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Supplementary Report 1 of the SuRF-UK Framework: A General Approach to Sustainability Assessment for Use in Achieving Sustainable Remediation

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Supplementary Report 1 of the SuRF-UK Framework: A general approach to sustainability assessment for use in achieving sustainable remediation (SR1)

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Supplementary Report 1 (SR1) and Supplementary Report 2 (SR2) supersede "Annex 1: The SuRF-UK Indicator Set for Sustainable Remediation Assessment" (2011)

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- Hayley Thomas – Shell Global Solutions International BV. [representing SAGTA] (Joint Chair)
- Paul Bardos – r3 Environmental Technology Ltd (Joint Chair)
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Contents

1. Introduction

The United Kingdom's Sustainable Remediation Forum (SuRF-UK) was established in 2007 to advance, understand and promote the application of sustainable remediation in the UK. The SuRF-UK *Framework for Assessing the Sustainability of Soil and Groundwater Remediation* (CL:AIRE, 2010) helps assessors include sustainable development considerations into land remediation decisions.

Further work has been published by CL:AIRE and is freely available through the SuRF-UK Roadmap: https://www.claire.co.uk/surf-uk. This body of work includes the world's first (and so far only) guidance on identifying indicators for the assessment of sustainable remediation: *Framework for Assessing the Sustainability of Soil and Groundwater Remediation, Annex 1: The SuRF-UK Indicator Set for Sustainable Remediation* Assessment (CL:AIRE, 2011). It also includes SuRF-UK's 2014 guidance (in presentational format) on the process of sustainability assessment.

What is an indicator/criterion/metric?

An *indicator* is a single characteristic that represents a sustainability effect which 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. (From Network for Industrially Contaminated Land in Europe (NICOLE) 'Road Map for Sustainable Remediation', www.nicole.org).

When an indicator is a basis for comparison to support a decision, then it becomes a *criterion*.

Since their publication, the Framework indicators and supporting guidance have been used widely, both in the UK and internationally (Bardos *et al*., 2018). Subsequently an ISO Standard 18504:2017 on *Soil Quality - Sustainable Remediation* (ISO, 2017) was published in 2017, which drew on the work of SuRF-UK. With the benefits of nearly ten years' experience implementing the Framework, the SuRF-UK Steering Group considered it was timely to review and refine the "Annex 1" indicator guidance, as well as more clearly describe the process of indicator selection and how it fits into sustainable remediation assessments. As a result of the review, SuRF-UK has now created two supplementary reports that support the SuRF-UK Framework which replace the 2011 Annex 1, which is now withdrawn.

This report is *Supplementary Report 1* of the SuRF-UK Framework. It describes a general approach to sustainability assessment that consolidates a range of guidance issued by SuRF-UK since 2011. It provides guidance on how to carry out sustainability assessments for remediation design and strategy setting and remediation technology selection[1].

[1] Accompanying this report is *Supplementary Report 2 of the SuRF-UK Framework: Selection of indicators/criteria for use in sustainability assessment for achieving sustainable remediation.* This report provides a detailed checklist of possible indicators/criteria to support agreeing the scope of sustainability assessment.

2. Objectives of this document

SuRF-UK defines sustainable remediation as *the practice of demonstrating, in terms of* ***environmental, economic*** *and* ***social*** *indicators, that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a* ***balanced*** *decision-making process* (CL:AIRE, 2010), in line with ISO 18504:2017.

> The objective of this report is to briefly describe a process for sustainability assessment of options for the purposes of land contamination management. This can take place at the stage of project design and planning (which SuRF-UK terms Stage A) and at the stage of option appraisal for remediation technology selection (which SuRF-UK terms Stage B) or both.

Sustainability assessment broadens out the factors to be considered in remediation decision-making to optimise the functionality and improve the value (in environmental, social and economic terms) of the work being carried out. However, sustainability assessment does not replace the underpinning role of risk assessment in decision-making for the remediation of land contamination. This is one of a series of key principles that form the foundation of the 2010 SuRF-UK Sustainable Remediation Framework, which are reproduced in Box 2.1, below.

Sustainability assessment is a part of options appraisal, either when a project that might involve remediation is being planned, and/or for selection of remediation actions. It supports technical option appraisal. Needless to say sustainability assessment of an option that is not effective, practical nor technically feasible is superfluous.

Box 2.1: Key principles of sustainable remediation (from CL:AIRE, 2010).

Principle 1: Protection of human health and the wider environment. Remediation [site-specific risk management] should remove unacceptable risks to human health and protect the wider environment now and in the future for the agreed land-use, and give due consideration to the costs, benefits, effectiveness, durability and technical feasibility of available options.

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

Principle 3: Consistent, clear and reproducible evidence-based decision-making. Sustainable risk-based remediation decisions are made having regard to environmental, social and economic factors, and consider both current and likely future implications. Such sustainable and risk-based remediation solutions maximise the potential benefits achieved. Where benefits and impacts are aggregated or traded in some way this process should be explained and a clear rationale provided.

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 in order to demonstrate to interested parties that a sustainable (or otherwise) solution has been adopted.

Principle 5: Good governance and stakeholder involvement. Remediation decisions should be made having regard to the views of stakeholders and following a clear process within which they can participate.

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

3. Context: the role of sustainability assessment

The purpose of applying sustainability in remediation is to ensure that good, and ideally optimal, choices are made during risk management decision-making, i.e. *sustainable* and risk-based land management. Sustainability is related to sustainable development, as defined by Brundtland in 1987 and updated in the UN Sustainable Development Goals of 2015 (UN World Commission on Environment and Development, 1987; UN, 2015). Risk assessment remains the trigger for remediation for historically contaminated sites, and defines its critical objectives, as set out on the UK Government website *Land contamination: risk management*[2]. Remediation to background conditions may be required where land has been contaminated as a result of a current or recent breach of environmental permitting, where the affected land is a protected habitat site, or indeed as a result of a specific land owner policy.

This guidance relates primarily to risk-based decision-making and supporting better choices about how risk-based objectives are delivered. Improvements are achieved by recognising opportunities for wider benefits and minimising/mitigating undesirable wider impacts, and so improving the overall value of the remediation work. However, the consideration of sustainability would also be beneficial in the other circumstances mentioned.

The SuRF-UK approach is comparative:

- Comparing across a range of available options.
- Comparing a single option with a baseline ‘do nothing’ scenario.

Note: even where several options are being compared, inclusion of a ‘do nothing’ scenario can be good practice.

There are various UK (EU or international) policy and regulatory drivers (CL:AIRE and NICOLE, 2015), as well as corporate sustainability policy drivers, that are linked to the achievement of sustainability in remediation. For example, in England public authorities are required “to have regard to economic, social and environmental well-being in connection with public services contracts” under the Public Services (Social Value) Act 2012 (2012 Chapter 3).

3.1 When to consider sustainable remediation

Early action yields greatest benefit. The SuRF-UK Framework (CL:AIRE, 2010) describes two points in decision-making at which sustainable remediation considerations may be influential (see Figure 3.1):

- At a project/land use planning stage, when remediation outcomes might be used to influence the pattern of use for a site, for example, siting of building plots and car parks and landscaping, which in turn defines the likely risk management outcomes required (“**Stage A**”); and

[2] https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks.

- At a treatment specification stage, when remediation objectives have been determined and the decision is based on optimising the remediation route by which these agreed objectives will be delivered ("**Stage B**").

Typically, while it is possible to consider remediation sustainability at Stage A for some sites, there will be a number of projects where remediation objectives are already agreed (and hence not easily changed) so consideration will start at "Stage B".

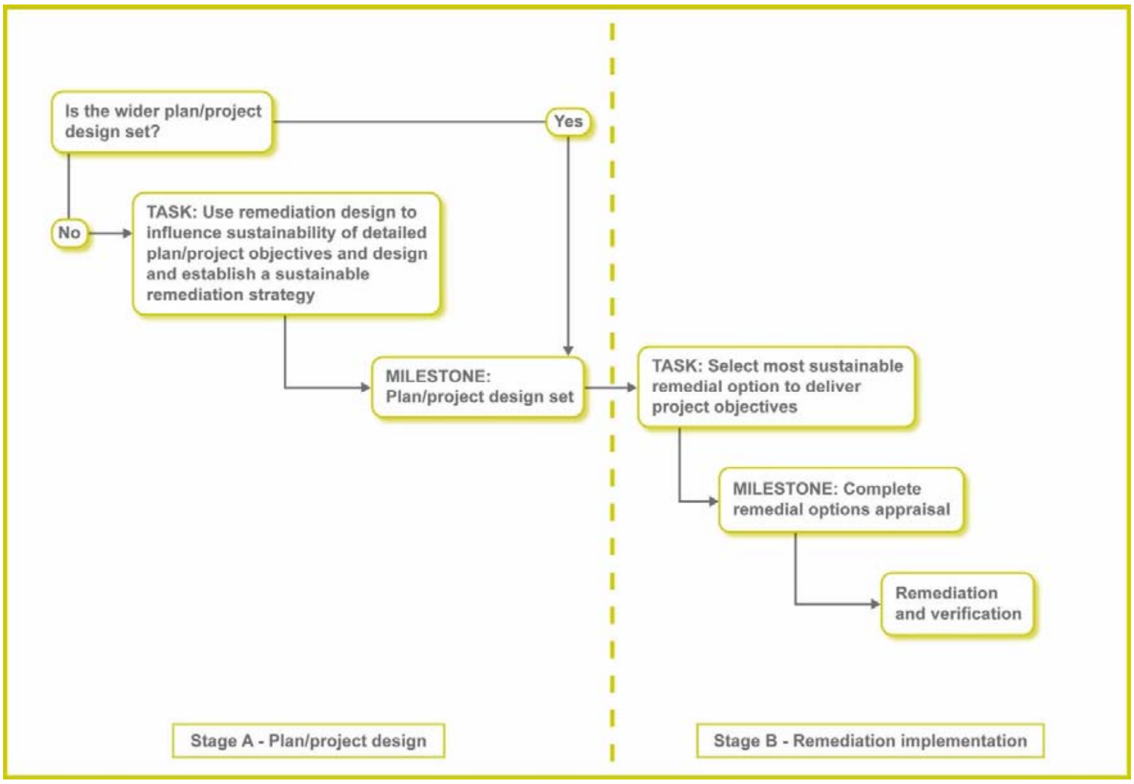

Figure 3.1. Overall schematic of the SuRF-UK Framework (CL:AIRE, 2010).

3.2 Sustainability and risk management

With several decades of experience gained in land contamination management, the policy and technical consensus is that land contamination decisions should be made on the basis of risks to human health and the wider environment. For a risk to be present, a source (of hazardous substance or property), a receptor (which could be adversely affected by the contamination) and a pathway (linking the source to the receptor) must be present (a Source-Pathway-Receptor (S-P-R) linkage). A receptor might be a human, an ecologically sensitive site, water resources, or a building. While not generally legislated for, ecological system 'goods or services' provided by the wider environment[3] may become an increasingly important receptor to consider in risk analysis. Where a risk is unacceptable risk management interventions can take place at any point in the S-P-R linkage, as long as it breaks the linkage. The source may be removed, the pathway intercepted, or the receptor behaviour or location modified. A

[3] e.g. as described by the World Health Organization: https://www.who.int/globalchange/ecosystems/en

range of risk management/remediation options are available at different points across any particular linkage[4].

Remediation is not intrinsically sustainable and poorly planned projects can have serious negative impacts. Sustainable *and* risk-based contaminated land management seeks to address this through linking risk management and sustainable development principles (NICOLE and COMMON FORUM, 2013). Sustainable risk-based management is the optimal approach for contaminated land decision-making, combining a risk-based framework for determining when harm (or potential harm) is unacceptable and where action is necessary, and ensuring sustainability is a part of deciding how such unacceptable risks are to be managed. It ensures a balanced decision is taken which optimises overall benefit. Much has been learned in applying sustainability assessment to contaminated site management projects. In the best examples, significant improvements in project sustainability have been delivered, including concurrent reduction of the environmental footprint of the remediation, improved social performance, cost savings and/or value creation. Examples of sustainable remediation can be found as case studies at www.claire.co.uk/surfuk. Sustainable remediation provides the land contamination management community with a framework to incorporate sustainable development principles into remediation projects and deliver significant value for affected parties and society more broadly (Smith, 2019).

Sustainability assessment is not intended to repeat or supplant the risk assessment and risk management decision-making that have triggered a project. *A consequence of this is that simple compliance with risk management objectives is not a primary consideration in SuRF-UK sustainability assessment*.

Sustainability considerations may also inform the following risk management considerations:

- At Stage A sustainability assessment may identify optimisations for the project in an overarching way, for example by suggesting changes to site layout that minimise the degree of intrusive/intensive activity required.
- It is legitimate to consider (as part of a sustainability-based comparison of options) whether particular remediation options beneficially offer a higher degree of improvement/protection than that specified in the project risk management objectives, or if they offer a more resilient or robust approach.
- The use of site-specific risk assessment at Stage A will enhance the optimisation of remedial objectives by directing risk management goals to the specific context of a site rather than relying on generic (and invariably conservative) assumptions. Moreover, it may also support a more exact rationale for supporting site design and layout or may significantly reduce or refine the overall quantum of remediation at a given site, to better prevent harm, while minimising the inputs necessary to achieve this.

3.3 Sustainability assessment is multifactorial and site specific

Assessing sustainable remediation is multifactorial across a wide range of categories which may or may not be readily quantifiable. SuRF-UK has defined five categories of indicators for each of the three elements of sustainability (environmental, economic and social), shown in Table 3.1. Within each of these is a range of individual indicators

[4] Land contamination: risk management, https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks

(criteria) that can be considered to arrive at an overall *scope* for what is to be considered as “sustainable”. Further guidance is provided in *Supplementary Report 2*.

Sustainability is not capable of being reduced to single metrics.

Single metrics, for example a carbon footprint, are inevitably highly reductive and do not represent “sustainability” in any kind of overall way (e.g. Laurent *et al.,* 2012). It is for this reason that SuRF-UK recommends taking a tiered approach to sustainability assessment for remediation, beginning with a qualitative tier that enables the most wide-ranging scope of sustainability to be considered with a more readily manageable degree of effort. There is no single unit or quantum of sustainability (Bardos *et al*., 2011): sustainability assessments are site and project specific, and for a significant number of indicators depend on stakeholder/expert opinion rather than an intrinsically measurable property. There are two consequences to this. Firstly, sustainability assessments need to be comparative between options within a particular site/project. They are unlikely to be directly comparable across different sites or projects. Secondly, to be robust and persuasive, it is sensible to consider views across a range of interested parties, not least the different stakeholders who need to take account of the assessment outcomes in their decision-making and have a material impact on the project (e.g. site manager/owner, land-use planner, regulator, service provider).

Table 3.1. SuRF-UK headline categories for sustainability indicators.

Environmental	**Economic**	**Social**
ENV1: Emissions to air	ECON1: Direct economic costs and benefits	SOC1: Human health and safety
ENV2: Soil and ground conditions	ECON2: Indirect economic costs and benefits	SOC2: Ethics and equity
ENV3: Groundwater and surface water	ECON3: Employment and employment capital	SOC3: Neighbourhoods and locality
ENV4: Ecology	ECON4: Induced economic costs and benefits	SOC4: Communities and community involvement
ENV5: Natural resources and waste	ECON5: Project lifespan and flexibility	SOC5: Uncertainty and evidence

Sustainability outcomes are site and project specific, and not solely related to the remediation technique. An outcome that is strongly site related might be the impact of site restoration on surrounding property values (part of *ECON2 Indirect economic costs and benefits*). An outcome that is strongly related to technique might be the capacity to generate recyclates (part of *ENV5*, *Natural resources and waste*). An outcome generally related to *both* site *and* technology might be the energy intensity of the remediation (affected by choice of *in situ* approach and the nature of the subsurface as well as other factors).

Sustainability assessment is subjective, given its site and project specific nature and because some important factors may be largely opinion based (for example perceptions relating to *SOC3 Impacts on neighbourhoods and localities*).

Given its inherent subjectivity, the usefulness of a sustainability assessment, its transparency, its resilience and its persuasiveness depends on careful “framing”. Framing is a process of preparing and defining the sustainability assessment approach so that it is fit for purpose for the particular site/project it is being applied to.

Chapter 4 sets out SuRF-UK's approach to framing and carrying out (executing) a sustainability assessment. The approach consists of simple steps, which are not unduly onerous, and are in line with ISO 18504:2017 (ISO, 2017). It is intended to be used in conjunction with *Supplementary Report 2*, which provides more detailed guidance on the selection of indicators/criteria to set a site/project specific scope for sustainability assessment.

3.4 Wider project management benefits of sustainability assessment

A key wider project management benefit of sustainability assessment is identification of effects where compensatory or mitigation measures might be put in place to improve the outcomes for one or more of the options being considered, to help ensure the project delivers net benefit. (Hence the assessment work can also be iterative because opportunities for improvement can be identified and then outcomes re-assessed).

Considering sustainability during risk management, including remediation design, can also generate additional project management benefits:

- In early stages of decision-making it may show how changes in the project design can avoid unnecessarily intrusive/intensive remediation.
- It provides a rigorous framework for predicting pinch points and potential areas of difficulty in delivering remediation. For example, where stakeholders may have differences in opinion about measurements used to predict the effectiveness of remediation or how they value different remediation impacts. The process of considering sustainability may also identify secondary impacts which might then either be designed out or mitigated.
- It provides a due diligence process for the overall understanding of the net benefit of the remediation work envisaged and a rigorous rationale for making choices between different approaches and methods that might be available/offered.
- It may identify beneficial opportunities for synergy, for example with other project activities (for example in the more effective use of energy or recyclates).

4. The process of sustainability assessment

Figure 4.1 summarises the SuRF-UK suggested approach to sustainability assessment, and this chapter is organised across its three broad tasks: (1) preparation, (2) definition and (3) execution, summarised in Table 4.1 (Bardos *et al.,* 2016).

Task 1. **Preparation** sets out the rationale for the assessment, the project or site being considered, the scenarios being compared, any opportunities and constraints that may apply, who will be consulted and when, and how the assessment will be reported and communicated. Comparison of sustainability is only possible if all the scenarios/options being compared have the same risk management objectives. At **Stage A** objectives may be broader. At **Stage B** these may be quite closely defined.

Task 2. **Definition** summarises and formats the preparation work as a series of objectives for the assessment, and then goes further to set careful boundaries for the work, how the comparison will be made, and how uncertainties will be dealt with.

Task 3. **Execution** applies the outputs from the first two tasks (i.e. the "framing" of the assessment) to a sustainability assessment. The preparation and definition of tasks are specific to each site/project.

Together the preparation and definition tasks provide the "framing" of the sustainability assessment. This framing underpins the fitness for purpose of any sustainability assessment. Qualitative, semi-quantitative and potentially quantitative tools can all be applied to sustainability assessment. A critical point is that for a given site or project the *same* framing process needs to be used for all tiers of sustainability assessment whether qualitative (Tier 1), semi-quantitative (Tier 2) or quantitative (Tier 3) to ensure transparency, and to ensure all tiers have a consistent definition and purpose.

Sections 4.1 to 4.3 describe the processes of preparation, definition and execution in further detail. Appendix 1 provides an *aide memoire* for the key questions and information to be collected from each step of the sustainability assessment. Additional information and support are also provided below:

- SuRF-UK has developed a simple qualitative sustainability assessment tool, described in Appendix 2. This closely matches the steps set out in Section 4.3.
- For users interested in semi-quantitative or quantitative approaches, further information is provided in Appendix 3.
- Conceptual models may be useful in carrying out and communicating sustainability assessments. Information about this approach is provided in Appendix 4.
- A spreadsheet has been developed using *MS Excel* which is downloadable from www.claire.co.uk/surfuk and can be used to guide and record the process of framing and Tier 1 qualitative sustainability assessment.

A key feature of the sustainability assessment process, evident from Figure 4.1, is that it is iterative. This iteration may be a function of how stakeholders are engaged with the sustainability assessment process, or, as a result of refinements which become evident as the process is conducted.

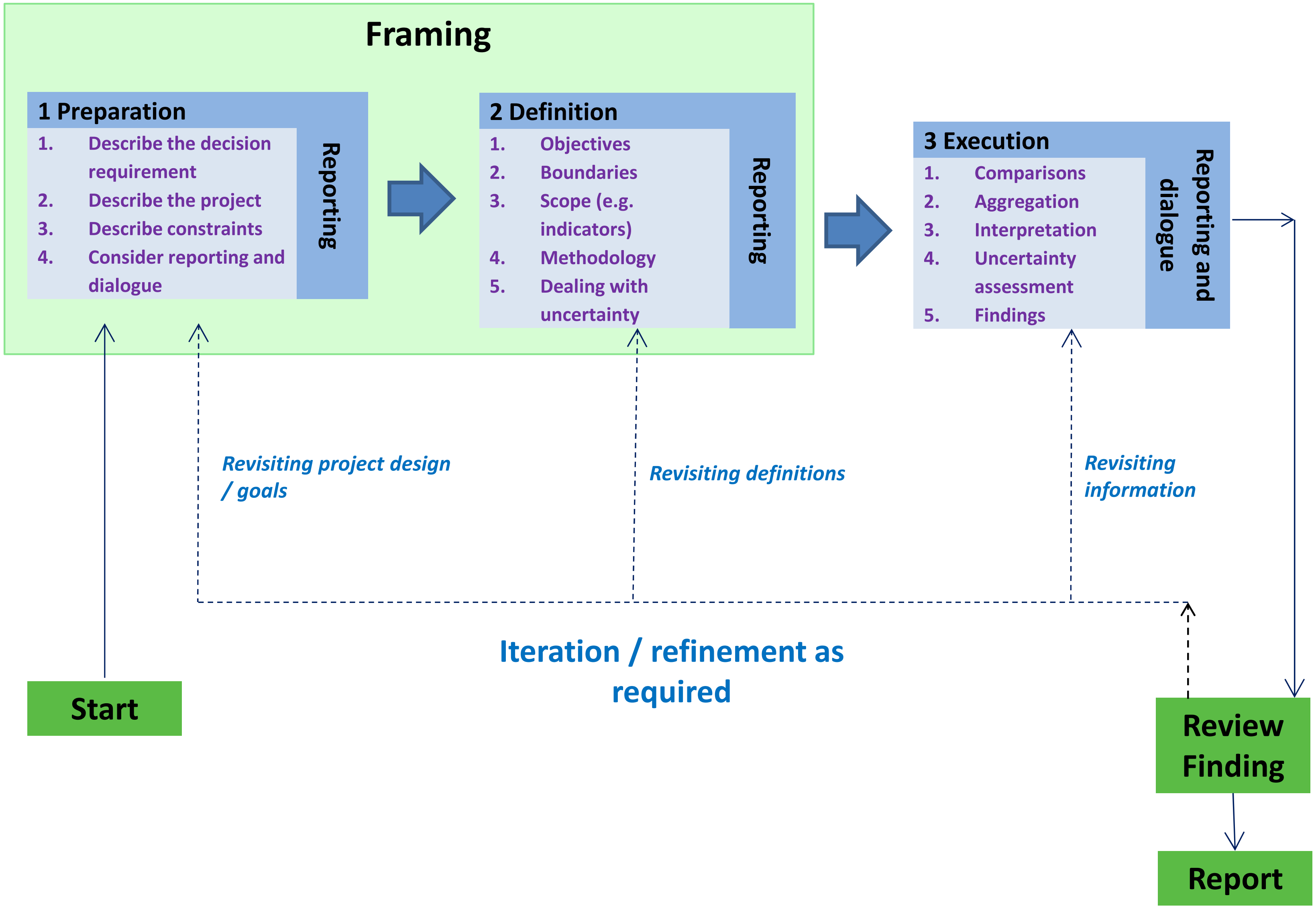

Figure 4.1. Sustainability assessment and its framing (adapted from CL:AIRE, 2014).

Table 4.1. Summary of the key steps within each broad task of SuRF-UK sustainability assessment.

Task 1 - Preparation	Task 2 - Definition	Task 3 - Execution
Step 1.1: Describe the decision requirement Describe the decision the sustainability assessment is intended to support and how its outcomes will be used, and also the stakeholders who need to be engaged with it.	*Step 2.1: Summarise objectives* This activity reviews the preparation steps and consolidates them, especially since the preparatory and definition stages of framing may be separated in time.	*Step 3.1: Comparisons by indicator/criterion* Compare options for each individual sustainability indicator/criterion (identified in Step 2.3) in a way that is compliant with the methodology agreed (Step 2.4).
Step 1.2: Describe the project Clearly describe the project's remediation, risk management goals and any wider goals of importance. Specify the options to be compared using sustainability assessment.	*Step 2.2: Identify boundary conditions* Describe the assessment boundary conditions related to system, depth of consideration, proximity and timeframe.	*Step 3.2: Aggregation of individual comparisons* Aggregate individual outcomes, for example to overall comparisons by headline category, and from there comparisons for each of the three elements of sustainability, as set out in Step 2.4.
Step 1.3: Describe constraints & opportunities Identify constraints and opportunities. Constraints limit possibilities for remediation. Opportunities are where features of the site could create benefits, for examples synergies in energy or materials use.	*Step 2.3: Agree scope/indicators* Describe the range of individual sustainability considerations to be included in the assessment from the headlines summarised in Table 3.1, which is set out in detail in *Supplementary Report 2*.	*Step 3.3: Interpretation* Initial conclusions are drawn from comparing options for "sustainability" in broad terms, and also for individual factors of special interest; discussion and review and ground truthing with wider stakeholders.
Step 1.4: Consider reporting and dialogue Plan how reporting and dialogue will involve the stakeholders identified in Step 1.1, in line with the SuRF-UK Framework's Key Principles, specifying who will be involved and when.	*Step 2.4: Agree methodology* Set out the methodology by which options are going to be compared for the different sustainability indicators/criteria being considered.	*Step 3.4: Understanding uncertainties* Sensitivity analyses can be applied to help stakeholders understand how uncertainties related to information/approach play out for the overall sustainability assessment outcome.
	Step 2.5: Agree how to deal with uncertainty Set out an approach for identifying uncertainties and reviewing their potential effect on sustainability assessment outcomes.	*Step 3.5: Presenting the findings* Check the clarity of the outcome, and determine conclusions. If the outcome is not clear consider a more detailed assessment (i.e. a higher "tier").

From a practical point of view, it can be helpful for a small team to make a preliminary framing and trial assessment. This is because it is often easier for people to comment on an existing draft than start something from scratch. For example, see Figure 4.2, an initial comparative sustainability assessment, including framing and qualitative assessment might be developed by the site owner and consultant based on their understanding of likely wider stakeholder perspectives. This can be used as a basis for discussions at a wider stakeholder meeting, or bilaterally with additional stakeholders. Based on their feedback the sustainability assessment can be refined and made more robust. Anecdotal experience is that the iterative steps of consultation and review meetings can be very quick for (Tier 1) qualitative sustainability assessments.

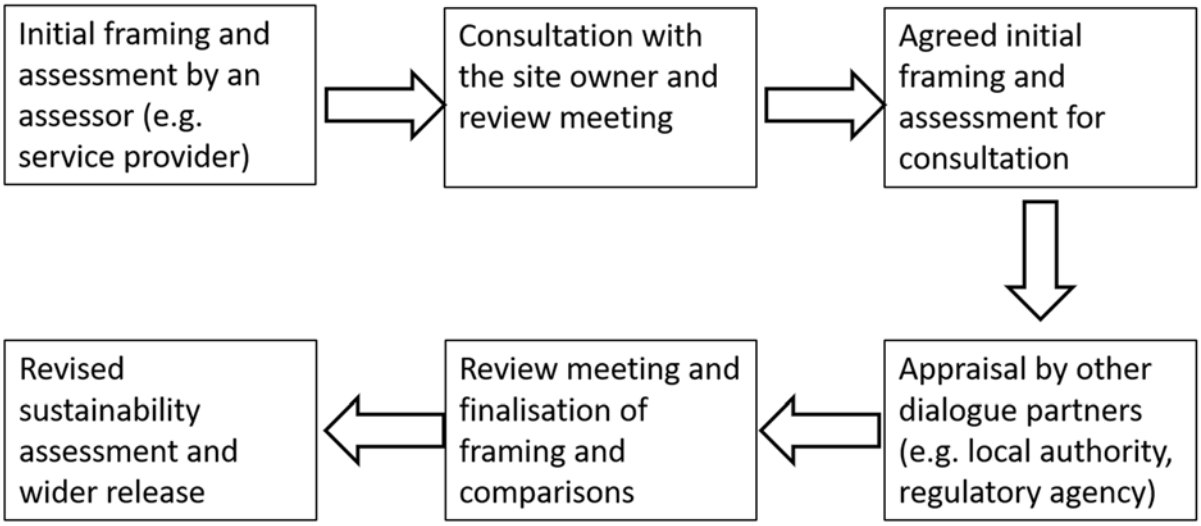

Figure 4.2. An example iteration pathway.

4.1 Task 1 - Preparation (part of framing)

4.1.1 Step 1.1: Describe the decision requirement

Describe the decision the sustainability assessment is intended to support, how its outcomes will be used, and also the stakeholders who need to be engaged with it.

Sustainability assessment can be used for different functions at Stage A or Stage B, which affects how it will need to be carried out and who will need to be involved, see Figure 4.3 (from the 2010 SuRF-UK Framework).

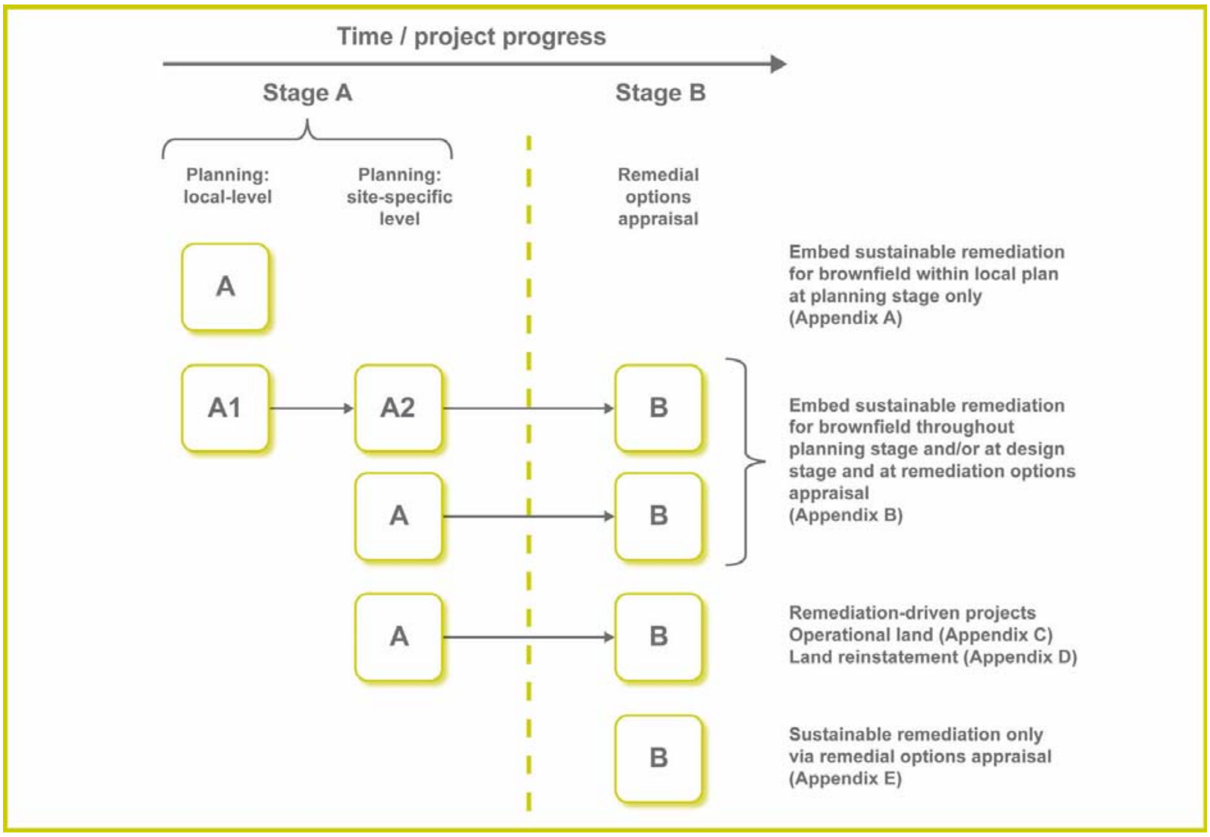

Figure 4.3. Decisions that might be supported by sustainability assessments. The appendices relate to the SuRF-UK Framework (CL:AIRE, 2010).

A particular set of circumstances will be the trigger for the sustainability assessment. This trigger will set the project, the decision, and who may need to be involved in the assessment process. For example, at Stage A there may be opportunities to change a masterplan to minimise the remediation work necessary, and at Stage B there may be a range of technical remediation options to deliver the risk management objectives agreed. These choices might represent the decisions that the sustainability assessment would support.

Any particular project will have its initiators and those who have an interest in its outcomes, for example the site owner, the service providers, the planner, the regulators, as well as wider interested parties in the local community. These stakeholders, and their willingness to support particular project decisions, might be influenced by the sustainability assessment.

The starting point for the sustainability assessment is therefore a clear description of what is the decision to be supported by the sustainability assessment and who are the people, the stakeholders, who need to be engaged with the sustainability assessment, and for what purpose.

4.1.2 Step 1.2: Describe the project

Clearly describe the project's remediation, risk management goals and any wider goals of importance. Specify the options to be compared using sustainability assessment.

The primary purpose of this step is to describe the overall project being considered, for example, a brief review of the context of the project and nature of the site and the aims of the project. At **Stage A** this may be related to master-planning goals and choosing between different scenarios which will result in different specific remediation strategies to fulfil a wider risk management and site development goal. For example, the project may be a site redevelopment where choices may be made between the locations of different features, which affect their end use in terms of risk assessment. At **Stage B**, choices are likely to be more about selecting between specific remedial techniques that could break S-P-R contaminant linkages and remove or reduce unacceptable risks.

There may also be wider goals for a project in addition to risk management that affect the choices being made, for example, additional goals for site preparation for geotechnical purposes. It is important to understand the full boundaries of each option, for example, the movement of materials off-site and the start and end points of a particular remediation approach (such as containment on site versus destruction of contaminants off site). This is needed to delineate the system boundary that the sustainability assessment will be based on

As previously mentioned, the SuRF-UK approach is comparative:

- Comparing across a range of available options
- Comparing a single option with a baseline 'do nothing' scenario.

Note: even where several options are being compared, inclusion of a 'do nothing' scenario can be good practice

This step should also summarise the key risk management context for the site (for example a conceptual site model) and identify the key documents that provide the wider technical context for the site, and how they can be sourced. The importance of this sign-posting is to ensure that this background is readily available should the sustainability assessment need to be revisited.

4.1.3 Step 1.3: Describe constraints and opportunities

Identify constraints and opportunities. Constraints limit possibilities for remediation. Opportunities are where features of the site could create benefits, for examples synergies in energy or materials use.

Constraints limit what options are feasible and may set minimum thresholds that have to be achieved for different sustainability considerations. Examples include:

- Available time, space and budget.
- Decisions that have already been taken and will not be revisited, for example, on-going/future land-use.
- Constraints resulting from legislation and policy such as regional/local planning policies, regulations on groundwater resources, corporate requirements.

Opportunities may favour particular remediation approaches, for example, integrating energy recovery with site restoration, or possible synergies such as linking to ground stabilisation for construction purposes. Wider opportunities might be: integration and contribution to corporate goals and/or the UN Sustainable Development Goals (SDGs) (UN, 2015; Sachs *et al.,* 2020); possibilities to create habitat and increase natural capital of a site; or the creation of community resources/benefits.

Features of the site, for example any infrastructure in place (or not in place) may also create both opportunities and constraints when selecting a technical option and in their sustainability assessment outcomes. An example of a constraint might be the presence of disused buried services that might interfere with particular *in situ* solutions. An example of an opportunity might be existing hardstanding which could be used to locate *ex situ* remediation treatments.

Constraints and opportunities may need to be explained to other stakeholders so that there is an upfront agreement on how these affect the goals of the project and the options being considered to deliver it. They may be hard or soft:

- A soft constraint could be there is only a limited area of land to undertake the remedial activities. This is a soft constraint because there could be a possibility of getting access to more land and you might decide to do that if one of the options needed that and was much more favourable than the others.
- A hard constraint is something that is very difficult to change, for example an absolute regulatory requirement. However, there are instances where it may even be worth challenging apparently 'hard' constraints with reasoned arguments and good evidence.

4.1.4 Step 1.4: Consider reporting and dialogue

Plan how reporting and dialogue will involve the stakeholders identified in Step 1.1, in line with the SuRF-UK Framework's Key Principles, specifying who will be involved and when.

During this step the assessor reviews in detail who will be involved as the key stakeholders for dialogue versus a wider audience for dissemination, initially determined in Step 1.1, and when and how engagement and dissemination will take place. Key considerations are as follows.

- Review the 'dialogue partners' and their roles, i.e. users of the sustainability assessment (e.g. client, consultant, regulator, planner etc.), and other parties who will need to play an active role in the sustainability assessment (e.g. the planner asks for or facilitates through the Town & Country Planning process, some form of community input).
- Review the 'wider audience' (if any) for the sustainability assessment, who will be told about the findings but will not play an active role in the assessment process.
- Decide when stakeholders be involved, for example already in preparation and definition stages, or after a first iteration of a sustainability assessment by a 'core' team?
- Decide how they will be involved – collecting and using inputs/resolving conflicting views (e.g. by planned sensitivity analyses)?

This reporting and dialogue could be integrated with broader project engagement considerations, where for example remediation is part of a larger undertaking.

Reporting records the process of developing the sustainability assessment. This needs to be transparent so that its users can verify that the approach taken and the outcome match their contributions to the assessment process, and any wider audience can see exactly how the sustainability assessment was carried out, how it was interpreted and how it was used to support decision-making. This should be in line with the SuRF-UK Framework Key Principles, which include **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 in order to demonstrate to interested parties that a sustainable (or otherwise) solution has been adopted.*

4.2 Task 2 - Definition (part of framing)

4.2.1 Step 2.1: Summarise objectives

This activity reviews the preparation steps and consolidates them, especially since the preparatory and definition stages of framing may be separated in time.

Following review and any necessary reconciliation, clear summaries should be recorded of:

- The decision-making being supported.
- The function of the sustainability assessment.
- The project (goals and options) being considered.
- The constraints and opportunities affecting choices and resulting thresholds.
- The plan for reporting and dialogue.

4.2.2 Step 2.2: Identify boundary conditions

Describe the assessment boundary conditions related to system, depth of consideration, proximity and timeframe.

Boundary conditions determine which effects will be considered within a sustainability assessment. For the assessment to be valid these boundaries must ensure a fair, like-for-like comparison of options, rationalise the use of effort and usefully distinguish effects over distance and time. SuRF-UK sustainability assessment requires the setting of two boundaries: a system boundary which defines the interfaces between the project under consideration and the wider world, and a boundary that defines the depth of analysis that will be undertaken (which has been termed “life cycle” boundary - see Box 4.1).

Box 4.1. System and life cycle boundaries explained
The System Boundary. The system encompasses both the project goals for which options are being compared, and the options being considered to deliver goals. The system boundary describes the “edges” of the system being considered, i.e. where it interfaces with the surrounding environmental, societal or economic processes or other systems. The system boundary needs to consider all of the processes that are needed to deliver the project, for example whether they take place on site or off site (e.g. at a disposal site or a fixed treatment facility). This is so that sustainability assessment can consider all impacts and benefits taking place as a result of the remediation work and truly compare like for like. For example, *the assessment will consider all remediation and ancillary work for [risk management objectives]. Movement of all materials to site, all operations to fully achieve agreed risk management objectives for the remediation. Removal and disposal of all residues. Management of all emissions. This can be often most easily communicated diagrammatically (see Figure 4.4).*   **The "life cycle" boundary.** “Life cycle" boundaries consider how far the option being considered should be broken down into sub-units requiring some sort of analysis. This boundary in effect sets a limit to the inputs and outputs that will be included in the assessment, in particular considering (a) how to deal with equipment (including its manufacture) that might be used on multiple projects; and (b) how to deal with items that might be seen as trivial, for instance, what considerations might be *de minimis*. For example, *the assessment will consider what is consumed by the remediation; the effect of operations – such as emissions; the deterioration on capital equipment that will be reused and the impacts of capital equipment operation and maintenance.*

Optionally, users can set (a) spatial boundary conditions to distinguish for example between local effects in the neighbourhood of a site and those that are more widespread, and (b) boundaries related to timeframe to distinguish between effects that will be considered temporary, compared with those considered permanent. These boundaries are optional because the overall sustainability assessment process is independent of distance or timeframe. However, it may be useful for operational purposes (for example ranking options across local impacts of concern) to flag some comparisons as “local” and/or “temporary”, which can then be drawn out as a subset of the overall sustainability assessment.

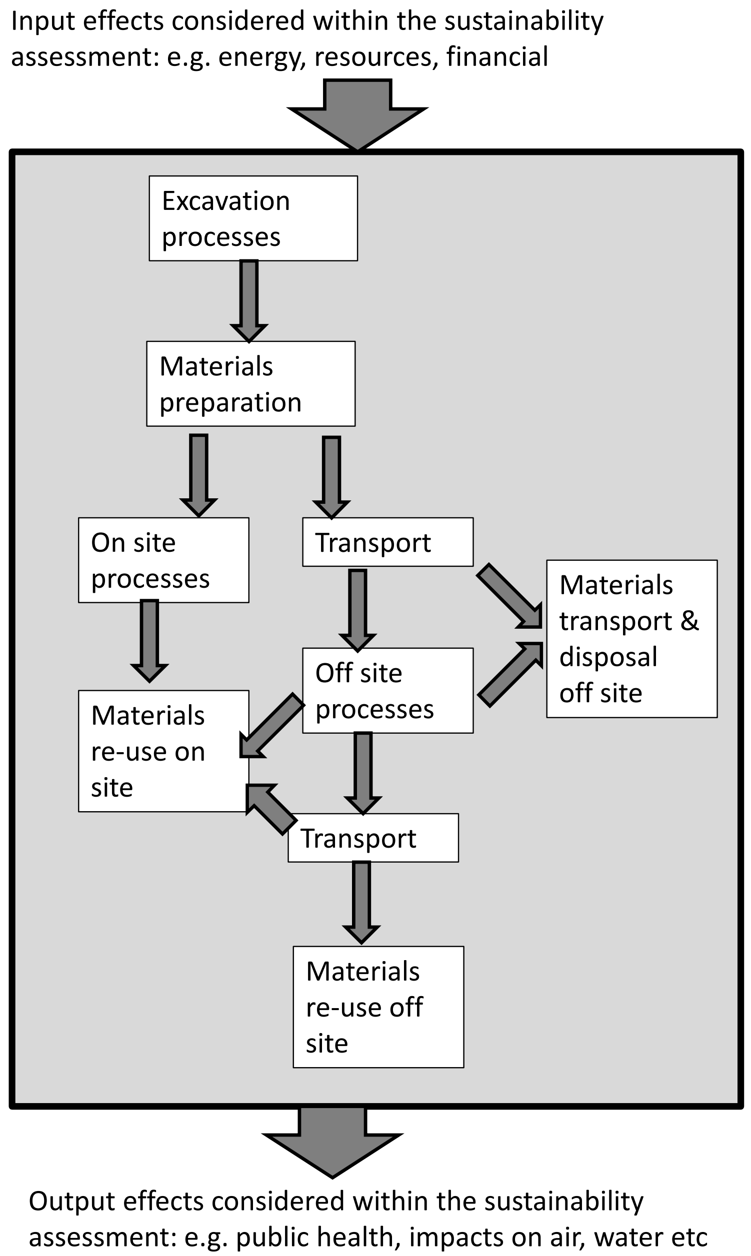

Figure 4.4. Example system boundary diagram.

4.2.3 Step 2.3: Agree scope/indicators

Describe the range of individual sustainability considerations to be included in the assessment (see Supplementary Report 2).

Supplementary Report 2 provides a checklist of possible individual indicators to include in the scope of a sustainability assessment. The checklist is hierarchical, following the SuRF-UK arrangement of having five broad headline categories of indicators for each of the three elements of sustainability (as set out in Table 3.1). This arrangement is intended to encourage a balanced consideration of environmental, economic and social factors in the sustainability assessment. The checklist adds more detailed information about each headline and individual indicators/criteria suggested for them. Use of the checklist will provide transparency for all stakeholders, benchmark the considerations selected to ensure they are suitably holistic, facilitate mapping to the headline categories in Table 3.1, and reduce risks of duplications. The checklist is not prescriptive, and not necessarily exhaustive. Users can discard indicators that are not relevant for their site/project, and add indicators they feel might be missing.

Figure 4.5 sets out the process for using this checklist to set a scope, which is explained in more detail in *Supplementary Report 2*. This report also explains how to record the evidential basis that will be used for each individual comparison, and their linkage to the UN SDGs (UN, 2015) if this is needed.

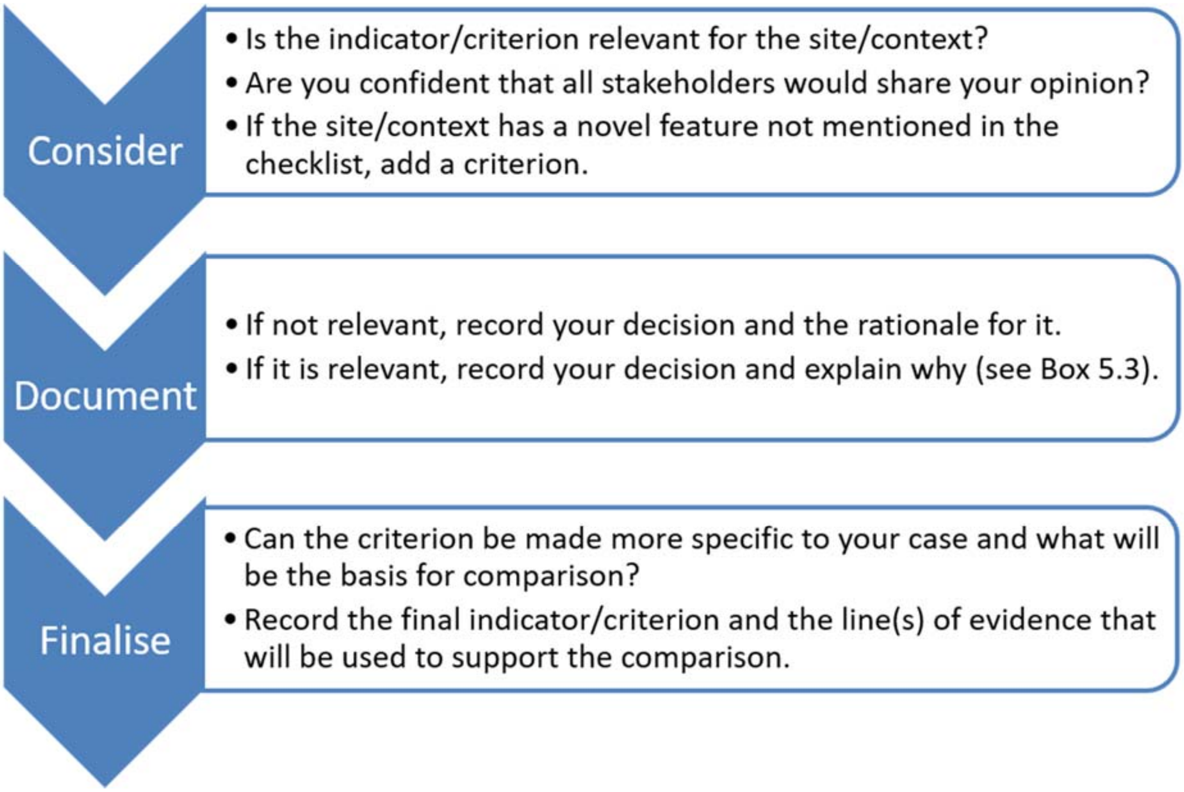

Figure 4.5. Selecting suggested indicators from the *Supplementary Report 2* checklist.

There are two broad overarching strategies that could be adopted for indicator selection:

1. Positive exclusion, only exclude an indicator/criterion when there is a clear reason to do so. (Recommended approach)
2. Positive inclusion, select indicators/criteria only when there is a clear reason to do so. (This is less robust, but simpler)

The assessor co-ordinating the sustainability assessment may make an initial indicator selection to progress an initial framing. However, later discussions with a wider number of stakeholders may bring that selection into question where they feel major indicators/criteria (in their view) have been excluded. Hence the “positive exclusion” strategy is recommended, as this reduces the risk of disputes, as the sustainability assessment is taken forward for wider consultation.

4.2.4 Step 2.4: Agree methodology

Set out the methodology by which options are going to be compared for the different sustainability indicators/criteria being considered.

Sustainability assessment depends on the aggregation of comparisons for individual indicators into a coherent overarching assessment of sustainability. The assessment outcomes then need to be clearly presented, interpreted and communicated.

The SuRF-UK Framework recommends a tiered approach to sustainability assessment, see Figure 4.6. The tiered approach has several advantages:

- It optimises decision-making effort by starting with the simplest approaches, and only progressing to more intensive information collection and analysis where there is a clear need.
- The qualitative entry level allows a wide range of individual sustainability indicators to be considered.
- It enables the widest engagement with stakeholders of all backgrounds, as the entry level avoids more complicated technical concepts like scoring, weighting or cost benefit analysis.

Since the development of the SuRF-UK Framework, SuRF-UK has also developed guidance on *Sustainable Management Practices (SMPs)* which provide simple means to support better practice at all stages of site management from site investigation onwards (CL:AIRE, 2014b). These can be envisaged as providing a “Tier 0” in the SuRF-UK Framework.

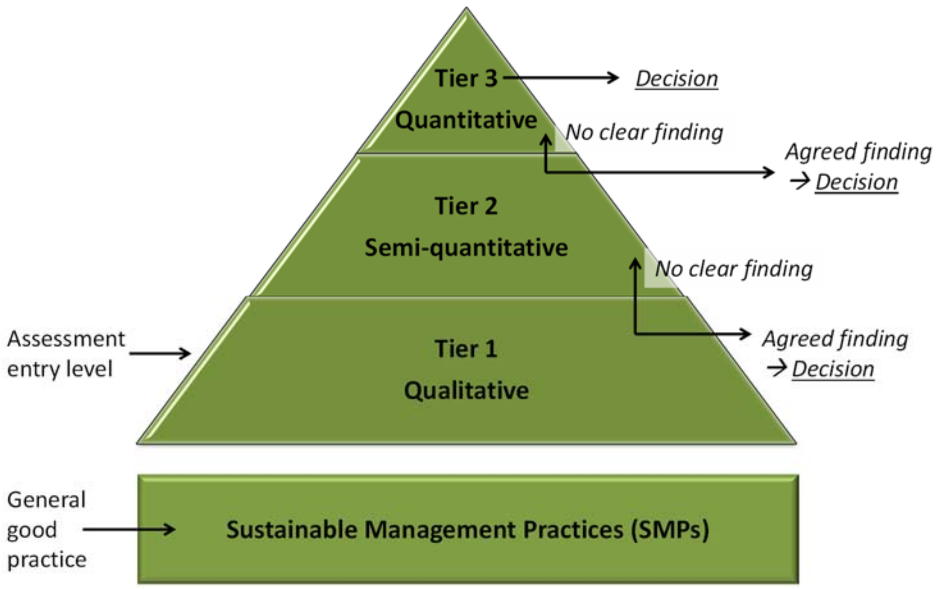

Figure 4.6. Tiered approach to sustainability assessment (CL:AIRE, 2014).

Comparisons should be made on a criterion by criterion (indicator by indicator) basis and aggregated subsequently, to ensure exhaustive consideration of sustainability effects and avoid unintentional confusion of effects.

In practice sustainability assessments, being comparative, distinguish relative performance rather than compliance with thresholds. However, some practitioners may want to incorporate the use of thresholds to identify some kind of *de minimis* performance that must be achieved on various key indicators, for example to rule out unsuitable options at an early stage of feasibility appraisal.

However, it is usually counter-productive to use thresholds as a benchmark of what is to be considered sustainable, especially if using a benchmark that all options meet (e.g. a legal requirement). This undermines the purpose of sustainability assessment which is to identify the greatest overall net benefit.

4.2.5 Step 2.5: Agree how to deal with uncertainty

Set out an approach for identifying uncertainties and reviewing their potential effect on sustainability assessment outcomes.

There are likely to be two broad causes of uncertainty:

- Disagreement or uncertainty over what should be considered within the definition of the sustainability assessment (objectives, options, boundaries or scope) or any assumptions underpinning the framing, for example related to long-term land use.
- Insufficient or conflicting information describing individual sustainability indicators/criteria, related to the performance/effects of the different options being compared.

Uncertainties may emerge during an assessors work, for example related to information. Uncertainties may emerge as a result of the dialogue process with different stakeholders, for example related to the definition of the sustainability assessment approach.

A convenient means of assessing the impact of uncertainty on outcome is to use sensitivity analysis:

- Comparing the outcome for sustainability assessment scenarios reflecting different definitions.
- Comparing the outcome for sustainability assessment scenarios reflecting the possible extremes in the range for an indicator/criterion, based on available information and opinions.

Sensitivity analyses require the consideration of multiple scenarios, for example a best and worst case scenario for different informational uncertainties, or the inclusion/exclusion of particular individual indicators/criteria that are contentious for some of the stakeholders. The outcomes of the sustainability assessment can then be compared for the different scenarios to identify if the overall outcome of the sustainability assessment is sensitive to the identified uncertainty or not.

In practice, it is likely to be most efficient to try and agree a "policy" at the start of the assessment process that all stakeholders can support, for example using "positive exclusion" for indicator selection, and using worst case assumptions only for informational uncertainties as far as possible. Having an agreed policy may make for a smoother dialogue, reduce the scale of sensitivity analyses needed and the scope for causing confusion by sensitivity testing multiple scenarios. Where there is large uncertainty this may suggest that an assessment at a higher tier could be helpful, but that will not hold true if uncertainties will simply transfer to semi- quantitative or quantitative based methods.

4.3 Task 3 - Execution

4.3.1 Step 3.1: Comparisons by indicator/criterion

Compare options for each individual sustainability indicator/criterion (identified in Step 2.3) in a way that is compliant with the methodology agreed (Step 2.4).

Comparisons are made differently based on which tier of sustainability assessment is being carried out. However, in all cases comparisons should start at the point of individual indicators/criteria for greatest transparency. The outcome will be a large number of individual comparisons, which will subsequently need to be aggregated.

At Tier 1 qualitative comparisons are made which can be purely descriptive or could be numeric rankings, where the number value denotes position between "best" and "worst", but not the scale of difference. For instance, the difference between adjacently ranked options, say for impacts on air could be slight or could be very large, but their ranking number would remain the same. See Appendix 2 for a suggested Tier 1 approach.

At Tier 2 scores are used to try and convey magnitude or scale of differences between options, and weights are used to convey the perceived (relative) importance of the indicator/criterion being considered. This approach is typically known as multi-criteria analysis. See Appendix 3.

At Tier 3 some form of valuation is made which might be related to a metric such as a carbon footprint or life cycle assessment, although these are limited in the scope of sustainability considerations they consider. Another form of valuation is to monetise comparisons, with the assumption that this monetary value will convey both the scale and importance of an effect. Given the limitations of monetisation for a range of sustainability concerns, some methods are a combination of monetary valuations and multi-criteria analyses (see Appendix 3).

There are several key underpinnings to these comparisons, at whatever tier is being used and these are formulated in the framing of the sustainability assessment:

- Clear objectives.
- Consistent boundaries applied equally to all options under assessment.
- A holistic understanding of scope, reflected in the selection of indicators/criteria against which options will be compared, that is agreed between stakeholders.
- Lines of evidence to support the comparisons being made.

A line of evidence is the information, measurements, or stakeholder opinions and expert judgements that support a comparison. A single comparison may be supported by more than one line of evidence. Lines of evidence may be based on quantitative information (e.g. costs, measurements, survey returns); based on technical opinion (e.g. a ranking on expected outcomes based on previous experience and expert opinions); or based on the collected viewpoint of the stakeholders taking part (e.g. on likely community impacts). While lines of evidence for Tier 1 can be numeric, the qualitative assessment does make the inclusion of opinion-based comparisons fairly straightforward. At Tier 2 opinions need to be converted to scores and weights, and at Tier 3 into monetisation. There may be significant space for debate in these processes.

4.3.2 Step 3.2: Aggregation of individual comparisons

Aggregate individual outcomes, for example to overall comparisons by headline category, and from there comparisons for each of the three elements of sustainability, as set out in Step 2.4.

Aggregation adds clarity to comparisons by providing an overarching picture. Without it users would struggle to clearly understand which options are most sustainable based on (say) 50 individual comparisons, compared with (say) comparisons across the 15 SuRF-UK headline categories or the three elements of sustainability: environmental, economic and social.

Aggregation may not be numeric at Tier 1 where symbols or descriptors like "good" have been used. It may depend on looking at which options gather the greatest frequency of particular descriptors, so if the majority of individual comparisons for an "Option A" rate it as "good", then the aggregated value is "good". The use of rankings makes aggregation at Tier 1 much more straightforward and transparent.

Aggregation at Tier 2 is typically arithmetic and is usually based on a summation of scores multiplied by a weighting across the group of indicators/criteria being combined, done separately for each option (see Appendix 3).

The method of aggregation at Tier 3 is usually specified for the type of assessment being used (e.g. a carbon or water footprint or monetisation).

Aggregation is typically the step where transparency is poorest, especially for non-expert stakeholders. Often the number values and the mathematical processes used may not only be opaque to some stakeholders, but may also convey a false sense of confidence in outcomes, somehow making them seem more objective, even if they are underpinned by subjective assumptions and lines of evidence. To overcome these problems, it is sensible to take the simplest possible approach to aggregation, and provide some kind of commentary that explains the process and the provenance of the higher level comparisons developed.

4.3.3 Step 3.3: Interpretation

Initial conclusions are drawn from comparing options for "sustainability" in broad terms, and also for individual factors of special interest; discussion and review and ground truthing with wider stakeholders.

Typically the outcomes of the sustainability assessment will be summarised, aggregating the individual comparisons they are based on. These summaries might be based on a combination of tables, but also (and particularly at Tier 2 or 3) numerically based charts. The summary information should be clearly relatable to individual comparisons and the lines of evidence on which these were based.

Step 3.3 is fairly close to the end point of an iteration of sustainability assessment, and may be the point at which an initial attempt at a sustainability assessment is offered for comment to a wider group of stakeholders (see Figure 4.2).

4.3.4 Step 3.4: Understanding uncertainties

Sensitivity analyses can be applied to help stakeholders understand how uncertainties related to information/approach play out for the overall sustainability assessment outcome.

The possibility of uncertainties and how they will be managed will have been set out during framing. A simple approach is to compare 'what if' scenarios as a sensitivity analysis by making different comparison tables representing the different extremes causing the uncertainty, for example comparing a table that considers 'what if we consider particulate emissions' on air quality to 'what if we don't'.

The key outcome is the impact of changed individual comparisons on the aggregated data in higher level summaries, for example, at Tier 1 comparison tables or other visualisations can be compared. At Tier 2 and Tier 3 the sensitivity analysis outcomes may be translatable into some form of error bar for aggregated scores or costings.

4.3.5 Step 3.5: Presenting the findings

The assessor and users of the information check clarity and outcomes and determine conclusions. If the outcome is not clear, consider a more detailed assessment (higher "tier").

In broad terms there are five possible types of finding:

1. The comparison tables are clear enough to show that:

   - One particular option is more sustainable than others, or
   - An option being benchmarked, for example against a no intervention scenario, performs favourably – or not.

2. The process of discussion identifies improvements that can be made to the design of one or more options, so decision-making may be postponed until this is completed and an updated sustainability assessment carried out.

3. Wider stakeholder opinions indicate that definitional stages need to be revisited and an updated sustainability assessment carried out.

4. The Tier 1 assessment contains too much uncertainty to come to a clear decision, in which case either:

   - Greater effort is required for information collection for the lines of evidence giving rise to the greatest uncertainty, or
   - A higher tier assessment is required (perhaps focusing on indicator categories that are most uncertain).

5. Two or more options are tied, indicating that a higher tier assessment is necessary unless it is agreed between stakeholders that either option would be an acceptable choice and can be implemented.

5. Summary of key points

Sustainability assessment is an important tool in optimising risk management solutions for the management of land contamination. Comparing options using sustainability assessment can be used to maximise net benefit from projects and minimise detrimental effects. Choices between options can be made at a project design stage, at the stage of remedial option selection or both.

Sustainability assessment is site specific and subjective. It depends on the inclusion of a wide range of considerations across different stakeholder perspectives.

Taking a tiered approach to sustainability assessment offers important advantages, starting from a qualitative assessment and moving through to semi-quantitative and quantitative assessments on an ‘as required’ basis only.

Transparent and rigorous preparation and definition of sustainability assessment (whatever the tier) underpins successful and persuasive assessments, taking into account the nature of the project and site, the stakeholders involved, the decision objective, the boundaries of the assessment, its scope, the methodology to be deployed and how any potential uncertainties will be accommodated. SuRF-UK calls the stages of preparation and definition “framing” of the assessment.

Iteration is typically an important process in sustainability assessment leading to more refined and generally accepted outcomes.

This SuRF-UK report sets out processes for framing and Tier 1 assessment and provides information on higher tiers of assessment and the potential usefulness of using conceptual site models of sustainability. It should be used in conjunction with *Supplementary Report 2* which provides detailed guidance on the identification and use of indicators/criteria for setting the scope of a sustainability assessment (Definition Step 2.3).

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Appendix 1: *Aide memoire* for the key questions and information to be collected during sustainability assessment

1. Preparation

Step 1.1: Describe the decision requirement

Key Questions

- The sustainability assessment is intended to support this decision…
- The following interested parties have a stake in this decision and/or need to be informed by it…

Information to be recorded

- Clearly describe **what decisions/actions** are going to be informed by the sustainability assessment and how it is linked to the wider project management process/decisions
- List the **"key stakeholders"** and their roles (i.e. those where there will be dialogue):
  - Users of the sustainability assessment (e.g. client, consultant, regulator, planner etc.)
  - Other parties who will need to play an active role in the sustainability assessment (e.g. the planner asks for, or facilitates through the Town & Country Planning process, some form of community input)
- List the **"wider audience"** (if any) for the sustainability assessment, who will be told about the findings but will not play an active role in the assessment process

Step 1.2: Describe the project

Key Questions

- The sustainability assessment plays a role in this project…
- The sustainability assessment compares these specific options…

Information to be recorded

- Clearly describe **the project goals**
- Clearly describe the **options** for delivering the project that are to be compared using sustainability assessment
- The goals and options will define the *system boundary* that the sustainability assessment will need to be based on
  - This may be a starting point which may be refined as assessment continues
  - A similar process of refining goals and options is required when applying sustainability appraisal to a strategy at a regional level or across a number of sites

Step 1.3: Describe the project

Key Questions

- What are the constraints for this site…
- What are the opportunities for the site…

Information to be recorded

- Clearly describe **key constraints and opportunities**
- Constraints or opportunities change what options are feasible, and may set minimum thresholds that have to be achieved for different sustainability considerations or create opportunities for sustainability gains
- Examples of constraints and opportunities include
  - Available time, space and budget
  - Decisions that have already been taken and will not be revisited, for example, on-going/future land-use
  - Constraints resulting from legislation and policy (government or corporate)
  - Features of the site, for example any infrastructure in place (or not in place)
- Tabulate the constraints/opportunities and any consequential thresholds for them

Step 1.4: Consider reporting and dialogue

Key Questions

- Who do we critically need to engage with, when and how…
- The wider audience for the sustainability assessment outcomes are…

Information to be recorded

- Plan how reporting and dialogue will be undertaken, specifying who will be involved and when *(this could be integrated with broader project engagement considerations)*
- Who will be involved?
  - As dialogue partners
  - As the wider audience
- When will they be involved?
  - For example, already in the definition stage?
  - For example, an assessor may carry out the whole procedure through to execution in a first iteration, and then make this work available for comment and discussion with other parties as a second iteration
- How they will be involved, taking into account:
  - Getting and using inputs from different stakeholders
  - Resolving conflicting views between stakeholders

2. Definition

Step 2.1: Summarise objectives

Key Question

- The main outcomes of the preparation stage were…

Information to be recorded

- The decision-making being supported
- The function of the sustainability assessment
- The project (goals and options) being considered
- The constraints affecting choices and resulting thresholds
- The plan for reporting and dialogue

Step 2.2: Identify boundary conditions

Key Question

- The key boundaries the sustainability assessment needs to apply, to ensure like for like comparisons, are …

Information to be recorded

- Describe the assessment boundary conditions
    - System (that reflects all options equally)
    - "life cycle" (e.g. dealing with equipment that will be re-used, level of detail of the assessment)
- Spatial (e.g. to distinguish local from global effects)
    - Temporal (e.g. to distinguish temporary from permanent effects)

Step 2.3: Agree scope/indicators

Key Questions

- The indicators/criteria that will be used to define the scope of the sustainability assessment are …
- The rationale for including these and excluding others is…
- The evidential basis that will be used for comparisons is…
- (optionally) The link to UN SDGs is…

Information to be recorded

- Describe the range of sustainability considerations included in the assessment
- Describe the level of detail
- Describe the process through which indicators/criteria were included/excluded
- Record *for each* indicator/criterion why it was included/excluded in the scope of sustainability

Step 2.4: Agree methodology

Key Questions

- Individual indicator comparisons will be aggregated by…
- Outcomes will be interpreted on this basis… and presented as…

Information to be recorded

- The methodology by which options are going to be compared for the different sustainability indicators/criteria being considered
  - i.e. how those individual comparisons will be aggregated into broader assessment of sustainability; and how the assessment outcomes will be presented, interpreted and communicated

Step 2.5: Agree how to deal with uncertainty

Key Question

- Where outcomes are uncertain, this will be managed by…

Information to be recorded

- The approach agreed for identifying uncertainties and reviewing their potential effect on sustainability assessment outcomes

3. Execution

Step 3.1: Comparisons by indicator/criterion

Key Question

- The comparison across project options for each individual indicator/criterion are …

Information to be recorded

- The outcomes of the individual comparisons
- The lines of evidence on which the comparisons are based
- Any informational uncertainties that may affect comparison outcomes, and how these were managed in the comparison, and if they need to go forward to a sensitivity analysis

Step 3.2: Aggregation of individual comparisons

Key Question

- The overall sustainability comparison is …

Information to be recorded

- The outcomes of aggregation
- The origin and process by which the higher level comparisons were developed
- Any informational uncertainties that may affect comparison outcomes, and how these were managed in the comparison, and if they need to go forward to a sensitivity analysis

Step 3.3: Interpretation

Key Question

- The conclusions of the overall sustainability comparison are …

Information to be recorded

- Any aggregated information, for example comparison tables, radar plots, bar charts or similar as they will be presented to users/readers of the sustainability assessment
- The final comparison tables at least as an annex/appendix

Step 3.4: Understanding uncertainties

Key Question

- The impact of the uncertainties found in this assessment on the assessment outcome are…

Information to be recorded

- The "what-if" comparison tables
- The related aggregated information for the different scenarios assessed

Step 3.5: Presenting the findings

Key Question

- The overall findings are …

Information to be recorded

- The overall conclusions of the sustainability assessment and the decisions arising
- The participants in these discussions
- Any differing opinions and how consensus was achieved

Appendix 2: SuRF-UK Tier 1 qualitative assessment

In 2014 SuRF-UK developed guidance on qualitative sustainability assessment and tools for supporting its use at stakeholder meetings, called "SuRF-UK Briefcase", available from www.claire.co.uk/surfuk. The key features of this approach to qualitative sustainability assessment are set out below.

Qualitative sustainability assessment at Tier 1 is used to compare sustainability in a relative sense across different potential remediation options. It works with simple numeric or category rankings, for example: 1,2,..n, or "best", "better", "worst". It is a relatively low effort approach which can cover a broad scope of sustainability issues. In the majority of cases a Tier 1 assessment will identify the "most sustainable" of the options being compared, in a way that is relatively easy for all stakeholders to grasp.

Although the assessment is qualitative, its framing still requires the same rigour as more quantitative methods, and the rankings should be clearly based on good evidence and sound science, as set out in the underpinning SuRF-UK Principles. A template for recording progress is provided in the Appendix 1 *aide memoire*.

> As a precursor to these actions the assessor should verify that all necessary components of the framing are in place and that there is access to the information needed to make the sustainability assessment's comparisons.

Step 3.1: Comparisons by indicator/criterion

Goal: to compare the options under consideration for each individual sustainability indicator/criterion (identified in Step 2.3) using the methodology agreed during framing (Step 2.4).

Comparisons should always begin with separate and independent individual indicator/criterion (which could be an entire headline category, a series of subcategories, or individual considerations). Each comparison must be supported by specific lines of evidence to support the relative assessment made. Moreover, all options must be evaluated for all the indicators/criteria agreed during framing. This helps to ensure exhaustive consideration of sustainability effects and avoid unintentional merging or confusion of effects. The same system boundary and 'life cycle' boundary conditions set up in the framing work must apply to all of the comparisons being considered for all options and all indicators.

At a qualitative level these comparisons will be made using "comparison tables", for example see Figure A2.1, which may use descriptors such as "good", "fair", "poor" etc. Comparison tables may also use symbols, colours or rankings. Rankings may be numeric: for example 1, 2, 3 or descriptors, but all show a progression from the best to the worst outcomes for the particular comparison being made. The rankings carry no indication of scale or importance of the particular indicator/criterion options are being compared for. Note: scale (i.e. scores) and importance (i.e. weights) are used in semi-quantitative approaches (see Appendix 3).

Comparison tables may be drawn up at different levels of detail, for example at the level of the three overarching elements of sustainability, across the SuRF-UK headlines for one element, or for individual indicators/criteria within a single headline, as shown in Figure A2.2. However, the comparison tables should all start from the basis of comparisons made across individual indicators/criteria. Hence the tables at higher levels of abstraction are essentially reporting a level of aggregation from Step 3.2.

Environment	Option 1	Option 2
Emissions to Air	Good	Fair
Soil and ground conditions	Very good	Fair
Groundwater & surface water	Very good	Good
Ecology	Good	Poor
Natural resources & waste	Fair	Excellent

Figure A2.1. Example Tier 1 comparison table (completed to show example descriptors).

<table>
<tr><td>Example using sustainability elements, options are summarised across one table</td><td>

	Option 1	Option 2
Environment	Better	Worse
Society	Equal	Equal
Economics	Worse	Better

</td></tr>
<tr><td>Example using headline categories, three tables will be needed</td><td>

Environment	Option 1	Option 2
Emissions to Air	Trivial	Trivial
Soil and ground conditions	Significant impacts	Trivial impacts
Groundwater & surface water	Trivial impacts	Significant impacts
Ecology	None	None
Natural resources & waste	Significant	Trivial

</td></tr>
<tr><td>Example using individual indicators/criteria, multiple tables will be needed</td><td>

SOC 1 Human Health & Safety	Option 1	Option 2
Long term risk management performance	Meets targets	Exceeds targets
Short term risks from accidents	Does not meet targets	Meets targets
Health impacts of remediation process emissions	Exceeds targets	Meets targets

</td></tr>
</table>

Figure A2.2. Examples of comparison tables at different levels of detail (note the variety of descriptors that could be used).

Step 3.2: Aggregation of individual comparisons

Goal: to aggregate individual comparison outcomes, for example to overall comparisons by headline category, and from there comparisons for each of the three elements of sustainability.

Tier 1 is based on comparison tables. The comparison tables themselves are a first aggregation of individual comparisons into an overall assessment of sustainability, as well as supporting the communication of findings under Step 3.3.

However, the effectiveness of a comparison table as a communication tool diminishes as the complexity of comparison indicators/criteria and options included increases, for example, including multiple individual indicator/criterion comparisons. In these circumstances numeric rankings lend themselves very well to very simple aggregations such as numeric means or sums. SuRF-UK does not prescribe how these aggregations should be done, but Figure A2.3 provides a simple schematic. Note these are rankings and not scores.

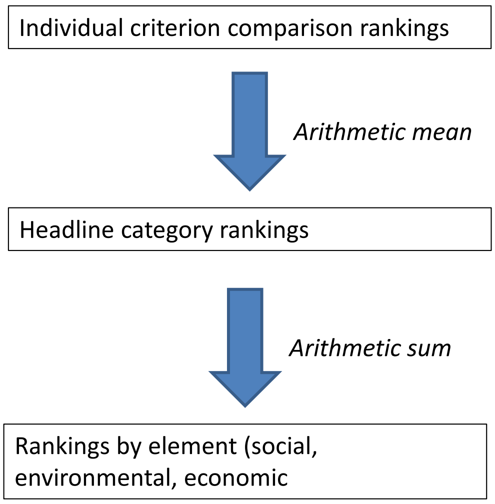


Figure A2.3. Example schematic for aggregation of numeric rankings.

Step 3.3: Interpretation

Goal: to draw initial conclusions from comparing options for “sustainability” in broad terms.

At its simplest initial conclusions may be drawn from comparison tables based on the relative frequency with which an option is described as “best” or similar, or has the best ranking, for example see Figure A2.4. However, where numeric rankings are used figurative charts are possible such as bar charts or radar plots, for example see Figure A2.5.

Environment	Option 1	Option 2
Emissions to Air	Good	Fair
Soil and ground conditions	Very good	Fair
Groundwater & surface water	Very good	Good
Ecology	Good	Poor
Natural resources & waste	Fair	Excellent

- Option 1 has more good or higher assessments than option 2, so appears to perform better for the environmental element of sustainability.
- The use of three simple tables for each element of sustainability (environment, society and economy) using the SuRF-UK headline categories may provide sufficient information to support a decision.
- The tabular approach is simply a suggestion. Assessors may design alterative approaches to setting out comparisons and aggregating them.

Figure A2.4. Simple interpretation of a comparison table.

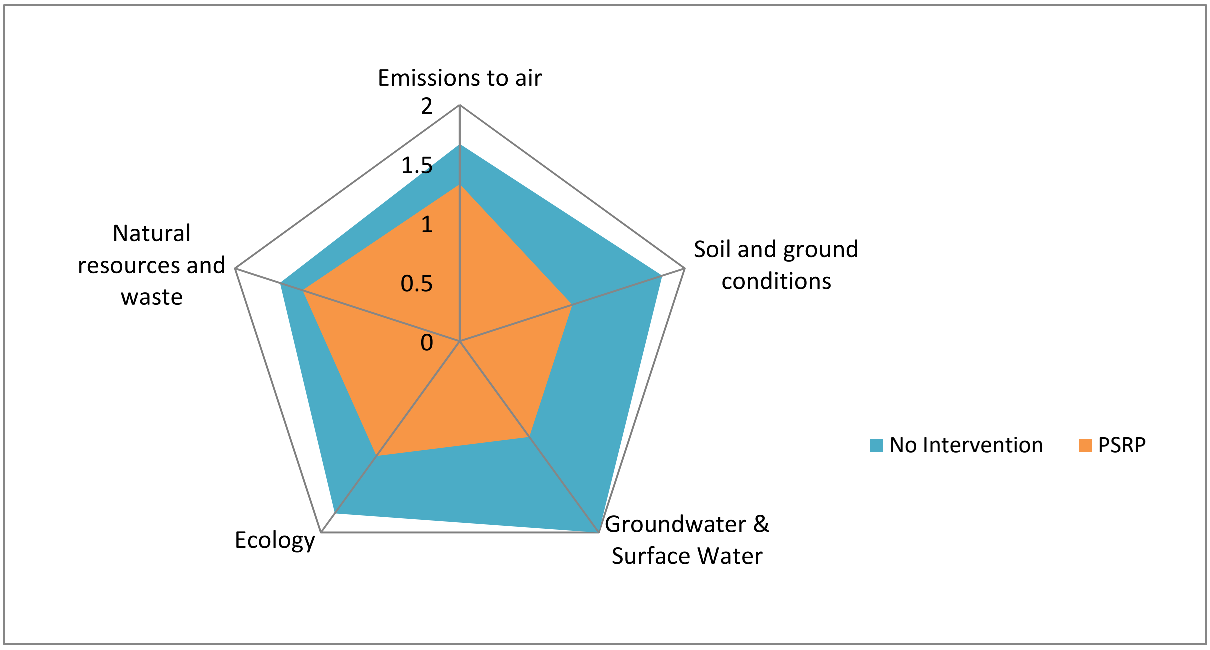


Figure A2.5: Example radar plot of average rankings across SuRF-UK headlines for the environmental element of sustainability. The smaller the coloured area the better the overall environmental sustainability ranking. This example compares a parkland restoration scenario (Port Sunlight River Park - PSRP) against a no intervention baseline (Taken from Li *et al.*, 2019).

Step 3.4: Understanding uncertainties

Goal: to evaluate the impact of any uncertainties identified on assessment outcome

Sensitivity analyses can be applied to help stakeholders understand how uncertainties related to information/approach play out for the overall sustainability assessment outcome.

The possibility of uncertainties and how they will be managed will have been set out during framing. A simple approach is to compare 'what if' scenarios as a sensitivity analysis by making different comparison tables representing the different extremes causing the uncertainty, for example comparing a table that considers 'what if we consider particulate emissions' on air quality to 'what if we don't'. The impact on aggregated data in higher level comparison tables (e.g. at headline category level, see Figure A2.2) or in radar plots or other visualisations can be compared. This allows you to determine the effect of uncertainties on the overall sustainability assessment.

Step 3.5: Presenting the findings

Goal: to finalise the reporting for the sustainability assessment (and the assessor and users of the information check clarity and outcomes).

In broad terms there are five possible types of finding:

1. The comparison tables are clear enough to show that:
   - One particular option is more sustainable than others, or
   - An option being benchmarked, for example against a no intervention scenario, performs favourably – or not.

2. The process of discussion identifies improvements that can be made to the design of one or more options, so decision-making may be postponed until this is completed and an updated sustainability assessment carried out.
3. Wider stakeholder opinions indicate that definitional stages need to be revisited and an updated sustainability assessment carried out.
4. The Tier 1 assessment contains too much uncertainty to come to a clear decision, in which case either:
    - Greater effort is required for information collection for the lines of evidence giving rise to the greatest uncertainty, or
    - A higher tier assessment is required (perhaps focusing on indicator categories that are most uncertain).
5. Two or more options are tied, indicating that a higher tier assessment is necessary unless it is agreed between stakeholders that either option would be an acceptable choice and can be implemented.

Appendix 3: Tier 2 and Tier 3 in brief: semi-quantitative and quantitative sustainability assessments

The SuRF-UK Framework suggests that semi-quantitative and quantitative assessments are only needed if there is no clarity of decision outcome from an entry level Tier 1 assessment. Semi-quantitative methods are generally based on multi-criteria analyses (MCA) which combine scores (indicating scale of impact) and weights (indicating the perceived importance of the criterion) across multiple effects (e.g. Havranek, 2019).

Scores may be based on direct quantities (metrics), for example a carbon footprint, a direct costing etc; or some form of expert view or opinion. Each score is a dimensionless value within a range, for example 1 to 10, or 1 to 100. Weights can be derived according to preferences expressed by different stakeholders, albeit often a fairly narrow range of stakeholders. Weights are also dimensionless, for example in a range of 0 to 5. The analysis of each individual consideration (criterion) is the product weight times score. The outcomes for the criteria may need to be normalised before they are combined to ensure that they all lie within the same range.

Not all users of SuRF-UK's guidance start with Tier 1 as an entry level. Some choose MCA (Tier 2) as an entry level. The choice is made, for example, because:

- It is acknowledged at the outset that the site may be sufficiently complex that a Tier 2 assessment provides greater opportunity to draw out and document differences between remedial approaches.
- Clients feel that a numeric approach is easier for them to interpret, or to apply the results in a financial planning context.
- It is more persuasive for criteria that a stakeholder wishes to discard at Tier 1.
- It may make subjective stakeholder biases more transparent as weightings.
- Simple quantitative models can readily lend themselves to sensitivity analyses and iterative approaches, as recommended in the text.

Tier 3 assessments are primarily cost benefit or cost effectiveness assessments, where rather than using scores and weights, some form of valuation is applied to individual considerations, and the overall considerations aggregated on the basis of perceived value. The Environment Agency has published extensive guidance on the use of cost benefit assessments in remediation projects (Environment Agency, 1999a; 1999b; 2000a; 2000b; 2002). Cost benefit assessments can be highly contentious, especially in a brownfield/remediation context, and therefore there has been some interest in the use of combined MCA-cost benefit approaches (Rosén *et al.,* 2015).

Quantitative methods based on footprint or life cycle assessment methodologies have been used to compare remediation options (e.g. Cappuyns and Kessen, 2013), in particular in the case of so-called "green remediation" (U.S. EPA, 2008). However, these do not provide a complete sustainability assessment because they relate only to a limited number of the SuRF-UK headline categories.

For complex sites, where achieving sustainability is a major project driver, a Tier 3 analysis may integrate two or more quantitative assessments, for example from, social impact assessment, natural capital assessment, life cycle analysis, cost benefit assessment.

There are some words of caution necessary for Tier 2 and in particular Tier 3 assessments.

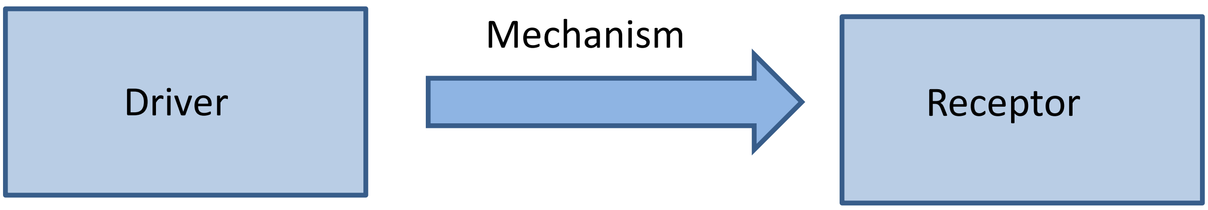
- They may not necessarily produce a more reliable outcome for decision-making; qualitative methods can be very effective (Smith and Kerrison, 2013).
- They may lack transparency, and for some stakeholders legitimacy (Bardos *et al.,* 2016).
- They may cost more, and take more time to carry out.
- They may be based on a narrower scope of sustainability considerations, which undermines their relevance to sustainability in an overall sense. A combined approach can be used where cost benefit analysis can be used to focus on key areas where simple assessments cannot differentiate, and that cost benefit analysis ranking/output can be fed back into a simpler, but broader assessment. This is a similar approach to the cost effectiveness approach of Rosén *et al.* (2015).

Some further information for Tier 2 and Tier 3 assessments are signposted at www.claire.co.uk/surfuk. SuRF-UK is aware of a range of approaches which have been developed by businesses in the UK. For this reason, SuRF-UK's Steering Group has taken the view that introducing its own specific Tier 2 and Tier 3 methodologies for sustainability assessment might be counter-productive and stifle innovation. This position is regularly reviewed and should there be evident demand for SuRF-UK methodologies, their development may be considered.

Appendix 4: Conceptual site models of sustainability

The rationale for using a conceptual site model of sustainability is to facilitate consistency between different tiers of sustainability assessment. It can also facilitate discussions between stakeholders and identify where potential duplication in sustainability comparisons is taking place. Typically it would begin during framing (Step 2.3 Scope) and support methodological development (Step 2.4) to facilitate the execution of the sustainability assessment at different tiers. The use of a conceptual model is not an obligatory part of sustainability assessment but may be a useful tool.

Land contamination practitioners are familiar with the source-pathway-receptor, or contaminant linkage, paradigm for providing a structure for assessing risks, evaluating them and planning a risk management response. An analogous thought process can be applied to considering the various individual considerations of a sustainability assessment. Li *et al.* (2019) describe how individual *sustainability linkages* can be collated to provide a conceptual site model for sustainability for a brownfield project. The *sustainability linkage* describes the connection between a driver (a pressure or a change), something that might be affected (i.e. a receptor) and the mechanism by which a pressure or change affects a receptor, see Figure A4.1. A sustainability effect only takes place when there is also a receptor that might be affected and a mechanism by which this affect can happen.



Health and safety risks (part of SOC1)	Materials excavation and handling on site	Site workers
Road traffic accident risk (part of SOC1)	Traffic movements from the remediation project	Local community
Exhaust emissions affecting local air quality (part of SOC3)	Traffic movements from the remediation project	Local community
Increased sense of pride/place (part of SOC4)	Improvement of the urban landscape/removal of blight	Local community
Greenhouse gas emissions (part of ENV1)	Remediation operations	Atmosphere
Property value uplift (part of ECON1)	Site improvement	Site owner
Property value uplift (part of ECON2)	Improvement of the urban landscape/removal of blight	Surrounding property owners

Figure A4.1. A sustainability linkage and some possible examples (by no means exhaustive).

As illustrated by Figure A4.1 there may be a number of possible sustainability linkages within any of the particular headline categories listed in Table 3.1. Some of the examples are likely to be more important for a *Stage A* (see Figure 3.1) decision and less so at *Stage B*, and *vice versa*. Some may be more relevant for a brownfield regeneration context than for remediation at an operational site. Some may be particular "assets" for some remediation options and not others, especially for long-term management scenarios, for example brownfield management by phytoremediation to generate renewables.

Individual sustainability linkages can be collated into a conceptual site model that summarises the drivers (i.e. pressures/changes leading to an effect), mechanisms and receptors across a site, for example as shown in Figure A4.2. Figure A4.2 is an example describing a wider brownfield regeneration project. *Stage B* operational site conceptual models may have substantially fewer linkages.

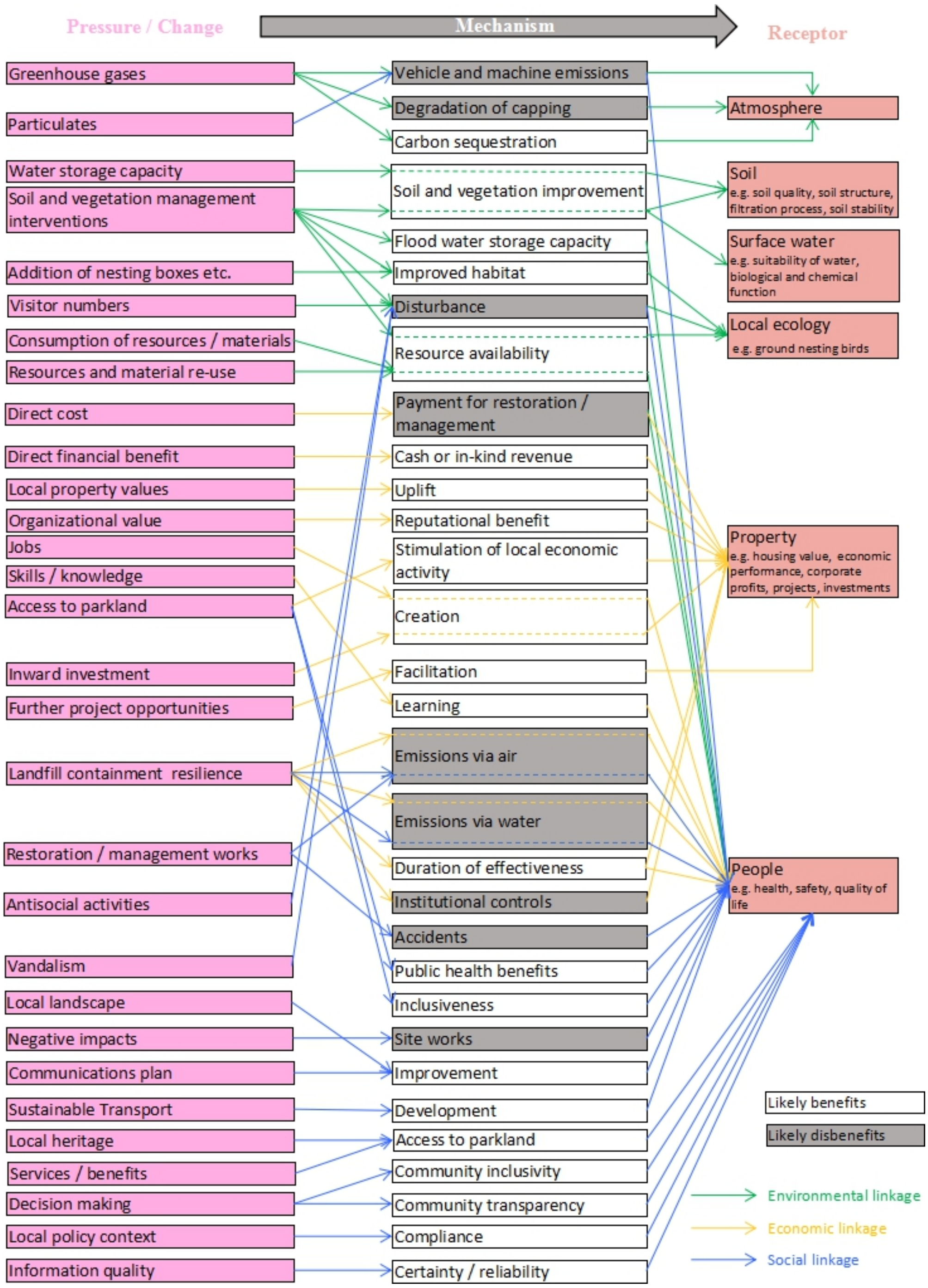


Figure A4.2. A conceptual site model for sustainability (network diagram) for the Port Sunlight River Park near Liverpool taken from Li *et al*. (2019).

The identification of sustainability linkages and their collation as a conceptual model can be done at the qualitative (Tier 1) entry level of the sustainability assessment process. In this approach the checklist of sustainability indicators provided in this document becomes a checklist of potential *drivers*. The same structure can be used for subsequent assessments, such as semi-quantitative (Tier 2) assessments, for example monetary cost benefit analysis (Tier 3), as described in Li *et al.* (2019). Applying the same conceptual model clearly shows how more complicated treatments still follow the same considerations as the sustainability assessment that stakeholders originally agreed to. This transparency may be particularly important in situations where processes of cost benefit analysis may not be very obvious or convincing for many community stakeholders.

The discipline of thinking through linkages, and combining them in an overarching conceptual model, can also be useful in identifying duplicate considerations. While great effort has gone into avoiding the potential for duplication in the 15 headline categories and the supporting individual considerations introduced in *Supplementary Report 2*, remediation projects can be complex and remediation practitioners are diverse so interpretations can often vary.

The use of sustainability linkages and conceptual site models may be helpful in these circumstances:

- More complex scenarios, particularly where there is a heightened possibility of “double counting” of sustainability considerations or a lack of clarity as to where individual considerations belong in a sustainability assessment scheme.
- Where stakeholders are concerned to see clear cause and effect linkages when reviewing which indicators to include in a sustainability assessment.
- Where a semi-quantitative (Tier 2) or quantitative assessment (Tier 3) is likely to be applied.