

1. Introduction

Extreme weather events and wildfires are increasing with the potential to impact hazardous waste sites and undermine the goal of cleanup—to protect human health and the environment. Confronted with these newly realized risks, the convention of assessing and designing remedies that require years of operation or monitoring beyond initial remediation construction should be reassessed. Sustainable resilient remediation (SRR) is an optimized solution to cleaning up and reusing hazardous waste sites that limits environmental impacts, maximizes social and economic benefits, and creates resilience against the increasing threat of extreme weather events, sea-level rise, and wildfires.

This guidance is an update of ITRC's *Technical and Regulatory Guidance: Green and Sustainable Remediation: A Practical Framework (ITRC 2011a)*, and includes a strong resilience component to address the increasing threat of extreme weather events, sea-level rise, and wildfires. The new guidance recommends a careful and continuous consideration of the social and economic costs and benefits of a cleanup project on equal footing with environmental costs and benefits.

This SRR document is intended to apply to any remediation program. It can be used by state regulators, federal employees, and the private sector, including consultants and industrial and commercial companies. This document can also be used by remediation industry stakeholders, including communities, local organizations, advocacy groups, and nongovernmental organizations. This SRR guidance may be used in part or in its entirety. It may be used for a particular phase of a project or applied to the entire project life cycle. It is not intended to supplant any regulatory requirement. Any user may concur with this document, but it may not comprehensively align with existing guidance due to variations in existing rules and statutes across different regulatory cleanup programs.

In the context of cleaning up contaminated sites, sustainability and resilience can be thought of as two sides of the same coin: while sustainability considers the remedy's impact on the environment, resilience considers the environment's impact on the remedy. But this distinction is not so simple. To be truly sustainable, a remedy must maintain functionality for the duration of its design life and do so by being resilient to extreme events and changing conditions. The interconnectedness of sustainability and resilience, particularly as they relate to the cleanup of contaminated sites, reemphasizes the importance of an integrated approach.

Many lessons have been learned in the nearly 10 years since ITRC's green and sustainable remediation (GSR) guidance was published. This new SRR guidance, which leverages many of these lessons learned, is organized into the following sections.

Section 2: Importance and Value of SRR – Section 2 addresses the evolution of environmental remediation to SRR, provides a brief overview of how sustainable remediation was first integrated into remediation, introduces important attributes to be considered in resiliency, summarizes case studies in SRR to provide readers context of how SRR has been implemented, and answers frequently asked questions related to the value and misperceptions of SRR. Overall, this section will help practitioners understand the benefits of implementing SRR, visualize benefits, and help convey to project stakeholders the importance and value of implementing SRR.

Section 3: Perspectives – This section assesses state survey results and is a policy developer's how-to guide, highlighting opportunities to implement SRR in state programs. It also provides insight into SRR options at private-party sites; approaches of various federal government branches and public and tribal stakeholders; and provides an overview of ASTM International's (ASTM) SRR-related guidance. Practitioners (for example, owners, consultants) planning to conduct investigation or cleanup of contaminated sites can use this resource to gain an overview of the tools available to guide their planning, design, and implementation.

Section 4: State Resource Map – This section provides fingertip access to the building blocks of SRR, climate resilience, showcasing state programs around the United States. Within each layer, state resources are categorized by type with a link to program-specific resources, including but not limited to legislation, gubernatorial actions, policy, and guidance. This resource map will quickly guide practitioners to state-specific SRR resources and relevant options in each state.

Section 5: Advancing the Practice: Social and Economic Dimensions of Sustainability and Resilience – This section focuses on the importance of considering the social and economic impacts of remediation on communities and discusses environmental justice, linking desired outcomes to metrics or progress indicators, and incorporation of resilience into brownfield sites. This section also proposes three different evaluation levels to be considered when assessing the social and economic dimensions of SRR. These topics, along with a discussion of ecosystem services, will help readers to better understand the social and economic dimensions of SRR so these attributes can be better integrated into cleanup projects.

Section 6: Integrating Resilience and Sustainability into the Remedial Project Life Cycle – The section provides an interactive view of the remediation project life cycle, the various components integral for successful completion, and recommendations on how SRR can be implemented in specific project life-cycle phases, starting with project planning and moving through site characterization; remedy planning; implementation; operation, maintenance, and monitoring (OM&M);

and site closeout. Like Section 5, this section proposes use of three scalable evaluation levels when integrating SRR into the project life cycle.

Section 7: Key Sustainable Best Management Practices – This section identifies important sustainable best management practices (SBMPs), key resources, and additional considerations for evaluating, implementing, and maintaining resilience to extreme weather and wildfire events at a remediation site. Response considerations and actions are also included. SBMPs are effective and practical methods or techniques to build or adapt a sustainable and climate impact-resilient environmental remediation site. SBMPs are an integral part of SRR. SBMPs are organized by type of extreme event. SBMPs are provided for a number of weather-related events, including wind, snow and hail, fluctuating groundwater levels, flooding, bank and shoreline erosion, wildfires, sea-level rise, evapotranspiration, storm surge, and permafrost thaw. This section will help readers understand different management practices that can be implemented to make projects more resilient and sustainable. A tool is included that can be used to create a site-specific summary of SBMPs and document whether specific SBMPs are applicable, prioritize SBMPs, and track implementation.

Section 8: Recommendations for the Future – In discussion with the members of the Sustainable Resilient Remediation Team as to what areas they believed could use further research, several topics were indicated.

Qualifier for the Superfund Program – During the course of developing this guidance, several workgroup team members and stakeholders have commented on how sustainability and resiliency are included in some regulatory cleanup programs, to varying degrees. For example, the U.S. Environmental Protection Agency (USEPA) provided the following comment on the document:

Superfunds position is on the guidance: Remedy decisions need to be made in the context of the regulatory scheme within which the remedy is being conducted. For example, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, aka Superfund) program has a defined regulatory process, and consideration of sustainability is already woven into remedy selection, design and operations. Remedies may often be implemented in ways that factor in social, and economic, and environmental footprint perspectives. For example, remedy decisions consider remedy cost and reasonably anticipated land use as part of the alternatives development and remedy selection. Consideration of the environmental footprint was outlined in the 2016 guidance on Consideration of Greener Cleanup Activities in the Superfund Cleanup Process. Community acceptance, which is considered in remedial alternative analyses, may also contribute more expansive concepts social and economic perspectives to the remedy selection process under CERCLA, and the 2020 Superfund Community Involvement Handbook (found at:

<https://www.epa.gov/superfund/superfund-community-involvement-tools-and-resources>) provides a robust framework to engage communities consistent with CERCLA requirements and processes.

This document will be valuable complement to USEPA's Superfund guidance, as it pertains to sustainability and resiliency. The authors of this document recognize that there are numerous regulatory cleanup programs that may not fully address the sustainability and resilience elements. This document will provide, or complement, other existing cleanup program guidance on implementing sustainability and resiliency into cleanup projects.

Nomenclature – A brief note on nomenclature used in this document: SRR is inclusive of "green remediation," "sustainable remediation," "green and sustainable remediation (GSR)," and "resilient remediation." The SRR term was developed in the course of preparing this guidance document and was developed to consolidate the above four terms. This document will use these four terms that can be considered to collectively represent SRR when citing previous documents or describing a unique component of one of the four terms. For example, the term "greener cleanup BMPs" in [Table 5-3](#) refers to specific BMPs associated with green remediation.