United States
Environmental Protection
Agency

542-R-13-008
June 2013
Office of Solid Waste and Emergency Response
Office of Superfund Remediation and Technology Innovation

Remediation Optimization: Definition, Scope and Approach

Background

For more than a decade, the U.S. Environmental Protection Agency's Office of Superfund Remediation and Technology Innovation (OSRTI) has provided technical support to EPA Regional offices through the use of third-party optimization evaluations. OSRTI has conducted more than 150 optimization studies for Superfund and other EPA programs nationwide.

In September 2012, OSRTI finalized its *National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion* (Strategy).[1] The Strategy unifies the previously independent optimization efforts (such as RSE, IDR and LTMO) with other practices complimentary to optimization (such as the Triad Approach and Green Remediation) under the singular term "optimization," which can be applied at any stage of the Superfund project pipeline. The Strategy also encourages other activities intended to facilitate better site characterization, remedy selection, remedy design, construction and operation of the remedy, by applying various techniques and methods to improve a given project's scope, schedule and cost.

This document provides a general definition, scope and approach for conducting optimization reviews within the Superfund Program and includes the fundamental principles and themes common to optimization. It should be noted that although this document has been developed for optimization support in the Superfund Program, OSRTI acknowledges that the content of the document can apply to optimization in other remedial programs or regulatory frameworks.

Prior to the implementation of EPA's Strategy, optimization support was known by the remedial phases or for the type of support provided. These terms and acronyms have been phased out; however, they are provided below for clarification.

- **Remediation System Evaluation (RSE)** - optimization support during a Long-term Response Action (LTRA) or Operation and Maintenance (O&M).
- **Independent Design Review (IDR)** - optimization at the remedy selection, design, re-design stage.
- **Long-Term Monitoring Optimization (LTMO)** - optimization focused on long-term monitoring programs.

What is Optimization?

The EPA's Strategy defines optimization as:

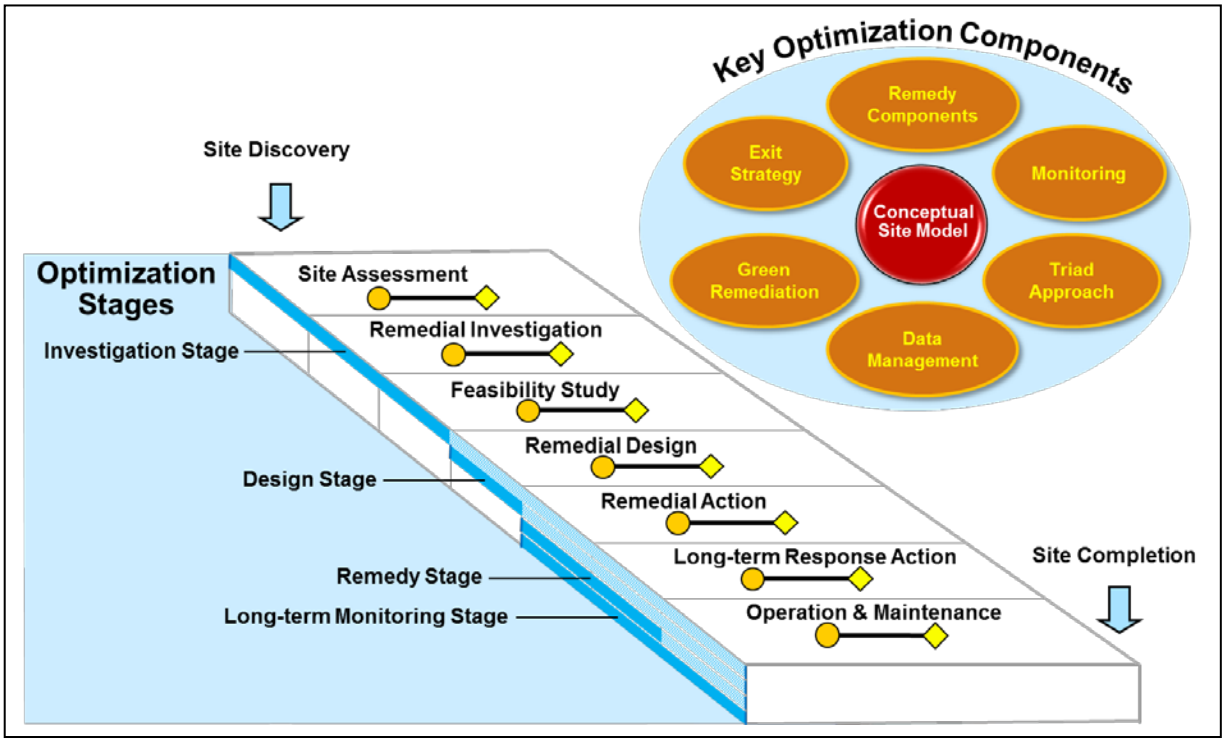
> ***"Efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from Green Remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness."***[2]

[1] U.S. Environmental Protection Agency. 2012. Memorandum: Transmittal of the National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion. From: James. E. Woolford, Director Office of Superfund Remediation and Technology Innovation. To: Superfund National Policy Managers (Regions 1 – 10). Office of Solid Waste and Emergency Response (OSWER) 9200.3-75. September 28, 2012.

[2] The EPA encourages contractors, states, tribes, the public and PRPs to propose specific opportunities to improve protectiveness and efficiency for the Agency to consider.

Optimization focuses on protectiveness, effectiveness, cost efficiency, technical improvement, progress toward site completion, site closure and environmental footprint reduction (qualitative or quantitative). The key components of optimization and the remedial pipeline phases at which optimization can be applied are shown in Figure 1. An optimization review considers the goals of the remedy, available site data, the conceptual site model (CSM), remedy performance and exit strategy. Optimization review activities include: examining site documents, interviewing site stakeholders, potentially visiting the site, evaluating site data, developing findings and recommendations and compiling a report for the purposes of project documentation and technology transfer. The recommendations are intended to help the site team identify opportunities for improvements in these areas.

Figure 1 - Optimization Applied to Cleanup Activities from Site Assessment to Site Completion



The definition refers to a "systematic site review," indicating that the site as a whole is often assessed in the review. However, optimization may also be applied only to a specific aspect of a site (for example, one of several operable units or a specific remedial technology). Other site or remedy components are considered to the degree that they impact the specific aspect under consideration. Optimization may be applied at multiple phases of the remedial process for the same site, where appropriate. It is important that optimization be conducted by independent, third-party experts to provide an unbiased perspective of the site.

What is the Typical Scope of an Optimization Review?

Optimization reviews typically involve the following elements:

- Logistics, planning and scoping of optimization review activities
- Document and data collection and initial review
- Consultation with site stakeholders (either through an onsite meeting or conference call)
- Detailed data analysis
- Presentation of preliminary optimization findings and recommendations (such as a draft report, a technical memorandum or web conference presentation)
- Finalization of the optimization findings and recommendations
- Implementation of recommendations
- Tracking of recommendation implementation
- Technical support for existing recommendations, as appropriate
- Potential future optimization event(s) at the site

Logistics, Planning and Scoping – This set of activities typically involves an introductory call between the site and optimization review teams to confirm the scope of optimization activities, initiate the transfer of documents and data for review by the optimization review team, set the schedule and logistics for an onsite visit and meeting (if appropriate), plan for stakeholder interviews and set a schedule for presenting the optimization findings and recommendations.

Document and Data Collection and Initial Review – The document review process includes documents from the current pipeline stage and *may include documents from any prior pipeline stage*. Table 1 presents typical documents and data that are most commonly reviewed during an optimization event.

Table 1 – Typical Documents and Data Reviewed During Optimization at Primary Pipeline Stages

Investigation/Feasibility Study	Design	RA/LTRA/O&M
• Preliminary Assessment/Site Inspection (PA/SI) Report • Technical Memorandums • Investigation work plans • Quality Assurance Project Plan (QAPP) • CSM, including, but not limited to: o Historical site information o Local/regional geologic and hydrogeologic information o Information from online database reports o Any other relevant documents or data sets	• Remedial Investigation (RI) Report • Supplemental RI Reports • Feasibility Study (FS) Report • CSM updates • Record of Decision (ROD) or Interim ROD • Design technical memorandums • Design criteria/basis reports • Interim design reports • Modeling or 3-D visualization and analysis reports • Remedy implementation cost estimates • Any other relevant documents or data sets	• RI Report • Supplemental RI Reports • FS Report • CSM further updates • Decision documents (Proposed Plan, RODs, ROD Amendments, Explanation of Significant Differences [ESD]) • Design documents • Operations and maintenance (O&M) manual • Recent system O&M reports* • Recent quarterly, semi-annual, or annual site monitoring reports** • Five-year reviews • Any other relevant documents or data sets

** Typically the prior 12 months of weekly or monthly O&M reports.*
*** Typically the prior 24 months of quarterly, semi-annual or annual monitoring reports; including databases of historical site data.*

In addition, where appropriate and available for LTRA/O&M optimization, the following typical cost information should be provided:

- Project management, technical support and reporting
- Site contractor labor (for example, plant operators, injection contractors and thermal remediation vendors)
- Utilities (for example, electricity, natural gas and potable water)
- Consumables (for example, general supplies, treatment materials, chemicals and nutrients)
- Waste disposal
- Groundwater sampling (for example, labor, equipment and travel)
- Laboratory analysis

***Stakeholder Consultation* –** Ideally, interviews are conducted as a group during an onsite meeting or in a series of conference calls and web meetings if there is no onsite meeting. The following individuals are typically consulted during a review.

- EPA Remedial Project Manager (RPM)
- EPA technical project team members
- Other federal agency representatives (for example, U.S. Fish and Wildlife Service and U.S. Geological Survey)
- State regulator/site or case manager
- Oversight consultant project manager (and potentially technical support personnel)
- Site contractors (including remedial system operator)
- Potentially responsible party or parties (if any)

Interviews with stakeholders may be conducted independently, but it is generally more effective if all parties are present for the onsite meeting or conference calls. An optimization review agenda may be implemented over the course of a one-day site visit, a lengthy conference call or a series of conference calls. Example agenda items for a typical optimization review site meeting or conference call are provided in Attachment 1.

Detailed Data Analysis – This step is conducted independently by the optimization review team based on information provided by the site team and includes many types of analysis including, but not limited to, those summarized in Attachment 2.

Presentation of Draft Findings and Recommendations **–** Optimization findings and recommendations are typically provided in a draft report or summary memorandum. EPA management or stakeholder presentations may also be prepared, as requested, to summarize findings and recommendations. A typical draft optimization review report or memorandum includes the following information:

- Executive summary
- General site background
- Summary of the characterization or remediation objectives
- Findings from document reviews, data analysis and interviews
- Recommendations (including expected costs/savings implications) that address critical data gaps, remedy implementation, protectiveness, cost, and progress to site closure

Review of Draft Findings and Resolution of Comments **–** The draft report or summary memorandum is distributed to the site team for review and comment. Feedback on the draft report is received, comments are addressed and a draft final report is prepared.

Finalization of Optimization Findings and Recommendations – Upon presentation and acceptance of the draft final report and the resolution of any remaining comments, the document is finalized.

Implementation of Recommendations – Regions implement recommendations based on confirmation with their respective organizational decision-makers and available resources.

Tracking of Implementation of Recommendations **–** Follow-up includes conference calls conducted at specified times after submission of the final optimization review report to determine which recommendations the site team has considered, which recommendations have been or are planned to be implemented and which recommendations are being declined and for what reasons. Costs and technical results from implementing recommendations are requested, as well as feedback on the optimization review process. Follow-up generally occurs on an annual basis and continues until all recommendations have been thoroughly considered by the site team.

Further Technical Support **–** Follow-on technical support by the optimization review team may also include: review of additional reports or documents; development of CSM products/visualizations; sampling design; technology evaluations; dynamic work strategies for additional characterization needs; and evaluation of site work plans in relation to the current optimization event.

Additional Recommendations **–** Based on the purpose and focus of technical assistance provided to the site team, additional recommendations may be provided for the site team's consideration and implementation.

Potential Future Optimization Event(s) at the Site – In some cases, additional optimization reviews are needed. In these cases, repetition of background, previous findings and previous recommendations may not be merited in each optimization submittal. Rather, a single summary document may be appropriate to provide general background and a compilation of major findings and recommendations.

How Is Green Remediation Considered During Optimization?

Optimization reviews consider the effects of project activities and remedy operations on the environment to identify site activities, technologies, supplies and associated resources which, if modified, could reduce the site's environmental footprint. Recommendations for environmental footprint reduction (and associated costs and cost savings) are provided. In addition, the optimization review report documents how recommendations made for other purposes (for example, improving effectiveness or reducing cost) affect the site's environmental footprint. More information on environmental footprint evaluation can be accessed at www.cluin.org/greenremediation.

How Do I Prepare For An Optimization Review?

One of the best ways to prepare for a review is to be aware of the types of questions that may be asked. Example optimization review questions are provided below. In many cases, these questions are used to generate discussion and to lead the optimization effort toward more direct and detailed questions. A more comprehensive list of resources is provided for optimization reviews conducted at each stage of the remedial pipeline at www.cluin.org/optimization.

1. Please provide a history of the site up to the present time. Please include any significant changes in the approach or strategy taken at the site including ROD Amendments and ESDs (if any). Please note that many aspects of this site history will provide discussion points.
2. What are the key site conditions, as reflected in the CSM (for example, sources, hydrogeology, geochemistry, etc.)? How has new operational data (if any) changed the CSM? What data gaps exist in the current CSM? Are the scales of measurements represented by the CSM appropriate for the proposed investigations, designs or remedies?
3. What are the characterization objectives? What are the remedial action objectives (RAO)? Are they still relevant and appropriate? Have there been any changes in conditions or policy since these objectives were established?
4. Have end data users (for example, risk assessors, design engineers) been identified and engaged as part of the site team? What are their data needs? Can these be addressed with collaborative data sets that combine high spatial density of screening data or less rigorous analytical requirements with conventional laboratory and field analytical data?
5. What is the data management strategy as related to project and site decision making? How are data collected, stored, processed, evaluated and communicated? Would the project benefit from the use of 3-D visualization and analysis or other decision support tools?
6. What are the stakeholder dynamics? Are the relationships collaborative or adversarial? What level of effort is likely required to increase social capital to support achieving a consensus site vision with reasonable exit strategies?
7. What is the current characterization or remedial strategy for the site? How has this strategy changed over time? What elements of the remedy have led to these changes?
8. What aspects of the selected remedy and conceptual design cause the most concern about future performance? What are the likely points of failure for the remedy?
9. What are the various sources of uncertainty in the characterization or remedy design? What is the priority for addressing these uncertainties? What is the level of certainty about each major characterization or design parameter? How sensitive is characterization or remedy performance and cost to this parameter?
10. How will remedy performance be evaluated to ensure satisfaction of RAOs? How will stakeholders know the remedy is successful? What parameters will be measured? What values will indicate adequate performance/progress or represent a trigger point for considering other remedial alternatives? How will these data be used to evaluate the remedy?
11. For operating remedies, is the remedy performing as designed? How have site conditions changed since design? Are the design parameters still valid?
12. What functions do the component technologies provide and what else could provide those functions more effectively or efficiently?
13. What is the point of diminishing returns for the various aspects/components of the remedy? What approaches/components would be more appropriate once this point of diminishing returns is reached?
14. Are there alternatives to any remedy components? Are there alternatives to the remedy itself? Are there appropriate supplemental remedies (for example, bioaugmentation) for this site?
15. Is there remaining source material or indications of potential source material not being fully characterized? What is its known extent? Could it be more effectively addressed with a more aggressive characterization and or remedial strategy, with either yielding a higher degree of certainty?

Attachment 1. Example Agenda Items for Optimization Stakeholder Meeting

The following are examples of agenda items for an onsite meeting or conference call that may be used to facilitate a group interview of site stakeholders. Because each optimization review is site-specific, the agenda is designed to provide the optimization review team with information about the site characterization or remedial activities. Onsite visits may include a site tour to facilitate some of this discussion. All or some of the following example agenda items may be relevant based on the remedial phase, type of site, type of remedy, type of optimization support requested or other site-specific circumstances.

Item	Example Optimization Stakeholder Meeting Agenda
1	Introductions - The EPA Headquarters Optimization Lead introduces the optimization review team and the concept and activities to be conducted to complete the optimization review. Each participant is asked to state their name, affiliation and role at the site.
2	The optimization review team reiterates the scope of the optimization review and indicates site-specific issues to discuss based on their review of site documents.
3	Remedial Action Objectives (RAO) – A representative of the site team (typically the EPA Remedial Project Manager [RPM] or site contractor) describes the RAOs and remedial strategy. Concurrence or perspectives from all stakeholders is requested.
4	Conceptual Site Model (CSM) - A representative of the site team (typically the RPM or site contractor) provides a brief description of the CSM, including a presentation of any graphic renderings. The following are some of the CSM elements that would be discussed: ☐ Contaminants of concern and known or suspected sources ☐ Geology, hydrogeology, geochemistry and hydrology ☐ Contaminant fate and transport ☐ Previous and current remedies and their effectiveness to date ☐ Data gaps - can be prioritized or focused on uncertainties with high probability of occurrence and significant potential impact to remedy performance or protectiveness
5	Protectiveness ☐ Receptors, potential receptors and exposure pathways ☐ Receptor and potential receptor assessment or sampling ☐ Plume capture or migration control ☐ Performance monitoring ☐ Institutional controls (IC) ☐ Engineering controls (EC)
6	Extraction/Injection/Delivery Systems ☐ Confirmation of system components and specifications ☐ Performance relative to design specifications ☐ Geologic/hydrogeologic complexity and potential impacts to remedy implementation ☐ Associated sampling and analysis ☐ Maintenance, fouling, etc.
7	Remedial System (if other than an extraction/injection/delivery system) ☐ Description of treatment system components and specifications ☐ Performance relative to design specifications ☐ Downtime and any recurring technical problems ☐ Operator responsibilities and level of effort ☐ Utilities, chemical and materials usage ☐ Process monitoring ☐ Water discharge and waste disposal ☐ Exceedances, accidental releases, etc. ☐ Opportunities for system simplification

Item	Example Optimization Stakeholder Meeting Agenda (continued)
8	Costs ☐ Confirmation and clarification of provided cost information ☐ Estimated life-cycle costs ☐ Actual costs versus original cost estimates ☐ Primary cost drivers ☐ Opportunities for reducing cost ☐ Challenges or obstacles to implementing cost reduction opportunities
9	Footprint Evaluation ☐ Amount of electrical energy used per year in kilowatt hours (kWh) and peak electrical demand in kW ☐ Types and quantities of other energy used (for example, propane, natural gas, diesel, etc.) ☐ Distance of staff from site (to evaluate vehicle usage and emissions) ☐ Types and quantities of constituents emitted to air from treatment processes ☐ Amount of potable water used and potential for using treated water ☐ Local provisions or sensitivity to water conservation ☐ Potential uses for extracted water (treated or untreated), if any ☐ Ecosystem services provided at or near the site ☐ Amount and types of chemicals and materials used ☐ Amount of waste generated and method of disposal for that waste ☐ Potential future/planned property reuse
10	Site Completion ☐ Remaining source removal or source control needs ☐ Exit strategy for remedy, performance metrics and decision trigger points ☐ Exit strategy for various system components, performance metrics and decision trigger points ☐ Appropriate site-specific milestones towards site closure ☐ Other exit strategy issues – organizational, regulatory program, stakeholders, technical and administrative
11	Alternatives Consideration ☐ Major remedy components and potential alternatives to those components ☐ Technologies pilot-tested or applied to date at the site, limitations of those technologies and potential alternatives ☐ Typical costs and limitations of potential alternatives ☐ Innovative approaches for addressing site-specific issues ☐ Potential supplementary or alternative remedies to selected remedy, including cost and limitations of the alternatives
12	Debriefing and Action Items ☐ Schedule for submitting optimization findings and recommendations memorandum or draft report ☐ Requests for additional site documents or data ☐ Summary of concurrence or differing perspectives on information covered ☐ Remaining stakeholder questions for the optimization review team ☐ Identification of direct technical assistance needs for follow-up ☐ Anticipated time frame for recommendations implementation follow-up ☐ Additional action items covered during the meeting

Attachment 2. Example Types of Data Analysis

Investigation/Feasibility Study

- Identification of various sources of uncertainty and prioritization of addressing those sources of uncertainty
- Interpretation of existing conceptual site model (CSM) and identification of data gaps
- Considerations for CSM refinement
- 3-D visualization and analysis results
- Interpretations of characterization data
- Considerations for applying innovative sampling strategies and statistical sampling designs
- Considerations for applying real-time measurement and data collection technologies
- Determination of the need for a demonstration of method applicability (DMA) to confirm use of a real-time or other innovative technology
- Considerations for developing dynamic work strategy (DWS) work plans for characterization
- Considerations for electronic data deliverables (EDD) management
- Receptor and pathway data needs, sequencing of proposed activities

Design

- Analysis of investigation data
- Interpretation of the CSM and identification of data gaps
- Analysis of treatability and pilot study results
- Evaluation of design parameters developed by site team
- Estimation of pump and treat (P&T) extraction rates for plume capture
- Estimation of treatment chemical loading, available treatment technologies and expected performance
- Estimation of oxidant or nutrient demand for in situ remedies
- Estimated demand for soil/aquifer heating
- Estimates of other common remedy effectiveness and cost drivers
- Simplistic analytical or numerical modeling to assist with CSM refinement
- Simplistic analytical or numerical modeling to assist with development of appropriate performance monitoring
- Identification of supplemental or alternative remedy components
- Cost analysis of various technologies and approaches considered during design
- Consideration of green remediation best management practices
- Preliminary green remediation environmental footprint analysis

Remedial Action, Long-term Response Action (LTRA) or Operation and Maintenance (O&M)

- Analysis of historical data plus trends in performance monitoring data
- Interpretation of the CSM and identification of data gaps
- Review of existing performance monitoring program for gaps and or redundancies
- Statistical analysis of groundwater monitoring data to determine opportunities for monitoring program reductions
- Comparison of current chemical loading and or other site conditions to conditions considered during design
- Comparison of remedy performance to expected performance and or reasonable expectations
- Review of remedy component performance relative to expectations and expectations for competing technologies
- Preliminary capture zone analysis for pump and treat (P&T) systems
- Review of known receptors and potential for additional receptors since remedy design
- Consideration of supplemental or alternative remedy components and expected cost and performance
- Review of provided costs relative to expectations and cost for similar sites
- Preliminary green remediation environmental footprint analysis

The types of data analyses listed above are not exhaustive. Analyses listed under one remedial phase may also apply to optimization during other remedial phases. Additional or specific types of analyses to be conducted by the optimization review team should be discussed during logistics, planning and scoping.