Metrics for Integrating Sustainability Evaluations Into Remediation Projects

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The US Sustainable Remediation Forum (SURF) created a compilation of metrics (Metrics Toolbox) in response to a need for a broad set of metrics that could be used to assess and monitor the effectiveness of remedies in achieving sustainability goals. Metrics are the key impacts, outcomes, or burdens that are to be assessed or balanced to determine the influences and impacts of a remedial action. Metrics can reflect any of the three aspects of sustainability (i.e., environmental, social, or economic) or a combination of these aspects. Regardless, metrics represent the most critical sustainable outcomes from the perspective of the key stakeholders. The Metrics Toolbox is hosted online at www.sustainableremediation.org/library/guidance-tools-and-other-resources. By selecting metrics from the Metrics Toolbox as a starting point and considering a potentially wider suite of metrics in remedial program decisions, appropriate assessments can be made. Qualitative and quantitative metrics are tabulated for each remedial phase: remedial investigation, remedy selection, remedial design, remedial construction, operation and maintenance, and closure. Attributes for each metric are described so that remediation practitioners and key stakeholders can view the universe of metrics available and select the most relevant, site-specific metrics for a particular site. For this reason, SURF recommends that remediation practitioners consider the metrics compiled in the Metrics Toolbox as a companion to the sustainable remediation framework published elsewhere in this journal and other sustainability evaluations. © 2011 Wiley Periodicals, Inc.

INTRODUCTION

In this article, as in "Framework for Integrating Sustainability Into Remediation Projects" (Holland et al., 2011), the term *sustainable remediation* considers the impacts and influences of sustainability's triple bottom line (i.e., environmental, societal, and economic) while protecting human health and the environment. As such, sustainable remediation supplements the protection of human health and the environment with the consideration of broader benefits and impacts, as measured by metrics.

The US Sustainable Remediation Forum (SURF) White Paper (US SURF, 2009) identified the need for a common set of metrics that can be used to assess and monitor the effectiveness of remedies in achieving sustainability goals. Organizations such as the World Business Council for Sustainable Development have proposed that metrics should address the triple bottom line of environmental, social, and economic elements of a given project (SURF, 2009). Although significant advancement has occurred in the sustainable

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remediation field since the publication of the White Paper, the need for an extensive compilation of metrics remains unfilled.

In this article, metrics are defined as the key impacts, outcomes, or burdens that are to be assessed or balanced to determine the influences and impacts of a remedial action. The magnitude or presence of a metric is the measure of whether an objective has been met or the progress of achieving the objective. Metrics can reflect any of the three aspects of sustainability (i.e., environmental, social, or economic) or a combination of these aspects. Regardless, the metrics selected for a sustainability evaluation should represent the most critical sustainable outcomes from the perspective of the key stakeholders (Holland et al., 2011).

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By selecting metrics from the Metrics Toolbox as a starting point and considering a potentially wider suite of metrics in remedial program decisions, appropriate assessments can be made. Qualitative and quantitative metrics are tabulated for each remedial phase: remedial investigation, remedy selection, remedial design, remedial construction, operation and maintenance, and closure. Attributes for each metric are described so that remediation practitioners and key stakeholders can view the universe of metrics available and select the most relevant, site-specific metrics for a particular site.

METRICS TOOLBOX OVERVIEW

The metrics compiled in the Metrics Toolbox provide a tabulation of quantitative and qualitative metrics, as well as their attributes. The tables in the Metrics Toolbox provide remediation practitioners and key stakeholders with a broad universe of metrics for selecting the most relevant, site-specific metrics.

> The Metrics Toolbox is hosted online at www.sustainableremediation.org/library/guidance-tools-and-other-resources

The Metrics Toolbox is designed to be easy to use and, as such, is categorized into each phase of a traditional remediation project: remedial investigation, remedy selection, remedial design, remedial construction, operation and maintenance, and closure. A sustainability evaluation can be a part of any remediation phase, as indicated in "Framework for Integrating Sustainability into Remediation Projects" (Holland et al., 2011).

The objective of the sustainability evaluation is to balance parameters (i.e., considerations, impacts, or stressors of environmental, social, and economic importance) along with traditional selection criteria in a manner that increases the positive sustainability impacts of the project while reducing the negative sustainability impacts (Holland et al., 2011). The selection of appropriate metrics encourages remediation practitioners and key stakeholders to communicate early in the remediation process and select the critical few metrics (approximately five) that are of the highest value for a particular project.

Although various methods can be used to assess the metrics, "Guidance for Performing Footprint Analyses and Life-Cycle Assessments for the Remediation Industry" (Favara et al., 2011) promotes a consistent and repeatable process in which all pertinent information is provided in a transparent manner. The Metrics Toolbox is designed to

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complement both the sustainable remediation framework (Holland et al., 2011) and this guidance (Favara et al., 2011).

Structure

The Metrics Toolbox is organized into tables for each of the traditional remediation project phases. Practitioners and stakeholders are encouraged to use the contents as a starting point that can be modified or replaced with more appropriate content. The order that the sustainability parameters appear in the tables is not intended to reflect prioritization or superiority.

Each table includes the attributes summarized below.

- *Element*. Elements are direct or indirect tasks, products, or results that comprise the phase. Each table is separated into element groups or sections that reflect a specific aspect of a remediation project.
- *Parameter*. Parameters are considerations, impacts, or stressors of environmental, social, and economic importance. Each element contains related parameters or components with intrinsic potential to vary the impact, outcome, or burden of a remediation project.
- *Objective*. The objective is the goal or desired effect for improving the sustainability of the remediation project. Objectives are suggested goals that may be applicable to the identified element. Other site-specific objectives could be defined that may be preferred by the stakeholders.
- *Metric*. A metric is the specific aspect of the parameter to be measured. Metrics are further designated as quantifiable or qualitative and identified as environmental, social, or economic measures (described below).
- *Quantifiable (QN) or Qualitative (QL) Metric*. If a metric is quantifiable, a numeric value can be calculated using an acceptable methodology (e.g., a measurement of weight). Qualitative metrics are subjective, conditional, or categorized, but not calculated. A qualitative metric (e.g., the consideration of a specific best management practice) could, however, include the assignment of predetermined weighted values or a checklist to compare alternatives.
- *Environmental (EN), Social (S), or Economic (EC) Metric*. Metrics have inherent environmental, social, or economic benefits, impacts, or outcomes. The identification of this sustainability attribute enables stakeholder selection of metrics consistent with their overall site objectives and priorities. Some metrics may have both quantitative and qualitative aspects, as well as multiple attributes. This subject is discussed in more detail as part of the sustainable remediation framework published elsewhere in this journal.
- *Data Source*. Data source is the suggested location or process for assessing the metric. Sources may be broad categories, such as project records, or specific databases or websites and are recommended based on previous use and experience. Practitioners and stakeholders may identify and use equally valid, alternative sources of data for metrics assessment.
- *Implementation Guidance and Comments*. This column provides additional advice, clarification, or comments regarding the metric.

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- *External Benefit*. External benefit is the potential positive environmental, social, or economic "ripple effect" of implementing the sustainable remediation parameter. External benefits touch on the broader spectrum of benefits that may be quantitative or qualitative and may extend beyond the site-specific sustainability evaluation.
- *Challenges.* Challenges are the real or potential obstacles or complexities that may influence or complicate the use or implementation of a sustainability parameter and its associated metric(s). Additional general guidance may be included to assist the remediation practitioner in the application of the metric.

In each phase, an iterative collaboration between the project team and stakeholders is recommended to ensure that the metrics reflect critical outcomes and future site use.

The Metrics Toolbox is the result of the collective knowledge and research of SURF at the time of publication. As the practice of sustainable remediation evolves and additional research and knowledge concerning sustainability parameters and metrics expands, the Metrics Toolbox will be expanded and refined to reflect current knowledge. The most recent and up-to-date Metrics Toolbox will continue to be hosted online at www.sustainableremediation.org/library/guidance-tools-and-other-resources.

METRICS TOOLBOX APPLICATION AND EXAMPLES OF USE

"Framework for Integrating Sustainability Into Remediation Projects" describes the relationship between a framework and metrics as a process for assessing sustainability parameters at each phase of remediation (Holland et al., 2011). The examples that follow show how remediation practitioners and stakeholders might use the Metrics Toolbox as a project moves through the remediation process.

As seen in these examples, a sustainability evaluation can be streamlined by integrating sustainability parameters into each phase of a remediation project. Hypothetical conditions are included as examples of the connection between remedial elements and metrics selection. In each phase, an iterative collaboration between the project team and stakeholders is recommended to ensure that the metrics reflect critical outcomes and future site use. In addition, while some metrics can change or an evolution in the chosen metrics can occur as the project evolves and site conditions are better understood, many metrics will likely carry forward (as is or slightly refined) from one phase to the next.

Investigation

While preparing a remedial investigation work plan, a project team reviews the Investigation Table in the Metrics Toolbox to select the sustainability parameters and metrics associated with a sampling plan. The review should include stakeholders to ensure that critical metrics are addressed and are consistent with future site plans. After reviewing the table, they decide that "investigation technologies" (i.e., the parameter) that meet the goal of "implementing technologies with the least impacts" (i.e., objective) are aligned with the site- and project-specific values. Therefore, this parameter is selected for the remediation project and associated sustainability evaluation. To increase sampling event efficiencies, the team also selects the "sampling design" parameter and decides to evaluate the associated metrics of "fuel use" and "cost."

Both "investigation technologies" and "sampling design" parameters have quantitative metrics that measure environmental and economic benefits (e.g., quantity and cost of fuel use). By using the Metrics Toolbox, the project team and stakeholders gain the external

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benefit (in addition to these measurable benefits) of increased efficiency because the project will be completed in a shorter time frame.

Remedy Selection

During remedy selection, the project team and stakeholders review the Remedy Selection Table in the Metrics Toolbox to select or confirm the sustainability parameters and metrics appropriate to the site. In the review, they identify "materials consumed on site" as a parameter to be considered to "minimize environmental contributions" (i.e., objective) because large quantities of limestone and electricity will be required to implement the remedy. The team chooses air quality impacts, specifically "global warming potential" and "PM-10," as metrics for evaluation. Both "global warming potential" and "PM-10" are quantitative metrics that have both environmental and social impacts. By using the table, the project team and stakeholders gain the external benefit of incrementally reducing the demand of consumable materials to a potentially more productive use.

Remedial Design and Construction

At the beginning of the Design phase, the project team and stakeholders review the Remedial Design Table in the Metrics Toolbox to confirm or revise the appropriate sustainability parameters and metrics for the project in light of the potential site plan, revisions, or changes in site conditions. In the review, they determine that the selected remedial technology will likely require significant fuel consumption. Hence, they select "treatment technology with the least impacts" as one of the parameters to be considered with the objective of reducing the carbon footprint. The design team will evaluate selected remedial technology(ies) to determine fuel use by design components as part of their value-engineering effort.

When planning for construction, the remediation contractor and project team discuss opportunities to select the appropriate sustainability parameters and metrics for the construction phase. When reviewing the Remedy Construction Table in the Metrics Toolbox, the contractor proposes "sequence work to minimize double handling of materials" as one of the sustainability parameters because material handling is a major element of the remedy. As a result, the contractor schedules deliveries when needed and prepares a site traffic plan to unload materials at the point of use to minimize the carbon footprint of the materials-handling requirements. Thus, the remediation contractor and project team gain the external benefit of reducing implementation time and project costs.

Once the remedy is selected, the project team and stakeholders review the Remedial Design Table in the Metrics Toolbox to confirm or revise the appropriate sustainability parameters and metrics for the project in light of the potential site plan, revisions, or changes in site conditions.

Operation and Maintenance

Once the remedy is implemented, the project team and stakeholders revisit the Operation and Maintenance Table in the Metrics Toolbox as part of annual or five-year reviews to confirm or revise the appropriate sustainability parameters and metrics for the project in light of current site plans or conditions. Because waste from discarded filters is a major operation element, the project team proposes "virgin material" as a parameter for evaluation and "use of virgin material" as a quantitative environmental, social, and economic metric. The team evaluates options, including filters made from recycled plastics and paper fiber, to ensure that process effectiveness is maintained with the

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alternate material. Through this evaluation, the project team gains the external benefits of a net reduction of both landfilled waste and the resources and burdens associated with the virgin materials.

SUMMARY AND RECOMMENDATIONS

SURF created the Metrics Toolbox in response to a need for a broader compilation of metrics that can be used to assess and monitor the effectiveness of remedies in achieving sustainability goals. SURF recommends that remediation practitioners consider the metrics compiled in the Metrics Toolbox as a companion to the sustainable remediation framework (Holland et al., 2011) and other sustainability assessments.

The Metrics Toolbox is intended to help remediation practitioners and key stakeholders identify the sustainability parameters and metrics that reflect their primary values, in the context of site-specific conditions and limitations, for each phase of the remediation project.

The Metrics Toolbox is intended to help remediation practitioners and key stakeholders identify the sustainability parameters and metrics that reflect their primary values, in the context of site-specific conditions and limitations, for each phase of the remediation project. Metrics that are not related to higher-level objectives or goals consume project resources without adding value. Likewise, the selection of too many criteria can dilute the value of the sustainability evaluation. As a result, SURF recommends a limited number of applicable, focused, and site-specific metrics (approximately five) in order to balance the project objectives meaningfully.

SURF recognizes that the qualitative and quantitative metrics listed in the Metrics Toolbox are applicable to a wide range of sustainability parameters in all phases of the remediation process. For this reason, the selection of appropriate, site-specific metrics requires stakeholder and remediation practitioner communication and collaboration. SURF recommends iterative collaboration between the remediation practitioner and stakeholders *throughout the remediation process* to ensure that the metrics reflect critical outcomes and future site use. SURF recommends that the metrics selected for sustainability evaluations should be limited to the critical few that are of the highest value.

By way of this publication, SURF is presenting the first version of its Metrics Toolbox. The Metrics Toolbox will be expanded and refined as the practice of sustainable remediation evolves and additional research and knowledge concerning sustainability parameters and metrics expands.

DISCLAIMER

This document was produced by the Sustainable Remediation Forum (SURF), which is a New Jersey nonprofit corporation with broad membership. The views and opinions expressed in this document are solely those of SURF and do not reflect the policies or positions of any organization with which SURF members are otherwise associated.

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