

3. Perspectives

This section uses the results of a survey of environmental state agencies to identify challenges and opportunities related to implementing SRR in state programs. This section 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 SRR-related guidance.

3.1 State Survey Summary

In 2019, a survey was distributed to state environmental agencies ([Appendix B](#)). The survey consisted of 16 questions pertaining to the availability, use, and value of different mechanisms to state governments that incentivize or require use of SRR at contaminated sites. Fifty-two individuals from various state agencies responded. Most (74%) of the state representatives surveyed agreed that a sustainable remediation guidance or framework that also addresses extreme weather events and wildfire impacts related to climate change at contaminated sites would be useful for their states. The survey results also indicated a state-led cleanup or a brownfield site as the type of site on which SRR would most likely be used. State or federal grant incentives were most likely to move a cleanup toward SRR, with mandates being the second most likely over local permits, land-use controls, or private certification. The respondents placed a high value on economic metrics (for example, job creation or job preservation) when evaluating whether SRR should be used at a site. Social impacts (for example, future use as parkland or open space) were of medium value to the respondents. The data gathered from this survey were factored into the development of the content provided in this SRR guidance document.

3.1.1 Challenges

The state survey identified three primary challenges that can impede implementation of SRR in site remediation: lack of regulations and/or policies, perceived higher cost, and lack of knowledge. These challenges are summarized in the following sections.

3.1.1.1 Lack of Regulations or Policies

Many states have no regulations or laws requiring SRR considerations during remedy selection. Even in those states that have policies, SRR may be treated as optional rather than an enforceable requirement. This makes it difficult to implement SRR with any consistency or reliability. Specific state regulations and policies are accessible through the [State Resource Map](#). [Section 3.1.2](#) presents strategies on how to overcome this barrier.

3.1.1.2 Perceived Higher Cost

Oftentimes, sustainable assessments and SRR evaluations and technologies are perceived as too expensive to incorporate into the remedy or redevelopment when, in fact, SBMPs can result in short- and long-term cost savings. For example, using SBMPs ([Section 7](#)) can lower material, energy, and water use, as well as reduce processing, transportation, and labor costs. Factoring life-cycle costs into a decision-making process that includes SRR remedial alternatives and long-term protectiveness or resilient alternatives will provide a comparison of overall anticipated costs ([ITRC 2006](#)). It is possible that a remedial alternative that is more expensive in the short term will save money over the long term, especially if the site is vulnerable to climate change impacts such as sea-level rise, flooding, wildfires, or other extreme weather events.

In addition, some states provide monetary incentives (see [Section 3.1.2.4](#)) to further encourage the incorporation of sustainable and resilient considerations into the remedial process.

3.1.1.3 Lack of Knowledge

Lack of knowledge on behalf of the regulators and regulated community is problematic, and gaps in knowledge should be discussed between both parties. This may include a lack of understanding of the environmental footprint of the cleanup actions; the potential risks of climate change to the selected remedy; applicable regulations; and the technical aspects of SRR.

For example, in relation to resilience, very few research studies have addressed the issues of residual contaminants and potential hydrological shifts ([Libera et al. 2019](#)). There are few guidelines on how to model hydrological systems in changing climate conditions or how to implement climate resilient remediation and monitoring systems. In addition, such assessments require modelers to choose the range of climate-forcing parameters in the future (for example, precipitation and recharge values), even if these parameters may be highly uncertain. Although there are several [climate assessments available](#) on the national scale—for example, U.S. Global Change Research Program ([USGCRP 2018](#))—they are mostly qualitative and less

specific at each location. More guidelines and tools are needed to select the appropriate range of future climate conditions for each assessment and how to quantify the future climate conditions at the local site scale.

This lack of knowledge often leads to SRR not even being considered during remedial selection and implementation. To address this lack of knowledge, a few states and organizations are developing resources and tools, such as an assessment tool to evaluate climate change risks at state-led sites:

- [Massachusetts Climate Change and Hazardous Waste Site Screening](#) is a research study in which a simple model was developed and geographic information system (GIS) tools were used to evaluate the potential vulnerability of a subset of 6,001 high-interest state-listed sites based on their locations and remediation status ([Mielbrecht and Tarrío 2019](#)).
- The State of Washington Department of Ecology has published a written procedure entitled [Adaptation Strategies for Resilient Cleanup Remedies: A Guide for Cleanup Project Managers to Increase the Resilience of Toxic Cleanup Sites to the Impacts from Climate Change \(Ecology 2017\)](#).

3.1.2 Opportunities

This section presents various drivers for integrating SRR into remediation projects. This ranges from strong legally binding statutes, regulations, executive orders, and contracts to nonbinding guidance and policy, to opportunities to voluntarily incorporate into procurements or remedial planning. Even in states without existing legally binding statutes and regulations, opportunities exist to incorporate SRR into remedial selection and implementation decisions. Specific state regulations, executive orders, and policy are accessible through the [State Resource Map](#).

Since the 2011 release of the ITRC GSR guidance ([ITRC 2011b](#), [ITRC 2011a](#)), some states have taken steps to incorporate GSR into their programs. In response to the threat of extreme weather events and wildfires, nearly all states have started [resilience planning and adaptation initiatives](#). Three states—California, Massachusetts, and New Jersey—have also begun to include resilience considerations in site remediation and redevelopment programs as follows:

- [California](#) - California has several programs, regulations, and policies in place for wildfires, climate resilience, and green remediation. The Tech Sheet: California SRR Resources in Appendix C summarizes these efforts. Of note are the following hazardous waste management resilience initiatives:
 - [DTSC Interim Summary Report of Woolsey Fire](#) - The California Department of Toxic Substances Control (DTSC) and a team of federal, state, and local agencies evaluated impacts of the Woolsey Fire on conditions at the Santa Susana Field Laboratory site (state-led cleanup) and in nearby communities. The interim report summarizes work done to address concerns about the impact of the Woolsey Fire on the site and surrounding communities ([DTSC 2018](#)).
 - [Los Angeles Region Framework for Climate Change Adaptation and Mitigation: Potential Regulatory Adaptation and Mitigation Measures](#) - This framework looks at the effects of climate change on contaminated sites and underground storage tanks and how these effects can be considered in the agency's actions ([LARWQCB 2019](#)).
 - [Existing Conditions and Stressors Report—Contaminated Lands](#)
The San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides project evaluated the current condition of shoreline and community assets and the stressors affecting them.
- [Massachusetts](#) - Massachusetts has established programs and enacted laws with ambitious goals to combat climate change and incorporate resilience in infrastructure and remediation. The [Massachusetts Climate Change Clearinghouse](#) is the primary gateway to data and information relevant to climate change adaptation and mitigation across the state. It provides the most up-to-date climate change science and decision support tools for the commonwealth to support scientifically sound and cost-effective decision making for policy makers, practitioners, and the public. The state also maintains a [climate action website](#) with links to supporting programs, policies, and laws. The [Tech Sheet: Massachusetts SRR Resources](#) in Appendix C summarizes some of these efforts.
- [New Jersey](#) - New Jersey has developed policies and passed regulations, statutes, and executive orders, taking specific actions to address sustainability and resilience at contaminated sites. The [Tech Sheet: New Jersey SRR Resources](#) in Appendix C summarizes the information available.

3.1.2.1 Laws and Regulations

This section provides examples where implementation of sustainability or resilient remediation is required through state **statutes** (legislative action) or **regulations/rules** (agency action) to be legally enforceable as laws. This is generally the strongest and longest lasting driver for implementation of SRR.

In response to the state's [2008 Global Warming Solutions Act \(GWSA\)](#), the Massachusetts Department of Environmental Protection (MassDEP) amended the Massachusetts Contingency Plan (MCP) to include the consideration of green approaches for the assessment and remediation of regulated sites. In response to the governor's [2016 Executive Order 569](#), MassDEP again amended the MCP in 2019 to require those conducting cleanups to (1) identify and assess foreseeable climate impacts that may affect the permanency and protectiveness of the cleanup at vulnerable sites; and (2) take reasonable measures to reduce vulnerabilities. These changes are expected to become final by 2021. For more information see the [Tech Sheet: Massachusetts SRR Resources](#).

In 2018, the New Jersey Department of Environmental Protection (NJDEP) addressed sustainability at contaminated sites in the state's [Technical Requirements for Site Remediation](#), which states that the NJDEP "encourages the use of green and sustainable practices during the remediation of contaminated sites" ([N.J. Admin. Code § 7:26E-1.9, NJDEP 2018](#)). Although not a strong directive, it incorporated green and sustainable practices into the lexicon of site remediation in New Jersey and encouraged their consideration at contaminated sites during the remediation process. A year later, the state incorporated GSR into its statutes when the Site Remediation Reform Act was amended. More detail about these laws is provided in the [Tech Sheet: New Jersey SRR Resources](#).

3.1.2.2 State Contract Language

Incorporating SRR into state-funded response actions is beneficial for many reasons, including:

- contributing toward state-mandated climate and sustainability goals reducing emissions and waste generation
- planning for extreme weather events that pose a risk of compromising the remedy

Depending on how state contracts are secured, this can be accomplished in various phases of project planning.

- State employees can work with project engineers and contract specialists to develop model language to include in design specifications and contracts with trade contractors
- If the state has a bid specification model, incorporate this language into the template. This will make SRR an automatic consideration for project managers as they evaluate approaches for remedial actions.
 - Consider beginning with a pilot study prior to implementing statewide.
 - Develop measurement and tracking mechanism to evaluate the costs and benefits.

3.1.2.3 State Executive Orders

This section provides examples in California, New Jersey, and Oregon, where the implementation of SRR is mandated through executive orders (EOs). At the state level, an EO is a mandate issued by the governor. EOs direct action and have the rule of law, but can be overturned by the legislature or the courts.

- In 2015, then California Governor Jerry Brown established [EO B-30-15](#), which aims to reduce greenhouse gas (GHG) emissions and incorporate climate change impacts into planning and investment decisions. This order also requires the state Natural Resources Agency to update the state's climate adaptation strategy every 3 years. For more information, see the [Tech Sheet: California SRR Resources](#).
- New Jersey Governor Philip Murphy signed [EO No. 89](#) on October 29, 2019, on the seventh anniversary of Superstorm Sandy. It directed the state, through the NJDEP, to develop a statewide climate change strategy to guide decisions and policies across state government. The EO also ordered the formation of a Climate and Flood Resilience Program within the NJDEP and created the Interagency Council on Climate Resilience to promote the long-term mitigation, adaptation, and resilience of New Jersey's economy, communities, infrastructure, and natural resources. For more information on SRR efforts in New Jersey, see the [Tech Sheet: New Jersey SRR Resources](#).
- In March 2020, Oregon passed EO 20-04, [Directing State Agencies to Take Actions to Reduce and Regulate Greenhouse Gas Emissions](#). The EO requires the state to reduce its GHG emissions at least 45% below 1990 levels by 2035 and 80% below 1990 levels by 2050. Agencies are directed to consider and integrate climate change and climate change impacts into their planning, budgets, investments, and policy-making decisions and to prioritize actions that will help vulnerable populations and impacted communities adapt to climate change impacts. The state's Environmental Justice Task Force must be consulted when evaluating climate change

mitigation and adaptation priorities and actions.

3.1.2.4 Policy and Voluntary Guidance

Strategies for implementing SRR can take the form of policy and voluntary guidance. The state agency may strongly encourage implementation of SRR at private-party and state-funded sites through policy or through guidance developed by the state agency or adopted from another entity such as ITRC, ASTM, or the USEPA. Vulnerability assessment resources ([Section 6.2.3](#)) and key SBMPs ([Section 7](#)) can help states identify if a contaminated site is vulnerable to direct or secondary impacts from climate change. Some ways to disseminate this information and build support for a state SRR voluntary program include:

- providing information on the state agency website
- sharing information and offering encouragement in state agency list serve distributions
- management encouraging and supporting staff to implement at state-funded sites
- encouraging SRR verbally in meetings with private parties
- providing or sponsoring training to agency staff, consultants, and the regulated community
- offering a good corporate citizen program that includes SRR in the point system for consideration

In addition to providing technical information to the regulated community, it is helpful to build a case for the benefits of SRR and how sustainability and resilience reduce long-term costs and liability at contaminated sites. Referencing state case studies is recommended to illustrate the potential for life-cycle cost reduction and resources saved when SRR practices are used. Numerous case studies are provided in [Appendix A](#).

Sometimes states provide financial assistance to incentivize incorporating SRR into the remedial process. For example, Delaware incorporated SRR evaluations and technologies into [brownfield reimbursement guidance](#), most recently updated in July 2020 ([DNREC 2020](#)). Other states, such as [Washington State \(Ecology 2017\)](#), simply provide guidance.

3.2 Private-Party Sites

Where explicit regulations requiring SRR do not exist or where guidance is lacking, private parties may still incorporate SRR components by looking to the broader requirements of existing regulation and policy. For example, if a state or federal cleanup program has a regulation or policy with the statements below, the potential risks of future changes in climate and extreme weather can be considered for a cleanup site.

- that the cleanup conducted not pose an unreasonable risk of injury to health or the environment
- that the subject property be returned to maximum beneficial use for the community
- that the cleanup decisions be protective of human health and the environment

Ask the question, “*Is this remedy vulnerable?*” See [Section 6](#) to learn how to integrate resilience into site plans and other phases of the project life cycle.

Owners can also voluntarily include contract language to require their contractors to evaluate or implement SRR remedial SBMPs. Such contract language and actions reduce the potential of climate impacts from remedial actions and increase resilience. As a result, owners demonstrate their commitment to corporate responsibility and reduce their long-term liability ([Section 2.1.4](#)).

3.3 Federal Perspectives

3.3.1 Executive Orders

There are no specific laws or regulations that mandate the implementation of SRR; however, federal EOs that require federal agencies to incorporate sustainability practices and climate change adaptation in agency operations were signed from 2013 to 2015. Some were revoked in 2017 and 2018, as noted below.

- *Efficient Federal Operations (EO 13834)* affirmed “that agencies shall meet such statutory requirements in a manner that increases efficiency, optimizes performance, eliminates unnecessary use of resources, and protects the environment.” In implementing this policy, agencies are tasked to prioritize actions that reduce waste, cut costs, enhance the resilience of federal infrastructure and operations, and enable more effective accomplishment of the federal government’s mission. Section 8 of the new EO **revokes** EO 13693 of 19 March 2015 (*Planning for Federal Sustainability in the Next Decade*), which incorporated sustainability principles and federal leadership in environmental, energy, and economic performance ([NARA 2015](#)). EO 13834, *Efficient*

Federal Operations, **revoked** EO 13693 ([NARA 2018](#)).

- *Preparing the United States for the Impacts of Climate Change* (EO 13653) directed federal agencies to promote engaged and strong partnerships and information sharing, risk-informed decision making, adaptive learning, and preparedness planning (National Archives and Records Administration 2013). *Promoting Energy Independence and Economic Growth* (EO 13783) **revoked** EO 13653 ([NARA 2017](#)).

3.3.2 U.S. Environmental Protection Agency

3.3.2.1 Office of Superfund

The USEPA's [Superfund Climate Resilience website](#) provides comprehensive guidance on climate resilience at Superfund sites and has developed an approach that raises awareness about the vulnerabilities that result from climate change. Superfund applies climate change and weather science as a standard operating practice in cleanup projects. In June 2014, the USEPA released its agencywide [Climate Change Adaptation Plan](#), which includes actions to be taken through the Superfund program ([USEPA 2014](#)). The climate resilience strategies involve three elements: [vulnerability assessment](#), [resilience measures](#), and [adaptive capacity](#).

3.3.2.2 Brownfields Program

The USEPA's [Climate Smart Brownfields Manual](#) provides a comprehensive approach for communities on climate mitigation, adaptation, and resilience for redeveloping these sites. Topics include the role of local communities in land-use planning, zoning, and building codes; green building techniques, practices, and adaptation strategies ([USEPA 2016b](#)). Further, incorporating sustainable and resilient BMPs in an application for a USEPA brownfields grant is considered favorably over an application that lacks those types of concepts.

3.3.2.3 Office of Research and Development

The USEPA Office of Research and Development is the scientific research portion of the organization. Specific efforts related to SRR include the following:

- [Sustainable and Healthy Communities](#) is a national research program that is focused on promoting and building sustainability and resilience at a community level. The program's research aims to answer the question, "How do we meet today's needs without compromising the ability of future generations to meet their needs in ways that are economically viable, beneficial to human health and well-being, and socially just?" A robust portfolio of intramural research projects is aligned with the main goals of SRR:
 - studying the benefits of sustainable remediation, restoration, and revitalization in terms of a community's total (that is, environmental, social, and economic) health and well-being with special focus on vulnerable groups
 - developing and providing practical tools and solutions
 - measuring the beneficial health and ecological impacts for communities

Under this program, the USEPA developed [the Sustainable and Healthy Communities Strategic Research Action Plan for 2019–2022](#) ([USEPA 2020b](#)). The purpose of this plan is to inform agency partners (program and regional offices) and external stakeholders of the program's strategic direction over the next 4 years. The plan focuses on remediation solutions for contaminated sites as well as revitalizing and protecting communities at risk from contamination and natural disasters. The 2019 plan concludes with nine priority topics, three of which address the importance of investigating the resilience to extreme weather events and other climate events, including the remobilization of contaminants.

- In 2020, as part of its Science to Achieve Results (STAR) Program, the USEPA funded six 3-year research projects under the 2019 request for applications entitled [Contaminated Sites, Natural Disasters, Changing Environmental Conditions and Vulnerable Communities: Research to Build Resilience](#).
- The USEPA has developed the [Climate Resilience Screening Index \(CRSI\)](#), which is designed to capture the sensitivity of five domains (natural environment, built environment, governance, social structure, and vulnerability or risk) to climate events. CRSI is a county-level score for climate resilience (scalable both upward and downward spatially) that is also defined by various indicators/metrics to quantify, for example, climate and demographic conditions. The "exposure" indicator includes the probability of a technological hazard being in the proximity of contaminated sites, including nuclear sites, toxic release sites, Superfund sites, and Resource Conservation Recovery Act (RCRA) sites ([USEPA 2017a](#)).
- USEPA's [Science Inventory](#) is a searchable repository of USEPA reports, currently showing seven results on "sustainable remediation."

3.3.3 U.S. Department of Defense

The Department of Defense [DOD] manual Defense Environmental Restoration Program Management instructs DOD to evaluate remedial alternatives to ensure that they are efficient; are environmentally, economically, and fiscally sound; consider sustainable practices; reduce the footprint of remediation systems on the environment; and “consider and implement green and sustainable remediation opportunities in current and future remedial activities when feasible” ([DOD 2012, page 48](#)). The manual notes that opportunities to increase sustainability considerations exist throughout all phases of remediation. [Section 6](#) of this guidance, Integrating Resilience and Sustainability into the Remedial Project Life Cycle, provides information about how to integrate these considerations during a remediation project.

3.3.3.1 U.S. Department of Navy

In 2012, the U.S. Department of the Navy (DON) announced a policy that requires continual optimization of remedies in each phase of the remedial process. The DON’s [Guidance on Green and Sustainable Remediation \(USN 2012\)](#) provides remediation program managers and consultants with a clear approach to incorporating GSR considerations in all phases of the environmental restoration process. A GSR analysis of each of the alternatives evaluated in the remedy evaluation documents is included, and the SiteWise tool is used to conduct a remedy footprint analysis of each alternative ([Bhargava and Sirabian 2013](#)). Additional remedy footprint analysis tools can also be used, but only in conjunction with or after an analysis using the SiteWise tool.

3.3.3.2 U.S. Air Force

In 2019, the U.S. Air Force issued [contracting policy](#) to incorporate GSR into environmental cleanup contracts ([USAF 2020](#)). The Environmental Restoration Technical Support Branch of the Air Force Civil Engineer Center has led efforts to implement environmentally friendly and effective technologies to restore contaminated sites. The Sustainable Remediation Tool ([Claypool and Rogers 2012](#)) evaluates remediation projects from a carbon-footprint perspective, and [CleanSWEEP](#) helps evaluate renewable energy sources. In collaboration with other federal agencies and intergovernmental organizations, the branch has also participated in establishing GSR guidelines and standards. More detailed information is available on the Air Force Civil Engineer Center’s [website](#).

3.3.3.3 U.S. Army Corps of Engineers

In 2010, the U.S. Army Corps of Engineers (USACE) finalized its interim guidance, [Decision Framework for Incorporation of Green and Sustainable Practices into Environmental Remediation Projects \(USACE 2010\)](#). The guidance provides a process for incorporating GSR practices into environmental remediation consistent with DOD policy and the Army Environmental Cleanup Strategic Plan during USACE execution of the Formerly Used Defense Site program. The scope of the document is to provide these processes for the entire environmental remediation life cycle, from project inception through site closeout ([Section 6](#)).

In addition, the USACE [Regional Sediment Management](#) and [Engineering with Nature](#) programs can complement and be coordinated with SRR activities.

3.3.4 U.S. Department of Energy

The U.S. Department of Energy (DOE) has been managing more than 100 sites with soil and groundwater contamination and radioactive waste associated with nuclear weapons production and government-sponsored nuclear energy research. Following EO 13653 *Preparing the United States for the Impacts of Climate Change*, DOE has been developing strategies to enhance climate preparedness and resilience ([Moore et al. 2016](#)). DOE released a series of DOE Climate Change Adaptation Plans ([USDOE 2014](#), [USDOE 2016](#)), as well as the DOE Climate Change Vulnerability Screening Guidance ([USDOE 2017](#)), to ensure inclusion of climate change adaptation as part of its planning and operations. [Moore et al. \(2016\)](#) investigated three sites that were impacted by wildfire, flooding, and groundwater changes. DOE also required the incorporation of contract language encouraging the incorporation of sustainability principles in its remediation efforts. Currently, DOE requires each of its sites to develop an annual Site Sustainability Plan that includes promoting resilience to disturbances from a variety of sources ([USDOE 2018](#)).

3.3.5 Federal Emergency Management Agency (FEMA)

The impacts of natural disasters are diminished with the right planning and preparation, which incorporates resilience. FEMA has numerous publications and resources to help with resilience preparation. For example, flood and wind map tools are available. FEMA has a program through which communities that prove resilience against impacts through wide-scale efforts (such as improving drainage basins and floodplain management) can be certified in a way that gives individuals and local

businesses reductions in rates from insurers.

3.3.6 Government Accountability Office (GAO)

In [a report published in 2019](#), the GAO reviewed various potential issues related to the impact of climate change on nonfederal National Priorities List (NPL) sites, which include some of the most seriously contaminated sites. The analysis was focused on flooding, storm surge, wildfires, and sea-level rise, based on federal data, including from the USEPA, FEMA, National Oceanic and Atmospheric Administration, and U.S. Forest Service. In addition, the GAO reviewed laws, regulations, and documents and interviewed federal officials and stakeholders. Among other objectives, they examined the following: (1) what available federal data suggest about the number of nonfederal NPL sites located in areas that may be impacted by selected climate change effects and (2) the extent to which USEPA has managed risks to human health and the environment from the potential impacts of climate change effects at such sites ([GAO 2019](#)).

The report suggests that climate change may result in more frequent or intense extreme events, such as flooding, storm surge, and wildfires, among other effects, which could damage remedies at nonfederal NPL sites and lead to releases of contaminants that could pose risks to human health and the environment. About 60% of all nonfederal NPL sites are in areas that may be impacted by these potential climate change effects. The GAO recommends broadly incorporating climate resilience into the site-level decision-making process to ensure long-term protection of human health and the environment ([GAO 2019](#)).

3.4 Public and Tribal Stakeholders

ITRC defines stakeholders as members of environmental organizations, community advocacy groups, or other citizens' groups that deal with environmental issues ([ITRC 2011a](#)). Likewise, tribal stakeholders are affiliated with, or are employees of, tribal nations, or are Native American, Alaska Native, or Native Hawaiian. These public and tribal stakeholders, other interested individuals, are the voices of the communities and tribes that are affected by environmental problems.

Stakeholders' perspectives for contaminated sites undergoing cleanup incorporate cultural, historical, and other community-based values. Contamination at sites can damage resources that belong to both current and future generations. This obligation to future generations is particularly strong among tribal stakeholders. While tribal stakeholders share many of the same concerns as other public stakeholders, they have additional concerns as custodians of ancestral lands and shared resources with federal, state, and local agencies. USEPA's policy is to consult on a government-to-government basis with federally recognized tribal governments when USEPA actions and decisions may affect tribal interests. Consultation is a process of meaningful communication and coordination between USEPA and tribal officials prior to USEPA taking actions or implementing decisions that may affect tribes.

Tribes have accumulated knowledge about the plants, animals, natural phenomena, landscapes, and timing of events at specific places, often referred to as traditional ecological knowledge (TEK). TEK continues to evolve and identify changes in the environment. TEK is an important part of the tribal consultation process and decision making. [Section 7.1.2](#) provides information on how to incorporate TEK into resiliency planning at the remediation site.

Remediation sites often contain hazardous substances that pose a risk to health, a threat to property, and a danger to resources. As individuals, members of environmental or community advocacy groups, and participants in official advisory bodies, stakeholders are the ultimate beneficiaries of environmental remediation activities and usually believe that contamination should be cleaned up to the extent practicable. While it may be impractical to remove or destroy all hazardous substances at a remediation site, stakeholders generally expect the following:

- Responsible parties, regulators, and others who engage in the investigation and remediation of hazardous waste have an obligation to reduce the toxicity, mobility, and volume of waste to the extent practicable and in the most environmentally responsible manner, considering sustainable and resilient options.
- All exposure pathways to hazardous substances that have been released into the environment should be eliminated, and innovative remedial technologies should be considered in all phases of the remediation process.
- Decision makers should include active SRR components in every remedy. Remedies that operate for long time frames require a robust system of long-term management, and the cost and other SRR challenges of long-term activity should be evaluated when considering initial remedies.
- Regulators who make remediation decisions should view public stakeholders and tribal representatives as partners in site remediation from the beginning to end of cleanup.
- Sites should be evaluated to determine whether the remedial design and objectives were based on an adequate characterization and a valid CSM. Finding and controlling sources reduces remediation time frames, cost of remediation, and overall ecological burden on public resources.

- The remediation of complex sites should use sustainable and energy- and resource-efficient remedial technologies except when doing so avoids restoring resources or delays remedial goals. Restoring resources is the priority value.
- Long-term management strategies at remediation sites should remove institutional controls as remediation reduces risks and return land and resources to community use. SRR may become more important and applicable as the cleanup progresses.

The SRR guidance builds on the 2011 ITRC GSR framework by recommending 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 ([ITRC 2011a](#)). Robust and transparent stakeholder engagement is almost always required to identify specific and meaningful social and economic goals for a remediation project and must be continued to ensure that community expectations are met as the project progresses ([see Favara et al. 2019](#)). Stakeholder engagement resources in [Section 5.9.1.5](#) provide essential guidance for structuring these processes ([Figure 5-5](#) and [Table 5-7](#)). Stakeholder engagement is addressed at each stage of the cleanup process in [Section 6](#).

3.5 ASTM International

ASTM International has produced several standard guides related to SRR, including the following:

- [Standard Guide for Integrating Sustainable Objectives into Cleanup](#) (ASTM E2876-13) presents a framework that allows and encourages practitioners to address sustainable aspects within cleanup projects ([ASTM 2013a](#)). Practitioners may implement this guide to integrate sustainable objectives into cleanup while working within applicable regulatory criteria.
- [Standard Guide for Climate Resiliency Planning and Strategy](#) (ASTM E3032-15e1) presents a generalized, systematic approach to the voluntary assessment and risk management of extreme climate-related events and conditions ([ASTM 2015](#)). It helps practitioners structure their understanding of the climate-related vulnerabilities and consequences they seek to manage and identify adaptive actions of both an institutional (legal) and engineering (physical) nature.
- ASTM E2893-16e1 [Standard Guide for Greener Cleanups](#) provides a process for identifying, prioritizing, selecting, implementing, documenting, and reporting activities to reduce the environmental footprint of a cleanup ([ASTM 2016](#)). The USEPA provides a [free webinar](#).
- [New Guide for Remedial Action Resiliency to Climate Impacts](#) (ASTM WK66522) is an additional document about remediation resilience that is currently in development. The guide will include sections on climate evaluation for remediation stages, potential climate impacts on remedies and adaptation, potential climate impacts on contaminants and contaminant migration, potential societal impacts, and appendices with examples of impacts of disasters on cleanup sites.