B-033, in: A.K. Bullard, D.T. Dahlen (Chairs), *Remediation and Management of Contaminated Sediments—2015.* Eighth International Conference on Remediation and Management of Contaminated Sediments (New Orleans, LA; Jan 12–15, 2015). ISBN 978-0-9819730-9-8, ©2015 Battelle Memorial Institute, Columbus, OH. **www.battelle.org/sedimentscon**

Molehills out of Mountains: Surmounting Hurdles to Adaptive Management at Superfund Sites

Megan Conlon McCulloch (MCMcCulloch@dow.com)
(The Dow Chemical Company, Midland, Michigan, USA)
Laurence S. Kirsch (lkirsch@goodwinprocter.com) and Christina L. Hennecken (chennecken@goodwinprocter.com) (Goodwin Procter LLP, Washington, DC, USA)

ABSTRACT: Most environmental professionals agree that adaptive management is a good idea in theory, but they seem unwilling to embrace it in practice because of several perceived impediments and risks. Regulators often lament that adaptive management is excessively resource intensive for agencies already strapped for resources, and that adaptive management is inconsistent with the more "linear" approach under the National Contingency Plan (NCP). Potentially responsible parties (PRPs) have justifiable concern that agreeing to an adaptive management plan is tantamount to writing a blank check that exposes them to potentially unlimited remedial obligations, and that the significant uncertainties about remedial costs make it difficult for PRP groups to achieve intra-group cost allocations and cash-out settlements. Several of these difficulties are real, but so are the benefits of adaptive management—this means there are major incentives for all concerned parties to find solutions to the impediments. For regulators, adaptive management can lessen the burden of the "one shot to get it right" mentality by providing an iterative process to develop and select an appropriate remedy, and the language and structure of the NCP offer more than enough latitude for an adaptive management approach. For PRPs, adaptive management may not create less certainty than a traditional approach to remedy development, selection, and implementation, especially at mega sites, and there are ways to constrain the perceived open-endedness of adaptive management. Consequently, adaptive management can be used in a manner consistent with both the NCP and PRP group needs.

INTRODUCTION

Too often we hear the lament, "Adaptive management is a good idea in concept, but we just can't make it work at my site because _____." Fill-in the previous blank with "it doesn't fit within the National Contingency Plan (NCP) and we can't draft a decision document incorporating it" or "my potentially responsible party (PRP) group needs finality and our group dynamics preclude its use." It is hard to dispute that true adaptive management (i.e., consciously testing hypotheses and feeding results back into the understanding and management of a site) is a good concept. Using experience to refine and improve on remedial approaches can lead to more-effective long-term remedies and a more-efficient use of resources. Given the benefits of adaptive management, finding solutions to practical impediments seems more than worthwhile.

Two of the primary impediments raised by regulators are that adaptive management demands too much of governmental resources and somehow clashes with the NCP because adaptive management does not follow the traditional, linear process of remedial investigation, feasibility study, record of decision, remedial design, remedial action, and

operations, monitoring, and maintenance. Although not the familiar, traditional, linear approach, adaptive management can be implemented within the framework of the NCP as discussed below.

One of the primary impediments raised by PRP groups is the lack of finality presumably created by adaptive management. Undoubtedly, PRP groups need finality because they need to determine who is participating in a remedy, which is driven in large part based on what their anticipated costs will be. Adaptive management, however, does not necessarily result in less finality than the traditional approach. An adaptive management approach could use the time otherwise spent on a traditional, linear investigation to actively learn—that is, test hypotheses and potentially reduce uncertainty for everyone. Reducing uncertainty may result in a better defined remedy with smaller error bounds on its cost estimate.

Thus, adaptive management can be used in a manner consistent with both the NCP and PRP group needs. Given the significant benefits that may be afforded by adaptive management, it is worth working hard to overcome any impediments to achieve what should be a common goal for regulators and PRPs alike—more effective remedies and better environmental outcomes, at potentially lower cost.

This paper first discusses what adaptive management is—its definition, the elements involved, its procedural differences from the traditional method of Superfund cleanups, and the spectrum of approaches to it. It then addresses both the benefits of adaptive management and the reasons both regulators and PRP groups resist it. Next, the paper examines how to overcome the obstacles to adaptive management. Finally, the paper concludes with ideas about how to work around concerns about uncertain timelines and costs.

WHAT IS ADAPTIVE MANAGEMENT?

The term "Adaptive Management" was first used in the field of environmental conservation and natural resource management (Satterstrom et al., 2007, p. 57). As applied to environmental remediation, adaptive management is a system for assuring that a desired remedial outcome will be achieved despite complex system dynamics by providing for testing and modifying remedial steps.

EPA defines adaptive management as "[a]n iterative approach to site investigation and remedy implementation that provides the opportunity to respond to new information and conditions throughout the lifecycle of a site. . . . Adaptive management is a thoughtful planning process whereby questions critical to the success of a project are identified early and decision points included at key steps in the process allow sampling activities or RA [remedial action] to be terminated or modified based on results of data analysis" (EPA, 2013, pp. 8-9). For example, "an adaptive management approach might include gathering and evaluating multiple data sets or pilot testing to determine the effectiveness of various remedial technologies at a site" (EPA, 2005, p. 2-22). The approach becomes a systematic tool for intentional learning through six key steps: regularly revisiting a project's objectives, modeling the system being managed, generating a range of remedial management alternatives, monitoring and evaluating outcomes, incorporating learning into future decisions through formal mechanisms, and allowing stakeholder participation and learning through a collaborative structure (Linkov et al., 2006, pp. 93-94).

One of the difficulties in evaluating the benefits and drawbacks of adaptive management is that the term can mean dramatically different things to different people. PRPs and

regulators have used a spectrum of adaptive management approaches in cleanup projects. On one end of the spectrum, cleanup projects may include adaptation in remedy implementation only—such as adjusting the details of implementation of a specific remedy to optimize its performance, but not changing the remedy itself. Sometimes adaptation is incorporated into components of one selected remedy. For example, a project may include the use of adaptive management to guide habitat restoration activities. Towards the other end of the spectrum, parties may use adaptation in developing, testing, and deciding upon the remedy itself, using pilot studies and investigations to support modeling and reduce uncertainty, and early actions and/or interim removal actions to test options. As this paper uses the term, it means more than tweaking implementation of the remedy; it means an intentional, thoughtful process that allows for changing the actual remedy options based on an ongoing assessment of how the various options work.

How Adaptive Management Differs from the Traditional Approach. The traditional approach to cleaning up Superfund sites generally follows a linear path: investigation, remedy selection (embodied in a decision document), implementation, and monitoring to evaluate whether the remedy achieved the remedial action objectives (RAOs). The remedy selected generally does not change unless—as sometimes happens—it fails to achieve its RAOs. The remedies selected are usually highly conservative based on a belief that those remedies are most certain to achieve RAOs. Two problems underlie the traditional approach: first, the actual protectiveness of remedies deemed "conservative" is unknown until monitoring following remedy implementation, and second, those remedies often have their own significant environmental detriments (e.g., large-scale dredging results in releases of dissolved contaminants, resuspension and downstream transport of contaminants, residual contamination, and, consequentially risk [USACE, 2008], as well as greenhouse gas emissions associated with large scale construction projects and habitat disruption [ITRC, 2014, Section 6]). Adaptive management offers the flexibility to try more innovative remedial measures while testing, monitoring, and evaluating their effectiveness, and adjusting remedial measures based on data-driven results. Thus, adaptive management allows project managers to optimize the use of innovative remedial approaches while ensuring the achievement of RAOs.

Benefits of Adaptive Management. Adaptive management has several benefits. First, it can speed up progress because it potentially avoids the indecision and paralysis that accompany the "one shot" mentality of traditional cleanups. It can reduce uncertainty by testing and evaluating options on a continuous basis, which in turn, helps ensure that the remedy will meet its RAOs. Traditional remediation's linear framework, by contrast, has relatively high uncertainty because it does not allow for learning through the process (Linkov et al., 2006, p. 92). Remedial alternatives tested using adaptive management may be less costly than traditional remedies, ultimately conserving resources and leaving a smaller environmental footprint. And finally, adaptive management can reduce political barriers. Trying to select cost-effective, appropriate remedies can result in heated debates about subjective probability predictions of various remedial alternative outcomes. By providing a demonstration of the effectiveness of a remedy and leaving the door open for further evaluation, political disagreements over remedy selection may be mitigated (USACE, 2010, p. 40).

THE PROBLEM: WHY DOESN'T EVERYONE USE ADAPTIVE MANAGEMENT?

Given the benefits of adaptive management and its sparse use in practice (Linkov et al., 2006, p. 93), there are clearly impediments blocking more widespread adoption. For PRPs, a key source of resistance is the perceived lack of finality. Questions such as "what type of pie is it," "how big is the pie," and "how big are everyone's slices of the pie" are legitimate questions that affect the parties' willingness to participate in a PRP group. Not knowing the nature and cost of the remedy makes it difficult to build a group of PRPs to implement the remedy, to "cash out" PRPs who seek a release of liability in exchange for fixed payments, and to allocate the cost of the remedy altogether. Agreeing to implement an adaptive management approach understandably makes PRPs feel like they are signing a blank check, allowing for EPA to demand progressively more cleanup actions without having to go through ROD Amendments or Explanations of Significant Differences. But adaptive management also provides a chance to demonstrate that less expensive remedial alternatives (e.g., surface amendments) can achieve RAOs, rendering more costly and damaging techniques (e.g., dredging) unnecessary. In reality, adaptive management holds both the promise of great benefits and the potential for great risk for PRPs. The ultimate goal is to achieve the benefits while limiting the risks.

For regulators, there are several more questions. Is it a technique at odds with the NCP's apparently linear remedial selection approach? Is it going to require additional agency resources to engage in intensive collaboration with PRPs to conduct on-going hypothesis testing? Or, is it a technique that allows EPA and PRPs to accomplish far more with their resources than does a traditional linear approach? Adaptive management, with its emphasis on hypothesis testing and iterative learning, adds feedback loops to the traditional process and therefore, may require some creativity, flexibility, and collaboration. But adaptive management may also lessen the burden of the "one shot to get it right" mentality. Rather than "one shot," adaptive management is, by definition, a process of testing ideas and learning from the results. Rather than shrinking from uncertainty, adaptive management productively addresses it head on by systematically working to reduce key uncertainties. As the analysis below demonstrates, adaptive management does not conflict with the NCP. And while adaptive management may require additional agency resources upfront, the benefits outweigh long-term costs.

SOLUTIONS: OVERCOMING THE HURDLES

The hurdles to adaptive management can be surmounted. Adaptive management is consistent with the structure and language of the NCP. EPA itself has recently endorsed the expanded use of adaptive management (EPA, 2013). And PRPs can protect themselves from the "blank check" and can address the perceived lack of finality in adaptive management projects.

Adaptive Management Complies with the National Contingency Plan. The NCP's language allows for an adaptive management approach to Superfund site cleanups. Formalizing adaptive management into the process complies with current law. The overarching goal of the remedial program under the NCP is to "select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste" (40 C.F.R. § 300.430(a)(1)(i)). Furthermore, the NCP repeatedly

touches upon the principle that decisions should be made based on what is "necessary or appropriate given the size or complexity of the site, or to expedite the completion of total site cleanup" (40 C.F.R. § 300.430(a)(1)(ii)(A)). These guiding principles are broad and allow for an iterative process in site cleanup. The NCP recognizes that complex sites can be cleaned more efficiently with management techniques that reflect the uncertainty and scope of the problems.

The structure of the NCP and its mandated processes allow for adaptive management. For example, adaptive management—intentional learning through hypothesis testing—can be incorporated into the remedial investigation/feasibility study (RI/FS). Parties can phase RI/FS sampling and design studies to reduce key uncertainties (e.g., collect data with a well-defined purpose), conduct pilot and treatability studies and evaluate their results, continually build on new information as the RI progress, target future sampling based on past learning, and update the conceptual site model with the new information. These activities are all consistent with the NCP's description of the RI/FS. The NCP states that the purpose of RI/FS is to "assess site conditions and evaluate alternatives to the extent necessary to select a remedy" (40 CFR § 300.430(a)(2)). It lists the following activities: project scoping, data collection, risk assessment, treatability studies, and analysis of alternatives. And it asserts that during scoping, the lead and support agencies "shall confer to identify the optimal set and sequence of actions necessary to address site problems" (40 CFR § 300.430(b)). The broad directive of tailoring the RI/FS to the complexity of the problem allows for iterative approaches, and, indeed, phased RI/FS's are commonplace. The "optimal set and sequence of actions" often involves an iterative process of data review, updating the conceptual site model, and goal adjustment. And both pilot and treatability studies to assess the effectiveness of possible remedial approaches are regularly incorporated into the RI/FS process.

In parallel with RI/FS, the parties can leverage EPA's Removal Authority as part of the overall adaptive management plan for the site. For example, the parties can conduct early actions (treating them, in essence as larger-scale pilot studies), monitor and evaluate the results of the early actions, and then use lessons learned from those early actions in shaping the remedy. This is entirely consistent with the NCP, which states, "[r]emoval actions shall, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action with respect to the release concerned" (40 CFR § 300.415(d)). Using Removal Authority to conduct early actions to better understand the site as part of an adaptive management program should contribute to the ultimate efficient performance of an effective remedial action. Moreover, removal actions can minimize the time and costs of large-scale cleanup projects, especially if acted upon early ("Sites should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of total site cleanup" (40 CFR § 300.430(a)(1)(ii)(A))). The NCP also allows an alternative that does not meet Applicable or Relevant and Appropriate Requirements (ARARs) to be selected if it is "an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement" (30 CFR § 300.430(f)(1)(ii)(C)(1)). In other words, alternatives can be implemented early on before formal remedy selection in order to determine which approach may be best.

Remedy development and selection can also include adaptive approaches while staying within the boundaries of the NCP. The NCP lists several criteria for remedy selection, including adequate protection of human health and environment, short-term effectiveness, long-term effectiveness and permanence, implementability, and costs (30 CFR § 300.430(f)(1)). Effectiveness, permanence, and implementability of remedies are largely difficult to predict with a high degree of certainty at the FS phase of Superfund mega sites. Appropriate monitoring and focused experimentation early on (e.g., via early actions, pilot studies, treatability studies) will reduce key uncertainties, which, in turn, will lead to a more thorough understanding of the site and the potential effectiveness of remedial alternatives. This will allow for a more comprehensive evaluation of the NCP's remedy selection criteria.

The remedy ultimately chosen must undergo review "no less often than every five years" (40 CFR § 300.430(f)(5)(iii)(C)). Rather than awaiting a five-year review to assess the effectiveness of a remedy and potentially change course, if needed, adaptive management allows PRPs and regulators to, when necessary, change course earlier on in the process. Thus, the parties may avoid wasting resources on an ineffective remedy. While a Record of Decision (ROD) must include a preferred alternative, it also shall "[w]hen appropriate, provide a commitment for further analysis and selection of long-term response measures within an appropriate time frame" (40 CFR § 300.430(f)(5)(iii)(D)). Thus, even though a ROD must include a "preferred" alternative, a "commitment for further analysis" allows for review and modification of this alternative. Thus, a ROD can include a schedule for monitoring, site-specific metrics to measure progress and trigger re-evaluation of the remedy and its implementation, a systematic mechanism for incorporating new learning into future decisions, and limits on the extent to which EPA can mandate additional actions (to constrain the "blank check" that legitimately troubles PRPs). This type of adaptive ROD would allow a remedy to be implemented based on sound, scientific data. The same kinds of limits can—and have been—inserted into Consent Decrees, to further protect against the "blank check" risk.

In sum, the NCP's broad language and flexible structure allows for the use of adaptive management at Superfund sites.

EPA Endorses Adaptive Management for Superfund Sites. EPA encouraged project managers to incorporate adaptive management into Superfund sediment sites in 2005 (EPA, 2005, p. 2-22). More recently, EPA released its "Superfund Remedial Program Review Action Plan," which moves to formally integrate adaptive management into the Superfund remedial process as a way to more effectively and efficiently manage site cleanups (EPA, 2013, p. 2). EPA expects to improve remedy effectiveness and better track progress toward meeting RAOs by incorporating adaptive management into cleanups (EPA, 2013, p. 7). Moreover, EPA notes that adaptive management can be implemented consistent with the NCP and it should be incorporated where possible: "[a]daptive management assumes there is an explicit intent to respond to new information and conditions, and to the extent it can be done under CERCLA and the NCP site decision making, formal remedial decision documents as well as other project plans and reports incorporate appropriate language that enables efficient planning and execution of adaptive management techniques" (p. 8).

The Action Plan identifies short-term and long-term actions to incorporate adaptive management more deliberately into the Superfund cleanup process. These actions include issuing an OSWER Directive to Employ Adaptive Management Approaches for Superfund Remedial Sites. EPA recognizes that there is no formal policy encouraging the use of adaptive management and requires this directive to aggressively encourage the approach in order to facilitate its use and improve cleanup efficiency. Other shorter-term actions include developing adaptive management pilots and a subsequent portfolio of adaptive management tools to refine implementation of the approach (EPA, 2013, pp. 8-10). In the long term, EPA commissioned a branch-chief level workgroup of Regional and Headquarters management to set priorities for implementation of adaptive management into site cleanups. EPA has also stated its intent to combine the Remedial Design and Remedial Action steps of the cleanup process, specifically by streamlining data collection and decision making through adaptive management (p. 13). EPA has explicitly stated its goal of cleaning up Superfund sites faster by focusing on early actions like time critical removals, non-time critical removals, and interim remedies instead of relying on long-term, site-wide "final remedial strategies" (p. 16). With respect to contaminated sediments, the Action Plan encourages the use of amendments at sediment sites to reduce the bioavailability of contaminants. Specifically, EPA aims to develop a policy directive to encourage consideration of this technology to manage risk from contaminated sediments. All of these examples from EPA's Action Plan demonstrate that EPA is seeking a more flexible approach to site cleanup and reflects a paradigm shift away from static goal selection to a more malleable strategy that reflects on new information garnered during the cleanup process.

CONCLUSIONS

Given EPA's recent stated enthusiasm for adaptive management (EPA, 2013), PRPs will need to overcome hurdles to adaptive management and actively use it to effectively and efficiently address Superfund sites. To address concerns about the "blank check," PRPs should seek to limit, in administrative orders and consent decrees, the extent to which required work can expand beyond a certain point. Moreover, PRPs and EPA should use "work group"/collaborative approaches to the RI/FS and the RD/RA in order to implement adaptive management and to avoid surprises for everyone. To alleviate concerns about finality, PRPs should recognize that finality has its limits under the traditional approach, especially at complicated mega sites, and focus on the potential cost-saving benefits of adaptive management. Specifically, RODs that select a fixed remedy do not necessarily offer finality to PRPs because the cost and effectiveness of the selected remedy is unknown until implementation, and sometimes not until subsequent five-year reviews. To avoid concerns about consistency with the NCP, PRPs and EPA should design the adaptive management approach with NCP considerations in mind. Agencies can avoid their own concerns about agency resources for ongoing monitoring and data evaluation by embracing the "work group" approach, which minimizes the back-and-forth document exchange with PRPs and uses resources more effectively.

PRPs and agencies have much to gain from incorporating adaptive management into Superfund cleanups. It has the potential to save time, resources, increase the effectiveness of the remedy, and reduce the environmental footprint of the remedy (EPA, 2014). It can be implemented in a way consistent with the NCP, and EPA has endorsed its wider adop-

tion. Smart implementation of adaption can avoid significant concerns and enable more widespread use of this beneficial technique.

The views expressed in this paper are the personal views of the authors alone. They do not represent the views of The Dow Chemical Company or Goodwin Procter LLP or its clients.

REFERENCES

ITRC (Interstate Technology & Regulatory Council). 2014. *Contaminated Sediments Remediation: Remedy Selection for Contaminated Sediments (CS-2)*.

Linkov, I., F.K. Satterstrom, G.A Kiker, T.S. Bridges, S.L. Benjamin, and D.A. Belluck. 2006. "From Optimization to Adaptation: Shifting Paradigms in Environmental Management and Their Application to Remedial Decisions." *Integrated Environmental Assessment and Management*. 2(1): 92-98.

National Oil and Hazardous Substances Pollution Contingency Plan. 40 CFR Part 300.

Satterstrom, F.K., I. Linkov, G. Kiker, T.S. Bridges, M.S. Greenberg. 2007. "Adaptive Management: A Review and Framework for Integration with Multi-Criteria Decision Analysis." In G.P. Macey and J.Z. Cannon (Eds.), *Reclaiming the Land: Rethinking Superfund Institutions, Methods and Practices*, pp. 49-87. Springer US, New York, NY.

U.S. Army Corps of Engineers. 2008. *The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk*. ERDC TR-08-04.

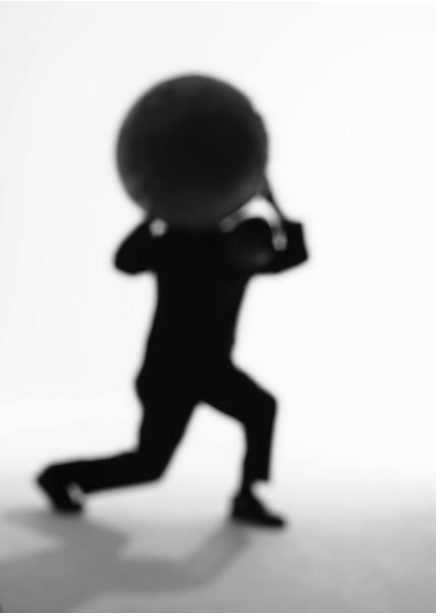
U.S. Army Corps of Engineers. 2010. *Decision Making Under Uncertainty*. ERDC TR-10-12.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. 2013. *Superfund Remedial Program Review Action Plan*.

U.S. Environmental Protection Agency Superfund Program. Nov. 6, 2014. *Optimization and Green Remediation: Strategies for Effective Cleanups with a Smaller Environmental Footprint*. Federal Remediation Technologies Roundtable. http://www.frtr.gov/pdf/meetings/nov14/presentations/handouts/biggs-pachon-opening-handout.pdf.

GOODWIN | PROCTER



Molehills Out of Mountains: Surmounting Hurdles to Adaptive Management at Superfund Sites

Megan Conlon McCulloch
The Dow Chemical Company
2030 Dow Center
Midland, Michigan 48674
(989) 636-8790
MCMcCulloch@dow.com

Laurence S. Kirsch
Goodwin Procter LLP
901 New York Avenue, N.W.
Washington, D.C. 20001
(202) 346-4000
lkirsch@goodwinprocter.com

Important Caveat

- The views expressed in this paper are the personal views of the authors alone. They do not represent the views of The Dow Chemical Company or Goodwin Procter LLP or its clients.

Goal: Make Molehill out of Mountain

Break down Barriers to Adaptive Management

Overview

I. What is Adaptive Management?

- Definition
- Differs from Traditional Management
- Adaptive Management Spectrum
- Benefits of Adaptive Management
- PRP and Regulator Resistance to Adaptive Management

II. Overcoming the Hurdles to Adaptive Management

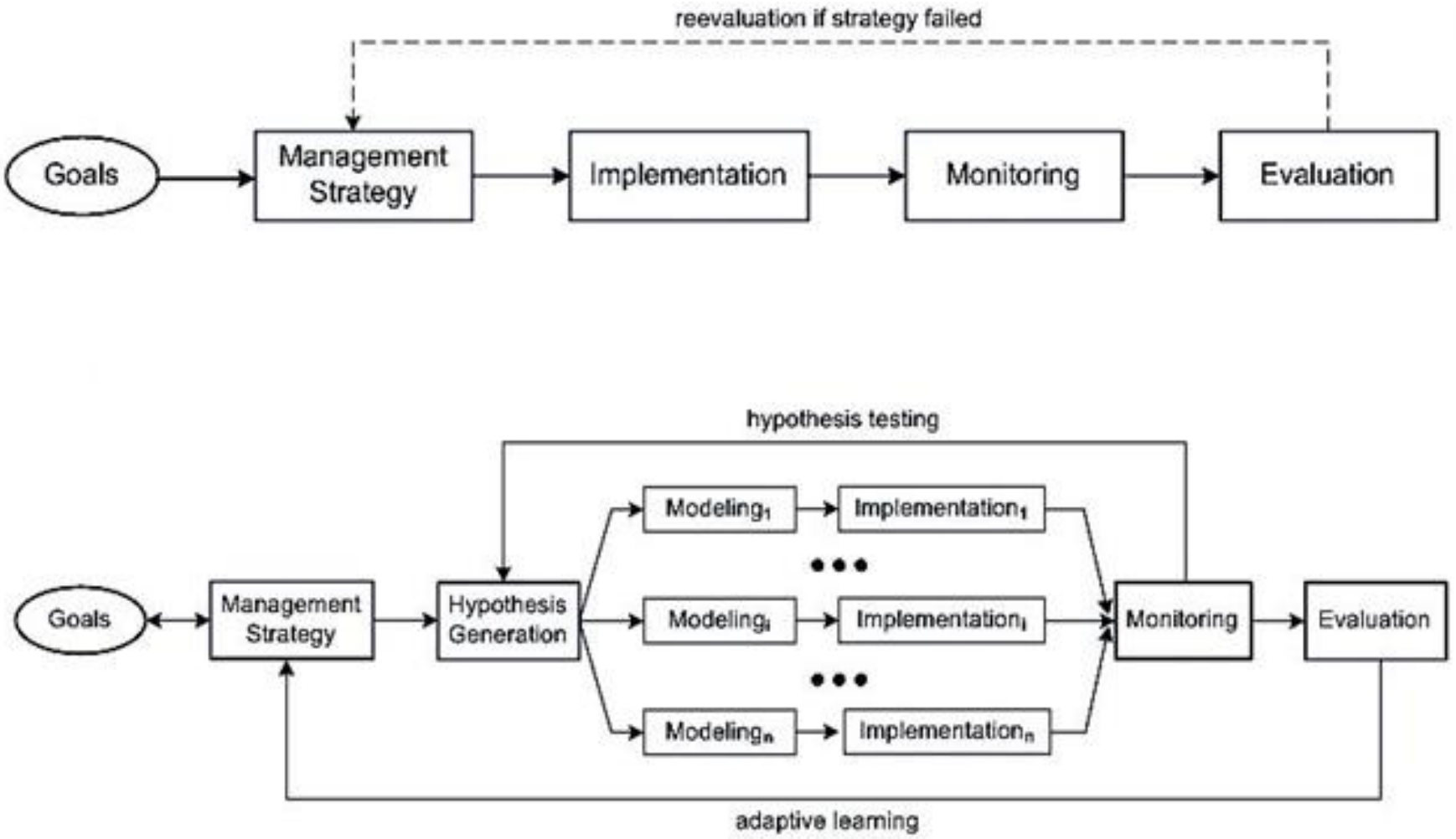
- Implementation Consistent with the NCP
- EPA Endorsement of Adaptive Management

III. Concluding Thoughts

What is Adaptive Management?

- A system of assuring that a desired remedial outcome will be achieved despite complex system dynamics by providing for testing and modifying remedial steps
- EPA definition in the Superfund remedy context:
  - "An iterative approach to site investigation and remedy implementation that provides the opportunity to respond to new information and conditions throughout the lifecycle of a site."
    - Office of Solid Waste and Emergency Response, EPA, *Superfund Remedial Program Review Action Plan* 8-9 (2013).
    - Explicit intent to respond to new information and conditions
    - Focused data collection to reduce key uncertainties, resulting in more efficient progress
    - Incorporating results of data analysis
    - Modification or termination of actions

Comparison with Traditional Method

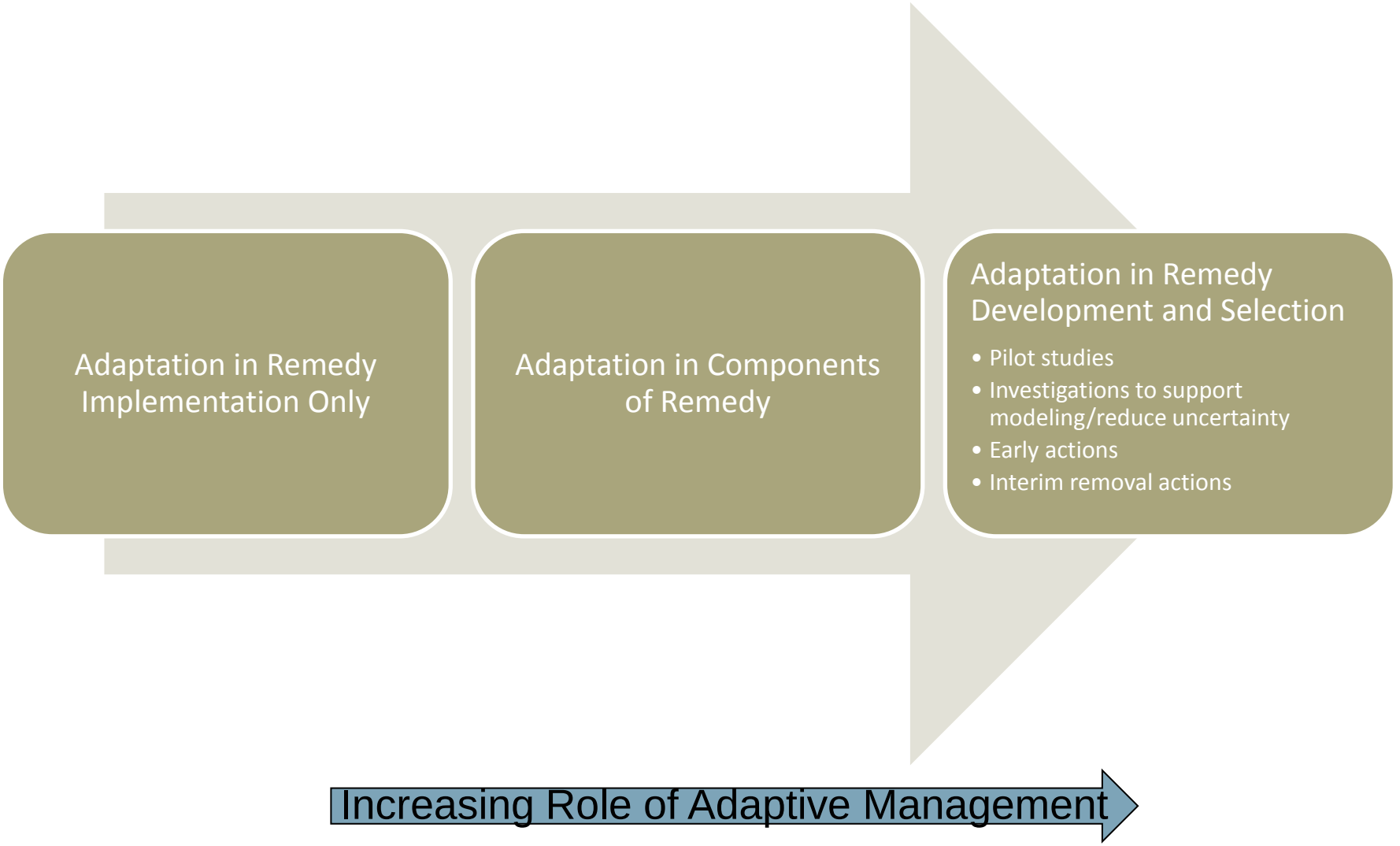


Source: I. Linkov, F.K. Satterstrom, G.A. Kiker, T.S. Bridges, S.L. Benjamin, and D.A. Belluck, "From Optimization to Adaptation: Shifting Paradigms in Environmental Management and Their Application to Remedial Decisions," Integrated Environmental Assessment and Management 92-98 (2006).

Six Elements of Adaptive Management

- Systematic tool for intentional learning
  - Regularly re-visiting project's objectives
  - Modeling system being managed
  - Generating range of remedial management alternatives
  - Monitoring and evaluating outcomes
  - Mechanisms for incorporating learning into future decisions
  - Collaborative structure for stakeholder participation and learning

Spectrum of Approaches to Adaptive Management



Traditional Management

- Typical approach to remedy selection: pick remedies deemed highly “conservative” based on a belief that those remedies are the most certain to achieve RAOs
- Two problems with the traditional approach:
  - The actual protectiveness of remedies deemed “conservative” is not known until the remedy is implemented
  - Those remedies often have their own significant environmental detriments

Benefits of Adaptive Management

- Adaptive management offers the flexibility to try more innovative remedial measures while testing, monitoring, and evaluating their effectiveness, and adjusting remedial measures based on results
- Ability to optimize use of innovative remedial approaches while ensuring achievement of RAOs

Benefits of Adaptive Management

- Quicker progress
  - Potentially avoid indecision and paralysis due to “one shot” mentality
- Reducing uncertainty
  - Traditional remediation involves a “one-shot,” linear framework, often with relatively high uncertainty
  - Potentially mitigate the costs of making the “wrong” choice by testing and evaluating options
- Results in a more effective remedy
- Remedial alternatives tested using adaptive management may be less costly than traditional remedies, and may ultimately be more effective

Benefits of Adaptive Management

- Reduces Political Barriers
  - Large, complex Superfund sites lend themselves to contentious debates about remedy selection and subjective probability assessments
  - By providing a demonstration of the effectiveness of a remedy, political disagreements may be mitigated

So, given the benefits of adaptive management, why doesn't everyone use it?

PRP Resistance to Adaptive Management

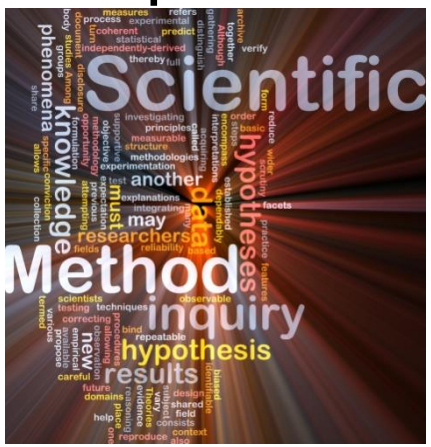
- Perceived lack of finality – without finality, how does a PRP group determine
  - Size of the pie?

  - Allocation of the pie?

- Affects willingness to participate in PRP group
- Affects ability to determine cash-outs for smaller PRPs

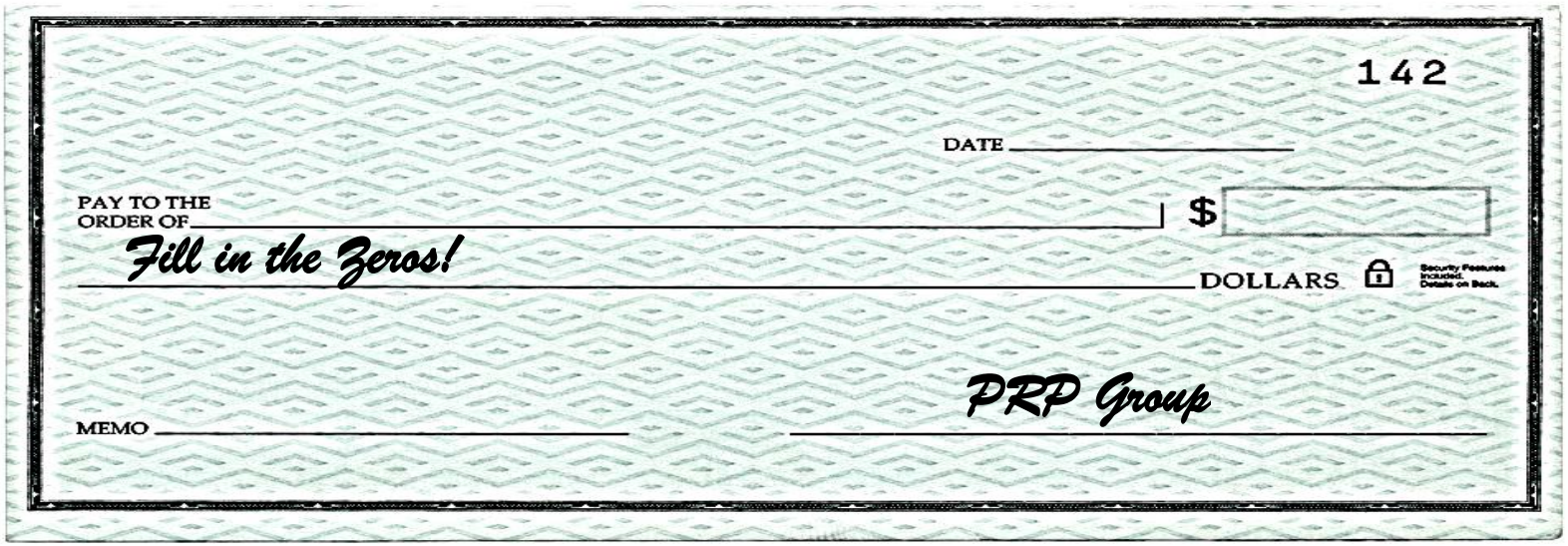
PRP Resistance to Adaptive Management

- Is Adaptive Management:



A promising technique?

OR



PRP Resistance to Adaptive Management

- Is Adaptive Management:
  - Promising technique?
    - The Big Hope: Achieve remedial action objectives by implementing cost-effective remedial alternatives

OR

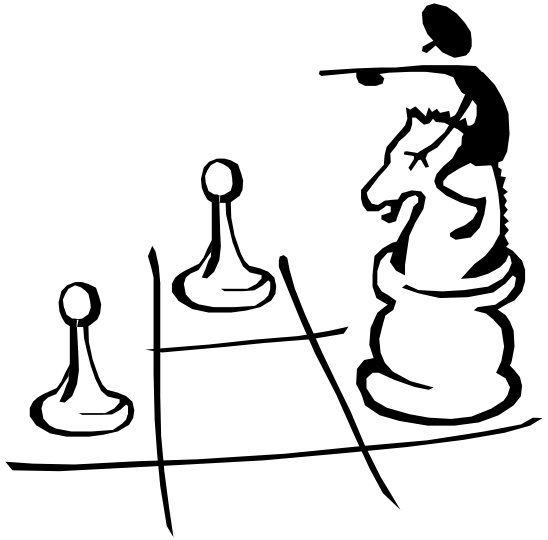
  - Blank check?
    - The Big Fear: What if the PRPs invest in more moderate innovative cleanup steps, and EPA is not satisfied and continues to demand more and more?

PRP Resistance to Adaptive Management

- The Answer is:
  - YES
  - It is both of those things – a proposition that holds the promise of both benefit and risk for the PRPs.

PRP Resistance to Adaptive Management

- So in light of adaptive management's promise and risk:
  - How can PRPs achieve the benefits of adaptive management while limiting the risks?



Regulator Resistance to Adaptive Management

- Is Adaptive Management:
  - A technique that is at odds with the National Contingency Plan's apparently linear remedial selection approach?
  - A technique that requires additional agency resources to engage in on-going hypothesis testing?

OR

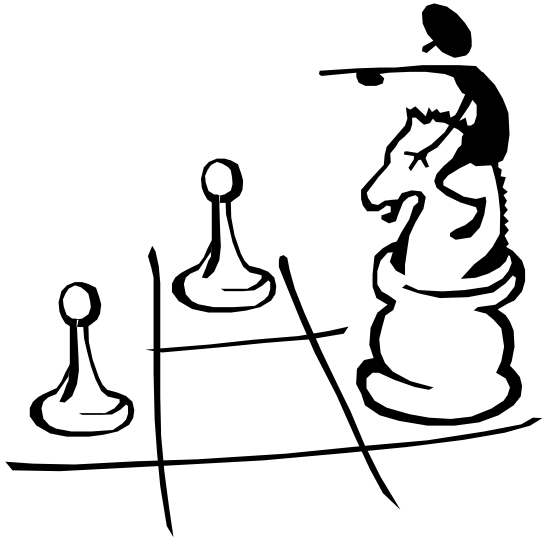
  - A technique that allows EPA and PRPs to accomplish far more with their resources than does a traditional linear approach?

Regulator Resistance to Adaptive Management

- The Answer is:
  - NO, adaptive management is not at odds with the NCP, but
  - YES, it may require additional agency resources (at least upfront), but the benefits are worth it.

Regulator Resistance to Adaptive Management

- So in light of that cost and promise:
  - How can agencies achieve the benefits of adaptive management while limiting the burden on themselves, and acting consistently with the NCP?



Overcoming the Hurdles

- Adaptive Management can be implemented consistent with the NCP
- EPA supports Adaptive Management
- PRPs can be protected from the "blank check"
- PRP groups can address the perceived lack of "finality"

Adaptive Management Complies with the NCP's Goals and Structure

- Overarching goal of the NCP:
  - "[to] select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." 40 CFR § 300.430(a)(1)(A).
- NCP principles dictate that decisions should:
  - Reflect "what is necessary or appropriate given the size or complexity of the site." 40 CFR § 300.430(a)(1)(ii)(A).
  - And "expedite the completion of total site cleanup." 40 CFR § 300.430(a)(1)(ii)(C).

Adaptive Management Complies with the NCP's Goals and Structure

- Remedial Investigation / Feasibility Study
  - "The purpose of [RI/FS] is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy. …The scope and timing of these activities should be tailored to the nature and complexity of the problem and the response alternatives being considered." 40 CFR § 300.430(a)(2).
  - "During scoping, the lead and support agencies shall confer to identify the optimal set and sequence of actions necessary to address site problems." 40 CFR § 300.430(b).

Adaptive Management Complies with the NCP's Goals and Structure

- Removal Action/Early Action
  - "Removal actions shall, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action with respect to the release concerned." 40 CFR § 300.415(d).
  - "Sites should generally be remediated in operable units when . . . phased analysis and response is necessary or appropriate given the size or complexity of the site . . . . " 40 CFR § 300.430(a)(ii)(A).
  - "An alternative that does not meet an ARAR under federal environmental or state environmental or facility siting laws may be selected under the following circumstances:

    "(1) The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement." 40 CFR § 300.430(f)(1)(ii)(C).

Adaptive Management Complies with the NCP's Goals and Structure

- Remedy Selection:
  - Criteria for Evaluating Alternatives:
    - Adequate protection of human health & environment
    - Short-term effectiveness
    - Long-term effectiveness and permanence
    - Implementability
    - Costs

    40 CFR § 300.430(f)(1).
  - Remedy Review "no less often than every five years."

    40 CFR § 300.430(f)(5)(iii)(C).

Adaptive Management Complies with the NCP's Goals and Structure

- Remedy Selection:
  - A Record of Decision must include a preferred alternative, but it also shall
    - "[w]hen appropriate, provide a commitment for further analysis and selection of long-term response measures within an appropriate time frame."

      40 C.F.R. § 300.430(f)(5)(iii)(D)

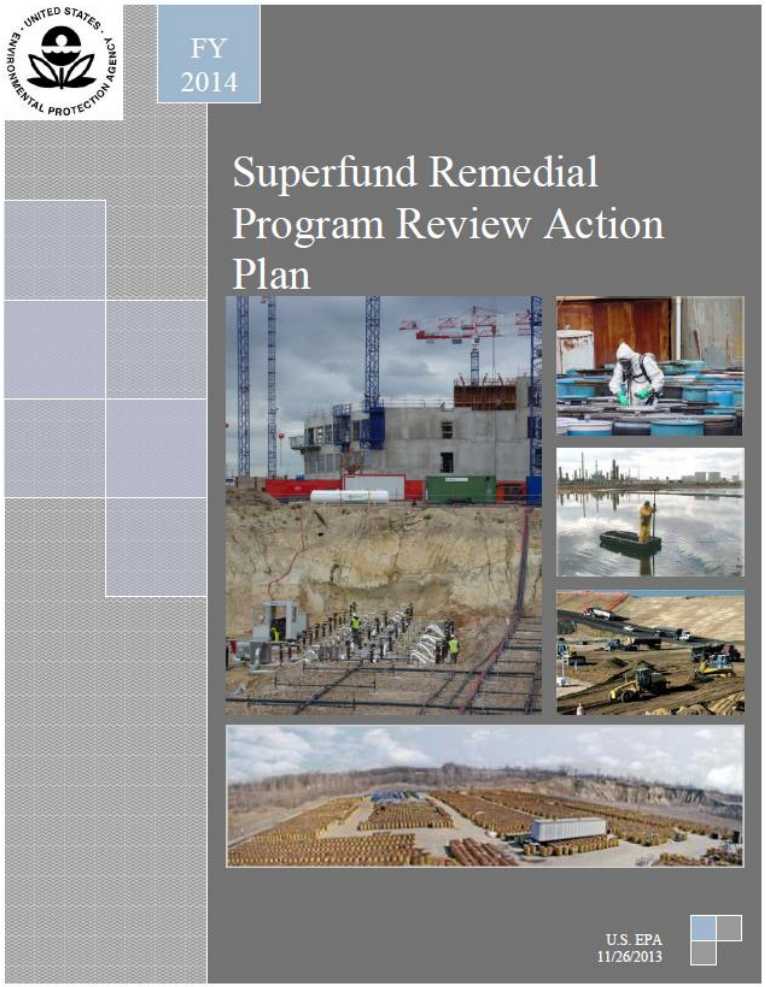
How to Use Adaptive Management within Existing Superfund Framework

- Build Adaptive Management into Remedial Investigation
  - Design studies to reduce key uncertainties – collect data with defined purpose
  - Conduct pilot studies and evaluate their results
  - Continually build on new information as RI progresses
- In parallel with RI, use Removal Authority as part of overall Adaptive Management Plan for site:
  - Conduct Early Actions
  - Monitor and evaluate results of Early Actions
  - Use lessons learned from Early Actions in the Remedial Investigation

Adaptive Management Can Be Incorporated Into Records of Decision

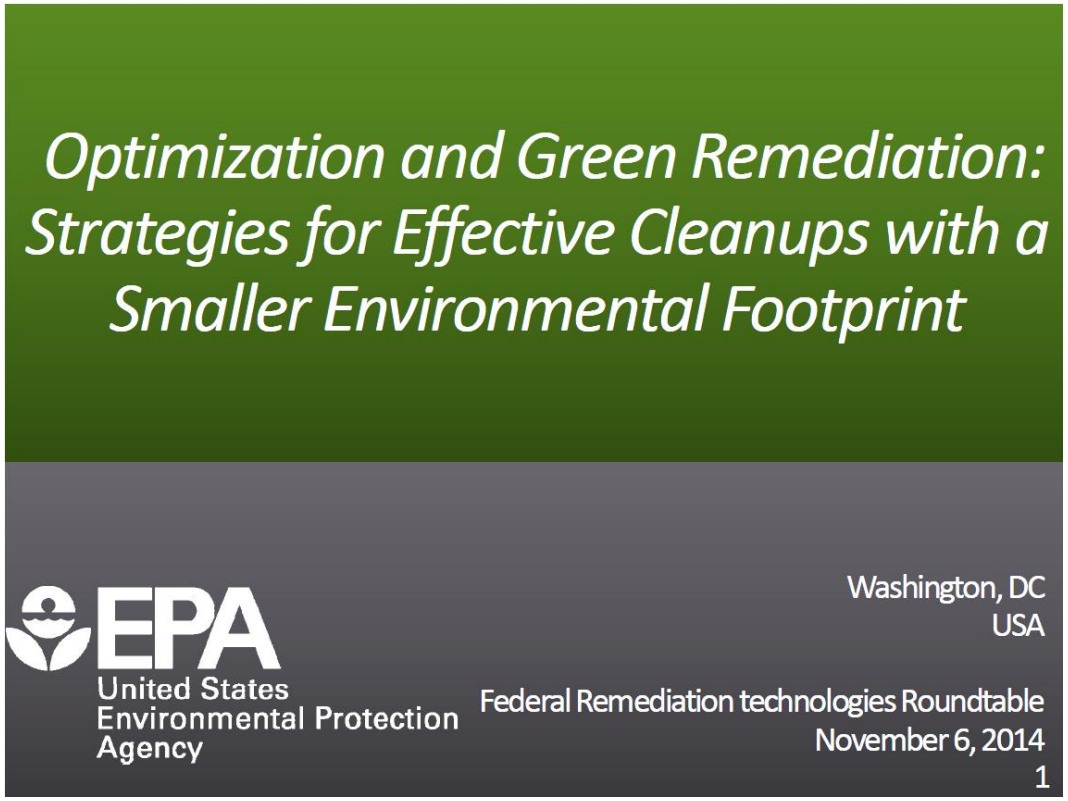
- The ROD can include:
  - Schedule for monitoring
  - Site-specific metrics to measure progress and trigger re-evaluation of remedy and its implementation
  - A systematic mechanism for incorporating new learning into future decisions
    - For example, a formal procedure for revisiting objectives and adapting to new information.
  - Limits on the extent to which additional work can be required – to constrain the “blank check” that legitimately troubles PRPs

EPA Recently Endorsed the Use of Adaptive Management Specifically for Superfund Sites



- Superfund Remedial Program Review Action Plan. Elements include:
  - New OSWER Directive to Employ Adaptive Management to aggressively encourage its use
  - Identification of Adaptive Management Priorities
  - Adaptive Management Pilots
  - Development of Portfolio of Adaptive Management Tools, Approaches, and Best Practices
  - Use of Early Actions
  - Encouraging Use of Amendments at Sediment Sites to Reduce the Bioavailability of Contaminants

Most Recent Statements by EPA



- Adaptive Management Benefits
  - Cost effective
  - Reduces environmental footprint of remedies
- Adaptive Management gaining ground for groundwater remedies
  - Monitoring allows for determining optimal transition time and place between remedy components
- EPA Going forward
  - Increase use of adaptive management and align with Superfund Program Review Actions

How to Overcome the Hurdles to Adaptive Management to Achieve Its Potential

Hurdle	Possible Work-Arounds?
Concerns about the "blank check"	1. Limit the extent to which the work can expand beyond a certain point 2. Create ongoing "work group" approach to RI/FS and RD/RA, to avoid surprises for everyone
Concerns about "finality"	1. Recognize that finality has its limits under any remedial approach – a key is defining "success" 2. Highlight the benefits of adaptive management, including potential cost savings
Concerns about regulatory consistency	Design the process with NCP considerations in mind – e.g., use of "early actions" to test remedial approaches, where appropriate
Drain on agency resources for on-going monitoring and data evaluation	"Work group" approach minimizes back-and-forth and utilizes resources more effectively

Concluding Thoughts

- PRPs and agencies have much to gain from incorporating adaptive management into Superfund cleanups
- Adaptive management has the potential to save time, resources, and reduce the environmental footprint of remedial action
- Adaptive management can be implemented consistent with the NCP, and EPA has endorsed wider adoption of it
- RODs that select a fixed remedy do not necessarily offer finality to the PRPs because the cost and effectiveness of the selected remedy is not known until implementation (or subsequent 5-Year Reviews)
  - “Blank check” risk is always present
  - “Size of pie” risk is always present
- Smart implementation of adaptive management can overcome many of the concerns and hurdles, and enable more widespread use of this beneficial technique