A Framework for Assessing the Sustainability of Soil and Groundwater Remediation

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Sustainable Remediation Forum (SuRF) Australia

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE)

Australian Land and Groundwater Association (ACLCA)

1. Executive Summary

This document presents initial suggestions by the Sustainable Remediation Forum (SuRF) Australia for a framework for incorporating sustainable development criteria in soil and groundwater remediation decisions that can be applied in Australia. The formulation of this document has drawn heavily from a similar document prepared recently by the Sustainable Remediation Forum (SuRF) UK and CL:AIRE, and its initial preparation was supported by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) and the Australian Land and Groundwater Association (ALGA).

Sustainable remediation is defined in this document as *the practice of demonstrating, in terms of environmental, economic and social indicators, that an acceptable balance exists between the effects of undertaking remediation activities and the benefits that those activities deliver.*

The proposed framework recognises that there are two main stages where sustainable remediation decision-making is applied: Firstly at the project/plan design stage when some of the most influential decisions about the remediation solution can be embedded into a sustainable project design; and secondly at the point of remediation selection and implementation when the decision is about selecting the optimum remedial strategy or technique.

The framework can be applied to various decision-making scenarios within a property life-cycle. This may be from the early stages when basic remediation requirements for a particular site can be considered as part of regional land-use planning, through the process of site-specific land-use considerations, to more detailed remediation strategy and technology selection at the project-design and delivery phases.

The framework can be applied to applications across a variety of remediation scenarios. These include brownfield redevelopment where the sustainability issues associated with remediation are just one of a number of factors that influence the whole project sustainability. It also can apply to remediation on operational land where the remediation decisions define the sustainability of the overall project and ecological remediation.

In selecting remedial solutions, a decision making process should be applied that identifies the key stakeholders and the requirements that must be satisfied vs those requirements that are desirable but not mandatory, and systematically identifies and selects a remedial strategy (i.e., source treatment, pathway interception or receptor modification) that is likely to satisfy the essential requirements, and optimises the net benefits of the risk-management actions that make up the strategy.

2. Introduction

2.1 Scope of this document

This document provides an initial suggestion for a framework for managing land and groundwater contamination in Australia a manner compatible with sustainable development principles. It has drawn heavily in terms of both the principles and text from a framework document prepared by CL:AIRE and SuRF UK[1].

The intention is that this framework will assist assessors take account of relevant sustainable development criteria in selecting the optimum land-use design, determining remedial objectives for contaminated land and groundwater, and in selecting an optimum remediation strategy.

The proposed framework identifies two fundamental stages at which sustainability can be considered: firstly at the plan/project design stage and, secondly, at remediation implementation. The framework is flexible and generic so that it can be applied to various decision-making scenarios within a property lifecycle and for different sizes of project or site.

2.2 Overview of sustainable development

Sustainable remediation forms one part of a much broader sustainable development agenda. Sustainable development was defined by the World Commission on Environment and Development[2] (1987), (commonly known as 'the Brundtland Commission'), and is concerned with the optimisation of environmental, social and economic benefits in human activities. This framework takes its definition of sustainable development from 'the Brundtland report', which is "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs". This is commonly interpreted as those actions that, taking account of environmental, social and economic factors, optimise the overall benefit (Figure 1).

Sustainable development assessments are commonly undertaken for large and extensive (in spatial and temporal scale) developments. Remediation activities are often just one component of a wider redevelopment project, but one that is commonly overlooked during initial planning and sustainable development appraisals. Consideration of remediation issues alongside other relevant considerations in wider sustainable development appraisals should result in projects that are 'better by design'. The principles of sustainable remediation should be applicable to not only large projects, but also to small projects and potentially can offer significant improvements in project outcome.

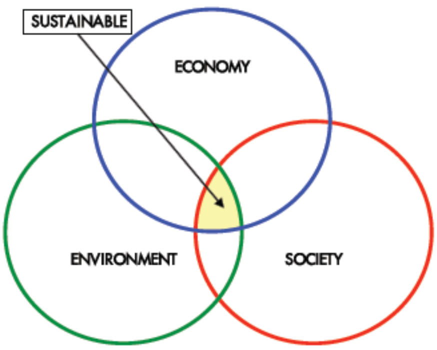

Figure 1. Sustainable development is a balance between environmental, social and economic factors

[1] CL:AIRE and SuRF UK (2009) *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation*, draft subject to public consultation, May [provided by Jonathan Smith]

[2] United Nations World Commission on Environment and Development. 1987. Our Common Future (The Brundtland Report). Oxford University Press 1987. ISBN 0 19 282080 X. Available at: http://www.worldinbalance.net/pdf/1987-brundtland.pdf

2.3 Role of remediation within sustainable development

The three elements of sustainable development (environment; society; economy) should be considered when assessing the likely benefits of undertaking any scheme, including remediation. Remediation is defined here as actions to assess or break a source-pathway-receptor linkage and thereby manage risks associated with the presence of contaminants in the environment.

The overall significance of soil and groundwater remediation to the sustainability of a scheme can vary depending on its relative contribution to an overall project. The earliest influence on the property lifecycle considered in this framework is regional spatial planning. At this stage remediation-related considerations are only one small component of a spatial strategy for a region. For example, demographics, flood-risk and transport are also factors. Therefore the impact of sustainable remediation decisions may have a relatively minor impact of the sustainability of a scheme. At this stage it must be recognised that on occasions decisions will be made that appear to be non-optimum with regard to remediation because other factors are more influential in optimising the overall (environmental, social and economic) benefits of a scheme.

At a site-specific level in a brownfield redevelopment scheme the role of the remediation process becomes more significant, and during the remediation of operational land (i.e. where there is no change of use proposed) the role of remediation defines the project. In such cases, the sustainability of the remediation design and implementation defines the sustainability of the whole project.

3. The Framework for Sustainable Remediation

3.1 Introduction and definition of sustainable remediation

Sustainable remediation can be defined[3] as *the practice of demonstrating, in terms of environmental, economic and social indicators, that an acceptable balance exists between the effects of undertaking remediation activities and the benefits that those activities will deliver*.

3.2 Key principles of sustainable remediation

There are a number of key principles that are associated with sustainable remediation, and which should be considered by assessors in the design, implementation and reporting of sustainable remediation schemes. These are[4]:

Principle 1: Protection of human health and the wider environment. Remediation should remove unacceptable risks to human health and to the environment, with due to consideration to the costs, benefits and technical feasibility.

Principle 2: Safe working practices. Remediation works should be safe for workers on-site, local communities and the environment.

Principle 3: Consistent, clear and reproducible evidence-based decision-making. Sustainable remediation decisions are made having regard to environmental, social and economic factors, and to current and future implications including the principles of intergenerational equity and the precautionary principle. A sustainable remedial solution delivers the maximum net-benefit achievable.

Principle 4: Record keeping and transparent reporting. Remediation decisions, including the assumptions and supporting data used to reach them, should be documented in a clear and easily understood format.

Principle 5: Good governance and stakeholder involvement. Remediation decisions should be made having regard to the views of stakeholders and following a clear process that they can participate in. In certain projects it is recognised that non-optimum remediation decisions may be made because other factors are more influential in optimising the benefit from a development scheme. Recording why such a decision was taken should be a minimum requirement for any decision making process.

Principle 6: Sound science. Decisions should be made on the basis of sound science, relevant and accurate data, and clearly explained assumptions. This will ensure that decisions are based upon the best available information and are justifiable and reproducible.

In selecting and deciding between remedial solutions, it is helpful to identify the requirements that flow from the application of these principles that must be satisfied vs those requirements that are desirable but not mandatory, and to restrict consideration to those solutions that are likely to satisfy the essential requirements.

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[3] CL:AIRE and SuRF UK, op cit

[4] CL:AIRE and SuRF UK, op cit

3.3 The structure of the framework

There are two stages in a project cycle at which sustainability can be considered:

(a) Stage A: at the plan/project design, and

(b) Stage B: at remediation implementation.

This is shown in Figure 2.

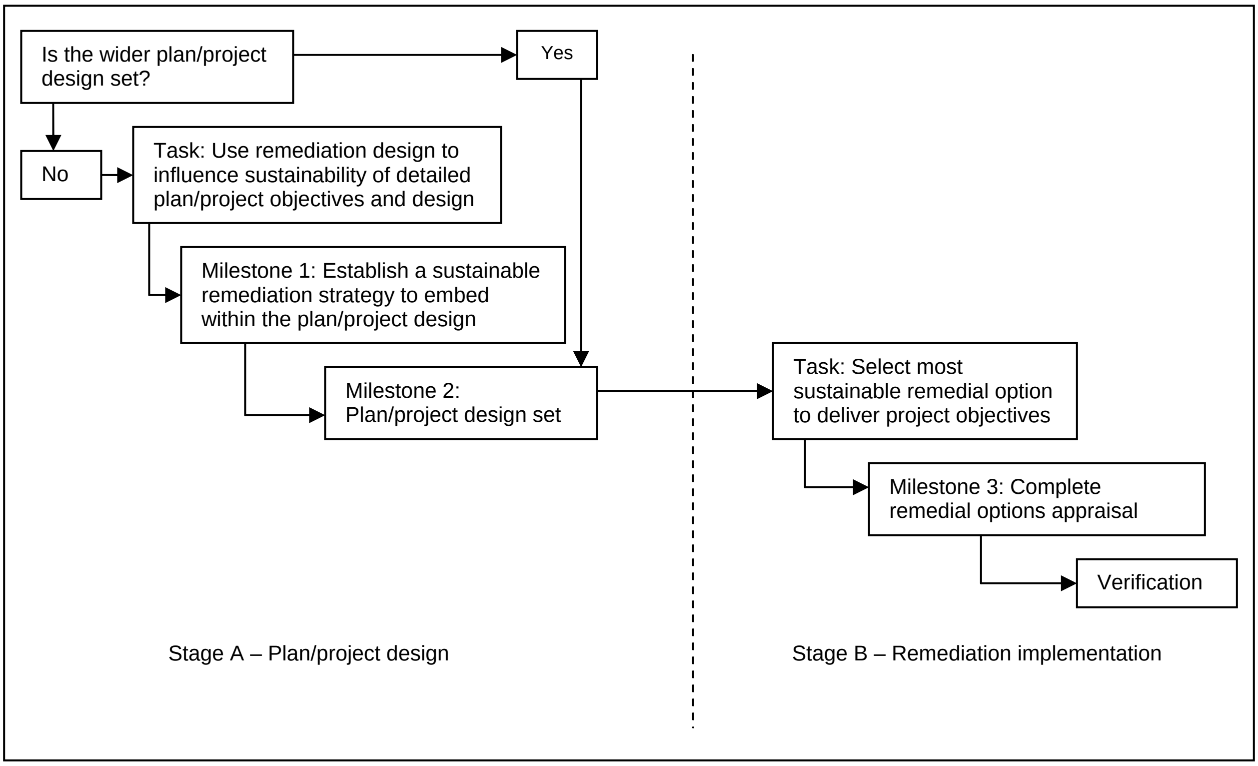

Figure 2. The Framework

The framework recognises that there is an opportunity to embed a sustainable remediation strategy into the wider project/plan design. This stage is considered a relatively flexible stage, permitting several design iterations in an effort to integrate the most sustainable remediation strategy into the wider project.

Usually completion of the project/plan design delivers a milestone related to an agreed and final project design or plan. Once the broader project frame is established the main influence that can be achieved by a sustainability assessment is to identify the optimum remediation that will facilitate delivery of the project design or plan.

Conceptually, within any scale of site (be it a regional plan, industrial mega-site or small site) or any type of project (brownfield redevelopment, operational site remediation) the same rules of the framework govern the approach:

- There is a starting point at which the project design or plan layout is under consideration. If remedial strategy factors are considered at this stage then there is a Task that involves developing and embedding a sustainable remediation strategy in the wider project/plan design. The first milestone is this embedded remedial strategy that feeds into the second milestone, which is the final project/plan design.
- At the completion of Milestone 2 there is typically a point of limited return (the break-point). This occurs because, for example, contracts, regulatory agreements, conditions of a permit or a planning consent are finalised. In contractual terms, the break-point often is the point of

signing a contract, irrespective of the form of agreement under consideration. It may also be the point at which remediation practitioners first become involved.

- After this point, the project design is set and the only relevant Task is to select the most sustainable remediation option. The third milestone is a completed Remedial Options appraisal, which results in selection of a preferred remediation solution that can be implemented and subsequently verified.

The framework identifies a break-point between these two stages because the opportunity to revisit the design once the design milestone has passed is often limited.

3.4 Applying the Framework

The framework is intended to be flexible so that it can be applied to various decision-making scenarios within a property lifecycle, and to different sizes of project or site. Figure 3 illustrates how it can be applied to different remediation scenarios by using one or both stages of the framework. Further, Stage A can be 'recycled' as stages A1 and A2 within a brownfield site assessment that is taken through design stages, firstly at regional-scale planning and then at a site-specific level.

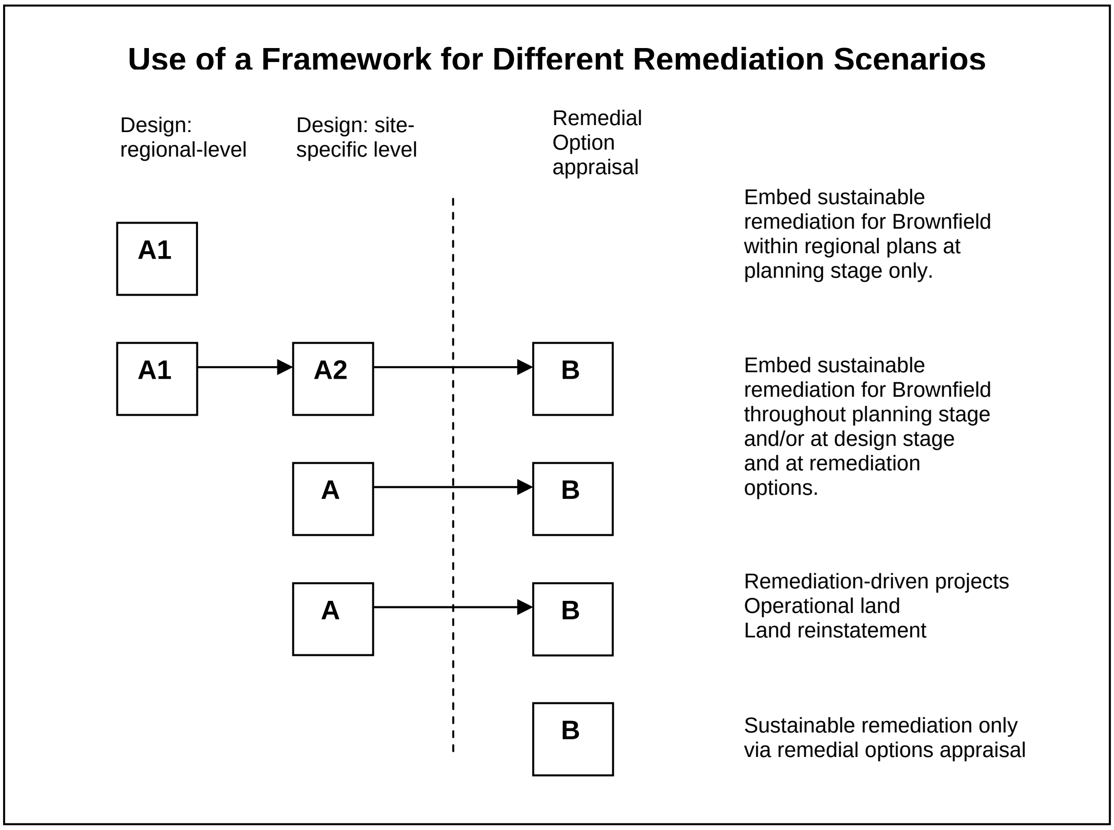

Figure 3. Use of Framework for different remediation scenarios

3.4.1 Town and Country Planning

In Australia, the Town and Country planning process develops local spatial plans and formally allocates land for different uses (e.g. employment, residential, retail etc.). Sustainable development is a core principle of this process.

Remediation requirements represent one of the factors that can be considered when developing the optimal mosaic of land-uses and site-specific designation.

This is essentially only Stage A of the framework, with knowledge of the likely remediation requirements of various sites influencing their land-use designation. In Figure 3 it is shown as a Stage A process. It is not linked to Stage B remediation implementation since it is exclusively a decision-making process at a regional planning level and the final milestone is a regional plan. It is presented within this document to demonstrate the potential overlap the framework may have with the planning sector.

3.4.2 Brownfield land

The framework recognises that a parcel of brownfield land may be subject to two phases of design, firstly at local-scale planning with a land-use determination and then at site-specific level, arguably with a breakpoint between them. This concept is presented on Figure 3 as two phases A1 and A2 and is supported by Appendix B. However, an alternative and perhaps more common option in practice for brownfield land is that the local plan is set and only the site-specific design issues will be considered.

Site-specific design examples of sustainability considerations might include:

- Location of different land-use types in a mixed-use scheme, given different risk-based remediation criteria and a heterogeneous distribution of contaminants across a site (e.g. locate most vulnerable receptors and land-uses away from most contaminated areas);
- Considerations for basement parking related to remediation requirements (e.g. avoid excavating clean soil to create basements while at the same time remediating other soils in-situ);
- Considering use of vapour membranes to intercept a potential ‘pathway’ rather than excavating and disposing of large volumes of soil.

3.4.3 Operational land

Remediation work on operational land (e.g. where there is no change of use and remediation is part of a liabilities management program) invariably drives the sustainability of the project, since the remediation work is the project. This scenario is shown as two stages on Figure 3. In this case establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design are part of the same milestone.

3.4.4 Land restoration for ‘soft’ end-uses

Remediation work as part of land restoration projects also normally represents one of the main drivers of the sustainability of the project since the remediation work is a significant part of project together with non-remediation earthworks.

Unlike brownfield redevelopment the subsequent life-time impacts of the scheme are commonly less. This scenario is shown as two stages on Figure 3. Often, establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design is the same milestone.

3.4.5 Remediation implementation only

The framework recognises that in many circumstances, a practitioner does not have an opportunity to influence the design work. They may only asked to implement a selected remediation strategy, in order to deliver the design requirement. This represents a Stage B framework process as shown on Figure 3.

At this stage the remediation options appraisal can only seek to influence the technologies or techniques used to achieve risk-based remedial objectives and also optimise the net (social, environmental and economic) benefit provided by the remediation.

4. Legislative and regulatory context

The Australian approach to the management of existing land and groundwater contamination is founded on a risk-based ‘suitable-for-use’ philosophy. There is national guidance on the assessment of contamination (the National Environment Protection (Assessment of Site Contamination) Measure 1999; however, the requirements relating management of land and groundwater contamination is determined on a State-by-State basis though State Environment Protection Acts and Regulations, and guidance prepared by State and Territory planning and environmental agencies. In Australia the environmental agencies appoint accredited auditors or third party reviewers to assist the agencies in review of work carried out by site owners and their consultants, and to ensure that the guidelines issued by the agencies are adhered to.

The environmental agencies in each State and Territory are most influential in setting the detailed technical requirements for the objectives and extent of clean up that is required. In general, because the environmental agencies are charged with protecting the environment, their guidance reflects this charter and requires protection of the beneficial uses or environmental values of land, groundwater and surface water. In terms of recognising that there is a balance to be achieved between the social, economic and environmental benefits of a program of management and remediation of contamination, existing guidance does not well address this, although the environmental agencies have developed guidance such as that relating to “Clean Up to the Extent Practicable” (eg Victoria[5], NSW[6]), “Remediation to the Extent Necessary” (eg South Australia[7]), Monitored Natural Attenuation (Western Australia[8] and others), and an assessment of risk to beneficial uses (rather than necessarily achieving strict compliance (Victoria[9]). This guidance recognises that in some cases complete clean up is not practicable or necessary, and allows for alternative methods to be applied that will not necessarily achieve full clean up within a short timeframe. There is also considerable flexibility in State and Territory guidance relating to the final outcome of site remediation methods, in that land can be certified as being suitable for particular land uses subject to certain conditions or controls on land use activities.

In general, Australian environmental agencies have recognised the importance of considering the broader issues of sustainability and achieving outcomes that provide a balance between social, economic and environmental factors when managing and remediating contaminated land and groundwater, and a body of practice is evolving, working within the constraints of existing guidance and through discussion with the regulatory agencies on a case by case basis.

In preparing this draft framework, it has been the intention to work within existing regulatory guidance to encourage the consideration of the principles of sustainability in the management and remediation of soil and groundwater contamination.

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[5] EPA Victoria (2002), The Clean up and Management of Polluted Groundwater Publication No. 840

[6] DECC NSW (2007), Guidelines for the Assessment and Management of Groundwater Contamination

[7] EPA South Australia (2009), *Guidelines for the Assessment and Management of Groundwater Contamination*

[8] DEP WA (2004), *Use of Monitored Natural Attenuation For Groundwater Remediation*

[9] EPA Victoria (2007) *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment* Publication No. 952.2

5. Applying the framework

5.1 A tiered approach to assessing sustainability of remediation activities

Sustainable remediation requires an assessment of the environmental, social and economic aspects associated with land and groundwater remediation, in order to ensure that the net benefits are maximised, and that they exceed the (economic, social and environmental) costs of undertaking remediation.

Sustainable remediation can involve decisions on an optimum remedial strategy at a number of points in a site's (re)development or risk-management process. The principal points at which a formal assessment may be made are:

- Spatial (land-use) planning: Consideration of the impact of remediation alongside other relevant criteria on the sustainability of different land-use allocations during regional spatial planning and redevelopment activities;
- Site specific master planning to ensure the allocated use of the site is set out in the most appropriate and efficient manner;
- Remedial strategy design: Selection of a remedial strategy (i.e., source treatment, pathway interception or receptor modification) that can satisfy essential requirements and optimises the net benefits of risk-management actions;
- Remediation technology selection: Selection of a remedial technology or technique that can satisfy essential requirements and achieves risk-based remedial goals in the most sustainable manner.

In addition, consideration of sustainability criteria can occur at the following points:

- Design of site characterisation strategies (e.g. by focusing site characterisation to improve understanding of plausible source-pathway-receptor linkages to improve a conceptual site model; minimising journeys to site for numerous poorly-planned phases of site investigation; use of non-intrusive technologies, and design of site characterisation to prevent new contamination by, for example drilling through low-permeability confining layers);
- Design of remediation verification strategies (similar issues to site characterisation);
- Collection of data to verify a sustainability assessment.

Consideration of remediation issues should be included alongside other relevant considerations in a sustainable development assessment undertaken as part of spatial planning activities. The potential implications take two primary forms. Firstly, allocating land for new potentially contaminating activities in low-sensitivity locations (e.g., remote from sensitive environmental receptors), in order to avoid future need for remediation in the event of a release close to potential receptors; and secondly, allocation of existing areas of brownfield land for continued potentially contaminating activities in preference to more sensitive end-uses in order to avoid new potentially contaminating activity on greenfield sites, and minimise remediation requirements to make the land 'suitable for use'.

At each assessment point there should be a review to identify the key stakeholders and mandatory requirements to ensure that these requirements will be met. Assuming that these requirements will be met or are likely to be met, the environmental, social and economic costs and benefits associated with the available options that could achieve the redevelopment / risk-management objectives can then be assessed. This assessment can be based on qualitative or quantitative methods.

In this process it is essential to maintain a view of the essential requirements that must be met, and to distinguish these from those that are merely desirable. It is also important to not allow the analysis to lose view of issues that are important to stakeholders, by summing and averaging many different criteria. It should involve a structured process that identifies the most important requirements and seeks to ensure that they are satisfied before moving to consider less important requirements.

SURF US[10] has provided a discussion on regulatory criteria that can form essential requirements in some instances. Drawing from CERCLA (ie Superfund), these include, for example, protection of human health and the environment, and compliance with other criteria that can include short term effectiveness, long term effectiveness, implementability, reduction in mobility, toxicity, volume of contaminants, and cost.

A hierarchy of suitable sustainability indicators that are relevant to remediation activities are described in the next section. A range of techniques is available to undertake the sustainability assessment. A tiered approach using simple qualitative approaches should be used where this is adequate to reach a justifiable decision. Semi-quantitative multi-criteria analysis and monetised cost-benefit analysis may be used for more complex and difficult site assessments.

The specific tool used for a sustainability assessment is less important than the process and thought that goes into an assessment. An assessment that considers environmental, social and economic factors from various stakeholder perspectives and which reaches a management decision based on a transparent and documented process is likely to be more acceptable than one which uses a sustainability assessment tool as a 'black box' and which fails to properly consider or justify input data and assumptions. Sustainability assessment tools should help evaluators undertake an assessment and make a management decision, not be the assessment.

A range of tools and methods are available for undertaking a sustainability assessment, but in essence they all seek to achieve the same goal: to assess the relative environmental, social and economic benefits and disbenefits (or costs) for a range of suitable options that meet a project goal. The assessment methods measure the benefits and disbenefits in some way (often financial cost, but could be any form of 'currency') and seek to identify:

- whether the overall benefits (of remediation) exceed the overall costs of doing the work;
- for those methods where net-benefit exceeds net-cost, the method or methods that offer the maximum overall benefit.

5.2 Sustainability indicators for remediation

Sustainability appraisal is generally based on an assessment of the performance of different remediation options against a list of sustainability indicators. Relevant assessment criteria fall under three headings: environmental, social and economic. For example, assessment criteria for remediation technology selection might include the 18 indicators presented in Table 1. These indicators are representative of the range of relevant indicators found in the international peer-reviewed literature on sustainability appraisals and are relevant to land and groundwater remediation activities.

[10] Sustainable Remediation Forum-US (SURF-US), 2009. Integrating sustainable principles, practices and metrics into remediation projects. Remediation Journal Summer 2009, Published online in Wiley Interscience (www.interscience.wiley.com). DOI: 10.1002/rem.20210

Table 1: Possible indicators for a sustainability assessment of remediation options

Environmental	**Social**	**Economic**
1. impacts on air; 2. impacts on soil; 3. impacts on water; 4. impacts on ecology; 5. use of natural resources and generation of wastes; 6. intrusiveness.	1. impacts on human health and safety; 2. ethical and equity considerations; 3. impacts on neighborhoods or regions; 4. community involvement and satisfaction; 5. compliance with policy objectives and strategies; 6. uncertainty and evidence.	1. direct economic costs and benefits; 2. indirect economic costs and benefits 3. employment and capital gain; 4. gearing; 5. life-span and 'project risks'; 6. project flexibility.

Sustainability appraisal techniques 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 appraisals. In general quantitative approaches are limited to particular aspects of sustainability, but may be useful for gathering evidence as part of an overall appraisal.

A system of scoring the relative importance or benefit / disbenefit that each remediation options provides against other alternatives is needed. At the cost-benefit stage this is performed by monetizing the costs and benefits that each remedial option incurs against each of the 18 sustainability indicators. However at the simpler assessment levels a non-monetized approach is typically used, such as 'a score out of ten' or high-medium-low ranking. Indicators are integral to the communication of sustainable development. They help assessors review progress objectively, they highlight where the challenges are, and they help people to understand what sustainable development means globally, nationally, locally and for them as individuals.

There have been various reviews of the qualities of, and uses for, sustainability appraisal indicators, and a review of sustainability indicators applicable to land and groundwater remediation projects has been provided for example in UK documentation[11].

[11] CL:AIRE, 2009. *A review of published sustainability indicator sets: How applicable are they to contaminated land remediation indicator-set development?* CL:AIRE, London.

6. Recording decisions

Clear recording of decisions, and of the assumptions made in reaching decisions on sustainable remediation is an important aspect of the framework. Good communication, an open and honest approach, reliance on sound science and documented decisions are fundamental to reaching an outcome that all parties recognise as being reasonable and equitable.

Sustainable remediation should deliver risk-based remediation of the environment acceptable to the key stakeholders and decision makers, with due to consideration to the costs and benefits of the strategy. As part of this process, it must be recognised that on occasions non-optimum remediation decisions will be made because other factors are more influential in optimising the overall benefits of a scheme. Such consideration may include, for example, demographic factors, flood-risk management and transport.

How these decisions are recorded in the context of the framework is shown in Figure 4.

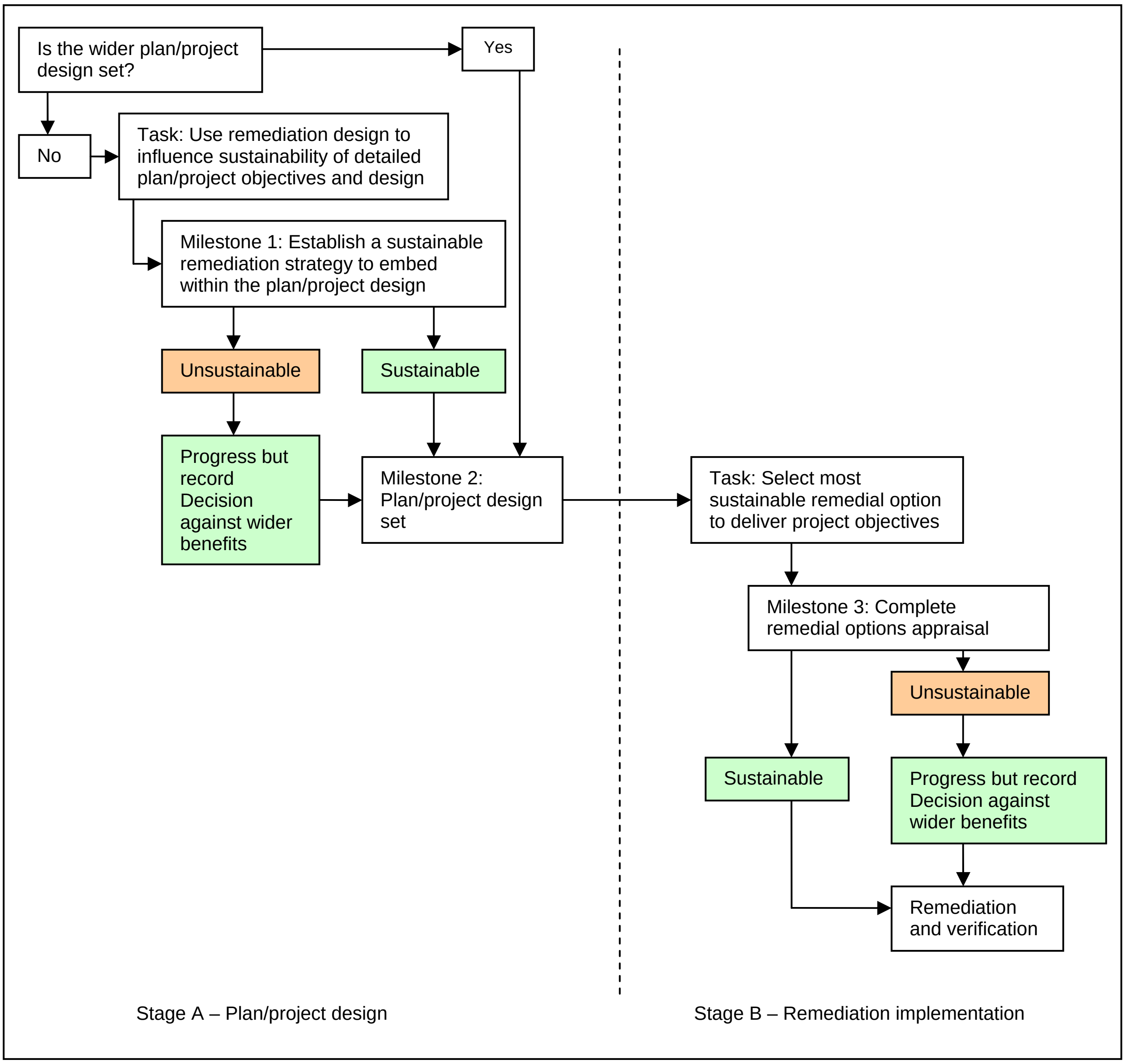

Figure 4 Recording non-optimum ('unsustainable') decisions

7. Interactions with other sustainable remediation initiatives

Sustainable remediation is a rapidly developing research and environmental management topic internationally. A number of other initiatives are currently active, and are summarised below:

7.1 SuRF-UK

SuRF UK is the United Kingdom's Sustainable Remediation Forum – an initiative set up to progress the UK understanding of sustainable remediation. The current working mission statement is as follows:

'To develop a framework in order to embed balanced decision making in the selection of the remediation strategy to address land contamination as an integral part of sustainable development'

The deliverable of SuRF UK and CL:AIRE (a key supporting organisation) is a framework, as opposed to a tool or model. In using the word 'balanced' the mission statement means for a framework to consider social, environmental and economic factors. 'Strategy' is meant to include the design and implementation phase of a remediation project whilst 'Land contamination' is meant to capture related groundwater issues. 'Development' is meant in a wider context of sustainable development as opposed to the narrower meaning of a property development scheme.

The work plan aims to deliver a working framework by spring 2009 using a series of open forum meetings and smaller working groups to share and develop ideas for the framework.

7.2 SuRF-US

SuRF-US is a collaborative initiative of industry and consultancy members, with active USEPA participation, that seeks to develop understanding and methods for sustainable remediation principles that are relevant in a US policy and regulatory context. A thorough overview of SuRF-US activity and progress has been recently published[12].

SURF-US' stated working concept is:

- In fulfilling our obligations to remediate sites to be protective of human health and the environment. We will embrace sustainable approaches to remediation that provide a net benefit to the environment.
- To the extent possible, these approaches will:
  - Minimize or eliminate energy consumption or the consumption of other natural resources
  - Reduce or eliminate releases to the environment, especially to the air
  - Harness or mimic a natural process
  - Result in the reuse or recycling of land or otherwise undesirable materials
  - Encourage the use of remediation technologies that permanently destroy contamination

[12] Sustainable Remediation Forum-US (SURF-US), 2009, op cit

7.3 NICOLE

NICOLE (www.nicole.org), the Network of Industrially Contaminated Sites in Europe, has a working group on sustainable remediation which seeks to establish a framework for sustainable remediation applicable across Europe. NICOLE is comprised dominantly of private-sector organisations and the approach largely reflects the views of industry and consultants. SuRF-UK steering group members are working with NICOLE to ensure consistency of approaches where appropriate.

NICOLE's working definition of sustainable remediation is: a "framework in order to embed balanced decision making in the selection of the strategy to address land [and/or water contamination] as an integral part of sustainable land use".

Any definition must allow ability to

- Make risk based decisions
- Consider [and define] boundaries in time and space
- Ensure a balance of outcomes can be achieved
- Consider land [and water] use first as part of the process

The basic decision making rationale behind contaminated land management is based on risk assessment. However, the means of achieving risk management must in itself not place unreasonable demands on the environment, economy and society, the three key elements of sustainable development.

7.4 USEPA Green Remediation

'Green Remediation' as defined by the US Environmental Protection Agency[13] is an initiative to encourage the use of renewable energy in remediation activities, and the avoidance of unnecessary use of natural resources and waste generation. It is anticipated to lead, in due course, to development of an ASTM standard. A key difference between Green Remediation and the approach outlined in this document is that the proposed approach seeks to consider remediation activities as part of the broader sustainable development objectives of the project, rather than simply to select the most 'environmentally-friendly' technology to achieve a given remedial objective. It is recognised that certain remedial activities and objectives may be 'unsustainable' regardless of the energy source used to achieve them. In these circumstances reconsideration of the fundamental remedial objectives is recommended, which is beyond the scope of Green Remediation. Nevertheless, lessons learned through the Green Remediation initiative may be extremely valuable at the technology selection stage. The USEPA define 'green remediation' as "the practice of considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup actions.".

Green remediation considers a range of impacts: air pollution caused by toxic or priority pollutants such as particulate matter and lead; water cycle imbalance within local and regional hydrologic regimes; soil erosion and nutrient depletion as well as subsurface geochemical changes; ecological diversity and population reductions; and emission of carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and other greenhouse gases contributing to climate change[14] (USEPA 2008).

[13] United States Environmental Protection Agency, 2008. Green remediation: Incorporating sustainable environmental practices into remediation of contaminated sites. Report EPA 542-R-08-002 (http://www.cluin.org/download/remed/Green-Remediation-Primer.pdf)

[14] USEPA 2008, op cit