

2022 ITRC Final Proposal Template

Proposed Project Title

Sediment Cap Design Guidance

Abstract

This project will develop Sediment Remediation Capping Design Guidance to supplement the *2014 ITRC Contaminated Sediments Remediation Guidance* on topics related to engineered capping alternatives for sediment remediation. It will provide technical guidance to designers and regulators that will facilitate greater consistency and efficiency in completing effective cap designs, including monitoring plans. The guidance will reflect recent advancements and address a critical need for standardization highlighted by the wide range of approaches reflected in recent projects. This document is proposed to cover the following aspects: (1) description and illustration of various types of engineered caps and the function of each layer, including layers that may have combined functions; (2) description and illustration of contaminant transport processes to be considered in design and their relative importance to chemical breakthrough in various environments; (3) types of remediation goals (RG) and various ways design criteria may be specified; (4) modeling tools for chemical isolation design; (5) specification of modeling inputs; (6) design approaches; (7) sensitivity analysis and factor of safety considerations in the design and construction specifications; (8) cap placement methods; (9) construction quality assurance methods; (10) long-term monitoring plan design and expectations for cap performance; and (11) case studies. The proposed effort includes introducing the new guidance to state and federal regulators and other stakeholders through an interactive online training series and via conference presentations to facilitate effective use of the guidance. It is proposed this technical guidance document would be published via the ITRC web page with links to modeling tools and technical resources.

Problem Statement and Highlight the Importance to the States and to the Broader Environmental Community

Experience on remediation of contaminated sediments has shown that dredging alone is often unsustainable, costly, and may not effectively achieve remedial action objectives. In this context, use of engineered caps for sediment remediation is becoming a commonly selected approach to achieve the remedy objectives either as a standalone approach or in combination with removal. However, technical guidance for key design activities is insufficient, outdated, or represented across a collection of varied literature that are collectively incomplete in covering key aspects. Design analysis typically involves designing a cap to isolate contaminants in sediments from the overlying aquatic system to reduce bioavailability and toxicity of contaminants. The cap layers contributing to chemical isolation may contain a range of natural or synthetic materials to achieve chemical isolation, such as sand, soils, mixtures of sand and soils or other reactive amendments such as activated carbon, organophilic clay, apatite, or synthetic products. Caps are effective long-term if they are physically stable and provide sufficient chemical isolation to achieve remedial goals. Chemical isolation performance of cap designs can be evaluated in multiple ways, typically using modeling, and the evaluation framework often differs greatly among designers, regulators and stakeholders that have varied familiarity with the key design specifications, construction standards and remedial objectives. In the absence of definitive guidance, this sometimes requires extensive site-specific negotiation between designers and regulators to reach consensus about performance expectations and appropriate levels of conservatism. This can lead to very different design

outcomes for sites with similar characteristics and contaminants and different expectations for long-term protectiveness and reliability. There is a distinct opportunity and need to improve sediment remediation with capping by preparing guidance to standardize the design process.

The most recent guidance discussing capping design and monitoring is the **2014 ITRC Contaminated Sediments Remediation Guidance**. That document, while comprehensive in some respects, lacks sufficient information to guide standardized cap design. This project aligns with the strategic priorities of federal and state agencies that regulate sediment capping projects and have expressed concerns with uncertainties on capping design and long-term cap monitoring approaches. By engaging a working group including state environmental personnel, stakeholders and tribal representatives, federal agencies, academia personnel, consultants, and industry representatives on the development of this guidance, this document will provide a road map to achieve protective cap design more efficiently and confidently for all stakeholders.

This proposal will supplement the 2014 ITRC Guidance by incorporating recent advancements, new information, and more details on key design considerations including:

- 1) Distinction among basis of design description for different types of sediment caps:
 - a. Monolithic sand caps (sometimes referred to as conventional caps)
 - b. Multi-layer reactive caps
 - c. Thin layer caps designed to enhance natural recovery
 - d. Backfill, and
 - e. Residuals cover layers designed to reduce post-dredging residual exposures
- 2) Key considerations in deriving cap performance targets in relation to:
 - a. Site-specific remedial goal concentrations and associated media (e.g., surface weighted average sediment concentration, porewater values, biological tissue targets, bioavailable concentrations, etc.)
 - b. Classes of contaminants of concern and chemical mobility (e.g., bioaccumulative chemicals, inorganic chemicals, other chemicals, chemicals that drive risk at a Site, and NAPL)
 - c. Background values or reference concentrations
 - d. Surface water criteria
 - e. Source control status
 - f. Sediment-water flux considerations (as related to surface water inputs), and
 - g. Conceptual Site Model/contaminant fate and transport mechanisms
- 3) Important considerations in selection of design criteria including those listed below and example statements of design criteria:
 - a. Design evaluation point within the cap and sediment column
 - b. Chemical flux control
 - c. Performance standards and evaluation time frame (e.g., breakthrough time to remedial goals), and
 - d. Long-term cap monitoring approach
- 4) Design process recommendations:
 - a. Model selection

- b. Statistical specification of major input parameters (e.g., Darcy velocity, partition coefficients, COC concentrations, sediment-water transfer rate, bioturbation, sediment deposition rate, overlying surface water COC concentrations, etc.), and
 - c. Approach to sensitivity analysis and to assess uncertainty to ensure cap protectiveness considering variability in key input parameters, cap construction specifications, expected post-construction conditions, and long-term monitoring methods
- 5) Advancements on data collection and measuring of modeling input parameters included in recently developed modeling tools (such as CapSim) including:
 - a. Description of each model parameter and in which cases use of default values can be appropriate and/or development of site-specific values are recommended
 - b. Identifying appropriate partitioning kinetics using either literature or site-specific methodology
 - c. Data handling/assessment to derive site specific inputs, and
 - d. Considerations of climate change/sea level rise
- 6) Updated information on cap placement methods and constructability of multi-layer caps in different environments
- 7) Development of construction specifications and construction quality assurance techniques to ensure effective construction
- 8) Compilation of key information from reviewed literature from other capping projects (Case Studies).

The focus of this guidance will be on chemical isolation. An equally important function of sediment caps is physical isolation to ensure physical stability of the capped sediments and the cap and in some applications, habitat. Design guidance on cap physical stability and habitat involves different factors than those applied in chemical isolation design. It is recommended that this guidance not be expanded to detailed design of physical isolation or habitat layers; however, this guidance will include one or more sections providing a summary of the issues and design evaluations that may be needed building on the 2014 ITRC Guidance, with links to available guidance on those topics as well as the role such layers may play in chemical isolation and cap protectiveness

Project Deliverables

The envisioned products for this effort are a Technical Guidance Document published on the ITRC website, supported by an online training series, and presentation at major sediment remediation conferences to introduce the guidance. The technical guidance document would make use of multi-media elements and links to modeling tools and technical resources accessible on the web.

Additional Information

The proposal contacts have extensive experience with capping design and implementation. Recently, they have worked with USEPA, sister agencies, and State agencies in developing a robust chemical isolation cap for a complex site impacted by a wide range of chemicals including bioaccumulative compounds, inorganic chemicals, and common ubiquitous urban waterway contaminants. The design was supported by a robust, multi-year pre-design investigation and treatability study to provide necessary information for cap design. The design used the latest, state of the art cap modeling tools. The design process involved working through all the required considerations that are not specified in existing guidance with the federal and state agencies and the responsible parties and supporting experts. Extensive contractor input was solicited regarding construction methods and for constructability evaluation and to assist in preparing

construction specifications. The design is supported by a detailed long-term monitoring design. In completing the effort, extensive information on other projects was compiled for reference, which highlighted the wide disparity in approaches being taken, even within similar states and USEPA regions. The efforts completed for this project, and multiple other simultaneous capping projects in various phases of development, design, construction, and long-term monitoring will be leveraged in developing this guidance.

This team has identified and reached out recently to leading subject matter experts and personnel from state and federal agencies with requisite experience on capping projects in addition to consulting team experts that work extensively on similar projects. A diverse team will be organized to help develop a useful guidance document that can be a valuable and timely contribution to the field of sediment remediation.