HOW TO IMPLEMENT SUSTAINABLE REMEDIATION IN A CONTAMINATED LAND MANAGEMENT PROJECT?

NICOLE SUSTAINABLE REMEDIATION WORK GROUP 2012 REPORT

AN INTRODUCTION

In September 2010, NICOLE's Sustainable Remediation Work Group (SRWG) published a Road Map to Sustainable Remediation, which was the primary deliverable of a two-year project. These chapters provide the background context and the full technical details for this project.

Over the past decade, good practice for contaminated land management has been based on assessing the risk to human health, water, buildings and the wider environment. Increasingly, professionals working in the contaminated land management (CLM) sector recognise that sustainability considerations are a key factor in holistic solutions for contaminated land management. The need for considering sustainability in contaminated land decision-making was recognised more than ten years ago by the CLARINET network. The risk-based land management approach (RBLM) elaborated by CLARINET in 2002 included several sustainability concepts (Vegter *et al.* 2002). It is now widely acknowledged, in and beyond Europe, that a more comprehensive approach to remediation projects should incorporate sustainability principles – integrating environmental, social and economical aspects (as described by the Brundtland Report, 1987).

In 2008, NICOLE launched a working group to assess the application of sustainable principles in remediation projects and to investigate how these principles could be developed and promoted.

From the outset, the NICOLE Sustainable Remediation Work Group has recognised the need to tackle this new and complex concept from a set of underpinning principles. Five key principles were developed which then structured the project work:

- **Communication** is the primary barrier and enabler of sustainable remediation (SR). Implementing a SR approach requires building trust between stakeholders ideally from the outset. Our community of practitioners has great experience in technical solutions but can be hesitant in determining when and how best to seek dialogue. However, good communication is crucial for defining a common understanding of a Sustainable Remediation management plan that is accepted by the main stakeholders.
- Risk based land management (RBLM) reflects current best practice for contaminated land management, and conceptually has a strong synergy with sustainable remediation. Indeed, inappropriate use of soil and water quality criteria is neither consistent with RBLM nor sustainable remediation. For example an overly precautionary or conservative approach to criteria, particularly where applied in a generic way, may lead to unnecessary environmental, social and economic burdens as a result of inappropriate and inflexible remediation requirements[1].

[1] Specific guidance on risk assessment and the precautionary principles can be found in Guidance on Risk Assessment and the Use of Conceptual Models for Groundwater, in Common Implementation Strategy for the Water Framework Directive, 2000/60/EC, guidance document n° 26, or the EU's Communication on Precautionary Principle, 2 February 2000, www.gdrc.org/u-gov/precaution-4.html).

- Experience in the use of **socio-economic factors** in contaminated land decision-making is only at an emerging stage and many practitioners may require support and guidance in their application in contaminated land decision-making. The choice of factors to consider and their use is important to the success of a SR project and a greater shared experience in practical case studies is needed.
- Demonstrating the practical delivery of sustainability performance by a SR project is a critical success factor to build trust among stakeholders. Therefore an important aspect of SR is how to **measure sustainability** during a remediation project with buy-in from stakeholders.
- Finally, and associated with the first item on Communication, a practitioner-led "bottom-up" approach is seen as the most efficient way to promote SR in Europe. A vital requirement for this is to start compiling **Case Studies** to share experience in applying SR, both to provide practical examples of the "added value" of SR, and to support the development of better decision-making methodologies.

Five sub-groups; Communication, Risk Assessment, Economics and Tools, Indicators and Case Studies were formed to address each of these five topics.

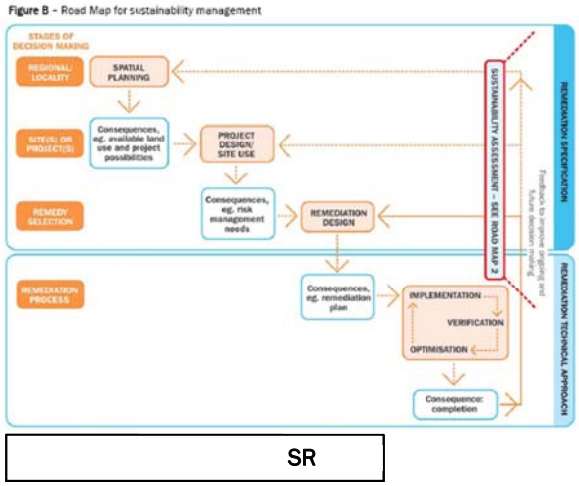
After two years of work and networking with other international organisations, the outcomes of this project are described in a series of interrelated documents. These are provided to the professional community with the objective to assist any stakeholder involved in a contaminated land management project, of any size, in the implementation of sustainability into their project.

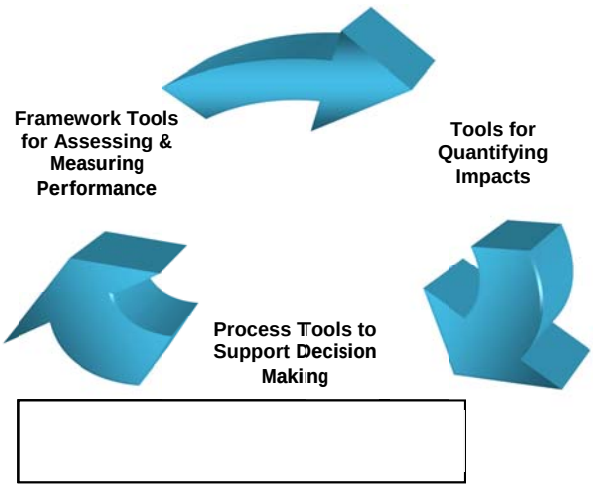
- The "**Road Map for Sustainable Remediation**". A concise four-page document that introduces NICOLE's vision of SR and the necessary steps and principles to implement a successful, sustainable remediation project.

  The NICOLE Road Map was finalised and published in September 2010 and was first introduced during the CONSOIL 2010 conference in Salzburg.

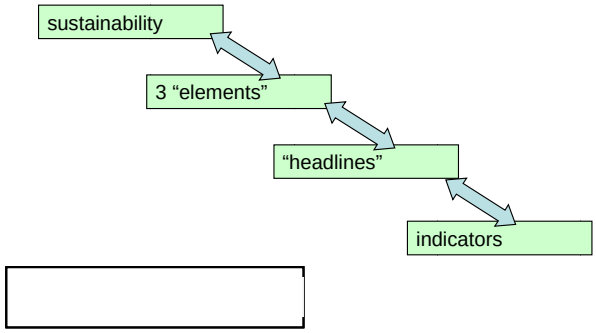
- The document "**Integrating Risk Assessment and Sustainable Remediation**" focuses primarily on the challenges of integrating sustainability into a risk-based approach and presents NICOLE's position on this topic.

- The document "**Economics and Tools**" reviews the economic aspects associated with SR and provides an overview of tools available on the market to assist with such analysis. Note that these tools are in constant development and this first overview presents a snapshot of the State of the Art as of December 2010.





- The "**Sustainable Remediation Indicators**" document provides guidance on how to measure the Sustainability of a SR project, and on the indicators that are currently being considered. This topic is also in constant discussion and this document presents a status of best practices as of May 2011.



Dissemination and perspectives

During this 2-year project, the work of NICOLE's SRWG was presented on a number of occasions at workshops and conferences:

- NICOLE Workshop on Sustainable Remediation in Leuven, June 2009
- Copenhagen Green Remediation conference in November 2010
- CONSOIL September 2010 conference in Salzburg, with a poster presenting the newly published Road Map for Sustainable Remediation

In 2011, NICOLE's SR work group activities focuses on testing the Road Map for SR on a number of cases with a plan to report back to the wider community of practitioners in 2012. For this purpose, NICOLE currently collecting and compiling case studies on SR projects with the objectives of building a data base of demonstration projects, and of validating the robustness of the SR approach in contaminated land management. If warranted, based on the feedback, the Road Map will be updated.

Acknowledgements

The documents published with this project are the result of the work of all members of NICOLE's SRWG, with particular contributions by the leaders of each sub group: Communication – Lucy Wiltshire (Honeywell) and Olivier Maurer (CH2M HILL); Risk Assessment – John Waters and Alan Thomas (ERM), Economics and Tools – Sarah McKay and Richard Clayton (WSP), Indicators – Paul Bardos (r3 Environmental Technology Ltd), Case Studies (Lucy Wiltshire (Honeywell) and Markus Ackermann (DuPont)).

The NICOLE SRWG work products have benefited greatly from intensive networking and generous input from other organisations and think tanks, in particular SuRF UK, Eurodemo*plus*, Common Forum, and a number of NICOLE's members. We want thank for their direct contribution in this document: Anja Sinke (BP), Corinne Merly (BRGM), Nicola Harries (CL:AIRE & SuRF UK), Thomas Mezger (AkzoNobel), Jonathan Smith (Shell), Frank Evans (National Grid), Johan De Fraye and John Lovenburg (CH2M Hill), Laurent Bakker (Tauw), Hans Slenders (Arcadis), Frank Westcott (RSK/Eco-Bos Development), Kristian Kirkebjerg and Arthur de Groof (Grontmij), and Common Forum members who reviewed the document (Dominique Darmendrail/BRGM France, Birgitta Beuthe/Spaque Belgium, and Dietmar Mueller/ UBA Austria), This debate is not over as we have open questions to address. But the main principles developed from this project have drawn, we believe, sufficient consensus to now seek a Joint Position with other networks working on Sustainable Remediation, and promote sustainable practices in our professional community.

Finally, this work would not have been possible without the continuous support of NICOLE's Steering Group.

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NICOLE SUSTAINABLE REMEDIATION WORK GROUP

2012 Report

INTEGRATING RISK ASSESSMENT, RISK MANAGEMENT AND SUSTAINABLE REMEDIATION

This Chapter was produced by the risk assessment and sustainable remediation sub group and is the product of a literature review and a questionnaire survey of NICOLE members. Risk assessment is a term that is multifaceted in use – it can be used as a strategic approach to support environmental governance, or as a specific tactical methodology or tool for assessing hazards (Edson Jones, 1995). In the context of this work a number of definitions developed by NICOLE (NICOLE 2002) were adopted:

- Risk assessment is concerned with defining the potential consequences of an activity and defining the probability that this could occur
- Risk management is taking courses of action that mitigate identified risks for specific circumstances taking into account factors such as the severity of the consequence, the ability to recover from the consequence, and the likelihood of success and its benefit.

Risk based land management (RBLM) describes how risk assessment and risk management can be applied at a site specific level to optimise contaminated land management decision-making – see box below. While there is a professional and technical consensus that supports RBLM, it has yet to be fully implemented into policy in a number of Member States. In a number of jurisdictions numerical criteria and guidance, ostensibly related to risk assessments – usually generic – are applied to contaminated land decision-making in a way that is not fully consistent with RBLM, or in some cases quite inconsistent.

Risk Based Land Management

In an influential report CLARINET concluded that contaminated land management decision-making needs to consider three main broad issues: (1) fitness for use, (2) protection of the environment and (3) long-term care (Vegter *et al.* 2002). The first two describe goals for safe use of land, including prevention of harm and resource protection. The third allows for a more rigorous assessment of the way in which these goals are achieved, to ensure that it is a sustainable way. The three components need to be in balance with each other to achieve an appropriate solution. CLARINET called this concept *Risk Based Land Management* (RBLM). RBLM is primarily a framework for the integration of two key decisions for remediation of contaminated land:

- The time frame: this requires an assessment of risks and priorities, but also the consideration of the longer term effects of particular choices.
- The choice of solution: this requires an assessment of overall benefits, costs and environmental effects, value and circumstances of the land, community views and other issues.

These two decisions have to take place at both an individual site level and at a strategic level, especially as the impact of contaminated land on the environment can have not only a large scale regional dimension but also potentially wide ranging long term impacts.

Background status of sustainability in risk-based policies

The risk-based approach to management of contaminated land provides a framework within which all industries are able to address the legacy of contaminated land (NICOLE, 2002). Risk-based policies are common in both EU Directives and the national legislations of European Countries, and in its White Paper the US-based sustainable remediation forum (SURF) noted that risk assessment is applied in some form or another at virtually every large or complex remediation site (SURF US, 2009). It is pivotal in determining the degree of remediation required and therefore is critical in sustainable remediation.

The link between sustainable development and risk management was first formally recognised by CLARINET in 2002, where it was concluded that 'sustainable development and risk management have

to be considered in a mutual and holistic way' and that the use of the risk-based land management concept would enable a wider perspective in identifying sustainable solutions (CLARINET, 2002).

CLARINET went on to say that sustainable solutions could be achieved by balancing the three main components:

- fitness for use;
- protection of the environment; and
- long term care.

Indeed in the context of RBLM, risk-based decision-making should be consistent with some of the goals of sustainable remediation as it offers protection of human health and the environment, guides allocation of resources, and enables management of risks in a cost effective way. Risk-based approaches (that are, in a number of countries, linked to brownfield development and the reuse of land) are seen as inherently sustainable, though this may not necessarily be the case.

NICOLE's members' view on the relationship between sustainable remediation and risk assessment

Currently, there remains uncertainty about the exact relationship between sustainable remediation and risk assessment / risk management. Table 1 indicates the outcome of a questionnaire response prepared as part of the NICOLE Sustainable Remediation workgroup.

Table 1 – Summary of NICOLE questionnaire responses

	Belgium	Czech Republic	France	Germany	Italy	Netherlands	Sweden	UK3	UK2	UK1	UK	USA
Is risk assessment and risk based remediation decision making accepted and used in practice? If not, why not?	1	1	1	2	2	1	1	1	1	1	1	4
can the approach or conservatism of input parameters to human health or ecological risk assessments be modified by sustainability issues?	4	3	2	-	-	3	Yes	3	Yes	3	4	-
is there a conflict between site specific risk assessment based on existing or future land use and sustainability ?	No	Yes	No	-	-	No	No	Yes	No	-	Yes	-
is sustainability only considered once the risk assessment is complete? If so, how	1	3	-	-	-	No	No	Yes	Yes	No	Yes	-
can sustainability principles be applied to remediation option appraisal?	-	-	-	3	3	No	-	Yes	-	-	-	-

Rating	Meaning / Description
1	It is widely accepted and recognised in regulation and practice across the country
2	It is included /allowed for in the country's legislation / regulation but is not applied by practitioners, organisations or regulators.
3	internal decision making and in developing a qualitative discussion with regulatory bodies.
4	It is not used and not applied in country's regulations / legislation or by practitioners.

Notes Responses are from NICOLE members
More than one response was recieved from some countries

Poor consistency in the use of risk assessment and of sustainability

The results of the questionnaire suggest that while there is widespread recognition and use of risk-based approaches to contaminated land management in Europe, how these are applied varies and there is much less consistency in the use or formal recognition of the relationship between risk assessment, risk management, and sustainability.

Strong dependencies on existing policies and regulations

From the results of the survey, it appears that the potential for interaction between sustainable remediation and risk assessment as practiced (as the basis for deriving/predicting risks and back-calculating remedial standards) depends on the existing policies and regulations by which risk assessment is implemented in any given regulatory setting and in particular, whether there is a broader opportunity for iteration between the process of risk assessment and risk management in the context of a broader risk based land management policy.

Where risk assessment is undertaken as a discrete process within the context of fixed or prescriptive guidelines, then the opportunity for interface between risk assessment and sustainable remediation is decreased. This approach is not only inconsistent with RBLM but also has the consequence that the potential to incorporate sustainable remediation principles is limited to evaluating the relative merits of

various technologies to meet the outcome of the risk assessment process as a 'fixed' goal rather than in questioning the goal itself through a site specific assessment or wider options or solutions.

When risk assessment is undertaken in the context of a RBLM framework. This involves a site-specific tiered approach. In this situation then there would appear to be the opportunity to consider options and potentially incorporate sustainability considerations between the iteration between the risk assessment and risk management process at each tier. Such methodologies exist in a number of European countries, but not all. In theory it allows for increasing complexity in the risk assessment process with a range of potential outcomes before committing to a specific risk management plan.

Historically a range of metrics have been used in the options appraisal process within risk management, and the incorporation of sustainability as a metric would be consistent with the overall process. For example the IRGC (International Risk Governance Council) includes sustainability as one of its key criteria in its assessment of risk management options (IRGC, 2005). More commonly, the incorporation of sustainability is less explicit.

The conclusion of the above analysis is that while RBLM theory is consistent with sustainable remediation (with protection of human health and the environment a key element of sustainable remediation), the degree to which the opportunity for real integration between the two occurs in practice is dependent upon the degree of completeness with which the RBLM framework is implemented within a given country. A risk based land management type tiered and iterative approach to risk assessment offers the opportunity to integrate risk assessment and sustainable remediation with no erosion of the fundamental principles used in risk assessment. Such an approach has been adopted in one published example of a sustainable remediation framework (Illinois Bureau of Land, 2009) and this approach should be highlighted and encouraged further.

Overly conservative approach of risk-assessment versus overall objectives of SR

An alternative perspective on the relationship between risk assessment and sustainable remediation is that risk assessment process itself is overly conservative and therefore contrary to the overall objective of sustainable remediation. This perspective was highlighted in the recent SURF white paper as follows:

"*the risks associated with many sites are relatively small, pertain to a small population, and/or are speculative to hypothetical in nature…. a far greater risk of significant injury and even fatality exists for remediation workers and impacted community (e.g., truck accidents on the open road). These risks are not given proper consideration in remediation decisions*". (SuRF USA, 2009)

This issue has been the subject of much debate, including at CONSOIL since 2003, and was demonstrated by a case study at the NICOLE conference on sustainable remediation presented in Leuven (June 2009) in which a calculated road fatality rate of 1:100 for a given remedial option was compared with the 1:1,000,000 risk of contracting cancer that was the basis of the remediation scope (Wallace, 2009a). Whilst the nature of these risks is different and are complicated to compare, such examples provoke a number of responses including whether in such cases the risk assessment is overly conservative? Should risks from contaminated land not outweigh risks from remediation or impacts? And whether as a result the incorporation of sustainability, some of the input assumptions of the current practice of QRA would be challenged?

At present there are no simple answers to the above, the relative perception of various forms of risk is a highly complex process influenced by a number of variables that govern the 'tolerability' and acceptability of various risks (IRGC, 2005) and direct comparisons of relative risks may not be valid. The points made do however appear to have some validity even where the incorporation of site specific data in a risk assessment has been included to the extent possible. There is some recognition that a balance exists between the degree of reasonableness and acceptance of a given risk with the sustainability of a given solution (Wallace, 2009b). Comparative risk assessment may offer some means of evaluating differing risks but is still developing as a practical tool.

Conclusions

- It is NICOLE's view that risk assessment, risk management, RBLM and sustainable remediation should be aligned to help obtain the overall goals of sustainable remediation. Incomplete applications of RBLM can be counter-productive.
- The relationship between the actual practice of risk assessment, risk management and sustainable remediation is currently very different according to the risk assessment and regulatory framework in place within any given country or even region;
- In some countries there are currently regulatory obstacles to effectively align risk assessment and sustainable remediation and perception issues that incorporating sustainable remediation may comprise effective risk assessment, despite the theoretical alignment of RBLM and sustainability
- Site-specific quantitative risk assessment coupled with a risk management process that includes remediation options appraisal offers the best interim opportunity to integrate sustainable decision-making in parallel with risk assessment process and does not comprise the assumptions or quality of the risk assessment;
- Risk assessment can remain inherently conservative. The incorporation of sustainability may lead to questioning of fundamental QRA assumptions & hence difficult choices, but also may encourage more holistic decision-making and more effective risk based land management.

Recommendations

- The relationship between risk assessment, risk management and sustainable remediation should be more clearly stated and incorporated in sustainable remediation guidance;
- Regulators, stakeholders and practitioners should be encouraged to fully utilise RBLM in a complete way so as to offer the opportunity to integrate risk assessment and sustainable remediation and examples published to inform and educate the wider community;
- The relationship between risks posed by contaminated land and risks posed by the act of remediation or contaminated site management should be more closely studied to allow more holistic future policy development.

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NICOLE SUSTAINABLE REMEDIATION WORKING GROUP 2012 REPORT

SUSTAINABILITY ASSESSMENT TOOLS

Introduction

Sustainable remediation presents the remediation practitioner with the opportunity to consider (assess, measure and may be quantify) a broad set of indicators.

There are a wide variety of tools available to support sustainable remediation design and remediation programmes. Unlike deterministic and quantitative tools, such as contaminant fate and transport models or human health risk models, many of these tools are “qualitative” or “semi-quantitative” and subjective in their nature. That is not to say they are limited or inappropriate. They support the remediation designer in incorporating and documenting sustainability within the decision making process. They do however require a different approach.

This paper was prepared following the Sustainable Remediation Working Group meeting at the October 2008 Madrid conference. It is one of four papers linked by the opening introduction chapter and to the NICOLE Sustainable Remediation Road Map (2010). The brief set for the sub-group was:

‘To identify the tools that are available and being used to assess the costs of remediation across Europe, how they incorporate sustainability (if at all) and comment on what these might look like in the future”

The initial brief for the group was to explore Tools and Economics. Following discussions amongst the sub-group and recognition of the wider activities of the Working Group it was concluded that tools for the measurement of sustainability in remediation requires consideration of economic, social and environmental factors which resulted in the initial scope of economic tools to be expanded.

A key part of the work undertaken in compiling this chapter was the NICOLE Questionnaire. A summary of the output and key findings is presented as Appendix A. The questionnaire highlighted the limited knowledge and consideration of social (beyond human health impacts) and economic (beyond cost) indicators, and how these metrics are measured.

Types of tools available to assess sustainability

Tools have various roles in sustainability assessment and management during the life-cycle of a remediation project including:

- predicting and evaluating sustainability impacts of remedies;
- describing, rating and monitoring the status of sustainability in projects; and
- Informing stakeholders and supporting actions.

As displayed in the inner loop of **Figure 1**, sustainability tools available for use throughout that project life-cycle either in planning or implementing the remediation programme include:

- Sustainability frameworks and tools for assessing, rating and measuring performance;
- Tools for quantifying impacts for indicators of sustainability;
- Decision making support tools.

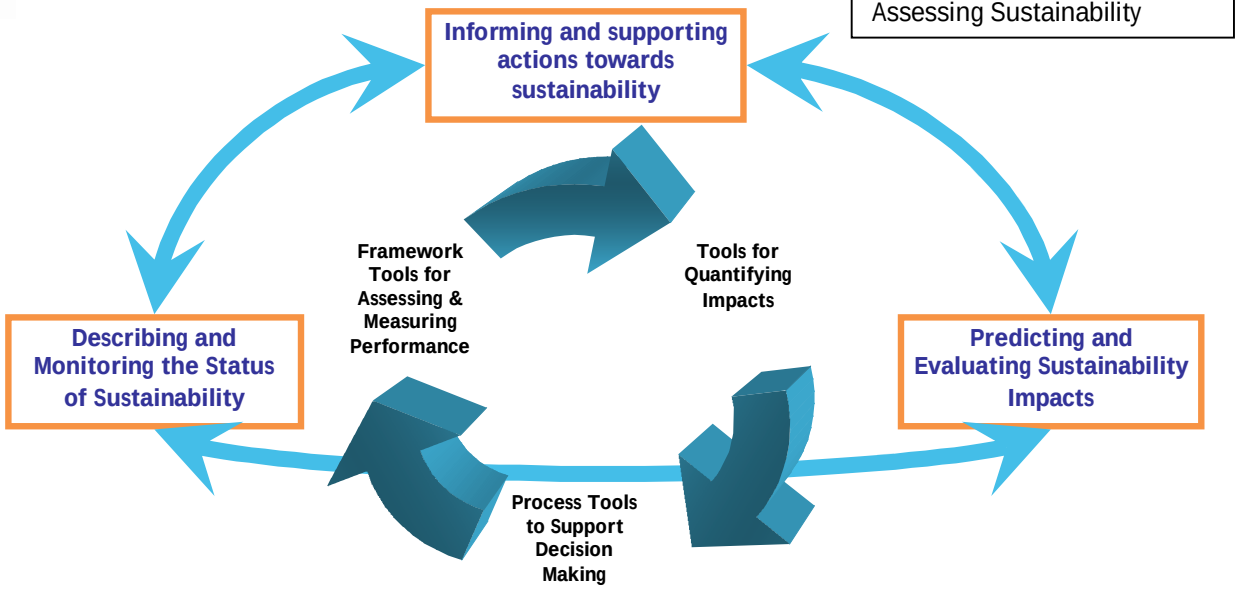

Figure 1 – Tools Available for Assessing Sustainability

The Sustainable Urban Environment – Metrics Model and Toolkits (sue-MOT) Report (BRE 2004, Therival 2004) prepared for the Building Research Establishment (BRE) and the Sustainable Remediation Forum (SuRF) White Paper (SURF USA 2009) provide good reference points for the wide availability and use of tools for measuring sustainability. The SuRF UK framework (CL:AIRE 2010) and the EURODEMO review (EURODEMO Consortium 2007) also provide useful summaries of tools, their scope and limitations.

Figure 2 provides an interpretation of where the working group sees the various tools sitting within the sustainability assessment cycle, although it is noted that not all of these tools could be currently applied to a remediation project.

There are also frameworks such as ROSA, EURODEMO and SuRF UK (CL:AIRE 2010, EURODEMO Consortium 2007, Slenders *et al.* 2005). These are not strictly speaking tools, as they describe a process and provide guidelines within which to operate. They are therefore good reference points to support the compilation of sustainability appraisals (*note that ROSA does not fully address sustainability in its true definition but could be readily adapted or expanded*).

A summary of terms and tools frequently used (both in remediation and wider sustainability assessments) is provided in Appendix B, courtesy of Dr P Bardos.

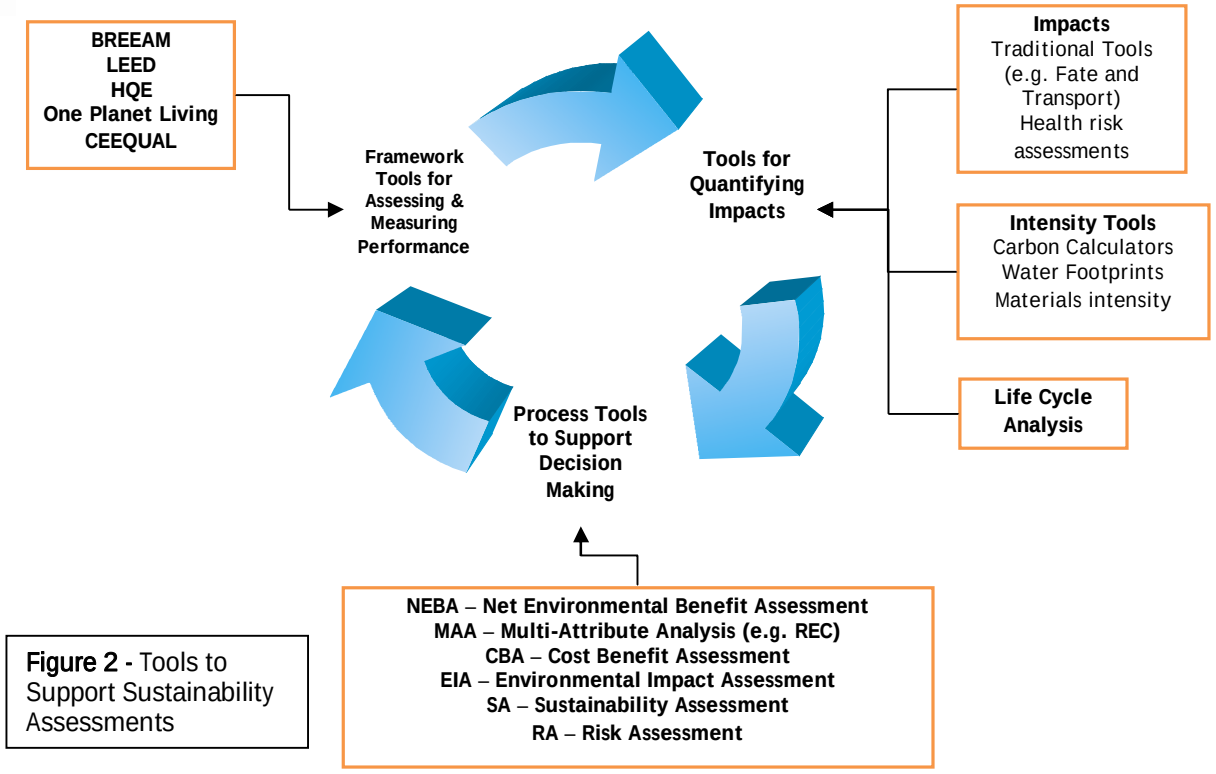

Figure 2 - Tools to Support Sustainability Assessments

Sustainability Framework Tools

In addition to tools and frameworks developed specifically for contaminated land management a wide range of framework tools for assessing (and rating) sustainability have been developed and applied across a range of design, construction and master-planning arenas. They can be applied at the design stage only, design and implementation or even implementation only and these include the following broad categories:

- Sustainable land development - Rejuvenate in the EU for crop systems (Bardos et al. 2011), LEED Neighbourhood, BREEAM Communities)- Newer land development frameworks / rating systems incorporating ecosystem and land sustainability;
- Civil engineering – CEEQUAL has been developed in the UK as a rating system for sustainability in civil engineering projects;
- General sustainability (One Planet Living is a framework being used for the London 2012 Olympics) - This framework includes both indicators and related goals (e.g, zero carbon and zero waste);
- Natural resource (e.g. Environmental Impact Assessments, Natural Capitalism and Natural Step); and
- Green buildings (e.g.; BREEAM in the UK, LEED in the US, HQE in France) - It is important to note that remediation and use of brownfield land are relatively minor components of these green building design scoring systems.

These *framework* tools are specifically UK, US and French examples. However, while compiling this document and the supporting questionnaires returned by practitioners and stakeholders across the NICOLE network (see Appendix B) it became apparent that practitioners limited awareness of these tools and did not recognise many more additional examples or *framework* tools that were applied within the wider European Community.

Such 'sustainability' framework (rating) tools have limitations (such as a fixed scope of metrics and/or indicators) and at present are not applicable for a remediation project as they are primarily for building or construction projects (see indicators chapter for guidance on indicators that need consideration within sustainable remediation). They do however present systematic, and in some cases, simple

frameworks for ensuring that aspects of sustainability are considered within the design and construction/implementation process. In addition, they provide useful pointers to the remediation community on how to develop a similar process. For example:

- Some framework tools consider both social and economic factors within a structured rating/scoring process. The BREEAM Communities scoring criterion (which acts as a checklist for designers) includes headings such as business investment, employment, connectivity, place shaping and community.
-
- A sub-set of the framework tools are sustainability monitoring tools that are specifically developed for large-scale land development programmes (e.g. London 2012 Olympics). These monitoring programmes have used a sustainability dashboard approach to track key sustainability performance indicators during construction and operations to manage and influence on-going programme decisions, increase knowledge about optimizing indicators to develop best practices and policies, and aid in future decision making. The monitoring tools have been coupled with sophisticated multi-attribute models to evaluate the optimum sustainable approaches, balancing trade-offs among criteria for multiple alternatives and help to influence more sustainable behaviours.

Tools for Quantifying Impacts

The Sustainability Indicators section of this guidance document provides a detailed examination of environmental, social and economic indicators that may be relevant for a sustainable remediation project. As an example, these indicators can include:

- Environmental – greenhouse gas generation, resource and materials utilisation and ecosystem impacts;
- Social – Human health and safety, ethical, and community impacts; and,
- Economic - Job creation and property value.

As displayed in Figure 2, a wide range of tools exist for predicting and measuring mainly environmental and human health (social) impacts of remediation projects. For example, this may be achieved qualitatively through the traditional environmental impact assessment approach, or quantitatively using environmental footprint, life-cycle analysis, and/or risk assessment tools. Quantitative tools are regularly used, of course, for quantifying the impacts of contamination on communities and the environment (e.g. cancer risk, fate and transport models).

A number of 'sustainable' remediation-specific tools have been developed, including the U.S. Air Force Sustainable Remediation Tool (AFCEE 2011), together with many consultant-specific tools, all of which focus primarily on the quantification of the environmental footprint of a project using 'eco-intensity' indicators such as carbon, water, waste, materials intensity (see also EURODEMO Consortium 2007). However, care is needed when considering the use of these tools to ensure that there is a match between the considerations they use, and those that might be required by the stakeholders involved in the particular project under consideration. For example, there is limited evidence at present that social and economic indicators (beyond cost, health impacts or health and safety) are incorporated into quantitative models.

Tools to Support Decision making

The types of tools that can be used to incorporate aspects of sustainability into decision making have been summarised by a number of existing papers (see previous references). Emerging tools/approaches include:

- Life-cycle analysis (e.g. ISO standards);
- Net environmental benefit analysis (NEBA) (implementation injury should not exceed that posed by the original release);
- Point scoring systems (e.g., BREEAM, LEED, HQE);
- Cost-benefit analysis (e.g. UK Environment Agency 1999a, 1999b and 2000);
- Multi-attribute analysis i.e. weighting of criteria (such as the ROSA system in the Netherlands, Slenders et al. 2005).

These are, on the whole, established and documented protocols with supporting databases and proprietary software tools. Nevertheless, they are not routinely applied to remedial decision making in the EU and they are not necessarily applicable or appropriate to remediation programmes in their current form (e.g. LEED, BREEAM, HQE).

Where the tools are applied, they are most often performed as a separate analysis in parallel with traditional remedial decision making processes. The amount of influence that sustainability considerations ultimately have on decision making at present is rather variable even when these decision support tools are applied.

Reporting

Whatever approach and tools are selected, the decision-making process should be transparent at each step, and for each step the inputs to the decision-making process, the assumptions and evidence used should be recorded. This is particularly important given that the choice of which tools and frameworks, and their considerations, should be used is made on a project by project basis.

Conclusions

A review has been completed of tools and techniques available to incorporate sustainability and sustainable management techniques into remediation design and decision making.

Tools to support sustainable remediation design are available. They are different to the tools traditionally used to quantify impacts to human health or environmental receptors and a fresh approach to the design process is required. Many indicators, particularly within the economic and social categories may not need a quantitative approach (even in circumstances where they may have a material impact on the remediation objectives or remedial design). They will however contribute to the overall cost-benefit assessment of the remedial approach.

On face value, there appears to be possibly too many tools and approaches available to remediation practitioners with little consensus on how the significance of how a wide range of indicators should be considered, either qualitatively or quantitatively.

In the first instance, a relatively simple approach may be merited using qualitative tools that allow sustainability to be recognised and decisions recorded and documented. Further complexity can then be considered when the potential costs and benefits of remediation require more detailed analysis.

Record keeping and reporting of SR decision making needs to be made on a transparent basis, so that all of the considerations and assumptions underpinning the decision are clearly evident.

Recommendations

The following recommendations are provided to enable better integration of sustainability into remedial decision making in the future:

- Consider organisational cooperation and collaboration among industry, regulators and consultants (e.g., through SuRF, NICOLE, etc.);
- Complete a series of cooperative pilot projects applying traditional remediation design and decision making and separate sustainability analyses;
- Complete a detailed review of available framework-rating tools (such as CEEQUAL or similar) or multi-criterion analysis tools and consider how they could be modified/adapted to allow application in sustainable remediation projects;
- Identify methodologies for practitioners to ensure that social (beyond human health) and economic aspects can be considered within the sustainability assessment;
- Promote and support the revision of regulation, training and enforcement in the EU to better define processes, so that sustainability can be integrated into remediation decision making and awareness and understanding of a suite of readily assessable sustainability metric is increased.

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APPENDIX A – SUSTAINABILITY ASSESSMENT TOOLS

Questionnaire

The brief for this paper was established by the Working Group at the October 2008 Madrid conference as follows:

'To identify the tools that are available and being used to assess the costs of remediation across Europe, how they incorporate sustainability (if at all) and comment on what these might look like in the future'

Objectives & Focus

In order to understand how readily the concept of sustainability was recognised by remediation professionals across the EC and what tools were already being used, the sub group developed a questionnaire to benchmark the recognition of tools in quantification of impacts during remediation projects.

The questionnaire (attached) focussed on the following areas:

Theme	Reason
Policy and Guidance	To establish whether the principle of sustainability is recognised or implied within policy and legislation.
Common Solution Selection Methods	To establish whether the principle of best available technique (not exceeding excessive cost) is recognised in legislation, which could imply an element of sustainability within the selection of remediation methodology or certainly support modification to reflect sustainability within the cost discussion.
Decision Support and Costing Tools	To benchmark the recognition and use of already recognised costing and decision support tools such as cost benefit analysis, multi-criteria analysis, life-cycle analysis and net environmental benefit assessment.
Aspects to Weigh Up	To identify any tools or processes that NICOLE members are using to measure social, economic or environmental cost outside of the categories discussed above.

As part of each question, we asked Nicole Members to consider the questions on the following basis:

Rating	
1	It is widely accepted and recognised in regulation and practice across the country.
2	It is included /allowed for in the country's legislation / regulation but is not applied by practitioners, organisations or regulators.
3	It is recognised by regulators and practitioners but only used / adopted occasionally as it has no official / legal support and is therefore only of use for internal decision making and in developing a qualitative discussion with regulatory bodies.
4	It is not used and not applied in country's regulations / legislation or by practitioners.

Feedback

Twenty two responses were received from consulting, contracting and industrial organisations. The key output from the Questionnaire was a matrix (Attached) showing the state of recognition of the various tools across the member states. Key themes and conclusions the subgroup has drawn from the Questionnaire are:

- Sustainability is generally recognised within the legislative framework but is not readily applied to remediation projects.
- The concept of Best Available Technique is frequently recognised and allowed for in legislation but less frequently applied.
- Multi Criteria Analysis and Cost Benefit Analysis are recognised by most practitioners but even less frequently applied or used.
- Net Environmental Benefit Assessment is recognised by most respondents but is not used.
- There is little recognition of other tools to support consideration of social and economic aspects across the respondents.

The questionnaire had a free section for further comments from the members. These responses are attached.

Nicole Economics Questionnaire Matrix of Member Responses

Country	Legislation Supports Sustainability?	Best Available Technique	Multi-Criteria Analysis	Cost Benefit Assessment	Net Environmental Benefit Assessment	Social Assessment Tools	Environmental Assessment Tools	Economic Assessment Tools
Belgium	3	1	1	1	3	2	3	3
Belgium	1	1	1	4	4	4	4	4
Czech Republic	3	4	3	3	4	4	4	3
Denmark	3	4	1	1	3	4	4	3
Finland	2	2	3	3	3	4	4	4
France	2	3	3	2	3	4	4	4
France	2	1	3	2	3	4	4	4
Germany	3	2	3	3	3	4	4	4
Germany	3	2	1	4	4	4	4	4
Italy	3	3	4	4	4	4	3	2
Netherlands	1	3	4	4	4	4	4	
Netherlands	3	4	1	3	4	3	3	3
Netherlands	2	1	1	1	2	4	1	1
Romania	4	4	3	3	4	1	1	1
Spain	3	3	4	3	3	3	3	3
Spain	2	3	2	2	2	3	4	4
Sweden	2	1	3	3	3	3	4	1
UK	2	1	3	2	2	4	4	4
UK				2		4	3	2
UK	2	2	2	2	3	3	3	3
UK	2	4	3	3	3	4	3	4
UK	2	2	4	3	2	4	2	2

Rating	
1	It is widely accepted and recognised in regulation and practice across the country.
2	It is included /allowed for in the country's legislation / regulation but is not applied by practitioners, organisations or regulators.
3	It is recognised by regulators and practitioners but only used / adopted occasionally as it has no official / legal support and is therefore only of use for internal decision making and in developing a qualitative discussion with regulatory bodies.
4	It is not used and not applied in country's regulations / legislation or by practitioners.

Nicole Questionnaire Summary of Closing/Opening Comments as Received by 01 June 2009

CZECH REPUBLIC

Jan Beba, CH2M – Czech Republic

Sustainability is not considered as a component of remediation projects. In remediation projects funded by private entities cost is us usually the only element used in evaluation. On government contracts it is cost plus administrative viability meeting the requirements of the public procurement regulations. This has not changed over the past 5 years.

No further comments

FINLAND

Marko Sjolund, WSP, Finland

Reuse of soil on site has gained acceptance among authorities. New legislation enabling risk based remediation targets has been applied and sustainability issues can be taken into account in the initial factors and conclusions of the risk assessment. Major land owners have programmes for reuse and utilization of contaminated soil.

What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:
If possible direct guidance in taking sustainability factors into account when designing remediation projects. Bringing together tools of which to use in order to better take into account sustainability issues.

NETHERLANDS

Yvo Veenis
Groundwater Technology BV
Netherlands

Sustainability is considered in two ways: 1: in setting remediation goals and defining which cases need remediation: there is a clear trend in The Netherlands leaving fixed concentration based remedial goals in favour of risk-based, fit-for-use goals. This led to a very significant cost-reduction or, vice versa, more sites can be addressed for the available amount of cash. 2: more recent: the sustainability of the implementation of remediation itself is beginning to be considered (in some cases, items such as carbon 'foot print' of remediation, pollution caused by the remedial actions themselves etc. are being considered.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Managing contaminated land has to a large extend matured in The Netherlands; it is part of overall spatial planning and as such not a 'hot' topic anymore; which is a form of sustainability of contaminated land management by itself. However, 'sustainability' as a separate item, is new. Sustainability-evaluation of the remediation effort itself is rather new and not yet part of 'main stream' decision-making procedures, nor is it embedded in regulatory or compliance protocols.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
An overview of various approaches taken in Europe, the methods and techniques used and their impact on contaminated land management.	

LH, Shell, Netherlands

In general, it appears as if cost-benefit type of information on environmental remediation and mitigation option has become more important, to support both decision making at the side of the regulator, and of the company responsible for mitigation. However, not all methodological issues related to environmental CBA have been resolved.

No further comments

DENMARK

Kristian Kirkeberg
Grontmij
Denmark

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
The term sustainability should be defined in relation to remediation. A sustainable drinkingwater production from groundwater may require an advanced, energy-consuming remediation technique – is this then sustainable?	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Provide benchmarking for the various remediation options, like the IFC environmental sustainability guidelines for industries: http://www.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines Provide a guideline for comparing the important parameters of various remediation options, including the ones that cannot be measured or calculated easily, and including the link to the overall sustainability of a community.	

BELGIUM

Lucia Buve, Umicore
Belgium

1. Location		
1a. Country	Please provide the name of the country / region for which subsequent answers apply.	Flanders - Belgium
1b. Regional Differences	Please comment on whether your responses apply to regions within a country and whether there is a substantive difference between regions	My answers apply to Flanders, which is 1 of the 3 regions in Belgium. Each region has its own regulation. Major differences are soil standards.

Apart from evaluating technical and economical aspects when deciding on a remedial technique, there is so far not much "sustainable" to the different projects we are carrying out.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Land use planning is a very important aspect when introducing the notion of "sustainability" into remediation. It is still not entirely clear what is meant by "sustainability". In the Sustainable Development World, the term means an ongoing process (and not an end-point), be it business or selling shoes, in which the 3 criteria are taken into account. What is accepted today, may not be the case in the future, so a sustainable business is flexible enough to pick that up. This aspect is in contradiction with the objectives of a remediation (or contaminated land management project) that is meant to have an end.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Cross-media evaluation when assessing best techniques.	

Wouter, Arcadis, Belgium

1. Location Wouter - Arcadis, Belgium		
1a. Country	Please provide the name of the country / region for which subsequent answers apply.	Flanders (Belgium)
1b. Regional Differences	Please comment on whether your responses apply to regions within a country and whether there is a substantive difference between regions	There is a substantive difference (differten legislation !) between Flanders, the Walloon region and the Brussels region. Nevertheless all three of them accept risk based remediation based on a BATNEEC evaluation (at least for historical contamination)

Sustainability is not really included as such. But the choice of a remediation technique is based on a BATNEEC evaluation; the Flemish regulator developed a methodology for this BATNEEC evaluation, including factors as energy consumption.

No further comments

SWEDEN

Bertil Grundfeldt
Sweden

An objective of the overarching law in environmental protection is to support a sustainable development. Sustainability issues have a place in the procedure used to for selecting remedial option, although in practise these issue are normally subordinated other objectives. This has been the case for the whole 5 year period.	
Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
The decision to perform remediation may in itself be a decision that the affects the sustainability of land use. In my view, choosing greener or browner remediation methods has little impact on the sustainability of the society.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
See above	

SPAIN

ERM Spain

In Spain, some Regional environmental regulations (for instance Madrid, Regional Law 2/2002) require the preliminary application and, if requested, preparation of a limited EIA of the Remedial Action Plan (RAP) previous to the remediation implementation. The EIA needs to consider a number of items that are related to sustainability (noise, power consumption, resources use, waste generation, etc..). To a National level, this would be required for big scale remediation projects. According to National RD 9/2005 on contaminated soils (and Regional regulations like Law 1/2005 in the Vasc Country) an assessment of the cost-effectiveness of the proposed remedial solution is required. In practical terms, sustainability, if properly presented and explained, could be considered of added value for the Administrations although will not be a decisive factor in both private and public sector.

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
A guidance on sustainable practices required / used to an international level.	

Luis Molinelli, CH2M, Spain

Sustainability is mentioned as a concept, but it is not considered as an added value that can make you to be awarded with a project, either by the private or the public sector. In practical terms, there is a clearer idea now, in regards to the past years, about collection of soil coring, excavated soil and groundwater when a remediation project is conducted. However, there is no any advance in concepts such as energy saving when a remediation project is accomplished.

What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:
A guidance on sustainable practices used in other countries.

ITALY

ERM Italy

Italy. Sustainability in remediation is still not considered during design stage. Since 2007 we have seen an increasing number of sessions during technical meeting.

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Costs and benefits of sustainable remediation approach to redefine targets of traditional remediation process decision.	

GERMANY

ERM Germany

There are different approaches how sustainability in remediation projects is considered in Germany. However, it is often not covered under the term “sustainability”. - In Germany in most remediation projects there is the goal to minimize energy consumption like in all engineering projects. - The state of North Rhine Westphalia released a guidance which specifies for SVE a threshold for kw/h to mass of solvent per unit from when on SVE is no longer seen as being effective. - The German soil protection law considers proportionality in remediation which includes energy and cost benefit ratio.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
We use probabilistic modelling for decision making	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
It will be interesting to see if sustainable remediation will also get the image of “do nothing” like it happened to MNA at least in the beginning of the use of MNA. If Nicole could help to get sustainable remediation out of this box, that would be helpful.	

Matthias Summan – Tauw

1. Location **Matthias Summan (Tauw)**		
1a. Country	Please provide the name of the country / region for which subsequent answers apply.	Germany
1b. Regional Differences	Please comment on whether your responses apply to regions within a country and whether there is a substantive difference between regions	So far, only the State of Nordrhein-Westfalen has published a guideline on how to address aspects of sustainability into evaluation of remediation alternatives.

In Germany, there have been some weak developments in the last 5 years to look at remediation measures not only in terms of remediation targets and costs for the necessary measures but also in terms of emissions, waste production, burden for neighbours and so on. But this has not developed to a detailed approach, the evaluation of these aspects is very general, usually by giving scores for aspects like “general negative effects on the environment” (what ever that might mean). There is usually not a comparison of remediation alternatives with respect to quantities of CO2 emissions, for example.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
The picture for Germany described above refers to the majority of cases as they are dealt with in the practice. However, there are a number of projects usually related to research	

projects that try to evaluate projects in terms of sustainability. However, these have little effects on the practice since there is hardly any exchange between practice and academia. Germany is characterized by many small consultancy firms that do not have the capacity to develop new approaches. And German industry is not very open minded to these issues (also reflected by the absence of German industry in NICOLE). Occasionally, international industry and/or international consultancy firms try to apply the approaches they have done in other countries (like the Netherlands). But really issues like sustainability, climate change, biodiversity etc. have not really reached the world of soil and groundwater remediation in Germany.

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
• List of indicators that should be addressed in the sustainability analysis • Guidance on how to evaluate the indicators quantitatively (calculation guidelines) and how to score on indicators so that really the sustainability issues are taken seriously (otherwise, for example, you might think a lot about sustainability but in the end you just apply subjective weighing factors putting 90% on the factor remediation costs and all the work is for nothing)	

United Kingdom

ERM UK

Sustainability is usually considered as a secondary issue to the overall project objective and issues such as timescale and cost. Occasions where there has been some level of consideration of sustainability has increased but this is more in the form of a tick box exercise of 'Have we considered sustainability?' rather than a detailed assessment. We are seeing increasing reference to sustainability from a number of private and public sector clients. Sustainability in the context of remediation projects typically focuses on environmental aspects rather than economic and social aspects of sustainability.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Any tool needs to allow for great site-specific variability (so that it can incorporate variability in areas such as client requirements, geology and contamination).	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Some indication of the boundaries that should be adhered to in terms of the range of indicator that should be considered. Then, as assessment of the sustainability of remediation projects is likely to be undertaken using in-house methods (due to the absence of legislation in this area), at least everyone will be considering the impacts on the same range of indicators.	

Philippa Scott, Shell, UK

Historically remediation considered beneficial and wider impacts to environment (above ground) and society rarely included in decision making. BATNEEC was generally considered in financial terms. Last 3 years CO_2, energy and societal impacts reviewed more often. UK Cost Benefit Assessment been available for >5years, complex and not used often. SURF UK active 2years and Sustainability highlow edge

Section E7 Closing

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Current need to get guidance out to practioners. Need to raise the profile of this important aspect because we are often unclear what impacts are being caused using following traditional treatment methods. Are we really helping the environment relocating chemicals from site to site or ground to air.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Identify potential "harm" caused by remedial technologies eg P+T (energy consumption, raw materials etc etc .vs benefit) Education of regulators + practioners ⇒ Can we continue using existing technologies? What is the cost? Is there a benefit?	

Giles Farrant, MWH, UK

There is much more emphasis on reasonable cost, cost benefit and risk assessment. Rather than comparing against fix targets and dig & dump.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
They must be easy and relatively cheap to use or the clients won't buy in to them. How do you know when you have arrived at the right solution?	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
How to go about quantifying and weighing subjective/qualitative factors like environmental or social improvement. More guidance on cost benefit analysis.	

Jonathan Smith, Shell, UK

Regulatory guidance issued around 2000, but little used due to high complexity and lack of data (particularly economic valuation of social and environmental aspects). Recent interest in sustainable remediation greatly expanded in past 2 years, leading to formation of SuRF-UK in 2007 (www.claire.co.uk/surfuk).

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Please try to ensure NICOLE approach is compatible with SuRF (US) and SuRF (UK) approaches, while beling applicable to EU law. A plethora of incompatible guidance will not be helpful.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
1. To successfully influence the text of the proposed EU Soil Framework Directive to include (as currently drafted) requirement to consider env, econ and social issues in remediation selection. 2. Metrics for different remediation technologies (CO2 emissions, water use, safety records, social impacts etc) and valuation of ecosystem goods and services 3. A statement (foreword?) from the European Commission or the European Environment Agency that it supports the principles described.	

Alex Lee, WSP, Scotland

Clients approach sustainability as a perceived cost burden at a time of finical pressure. The key to delivering sustainable remediation must be one of quantifying its value in a

frame of reference and in terminology that a client understands. To date in Scotland little efforts are expended on sustainable delivery instead focus is upon delivering liability management quickly and for the smallest of fee . client education is required to be driven by consultants yet few consultants have the depth of understanding to sell else manage risk outside their traditional delivery model.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
Danger of paralysis and unworkable frameworks evolving. A perfect framework will never be developed though aspirational. Efforts to date are inward facing within the sector to sell it we need to educate outwardly else it needs to be legislated as a requirement.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
Summary delivery of the available approaches e.g. SURF UK; SURF US, Eurodemo etc Broker a consistent approach !!!	

FRANCE

ERM France

The traditional dig & haul approach is dead, alternative on-site confinement or treatment are being more widely accepted when developing a remedial action plan on active industrial sites. The same is now happening on the real estate market, however at a somewhat slower pace due to the psychological marketing stigma of having residual contamination on a redeveloped site, with the implementation of usage restrictions and engineering controls. Sustainability is being looked at from both social and economical perspectives, with a clear drive to do more with less budget, looking for sustainable solutions with an acceptable risk profile. Carbon footprint of a remedial project starts to make its intro into remedial design.

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	
The evaluation of the remedial strategy within a risk-based and cost-effective framework should be developed as objective and generic as possible to avoid discussions with involved stakeholders and generate more consistency within the clean-up market. Evaluation should be done on a case-by-case basis.	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	
A trans-country comparison of sustainability implementation within the Europe remedial market. Create a generic evaluation tool that would integrate clean-up selection and sustainability.	

Nicole Questionnaire

NICOLE SUSTAINABLE REMEDIATION QUESTIONNAIRE

NICOLE's Sustainable Remediation (SR) Working Group has a number of subgroups considering the opportunities and barriers to incorporate sustainability in remediation projects across Europe. The aim is to develop guidelines on Sustainable Remediation in Europe.

The guidance is meant for all NICOLE's members and your help in determining the form of the guidance and its content is very much appreciated.

To leverage fully our regional network please share this questionnaire with experienced practitioners within your respective organizations.

Timescales are short !!! and we would be grateful if this questionnaire could be completed by return to be with the working group by 27 May 2009 to enable assimilation of the results before the June 3 conference on Sustainable Remediation.

To expedite the processing of your feedback, please return the questionnaire to all our Sub Group leaders:

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Thank you in advance for your assistance.

As a general introduction, please help us understand how sustainability is considered in general in remediation projects based on your own experience, and how has this changed over the past five years?

Economics Sub Group

Introduction

The Economics sub group of NICOLE's Sustainable Remediation initiative has been tasked with identifying existing and potential future tools, available to:

- Incorporate sustainability in remediation projects across Europe
- Describe how these tools incorporate remediation costs and other economic factors

To support the completion of this task the subgroup has identified the requirement to gather information across the EU member state countries on the status, availability and use of risk assessment, tools and key performance indicators in measuring sustainability in remediation.

Your answers will be used to benchmark the use of sustainable remediation tools across the EU at present. The data will be used to provide an indication of the scale of the work that may be required to facilitate its introduction across the EU.

The format of this section of the questionnaire is based on a rating system:

Rating	Meaning / Description
1	It is widely accepted and recognised in regulation and practice across the country
2	It is included /allowed for in the country's legislation / regulation but is not applied by practitioners, organisations or regulators.
3	It is recognised by regulators and practitioners but only used / adopted occasionally as it has no official / legal support and is therefore only of use for internal decision making and in developing a qualitative discussion with regulatory bodies.
4	It is not used and not applied in country's regulations / legislation or by practitioners.

There is a free comment box supporting each response; please respond with short answers only. Finally there is a free response section at the end of the questionnaire should you wish to provide any other relevant information.

The working groups aim is to use this information to create a matrix of current practices used in quantifying sustainable remediation across the EU member states.

Section E1 Location

1. Location		
1a. Country	Please provide the name of the country / region for which subsequent answers apply.	
1b. Regional Differences	Please comment on whether your responses apply to regions within a country and whether there is a substantive difference between regions	

Section E2 Policy and Guidance – Site Assessment

Question 2a		**Sustainability in environmental protection, planning and / or remediation / contaminated land in Legislation/ Policy / Guidance** - Is the concept accepted, or at least allowed for in the country's guidance / legislation for remediation?
Rating		Comment
1		
2		
3		
4		

Question 2b		**Risk Assessment for contaminated land and water** - Is risk assessment and risk based remediation decision making accepted and used in practice? If not, why not?
Rating		Comment
1		

2		
3		
4		

Question 2c		**If rated 1 in Question 2b,** can the approach or conservatism of input parameters to human health or ecological risk assessments be modified by sustainability issues?
		Comment

Question 2d		**If rated 1 in Question 2b,** is there a conflict between site specific risk assessment based on existing or future land use and sustainability ?
		Comment

Question 2e		**If rated 1 in Question 2b,** is sustainability only considered once the risk assessment is complete? If so, how?
		Comment

Question 2f		**If rated 2, 3 or 4 in Question 2b,** can sustainability principles be applied to remediation option appraisal?
		Comment

Question 2g		**Sustainability accreditation /assessment schemes** - Is the remediation phase of projects and/or brownfield development included in overall sustainability assessment of land regeneration / redevelopment projects (e.g., LEED or BREEAM)?
Rating		Comment
1		
2		
3		
4		

Section E3 Common Solution Selection methods

Question 3a		**BATNEEC** - Is Best Available Technology Not Exceeding Excessive Cost the basis for deciding the remediation approach / technology used?
Rating		Comment
1		
2		
3		
4		

Question 3b		**ALARP** - Is the cheapest approach/technology that meets the remediation objective (i.e. As Low As Reasonably Practicable) usually adopted?
Rating		Comment
1		
2		
3		
4		

Question 3c		Please note any other similar solution selection procedures used?
Rating		Comment
1		
2		
3		
4		

Section E4 Other Decision Support and Costing Tools

Question 4a		**MCA** - Is Multi-Criteria Analysis used to support remediation decision making?
Rating		Comment
1		
2		
3		
4		

Question 4b		**Cost Benefit - Cost Benefit Analysis** - Is quantitative analysis used that monetises internal and external (non-direct) costs and benefits to compare different options to achieve the objectives.
Rating		Comment
1		
2		
3		
4		

Question 4c		**NEBA** - Net Environmental Benefit Analysis – Is the decision of which remediation approach / technology to adopt based on choosing the one that maximises the net environmental benefit (e.g., qualitative / semi-quantitative and it includes impacts to ecosystems/natural resources, consideration of costs compared to clean-up criteria, material and resource use, waste and emissions such as Green House Gas).
Rating		Comment
1		
2		
3		

4		

Question 4d		**Sustainability analysis and decision tools** - Please note any other similar decision support tools used
Rating		Comment
1		
2		
3		
4		

Section E5 Aspects to Consider / Weigh Up

Question 5a		**Social Impacts and Benefits**- Are there any other tools used to measure social impact / benefit aspects of remediation and, if so, what?
Rating		Comment
1		
2		
3		
4		

Question 5b		**Economic Impacts and Benefits s** - Are there any other tools used to measure economic impact / benefit aspects of remediation and if so what?
Rating		Comment
1		
2		
3		
4		

Question 5c		**Environmental Impacts and Benefits** - Are there any other tools used to measure environmental impact / benefit aspects of remediation and if so what?
Rating		Comment
1		
2		
3		
4		

Section E6 - Indicators Sub Group

Question 6a How does your country's overall sustainable development policy framework affect your work in contaminated land management?

If you can help further with your country information, please supply a document link to any available information, particularly any information summarised in English. If no English language documentation is available, would you be prepared to assist the sub group to incorporate details into the study?

Question 6b What specific sustainable development policies are you aware of that apply to land management, and especially contaminated land management in your country?

If you can help further with your country information, please supply a document link to any available information, particularly any information summarised in English. If no English language documentation is available, would you be prepared to assist the sub group to incorporate details into the study?

Question 6c What criteria does your organisation use to assess sustainability (economic, environmental and social criteria) in an overall sense?

If you can help further with your country information, please supply a document link to any available information, particularly any information summarised in English. If no English language documentation is available, would you be prepared to assist the sub group to incorporate details into the study?

Question 6d In what ways are these criteria (or "indicators" grouped or simplified to facilitate assessment of sustainability?

If you can help further with your country information, please supply a document link to any available information, particularly any information summarised in English. If no English language documentation is available, would you be prepared to assist the sub group to incorporate details into the study?

Section E7 Closing

Question 7a	Are there any other comments you'd like to make about remediation decision making tools and sustainability?
Comment:	

Question 7b	What would be the most useful items that a NICOLE guidance document on sustainable remediation could include to support your needs?
Comment:	

APPENDIX B - SUSTAINABILITY ASSESSMENT TOOLS

Technique	Overview Description
Best Practical Environmental Option (BPEO) / Best Available Technique (BAT)	Royal Commission on Environmental Pollution (1988) defined the Best Practical Environmental Option (BPEO) as the outcome of a systematic consultative and decision making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, and at acceptable cost, in the long term as well as the short term. BPEO is not widely used outside the UK. It is essentially a strategic assessment to identify a preferred approach from several options (Environment Agency and SEPA 2004). The concept of BAT elaborated on the IPPC Directive (Directive 96/61/EC)[1]. The definition of BAT is "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole". Where there is a choice, the technique that is best overall will be BAT unless it is not an 'available technique'. There are two key aspects to the availability test: (a) what is the balance of costs and advantages? This means that a technique may be rejected as BAT if its costs would far outweigh its environmental benefits; and (b) can the operator obtain the technique? This does not mean that the technique has to be in general use. It would only need to have been developed or proven as a pilot, provided that the industry could then confidently introduce it. Nor does there need to be a competitive market for it. It does not matter whether the technique is from outside the UK or even the EU (Defra 2007b).
Carbon balance	Defra recently published a major report on *Carbon Balances and Energy Impacts of the Management of UK Wastes* (Defra 2006b). This uses carbon balance diagrams that show calculations of tonnes of carbon in various inputs and outputs, and how this balance changes for different waste management scenarios. The major flows of both carbon/greenhouse gases and energy through waste management systems result from: the use of fuel and energy in processing; the transportation of waste to and from sites (including collection); direct releases from waste materials on processing (e.g. biological processing or thermal treatment) or disposal in landfill; avoidance of greenhouse gas emissions or energy use elsewhere in the economy; and sequestration of carbon in landfill and soil. The carbon balance diagrams for each waste material and scenario detail: the carbon that remains within the material fraction following treatment or disposal (both carbon in inert fractions that have been deposited in land; as well as organic carbon that has not degraded but is sequestered in landfill or other soil carbon sink); carbon that is contained in products, such as recyclate or composts; and carbon that is released to atmosphere, as carbon dioxide (fossil / biogenically derived) or methane. The diagrams also include greenhouse gas

[1] http://ec.europa.eu/environment/ippc/

Technique	Overview Description
	balance calculations shown in tonnes of equivalent carbon dioxide.
Carbon footprint	A carbon footprint is a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide. A carbon footprint is made up of the sum of two parts, the direct / primary footprint and the indirect / secondary footprint. The primary footprint is a measure of our direct emissions of CO2 from the burning of fossil fuels including domestic energy consumption and transportation (e.g. car and plane). The secondary footprint is a measure of the indirect CO2 emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown[2]. *Note the carbon footprint is not measured in terms of area.* The world's first standard approach was recently published in the UK (Carbon Trust *et al* 2008a & 2008b). Ecological footprints are described below.
Cost benefit analysis (CBA)	CBA is widely used in policy and project appraisal in the Private and Public Sectors, for example the *Green Book* (HM Treasury). CBA is a form of economic analysis in which costs and benefits are converted into monetary values for comparison The aim of the assessment of costs and benefits is to consider the diverse range of impacts that may differ from one proposed solution to another such as the effect on human health, the environment, the land use, and issues of stakeholder concern and acceptability by assigning values to each impact in common units. Deciding which impacts to include or exclude from the assessment is likely to vary on a site-by-site basis. In many instances, it is difficult to assign a strictly monetary or quantitative value to many of the impacts. Hence, assessments can involve a combination of qualitative and quantitative methods (see below). It is also useful to include a sensitivity analysis step, particularly where this encourages decision-makers to question their judgements and assumptions through the eyes of other stakeholders (Hanley and Spash 1994). However, CBA has some serious weaknesses (Therivel 2004), which include the following: there is no standard "checklist" of indicators, so CBA is highly specific to the circumstances and method used for each particular assessment; the valuation procedures for public costs are both highly technical and also subject to serious inherent weaknesses
Cost effectiveness analysis	Cost-effectiveness analysis (CEA) is a simplified derivative of cost-benefit analysis. The aim of CEA is to determine "... the least cost option of attaining a predefined target..." without a monetary measurement of benefits (DETR 1999). Costs are calculated conventionally and benefits are scored individually. An aggregate score for benefits is then divided by cost to provide a measure of "cost effectiveness". The derivation of scores is an application of MCA. An example applied to land remediation is given in Harbottle *et al* 2008.
Eco-efficiency	Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource

[2] http://www.carbonfootprint.com/carbon_footprint.html

Technique	Overview Description
	intensity throughout the life cycle to a level at least in line with the earth's estimated carrying capacity. Seven critical factors for eco-efficiency have been identified (EURODEMO Consortium 2007): • Reduce material intensity of goods and services • Reduce energy intensity of goods and services • Reduce toxic dispersion • Enhance recyclability • Maximise sustainable use of renewable resources • Extend product durability • Increase service intensity of goods and services.
Ecological footprint	In theory the ecological footprint is the area of productive land and water ecosystems required to produce the resources consumed and assimilate the wastes produced (Chambers *et al*. 2007). Defra (2007a) state that it provides a measure of the extent to which human activities exceed two specific environmental limits: the availability of bioproductive land and the availability of forest areas to sequester carbon dioxide emissions. It is derived from data from resource flow analysis, about a range of activities such as transport, energy use, materials and product consumption, waste production and water use. The impacts of these activities are converted into a common currency, *global hectares* (gha). Using this common unit, a broad range of impacts can be aggregated to derive ecological footprints for products, processes, organisations etc. The method does have limitations. It does not incorporate all aspects of ecological resources and services, and it excludes the use of non-renewable resources. It does not consider social and economic considerations Related concepts are waste and water footprints. • Waste footprint is a "component" part of calculating waste footprints. Recently WRAP have begun development of a method for determining "waste neutrality" (WRAP 2007). • "Water footprint" is an emerging concept. A water footprint is defined as the total volume of water used to produce the goods and services consumed by an individual, company, nation, or planet. A water footprint adds together the amount of internal water resources withdrawn (excluding those waters which are exported as embedded water) with the amount of external water resources used (Waterwise 2007[3]).
Eco-management and audit scheme / environmental management system	The UK was one of the first countries to adopt a standard for environmental management systems, BS7750 (BSI 1994) – now superced by BS EN ISO 14001 (BSI 2004) and the European Eco-management and Audit Scheme (EMAS)[4], which is covered by EU Regulation 1836/93/EEC.
Energy / intensity efficiency	Energy intensity is a simple metric that can be used to compare processes such as waste management processes, for example, kWh to treat a tonne of waste. Energy intensity may also be an

[3] See also www.waterfootprint.org

[4] See http://ec.europa.eu/environment/emas/index_en.htm

Technique	Overview Description
	indicator of wider environmental effects, such as greenhouse gas emissions and emissions of acidic gases. Energy efficiency has been proposed as a means of comparing the overall environmental impact of remediation technologies by the European EURODEMO project (EURODEMO Conosrtium 2007). Similar metrics are water intensity and carbon intensity (Nichols and Looney 2007).
Environmental risk assessment	Risk assessment (DETR *et al.* 2000) is a way of evaluating potential hazards from contaminated land. A hazard is a substance or situation, such as contamination in the ground, which has the potential to cause harm (e.g., adverse health effects, groundwater rendered unfit for use, damage to underground structures, etc.) to a particular receptor. Risk is commonly defined as the probability that such a substance or situation will produce harm under specified conditions. Risk is a combination of two factors, the probability of exposure and the consequence of exposure. In the context of contaminated land management, risk occurs when three components are present (a source, a receptor and a pathway for that receptor to be exposed to the toxic substances from the source). In the UK this combination of source, pathway and receptor is called a pollutant linkage. Risks only occur when all three components are present.
Environmental impact assessment / Strategic environmental assessment	Environmental impact assessment (EIA) describes a procedure to make a structured appraisal of a broad range of environmental effects of a particular *project*. In the EU EIA is subject to Directive 85/337/EEC[5]. EIA methods are not prescribed in detail but tend to use stages such as (DETR 1999): • Screening: narrows the application of EIA to projects that may have significant environmental impacts. • Scoping: identifies the potential environmental impacts to ensure the assessment focuses on the key issues for decision-making. • identification: of key environmental impacts. • consideration of alternatives: in terms of sites, designs, processes. • prediction of impacts: predicts the magnitude of key impacts. • evaluation of significance: assessment of significance of the key impacts. • mitigation: proposal of measures to prevent, reduce or rectify the impacts. • documentation: presentation of EIA results for clear communication. • review: systematic appraisal of the quality of the environmental statement. • post-decision monitoring: to assess the ex post effect of the project on the environment. • post-project audit: comparison of actual outcomes with

[5] http://ec.europa.eu/environment/eia/

Technique	Overview Description
	predicted outcomes to assess the quality of predictions and effectiveness of mitigation. Strategic Environmental Assessment is a systematic decision support process aiming to ensure that environmental and possibly other sustainability aspects are considered effectively in *policy, plan and programme making* (Fischer 2007, ODPM 2005a). In Europe it is undertaken to meet the requirements of European Directive 2001/42/EC. Strategic Environmental Assessment (SEA) is a process to ensure that the environmental implications of decisions are taken into account before certain plans and programmes are adopted. The SEA process is integrated throughout the development of a plan / programme, notably during data gathering, feasibility of options, development of the preferred option, and monitoring its implementation (Environment Agency 2007). Key principles in SEA are to promote sustainable development; to take an integrated view recognising the cross-cutting aspects of environmental quality with the social and economic agenda of Sustainable Development; that the process of SEA is a means to ensuring that plans and programme do actually further environmental considerations, that the SEA should be realistic and participative involving interested parties and the public and creatively responding to their input. SEA is an iterative process that should be integrated into planning and decision making at all stages. It should also be focused, addressing the significant environmental issues of particular relevance to the scale and subject of the proposed project, plan or programme. Techniques used in SEA include: expert judgement; assessing cumulative effects on the environment, Best Available Technique (BAT) and Best Practicable Environmental Option (BPEO); constraints and opportunities mapping; consultation and participation; cost benefit analysis; ecological foot-printing; horizon scanning; sustainability appraisal and integrated appraisal; modelling; multi criteria analysis; network (casual chain) analysis; quality of life capital; risk assessment; scenario testing; and sustainability threshold assessment (STA). The SEA Directive (2001/42/EC) specifies the following topics should be considered: biodiversity, flora and fauna; population and human health; soil; water; air; climatic factors; cultural heritage; landscape; and material assets.
Financial risk assessment	Major projects affect businesses and administrations through their potential to influence liquidity, solvency and overall financial performance. These are financial risks relating to an organisation's ability to meet its corporate and project objectives. The precise nature and extent of financial risk depends on the context in which the project is undertaken. Financial risk relates to the internal rate of return (IRR) or Net Present Value (NPV). IRR represents the return that can be earned on the capital invested in a project; the risk is of it being reduced to a point at which a project becomes commercially non-viable. NPV represents the present day cost of some action taken at some time in the future; in essence the present day value of that distant cost is discounted by the applicable interest rate over that period of time (Finnamore 2000).
Industrial ecology	In this concept industrial processes are likened to living

Technique	Overview Description
	processes (industrial metabolism). Managers of the industrial system must treat it, at every level, as a set of organisms, subject to ecological constraints, like any other member of an ecosystem. "Industrial metabolism traces material and energy flows from initial extraction of resources through industrial and consumer systems to the final disposal of wastes (Lowe *et al* 1997). Industrial metabolism can be used as a basis to derive "metrics" or indices of an industrial system's efficiency and productivity, for example: ratio of virgin to recycled materials, ratio of actual/potential recycled materials, ratio of renewable/fossil fuel sources, materials productivity, energy productivity, resource input per unit of end-user service.
Lay Participation	Inclusion of views from non-specialists such as local residents for example by using: • Citizen's juries – Involves major stakeholders in the process of the identifying and appraising of options - lay people brought together to deliberate on an issue, call witnesses and come to a verdict. • Citizen's advisory groups - lay people bought together over a period of weeks to act as the voice of the community - can turn into a monitoring group once the decision has been made. (Maer 2007)
Life cycle assessment	Life cycle assessment is a technique to evaluate the environmental consequences of products or services from cradle-to-grave, and their use (Danish Topic Centre on Waste and Resources 2006, Wrisberg *et al.* 2002). In the context of contaminated land, such a function might be the remediation of a contaminated site. CHAINET describes the main features of LCA as follows: • LCA follows a cradle-to-grave approach: all processes connected with the function, from the extraction of resources until the final disposal of waste, are considered. • LCA is comprehensive with respect to the environmental interventions and environmental issues considered. In principle6, all environmental issues connected with the function are specified as resulting from extractions, emissions and other physical interventions like changes in land use. • LCA may provide quantitative or qualitative results. With quantitative results it is easier to identify problematical parts of the life-cycle and to specify what can be gained by alternative ways to fulfil the function. LCA reports may also be accompanied by assessments of the economic cost of any impacts reported (e.g. "human toxicity" and may include impacts that could be considered social rather than environmental such as injuries at work (Koneczny and Pennington 2007).
Multi-criteria analysis	A range of qualitative sustainability appraisal techniques have been

[6] *Our emphasis*: in most applications LCA is subject to a number of simplifying assumptions in order to make the analysis practically achievable. These simplifications can introduce a degree of subjectivity into the analyses.

Technique	Overview Description
	published based on scoring systems, for example for regional spatial strategies (ODPM 2005). These are typically fairly simple. The technique developed in the *MOD Sustainability and Environmental Appraisal Tools Handbook* (MOD 2006) is more detailed. MCA is a more sophisticated technique for combining scores and weightings that can be applied to sustainability appraisal or aspects of it, e.g. Harbottle *et al* 2008. Multi-criteria analysis (MCA) is often used in decision making. MCA is a structured system for ranking alternatives and making selections and decisions. Considerations used in MCA are: how great an effect is (score) and how important it is (weight). MCA describes a system of assigning scores to individual effects (e.g. impact on traffic, human health risk reduction, use of energy etc). These can then be combined into overall aggregates on the basis of the perceived importance (weighting) of each score. With MCA, ranking and decision making processes can be made very transparent (Bardos *et al.* 2000, Wrisberg *et al.* 2002). MCA is not an technique that directly analyses physical information or monetary information. Rather it is an analytical technique at a higher level, bringing together different considerations in a structured way. However, techniques such as CBA, CEA and LCA apply MCA principles in their use of weightings, scoring (valuations) and aggregation., as does the sustainability appraisal described in this guidance. MCA describes a range of techniques, and at its most complex might include analyses of individual preferences of stakeholders for weightings and quantitative valuations (such as LCA techniques) for deriving scores[7].
Multi-attribute techniques	Multi-attribute techniques (MAT) are a refinement of MCA principles, and have been extensively reviewed by Okx (1998). The majority of decision situations share important similarities. First, decision-makers evaluate a set of alternatives, which represent the possible choices. The objectives to be achieved drive the design (or screening) of alternatives and determine their overall evaluation. Attributes are the measurements of the objectives and specify the degree to which each remedial alternative matches the objectives. Finally, factual information and value judgements jointly establish the overall merits of each option and highlight the best compromise solution (Beinat 1997).
NEBA	Decisions regarding the selection of remedial alternatives rarely include a formal quantification of their effect on natural resources. As a result, the potential exists for a remedial action to create more natural resource harm/injury than the risk that is driving it. A Net Environmental Benefit Analysis (NEBA) provides a framework to estimate the ecological benefits and losses associated with a remedial alternative and uses quantifiable metrics to support and supplement decisions regarding the selection of an appropriate remedy. As such, a NEBA can be particularly useful when the balance of risks and benefits from remediation of a site are ambiguous. A NEBA may provide value at sites where: • the contaminated site retains significant ecological value; • the remedial actions are themselves environmentally damaging; • the ecological risks from the contaminants are relatively small, uncertain, or limited to a component of the

[7] In this scenario MCA approaches are used both in making valuations, and combining different valuations, for example environmental impacts and costs.

Technique	Overview Description
	ecosystem; • remediation or restoration may fail; • the remedy may create ecological services (quantify to offset other decreases); or • a change in the risk scenario (benefit) appears to be disproportionate to costs. The NEBA approach allows for a systematic evaluation of changes in natural resource values (ecological and human use) associated with remedial alternatives so that consistent comparisons across alternatives can be conducted to achieve the greatest net environmental benefit at the lowest cost, while maintaining protection of human health and the environment. A NEBA can be conducted for an individual operable unit, a site, or multiple sites. (e.g. US DoE 2003)
Public Benefit Recording System.	PBRS is a prioritisation technique developed for reclamation investment (The Environment Partnership 2005). This uses a range of metrics (measurable indicators) to assess the "Public Benefit" in investing in the reclamation of particular sites, taking into account indicators for: social benefit, public access, economic benefit and environmental benefit. Scores are derived for each indicator which can then be aggregated into scores for each of the four "headlines".
Quality of life assessment	Quality of life (QoL) capital assessment is a sustainability appraisal technique for maximising and integrating environmental, economic and social benefits as part of any land use or management decision. The core idea of QoL Capital is that the environment, the economy and society provide a range of benefits for human life, and that it is these benefits or services which need to be protected and/or enhanced. Assessment examines these benefits and services systematically, using a series of questions: • who the services matter to, why, and at what spatial scale • how important are they, distinct question from the previous one • whether the benefits and services are in short supply • what (if anything) could make up for any loss or damage to the service. Expert judgement and community views both need to be reflected, so QoL Capital draws on both public consultation and involvement processes and technical appraisal methods including (for environmental benefits and services) environmental impact assessment, landscape, ecological, archaeological and characterisation studies (Countryside Agency *et al.*2001). The output of the process is a matrix of written conclusions, rather than a formal valuation.
Sustainability threshold analysis	Sustainability threshold analysis uses a table or decision matrix to compare different options for a particular planning decision, for example for siting a housing development. Each option is scored against their ability to meet a set of policy targets (or thresholds). For example, public transport accessibility might be part of a desired sustainability policy, so settlement locations could be

Technique	Overview Description
	compared with a desired access time to healthcare, educational and employment facilities by public transport[8].

Note: Two recent UK reports have reviewed in excess of 100 individual sustainability appraisal tools from a wide range of developers and suppliers (BRE 2004, Therivel 2004). None of these tools had a holistic coverage of the cope of sustainable development. There is perhaps therefore a need for further development to focus on more holistic appraisals.

[8] E.g. see www.suburbansolutions.ac.uk

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NICOLE SUSTAINABLE REMEDIATION WORK GROUP
2012 Report
SUSTAINABLE REMEDIATION INDICATORS

Sustainable remediation is the application of the principles of sustainable development, as described by the Brundtland Report (Brundtland 1987), to risk-based land management. It describes the intention of achieving a balanced remediation outcome in terms of the environmental, social and economic elements of sustainable development

In the *NICOLE Sustainable Remediation Road Map* a key part of sustainability assessment is agreeing what individual factors should be considered for each of the three elements of sustainability to execute an effective decision that meets the needs of both the project team and all the stakeholders.

This chapter explains that factors can be represented by indicators, in order to make them measurable and comparable. And it sets out an initial checklist approach for carrying out the decision process.

The measurement of sustainability

Sustainability cannot be measured in absolute sense. It is a subjective assessment shared by the stakeholders involved in a particular decision. This assessment draws together individual environmental, economic and social concerns important for a project. For example, environmental concerns might include greenhouse gas emissions and impacts on soil functionality; economic concerns might include a project's direct costs and resilience to external shocks such as effects of the economic cycle, or regulatory change;.social concerns might include the protection of human health and provision of access to green space.

The terminology that is used needs to be clear to avoid confusion. Within this document the approach used is as follows.:

- The various issues of concern for sustainable remediation which are identified by stakeholders are ***factors*** in decision making, even if some of them might be disregarded at an early stage. These factors are related to the *effects* of the contaminated land management process. Effects may be positive benefits (for example, re-use of materials) or negative impacts (for example, cost).
- An ***indicator*** is a single characteristic that represents a factor that can be compared across options to evaluate their relative performance. Hence, indicators need to be measurable or comparable in some way that is sufficient to allow this evaluation, for example, amount of recycled soil. An indicator which is measurable might also be called a ***metric***, for example, tonnage of recycled soil.
- In other words, the factors that are **criteria** used in decision making can be represented by indicators and/or metrics.

Sustainability assessment is challenging because sustainability is a complex function of a wide range of social, economic and environmental factors. Furthermore, some factors are difficult to express in quantifiable indicators (metrics) and some cannot be directly quantified at all.
There have been remediation projects where decision-makers have attempted to make "sustainability" decisions based on one or two numerically quantifiable parameters. Parameters that have been used for remediation decision-making include carbon intensity, energy intensity, resource intensity and life cycle assessment-based measurements (Bardos *et al.* 2010). The emerging consensus in NICOLE and other fora is that such a narrow approach does not represent sustainability in an overall sense i.e. it is not a balanced approach to *sustainable remediation* decision-making because it does not include a sufficiently broad perspective of sustainable development.

The Working Group's opinion is that:

- Sustainability assessment should be based on a broad interpretation of sustainability, but using indicators that are acceptable to the stakeholders involved in a particular decision-making process;
- Numerical assessments such as carbon intensity; energy intensity; resource intensity; and life cycle assessment based measurements may have a particular value to important areas of environmental policy such as climate change and resource efficiency, but they have significant shortcomings in the overall description of sustainability, and should not be presented as representing sustainability in an overall sense; and
- However, these numeric measurements can describe particular aspects of sustainability, and as such they may be an important part of a broader sustainability assessment process.

Implicit in the NICOLE opinion is that a true impression of the sustainability of remediation should be based on observing the wider sustainability effects of decisions independent of their objectives. NICOLE's methodology provides a broad ranging concept of sustainable remediation, set against a consistent approach to a broad benchmarking of sustainability effects.

Scope of sustainability assessment

In practice, sustainability management and assessment will be highly specific to a site (or portfolio of sites), project and its context. The breadth of issues to be considered (i.e. the *scope* of the sustainability assessment) is something that will have to be agreed between all relevant stakeholders before the assessment begins. The *scope* of the sustainability assessment is likely to be influenced by:

- The characteristics of the site and the project (for example whether a site is liable to flooding);
- Project related considerations (for example, how the remediation project is connected to ongoing and future land use);
- The remedies that might be applied (to take an extreme example, if the remedies include the use of genetically modified organisms there might be a range of sustainability concerns that would otherwise not be considered);
- The prevailing local, regional and national policy context and also the corporate sustainability polices of the stakeholders involved (the issues that they need to report on at a corporate level);
- Sustainability considerations included in the regulatory and spatial planning context;
- Neighbourhood considerations.

The site-specific interaction of these influences is very important. For example, for a large mining area regeneration, a key sustainability effect of the remediation approach might be landscape effects related to the choice of vegetation-based (phyto) remediation methods, or the long term outcome for vegetation from other methods; however landscape impacts might not be seen as relevant to remediation being carried out to resolve a leaking petrol tank at an operational filling station.

These influences render sustainability assessment both site- and project-specific. It is also essentially subjective because its scope depends on the factors selected by the stakeholders involved.

Dialogue with stakeholders during sustainability assessment is very important because if the assessment considerations are not acceptable to key stakeholders, then the outcome of the assessment will not be acceptable either, and the exercise will likely have been a waste of time and money.

In a similar manner to risk assessment criteria, decisions on the relative importance of sustainability criteria will be affected by higher level societal and the policy framework considerations applying to the site.

Given the range of possible opinions about what constitutes sustainability, sustainability criteria (indicators) therefore need to be decided on a case by case basis. It is not possible or desirable to create a rigid European framework of detailed indicators or weightings. However to ensure that the process has credibility and consistency, it is important that lines of evidence are created that support any sustainability criteria that are used, and that the assessment starts from a holistic view across the "three elements" of sustainability.

The Working Group is not suggesting that all sustainable remediation projects have to consider every possible indicator. It is suggesting that a broad approach should be starting point for decision-makers who subsequently may have good reasons to use, discard or supplement indicators. What is important is that the choices made in arriving at a final set of indicators for a particular decision are justified and agreed by all those who will need to accept the outcome of the decision(s) made.

Sustainability Objective Setting and Key Performance Indicators

In some case project stakeholders may agree amongst themselves to include specific sustainability objectives in a project, as well as risk management objectives, perhaps as "key performance indicators". Here are some examples:

- Remediation work is part of a larger redevelopment and construction project which includes target objectives based on materials re-use and waste minimisation;
- An operational site remediation may be required to comply with corporate policies leading to objectives related to carbon intensity and water use;
- A community based restoration project might include a broad range of objectives relating to local area improvement and community benefits.

These explicit sustainability objectives can both be included with an overarching sustainability assessment and monitored separately. The advantage of this is that not only can decision-making take into account specific project sustainability and risk management objectives; but it can also consider the wider benefits and impacts that accrue to different ways of reaching these goals.
The best option in terms of key performance indicators, or specifically agreed project sustainability objectives, may not be the best option in terms of sustainability overall, particularly if the range of sustainability objectives is very narrow.

Providing a consistent sustainability assessment approach

While the range of indicators to be considered within the scope of sustainability will vary from case to case, it is important to provide some form of benchmarking, against a generally agreed checklist, which stakeholders can use to validate their selection of indicators. This ensures they have an adequate breadth of coverage and that they have adequately tested their own choices in selecting which indicators to take forward.
The NICOLE working group has not provided a checklist; these are being developed independently in more than one Member State. Two example approaches against which benchmarking can be carried out, one from the UK and one from the Netherlands, are described below.
Benchmarking should be seen as advisory and not prescriptive. It should function to stimulate discussion about the range of sustainability concerns that should be taken into account for determining the sustainability of a particular decision by:

- Identifying indicators which might not otherwise have been considered;
- Providing a structure in which indicators can be grouped to reduce or at least identify duplications; and
- Providing a holistic and broad ranging sustainability assessment.

During benchmarking, and on the basis of a sound rationale, stakeholders may:

- Adopt indicators;
- Discard indicators; and
- Add indicators, and place these in groupings of similar or related considerations.

The selection process has increased robustness if the stakeholders provide a brief evidence-based rationale for each of these choices. In particular they should provide the rationale why any particular indicator is seen as irrelevant for a particular sustainability assessment, or why an additional indicator should be included.

Examples of Benchmarking Approaches

Support for selecting indicators for sustainable remediation have been made in the UK and in Netherlands. The approaches are slightly different, but the overall goals of ensuring an adequately broad understanding of sustainability by stakeholders and supporting some consistency in approach are the same.

SURF-UK (CL:AIRE 2011) has made an initial suggestion of possible overarching categories ("headlines") for indicators across the three elements of sustainability, as shown in Table 1 below, based on an extensive review of indicator sets in various sectors (CL:AIRE 2009, 2010). These will continue to be developed as experience of their practical application grows. These categories are intended to be used for benchmarking project-based proposals for sustainability indicators to ensure that a sufficiently wide-ranging perspective of sustainability has at least been initially considered. However, it is acknowledged that subsequently stakeholders involved with a particular project will determine that factors within one or more of these "headline" categories, for a particular case, will be of limited or no relevance. This selection will be highly project and site specific. More detail on these categories is provided in CL:AIRE 2011.

Another example of an approach to indicators has been developed in the Netherlands. A large group of stakeholders has identified a set of indicators in the ROSA project (Slenders *et al.* 2005). ROSA provided a basis set of indicators for standard projects, which can be extended for site specific issues. Care was taken that there were no duplicates. The "Dutch" approach is based upon the idea that an assessment involves balancing the benefits of a remedial action with the impacts that the action brings with it. Starting with a checklist that is structured into social, environmental and economic indicators it is possible to divide the selected indicators into benefits and impacts. In the decision process focus is laid on the indicators that significantly differ between options. The preferable remedial option has the best balance between benefits and impacts. Table 2 is an example of a benefits and impacts table based on ROSA philosophy. Table 2 reflects the end-point of a series of discussions that narrowed down a wider range of possible indicators to a functional list for a particular sustainability appraisal at a particular site.

Table 1 Overarching categories of indicators for sustainability assessment of remediation options suggested by SURF-UK (CL:AIRE 2011)

Environmental	Social	Economic
1. Air[1] 2. Soil and ground conditions 3. Groundwater and surface water 4. Ecology 5. Natural resources and waste	1. Human health and safety 2. Ethics and equity 3. Neighbourhoods or regions 4. Communities and community involvement 5. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits 3. Employment and employment capital gain; 4. Induced economic costs and benefits 5. Project lifespan and flexibility

Table 2 Example Benefit Impact Table based on the ROSA Approach

Benefits	Impacts
Risk reduction	Cost
Increase of possible use	Risk of failure
Decrease of liabilities	Remediation duration and aftercare
Contaminant removal	Waste generation, CO_2 production, dust, noise, nuisance
Increase in property values	Consumption of non-renewable energy
Other site specific issues (care must be taken not to duplicate)	Other site specific issues (care must be taken not to duplicate)

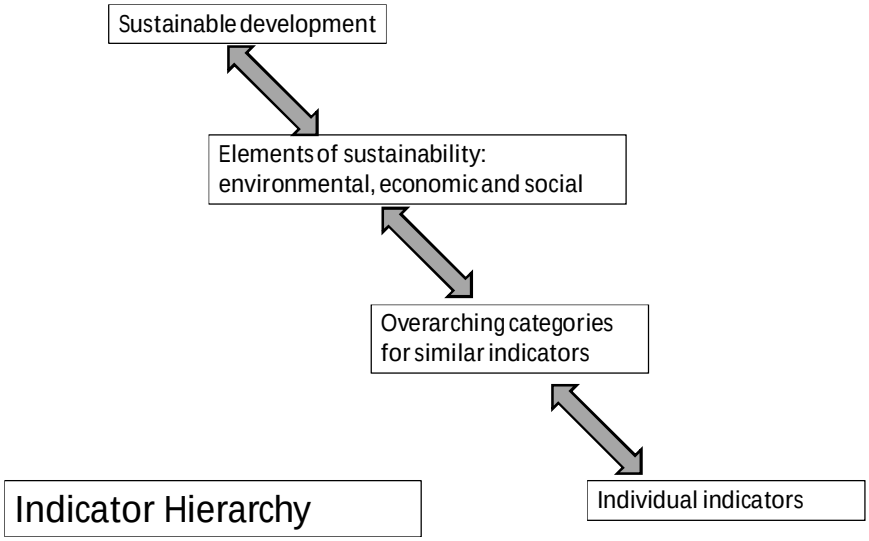
A structured checklist

Indicators can be organised into a structure or hierarchy that links individual indicators. Sustainability has three elements: economy, environment and society. Each element can be further subdivided into groups that collect similar types of indicators. Each group includes a range of individual indicators sufficiently similar that it makes sense to group them together. This is illustrated on the figure below.

[1] including climate change

For example, the headlines in the SuRF-UK suggestions are subcategories of “environmental”, “economic” and “social”.

Essentially, this hierarchy allows a *scaleable* approach to sustainability assessment and determining the scope of sustainability with the other stakeholders who may need to be involved in the process. The degree of rigour is likely to be set by what is agreeable to the stakeholders (e.g. client, regulator, planner, service providers) for a particular site / portfolio / project), and should not impose a burden that is out of proportion to any benefits that would be achieved.



Indicator Hierarchy

In situations where a high degree of rigour is required, e.g. a large number of comparisons for individual indicators, the hierarchical structure supports their aggregation. This helps, especially in structuring the ultimate presentation in assessments of the economic, environmental and social elements of sustainability for each of the options concerned. The way the indicators are structured depends on the situation, e.g. on the audience for the final sustainability assessment

Using indicators in tiered sustainability assessments

Sustainability assessment techniques all employ some means of aggregating individual assessments of indicators to provide an overall understanding of “sustainability”. Qualitative or quantitative approaches may be used in sustainability assessments. In general quantitative approaches are limited to particular aspects of sustainability.

It will generally be sensible to start with simple qualitative techniques to see if these provide a clear cut decision based on sustainability, rather than more expensive (and potentially more limited) scoring or quantitative techniques.

This is particularly important where the indicators are hard to deal with in a quantitative way. Furthermore, not all stakeholders may have sufficient time and expertise to fully scrutinise complex assessments. Methods where the stakeholders involved in a decision process have a good overview of the factors determining sustainability, facilitate decision-making. Quantitative techniques can make decisions seem more complex and may also add a false level of security to assessments which are still essentially subjective and heavily reliant on assumptions.

More generally, where a qualitative discussion does not deliver a clear cut decision, it should enable the team to determine which particular factors require further quantitative assessment, for example those for which no consensus exists or for which no distinct qualitative comparison between options is possible.

There are a range of techniques to set the scope of sustainability depending on the requirements of the user, for example decision tables, multicriteria analysis or cost benefit analysis. It may be sensible to

structure the use of indicators in these tools in the same way as the hierarchy suggested above, for example, a cost benefit analysis could be structured so that its considerations are grouped as economic, environmental and social elements. The level of detail will generally be dependent on what is agreed as a scope by decision-makers, and many techniques are flexible in the range of considerations (i.e. indicators) they can consider.

Record keeping

To maximise the change of acceptance of the results, all stakeholders must be able to keep track of the decision making process. This is especially important where stakeholders include lay participants. Therefore, the decision-making process should be transparent at each step, and for each step record the inputs to the decision-making process, the assumptions and evidence used in decision making, the working out of the decision, and the outputs of that step (which serve as the inputs to the subsequent step).

Thus, record keeping should cover all steps in the road map from the setting of initial objectives onwards.

Where decisions are made that simplify the process, e.g. disregarding particular management options or limiting the scope of what is to be considered as sustainability, the rationale for those decisions should be recorded in sufficient detail; so that, if they need to be revisited (e.g. following verification work, or because the decision is to be audited by some external organisation), it is clear why they were taken and how consensus was reached.

Way Forward

The next steps suggested are therefore to test the sustainability assessment approaches in case studies to refine approaches, and then to test them 'in the wild' on a number of remediation projects. NICOLE's SR work group will follow up on this from 2011.

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