, ecosystems and building materials. As well as achieving these "core" goals remediation processes ideally need to be sustainable, i.e. they must not lead to unacceptable environmental harm, make excessive demands on resources nor have any significant deleterious social or economic consequences.

The broad themes of this paper are:

- An overview of current practice in assessing the wider environmental effects of remediating contaminated land;
- The role of assessment of the wider environmental effects of remediation in the broader context of selecting appropriate remediation for a site;
- Issues for developing a framework for the assessment of the wider environmental effects when remediating contaminated land.

2 Current Approaches for Assessing Wider Environmental Effects

A number of tools are available for assessing the wider environmental effects of large projects in general, such as environmental impact assessment and best practical environmental option. However, these approaches may not be entirely appropriate for remediation projects, which are cost constrained and of limited duration and size. There are relatively few techniques reported in the open literature specifically intended for considering the wider environmental performance of remediation, and none are in frequent use. However, their development has stimulated a wide ranging debate about the wider environmental effects of remediation work. Published techniques include:

- A procedure developed by Scottish Enterprise (SE) in the broader context of regeneration projects (Curran and Hart 1998);
- The Sinsheim (Germany) assessment of the "secondary effects of remediation" (Bender *et al* 1998);
- German Federal Environment Agency research (Grimski et al. 1998);
- The Dutch *REC* system and its predecessors (NOBIS 1995).

The best known example is the Dutch "REC" approach which derives quantitative indices for "*r*isk reduction", "*e*nvironmental merit" and "*c*ost".

These assessments have a common approach which is the integration of a range of individual environmental criteria or attributes into more easily used decision-

making knowledge. The assessments use different combinations of qualitative methods; semi-quantitative methods; and formal quantitative approaches using life cycle analysis (LCA) or cost benefit techniques to derive simplified rankings or "scores". These can then be used in decision making tools such as: decision tables/matrices; multi-criteria analysis (MCA); or as single indices. Such indices are intended to convey a single measurement for wider environmental effects (Bardos et al. 1999a).

A number of problem areas were identified during the review for quantitative assessments. In brief these include (1) their diminishing ability to make a calculation for less tangible effects, such as landscape degradation compared with measurable effects such as those that can be related to regulations and guidelines; (2) the cost of the work necessary in developing the supporting data for implementation of an LCA based technique, compared with its added usefulness over a qualitative method. (3) a fear that numerical indices might attract a "currency" of their own, removed from the qualification and limitations of their derivation; and (4) the possibility of subjective judgements being masked as calculated values.

3 Assessing Wider Environmental Value in the UK

As part of this project, a workshop was held to consult with a representative group of different stakeholders in the UK about their views on best way forward for considering the "wider environmental value" (WEV) of remediation. The workshop favoured qualitative over quantitative assessments, which were felt unduly onerous in most cases. However, quantitative methods could have a role in specific situations where decision making was difficult.

Consequently the project focused on the use of a qualitative approach to the assessment of WEV. The difficulty with such an assessment is in achieving objectivity. Different stakeholders are likely to perceive environmental values in different ways. Dealing with this issue, is one of the drivers for the use of LCA techniques. However, use of LCA is a specialised business that may make decision making more opaque to some stakeholders, even if putatively more objective. In that case the benefit of objectivity is likely to be lost. Rather, collecting the input of different stakeholders could be used as a means of gaining a degree of objectivity, at least in the context of decision making for a particular project.

One possible qualitative approach is to consider WEV in a way that makes use of the views of different stakeholders. Three features of this approach are (i) its use of layered sets of choices to remove potential decision making conflicts, (ii) the recording of these choices as individual rankings which are combined to

provide an overall ranking at the end of the assessment process; and (iii) and consulting more than one stakeholder to gain a degree of objectivity in the rankings. The general assessment steps identified by the project team as a framework to assess WEV are presented in Tab. 1.

Stakeholders who might be involved (or wish to be involved) in decision making might include: land owners/problem holders; regulators and planners; site users; those with a financial connection to a site; the neighbours to a site including the local community; the consultants, contractors, researchers and vendors involved in designing and implementing the remediation. In some cases campaigning organisations and pressure groups may also seek involvement. Involvement of all of these groups could impede decision making both in terms of time taken and cost. Consultation of all stakeholders would be too onerous an undertaking for routine decision making based on WEV.

Conversely, stakeholder involvement in decision making underpins achieving sustainable development (UK Round Table 1998). In addition, in terms of environmental impacts, perceptions may be as important an influence as measured or calculated effects. Perceptions are likely to vary between stakeholders. What is needed is some means of finding a balance between a need for objectivity/accommodating different views and practical decision making.

Tab. 1. Proposed Steps in Making an Assessment of Wider Environmental Value

Step	Action
1	Determining the objectives of the assessment
2	Identifying the stakeholders for consultation
3	Determining the scope of the assessment (i.e. which components should be included and their basis for assessment)
4	Determining the boundaries for the assessment
5	Making a comparison of WEV for shortlisted remediation techniques (using an MCA approach)
6	Refining comparisons and testing sensitivity to changes in input values
7	Interpretation

4 "Core"/"Non-core": a Framework for Considering the Wider Environmental Effects of Remediation

Remediation of contaminated sites occurs as a result of specific needs, including; managing identified risks, enabling re-use of land, and/or reducing longer term liabilities. Usually a number of stakeholders (e.g. client, consultant, contractor and regulators) are involved in the decision-making process about what remedial works will be carried out. The possibilities for remediation are

subject to a number of constraints on what can be done, for example: the site's location, site specific factors in particular the exact nature of the contamination problem and its risk assessment, community considerations, environmental impacts, cost, time available, space available for remediation works and the availability of suitable remedial techniques.

The specific objectives for any remediation project therefore arise from a combination of the need to address specific project drivers, a series of specific constraints, and the involvement of a number of stakeholders in the decision making process. In practical terms these objectives constitute the *core* of a project. However, not all of the individual environmental, social or economic impacts that might be considered under the broad ambit of a sustainability appraisal are necessarily considered at this time.

A key question is, therefore how best to include the broad ambit of sustainability appraisal options within contaminated site decision making on a consistent basis for all sites. This question was one of several issues considered by the project workshop where it was agreed that "forcing" the discussion of the full range of possible sustainable development issues during the core decision-making process would not be justified. It was considered that the incremental benefit of such discussion would be small in comparison to its possible detrimental impacts. Risk management and the return of brownfield land to suitable use were seen as the key objectives and benefits of remediation. It was recognised that these objectives might be reached in different ways, each with different "sustainability" impacts. However, the added "environmental value" of always selecting the optimal route in terms of sustainable remediation was not felt to justify, either the cost of such considerations during "core" discussions, nor the risk that this added burden might reduce the attractiveness of brownfields redevelopment in a general sense.

It is possible to resolve this conflict between the need for consistent consideration of sustainability issues and not over burdening the core decision making process. Good practice in the UK and other countries provides clear risk management goals and a shortlist of potentially feasible remedial techniques as a basis for determining future actions. One view is that these are the *outputs* of the "core" decision-making process. This short-list of potentially feasible techniques may then be considered more closely. In particular techniques can be compared with each other against a range of sustainability appraisal criteria, which the workshop described as the "non-core" considerations. These considerations could be used to refine the shortlist of remedial techniques. In extreme cases, these non-core considerations may flag any unanticipated and potentially severe impacts that might lead to a re-evaluation of the core goals of a remediation project.

5 Assessing Wider Environmental Value

For Wider Environmental Value (WEV) to be a useful tool in refining a shortlist of potential remedial options, it must have a well defined scope agreed by all stakeholders. Three issues are important:

- Components: the individual environmental effects that may be combined into a single assessment of wider environmental value. Examples might include impact on soil function, impacts on water, legacy and others.
- Boundaries: the limits set on the assessment, for example in terms of time periods, geographical extent or the scope of the project; and
- Method of determination (as discussed in Section 3).

5.1 Components

Bardos *et al* (1999) identified a large number of possible environmental effects that could be considered within an assessment of WEV. These effects were grouped into the following themes;

Aggravation factors: considers environmental impacts which could have a direct and noticeable effect on some stakeholders. In some cases this effect may be more perceived than actual.

Air and atmosphere: considers those impacts on air quality and atmosphere function of emission due to operating the remediation process.

Water function: considers the effects of remediation emissions to surface and groundwaters, although for coastal locations, impacts to estuarine waters should also be considered.

Ground function: considers impacts on the solid subsurface, including impacts on soil water content. Impacts considered include toxic effects, mechanical impacts and changes in soil/ground function.

Legacy: explores how remediation processes vary in their ability to offer a permanent solution to contamination removal and improvement of land quality and to evaluate their long term impact on the site and the surrounding ecosystems.

Resource and energy use: considers the "costs of production" in non monetary terms of a remediation scheme. It is separate from other themes, e.g. legacy, both to make its consideration intuitively clearer, and also because the UK Government approach to sustainable development considers resource utilisation as a discrete issue (as noted in Section 1).

Conservation: explores the impact of remediation work on ecosystems and features of the environment valued by the community.

5.2 Boundaries

Defining the goals of a WEV assessment may appear to be simple at the outset, but it is important to ensure that like is being compared with like. The difficulty is in agreeing the scope of the processes or project under consideration, and its the constituent parts. Whether the assessment of WEV is qualitative or quantitative, the approach provided by LCA, may be useful in defining boundaries such as the practicality of the assessment; defining the environmental system under study; the environment; and other inter-related systems (van den Berg et al. 1995).

For example, a comparison of the wider environmental effects of a remediation based on excavating and disposing of materials to landfill with, say, soil washing might be significantly affected, depending on whether or not the impact of the soil washing operation on the overall site management was considered. Consider a case where 50 % of the excavated material could be dealt with by a specified treatment. If the comparison focuses only on the 50 % treated in the treatment plant it will ignore the wider impacts of the treatment component on the broader project, such as management of stockpiles, excavation and transport. These wider impacts may themselves have significant environmental effects and be substantially different for the removal only, and removal plus soil washing options.

Perhaps the most obvious way of ensuring that such questions are addressed equally for each option is to consider the remediation works as an integrated solution for each option. In this case the comparison would be made on all processes required for treating 100 % of the contaminated material rather than comparing options which treat differing proportions of the total material.

6 Conclusions

A wide range of environmental effects may be considered as components for assessing the wider environmental value of remediation, some of which may not be readily measurable. A key step in making any assessment is the setting of robust, logical and defensible boundaries. A range of qualitative through to quantitative approaches exist for using these components and boundaries to make an assessment. At this point in time no approach appears to have a clear advantage. A critical factor is the cost and effort of making the assessment, set against its practical value in contaminated land decision making. Equally important is the need to set the assessment of wider environmental effects in a broader context that considers: the impact of using the assessment (e.g. its costs and complexity) on brownfields re-use; its relation to, and integration with other decision-making considerations (e.g. remedial objectives and costs and benefits).

References

Bardos, R.P., Nathanail C.P., Weenk, A. (1999) Assessing the Wider Environmental Value of Remediating Land Contamination, A Review. R&D Technical Report P238. Environment Agency R&D Dissemination Centre, c/o WRc, Frankland Road, Swindon, SN5 8YF, UK

Bender, T., Volkwein, S., Battermann, G., Hurtig, H. W., Klopffer, W., Kohler, W. (1998) Life cycle assessment for remedial action techniques: Methodology and Application. 367-376 in Contaminated Soil '98, Thomas Telford. ISBN 07277 26757.

Curran, J., Hart, I. (1998) Sustainable redevelopment: Incorporation into project design. 201-207. In Land Reclamation Achieving Sustainable Benefits. Proc. 4th Intern Conf. Intern. Affiliation of Land Reclamationists. Nottingham, UK, 7-11 Sept 1998. Pub Balkema, ISBN 905809002 7

Department of the Environment, Transport and the Regions (1998) Opportunities for Change. Consultation Paper on a Revised UK Strategy for Sustainable Development. 97EP0277, DETR, PO Box No 236, Wetherby, L23 7NB

Department of the Environment, Transport and the Regions (1999) A Better Quality of Life: A Strategy for Sustainable Development for the United Kingdom. CM 4345. Stationary Office

Grimski, D., Doetsch, P., Rupke, A. (1998) Brownfield versus Greenfield sites under economic and long term environmental considerations. 651-660 in Contaminated Soil' 98, Thomas Telford. ISBN 07277 26757

NOBIS (1995) Risk Reduction, Environmental Merit and Costs. REC-Method, Phase 1. Document 95-1-03, CUR/NOBIS, Gouda, The Netherlands, tel. +31 182 540680

UK Round Table on Sustainable Development (1997) Second Annual Report. March 1997, DETR, PO Box No 236, Wetherby, L23 7NB

UK Round Table on Sustainable Development (1998) A Stakeholder Approach to Sustainable Business. UK Round Table on Sustainable Development, Ashdown House, 123 Victoria Street, London, SW1E 6DE

van den Berg, N. W., Dutilh, C. E., Huppes, G. (1995) Report 9453, Beginning LCA; A Guide into Environmnetal Life Cycle Assessment. NOVEM National Reuse of Waste Research Programme, Centre of Environmental Research, Leiden. ISBN 9051910886