Highlights from a Workshop Series:
Best Practices for Risk-Informed Remedy Selection, Closure, and Post-Closure Control of Contaminated Sites

Jenny Heimberg
Study Director

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

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Performance & Risk Assessment Community of Practice
Technical Exchange Meeting

Motivation for the Workshop Series

- Department of Energy—Office of Environmental Management's (EM) mission:

  The safe cleanup of sites associated with the government-led development of nuclear weapons and nuclear energy.

- Many sites have been cleaned up, although the largest and most challenging have not been fully remediated.

- EM is reviewing alternative approaches to increase effectiveness and improve cost-efficiencies of its cleanup activities, especially for sites that will have residual contamination when active cleanup is complete.

Statement of Task

An ad hoc committee will organize two public workshops on best practices for risk-informed remedy selection, closure, and post-closure control of radioactive and chemically contaminated sites that cannot be remediated for unrestricted release.

The workshops will explore the following topics (abbreviated):

1. **Holistic approaches for remediating sites**.
2. **Effective post-closure controls**.
3. **Approaches for assessing the long-term performance of site remedies and closures.**
4. **Approaches for incorporating a sustainability framework into the decision-making process**.

The workshops will also explore best-in-class approaches for remediation; regulatory practices that promote effective, risk-informed decision making; and future opportunities to improve these approaches and practices.

Workshop Committee and Staff

Planning Committee

Paul Gilman, Covanta Energy (Chair)
Michael Kavanaugh, Geosyntec Consultants, Inc.
Patricia (Trish) Culligan, Columbia University
Jeffrey Wong, California EPA

Staff

Jenny Heimberg, Nuclear and Radiation Studies Board*
Kevin Crowley, Nuclear and Radiation Studies Board
Marina Moses, Sustainability Roundtable†
Dominic Brose, Sustainability Roundtable*

*rapporteurs
†now at the American Academy of Microbiology

Workshops Overview

- Workshop #1 (October 2013)
  - Focused on tasks 1 and 4
    - holistic approaches for remediating sites
    - incorporating a sustainability framework into decisions

- Workshop #2 (January 2014)
  - Focused on tasks 2 and 3
    - post-closure controls,
    - assessment of long-term performance of site remedies
  - Identify the “best-in-class” approaches or best practices for risk-based remediation decisions

Workshops Summary Report

- Single report
  - Introduction and Overview (includes highlights)
  - Volume I: Workshop #1
  - Volume II: Workshop #2
- Workshop summaries contain factual descriptions of the presentations and discussions held at the workshops.
- Workshop summaries are ***not consensus reports***
  - No findings or recommendations
  - Two rapporteurs, NAS staff, one for each workshop

Overview: Highlights from both Workshops

Several themes and topics emerged from both workshops:

- Evolution of decision-making processes
- Flexibility of existing regulations
- Realistic models and timeframes
- Frequent communication with stakeholders
- Weighing intrinsic value of environmental resources

EVOLUTION OF DECISION-MAKING PROCESSES

Tools for, approaches to, and the evolution of decision-making processes for cleanup of sites with complex and long-term contamination were discussed.

General tools for and approaches to making decisions:

- risk assessment
- sustainability frameworks

Risk Assessment

Risk Assessment overview from the workshops

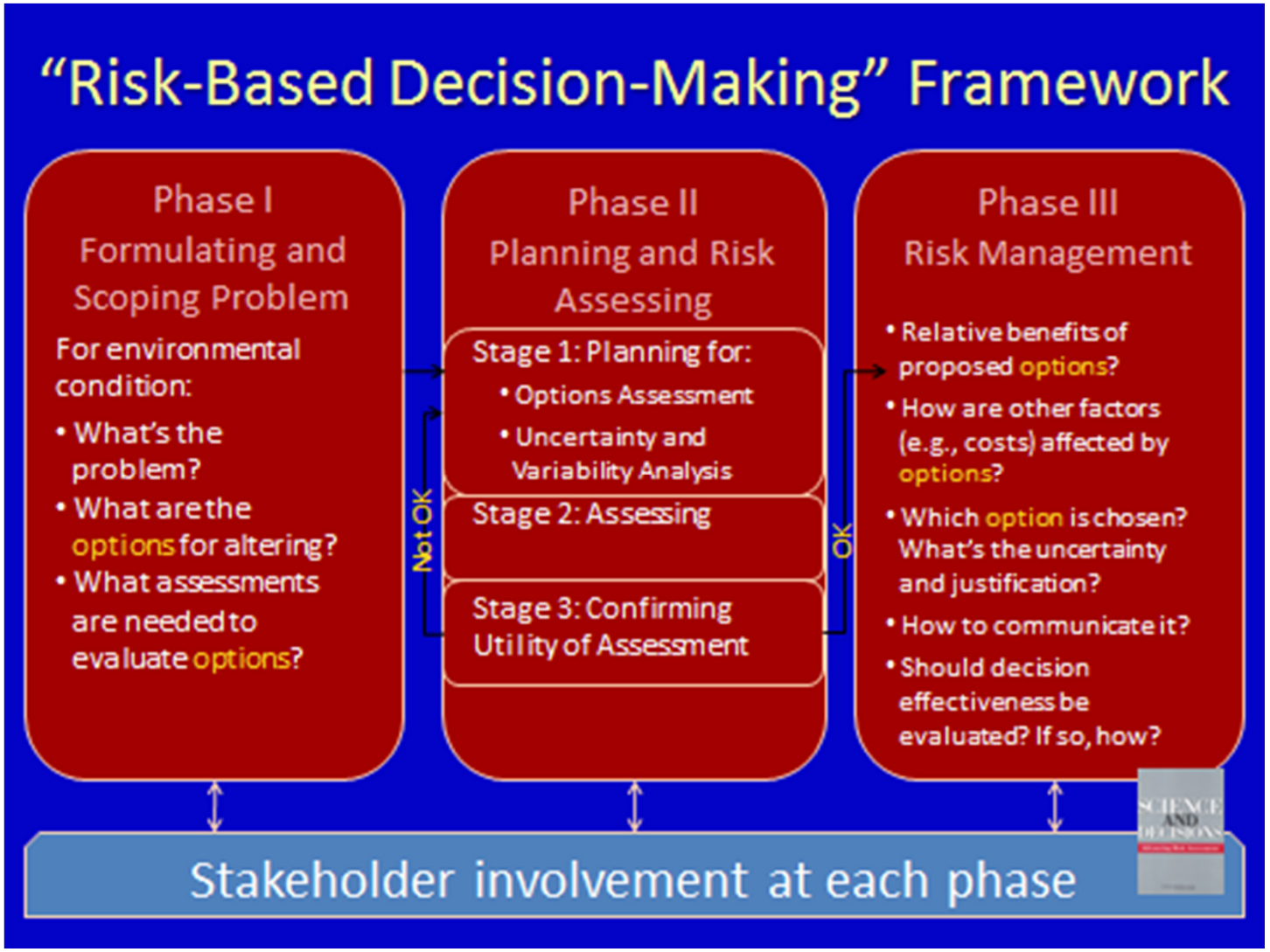
- Introduced to quantify the decision-making process
- Traditionally used to estimate technical risks (e.g., exposure risk)
- Other aspects of risk are gaining importance (scheduling, external factors)
- Challenge of integrating stakeholder input

Examples from the Workshops

Risk Assessment

Risk means many things to EM, including risks to human health, the environment, and programs and projects, as well as financial and operational risks. This view of risk has evolved over the past 25 years, since a time when it was simply about a leaking tank. Risk today is more subtle, and often disagreements are over the subtleties rather than the bigger issues that have been addressed in the past.

Alice Williams, associate principal deputy assistant secretary in DOE-EM
Workshop 1



Bernard Goldstein, Professor Emeritus, Department of Environmental and Occupational Health, University of Pittsburgh

Workshop 2

Sustainability Frameworks

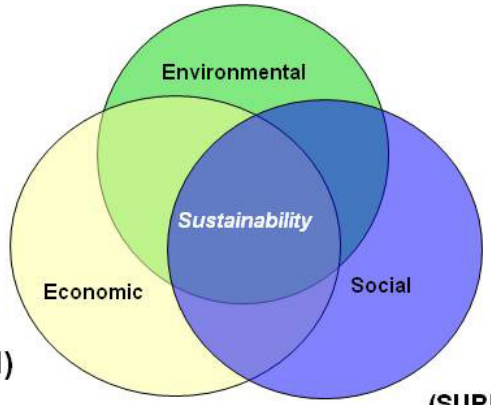
Sustainability Frameworks

- Three pillars are considered equally: environmental/societal/economic factors
- Communication among stakeholders is emphasized
- Balancing of the pillars requires frequent negotiations among all stakeholders
  - Results rarely provide a “win-win-win” solution for all stakeholders
  - But decisions are long lasting

Triple Bottom Line

Engineering, Operations & Technology | **Environment, Health and Safety**

- Compliance
- Environmental footprint reduction
- Project life cycle integration
- Partnering with all stakeholders
- Public awareness
- Safety
- Risk management
- Return on Investment (ROI)



(SURF White Paper, 2009)

Currently the practice of sustainable remediation is more qualitative than quantitative; however, metrics and tools are continually being developed to better quantify and assess the benefits of sustainable remediation. There have also been challenges to employing sustainable remediation because organizations lack the regulatory infrastructure to support it.

Nicholas Garson, president of the Sustainable Remediation Forum (SURF)
Workshop 1

Navy's Toolbox Approach

- Site Evaluation / CSM
  - Focus on GW useability and complete exposure pathways
- Risk Management
  - Plume Management Zones, Point of Compliance
- Remediation Strategies
  - Treatment Trains, Active vs. Passive, Containment , MNA as polishing technology
- Optimization / Sustainability
- New Tools
  - Mass flux
  - Plume stability/MNA software

Sustainability and Optimization –

"…maximizing benefit, minimizing risk, and finding the right balance between options"

Richard Mach, director of environmental compliance and restoration policy, Office of the Deputy Assistant Secretary of the Navy
Workshop 2

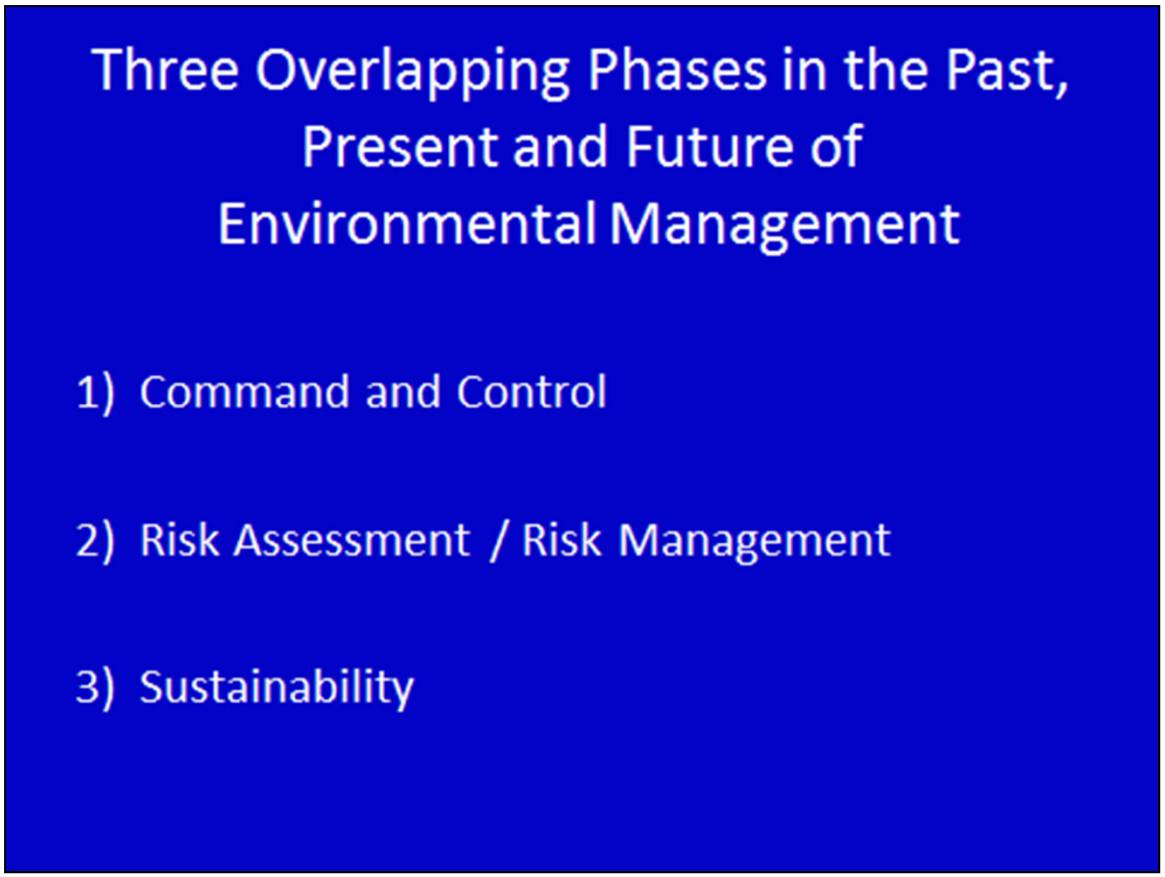
Evolution of Approaches to Decision Making

From CERCLA to Risk-Based End States

1. The once-and-for-all assumption
2. The risk critique
3. Future use
4. The physical realities of clean-up
5. DOE's risk-based end states directive
6. Long-term stewardship

Originally, CERCLA…held the basic premise that a site would simply be cleaned up. It was either clean or not. With the growth of risk assessment, however, the realization emerged that there was a spectrum rather than absolutes…This shift [to risked-based end state] meant that long-term stewardship would need to be considered concurrently. Sustainability is literally about time, and it is a useful concept under which risk and long-term stewardship fit well.

John Applegate, Walter W. Foskett Professor of Law and executive vice president for academic affairs, Indiana University



Bernard Goldstein, Professor Emeritus, Department of Environmental and Occupational Health, University of Pittsburgh
Workshop 2

REGULATIONS AND FLEXIBILITY

Flexibility of laws and regulations that govern environmental cleanup decisions and the incorporation of sustainability principles were discussed.

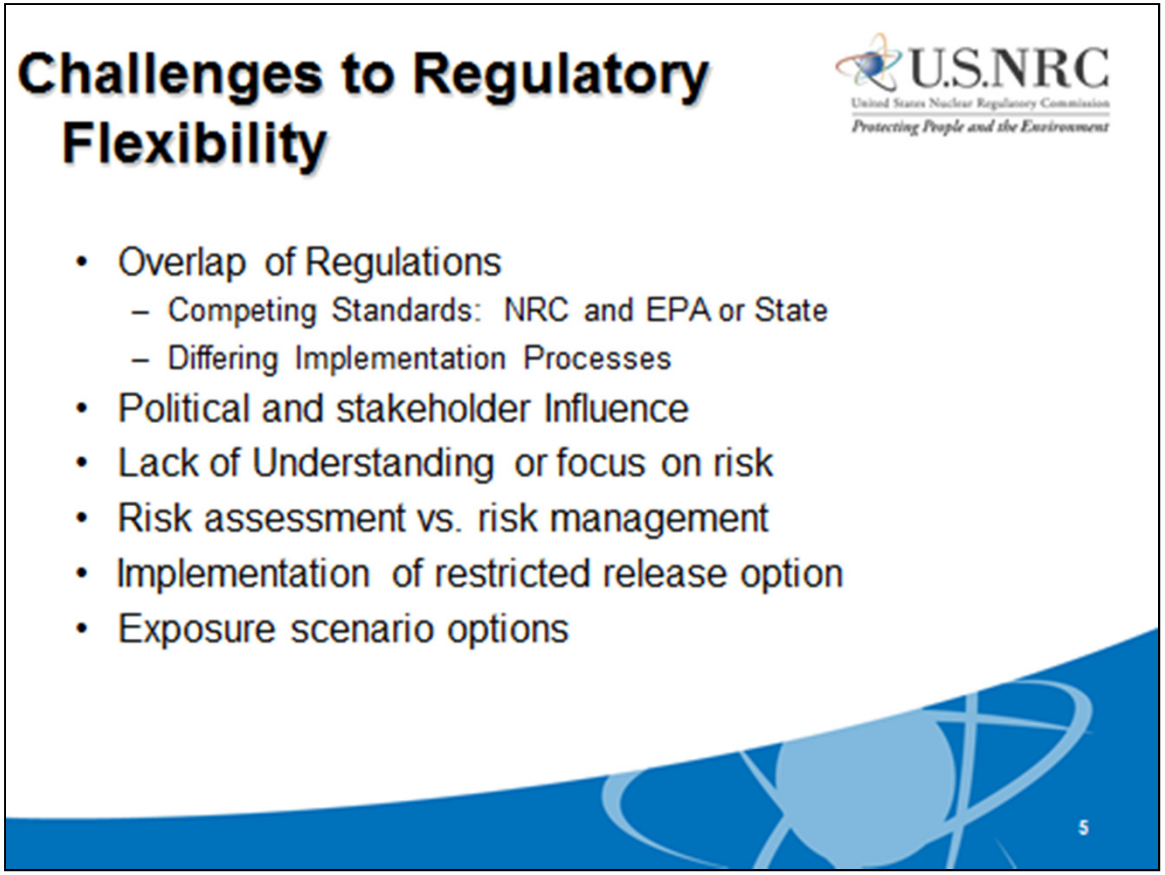
The following three laws were highlighted:

- National Environmental Policy Act (NEPA)—
  - contains language compatible with and favorable to incorporating sustainability principles
- Resource Conservation and Recovery Act (RCRA)—
  - described as a prescriptive law, this is the not flexible for incorporating sustainability principles
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) —
  - examples provided throughout the workshops demonstrated CERCLA's ability to accommodate sustainability principles, no "tenth criterion" is needed

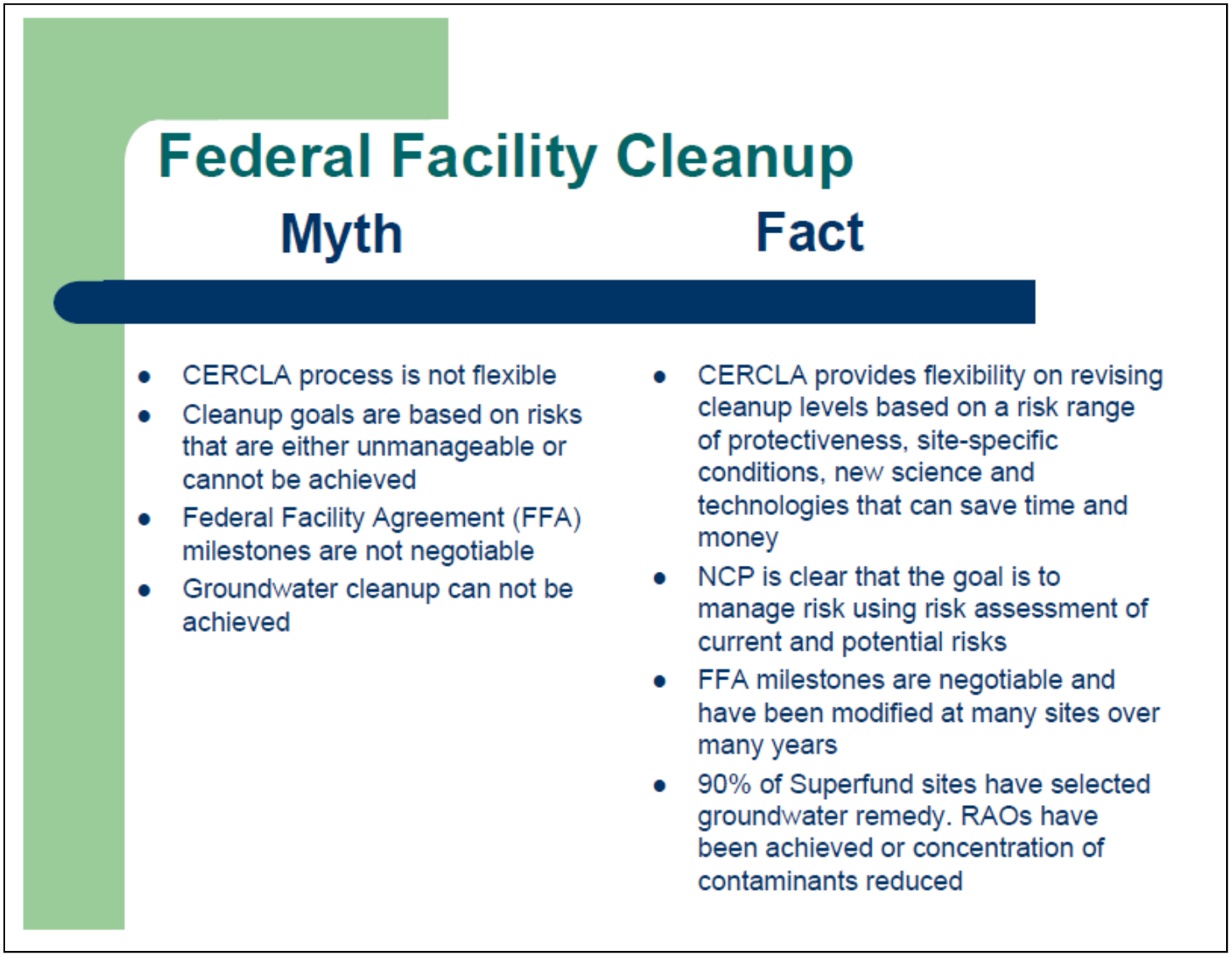
Flexibility of existing laws and regulations to allow remediation decisions to be guided by sustainability principles (Workshop 1)

The nine CERCLA criteria do not directly include sustainability, but a tenth criterion addressing sustainability could contribute to more holistic approaches at ongoing sites for more successful cleanup.

Alice Williams, Associate Principal Deputy Assistant Secretary, Office of Environmental Management, Department of Energy
Workshop 1



Larry Camper, Director, Division of Waste Management and Environmental Protection, Nuclear Regulatory Commission
Workshop 1



Reggie Cheatham, director of the Federal Facility Restoration and Reuse Office, Environmental Protection Agency

Workshop 2

Updating current laws and regulations

A “reset” of regulations and regulatory approaches has been suggested as a way to adopt disruptive—as opposed to incremental—change. Rethinking the current regulatory strategy while balancing options in a transparent way…may be needed as the nation becomes increasingly resource constrained.

Craig Benson, University of Wisconsin and member of the Consortium for Risk Evaluation with Stakeholder Participation (CRESP)
Discussion of “best practices”, Workshop 2

MODELS AND TIMEFRAMES

Models were discussed in both workshops. Examples of themes that emerged included:

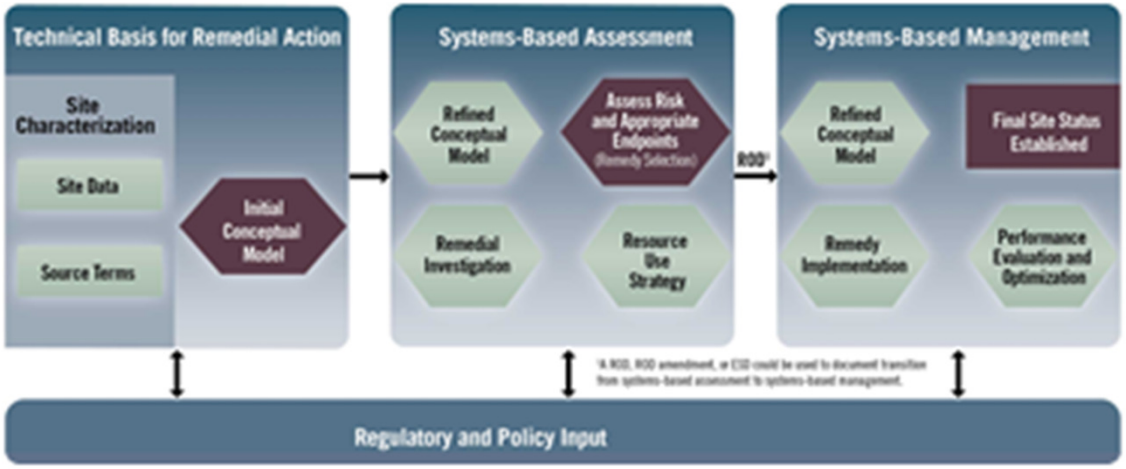
- Models are important communication tools to guide decisions and communicate between stakeholders.
- Models based on realistic estimates physical processes and updated with functional monitoring data can better guide decisions.

Discussions on the appropriate and technically reasonable timeframes used in modeling were held in both workshops including:

- Timing, sequencing of, and exit strategies for remediation activities ought to be considered in decision making.
- Sustainability frameworks may offer a way to better incorporate timing or sequencing into the decision-making process.

Holistic Remediation Approaches

- Conceptual models are a foundation for technical efforts and communication
- The subsurface system and site context can inform remedy approach and timeframe
- Maintain protection while addressing future risk and cleanup
- Adaptation may be needed as plume evolves and responses to actions unfold over time – enable adaptation/transition and allow time



Michael Truex, Environmental Systems Group at Pacific Northwest National Laboratory (PNNL)

Workshop 1

Simplified conceptual models and commonly understood analogies were found to be critical tools when discussing scientific concepts with stakeholders.

Carol Eddy-Dilek
Savannah River National Laboratory [SRNL]
Workshop 2

Conservative decisions can be made using realistic models, but good decisions cannot be made using conservative models.

Paul Black, principal and CEO, Neptune and Company, Inc.
Workshop 2

Functional monitoring and realistic estimates to improve models

Why Monitor? – Monitoring by Function

Monitor by Function: uncommon strategy

- **Why:** to confirm that feature is functioning as expected
- **Where:** at location near feature
- **When:** adequate frequency to characterize behavior

Advantages of Monitoring by Function

- Confidence in methods and procedures
- Evaluate and/or calibrate predictive capability

Disadvantages of Monitoring by Function

- Not meet regulatory requirements
- May not understand mechanisms (requires more info)

Craig Benson, University of Wisconsin and CRESP
Workshop 2

[Existing] data sets might be used to build confidence in existing models for the regulators and the public.

Patricia Culligan
Discussion of "best practices" in Workshop 2

The appropriate timeframe for modeling was discussed

- Example: hundreds of years versus millions of years

Many workshop participants suggested that remediation analyses should be based on 100-200 year timeframes, not 10^4-10^6 year timeframes as is common practice at present.

Discussion of "best practices," Workshop 2

- Consider a "rolling" decision-making process using realistic timeframes with monitoring to revisit effectiveness

Rolling timeframes for long-term stewardship decisions

"Rolling Stewardship" – A process of analysis, evaluation, and action to maintain remedy protection.

- "Created" by the National Environmental Policy Institute in 1999. Rolling Stewardship builds on the concept of "stewardship" by focusing on the links needed between generations to carry long-term stewardship forward.
- The current generation cannot determine the actions future generations will take, but it can ensure that the next generation is aware of remaining risks and is handed the tools to make sound and protective decisions.
- Rolling stewardship requires a framework for decisions that can be tailored over time, and empowers each generation with greater information on stewardship tools and practices.
- The rationale is that there are too many imponderables, in terms of planning for conditions many decades in the future, to make decisions today that will be effective many generations from now.
- Rolling stewardship allows greater flexibility, yet ensures there is an infrastructure in place to empower the next generation of decision-makers. This approach focuses onto practical issues that we can carry out today with some assurance of success. "Will the solution remain viable for a generation?" rather than, will it be viable for the next millennium and beyond.

Dave Geiser, director, Office of Legacy Management, DOE
Workshop 2

COMMUNICATION AMONG STAKEHOLDERS

- Communication among stakeholders throughout the decision-making process (“early and often”) was highlighted.

- Communication among stakeholders enables flexibility in decisions.

- Tools developed to support decision making can provide transparency and improve communications.

Priorities

- Early communication to the tribes on all activities that would involve LTS at the perspective site(s)
- Early communication to the tribes on all activities that would involve future land transfer at the perspective site(s)
- Following the DOE American Indian Policy, and reference to the Blue Ribbon Commission policy involving Tribes
- Ensuring that any land transfer that may be offered to tribes be contamination free above and below ground level
- Concerning LTS the tribes would like for the DOE to constantly monitor those areas that have administrative controls and to pass on the history of what was there previously-Tribes occupation as aboriginal or treaty rights areas.
- Following Treaty rights of Tribes regarding the LTS sites, federal trust responsibility.

Early and frequent communication is important—particularly when funding issues arise. All tribes understand the funding issue, but early communication of the issues will help with future decision making.

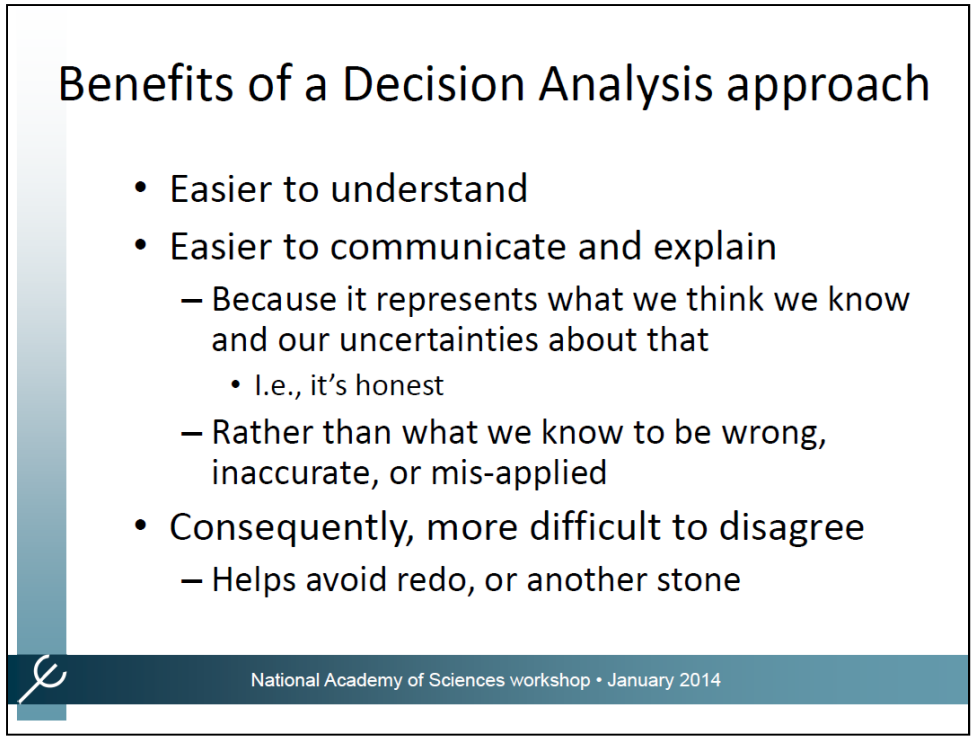
Willie Preacher, from the Tribal Department of Energy (DOE) Program and a member of the Shoshone-Bannock Tribes
Workshop 2

Communication among stakeholders enables flexibility in decisions.

It is important for a remediation project to provide a clear, concise, understandable statement of purpose to the general public and stakeholders. This communication is imperative for finding flexibility in existing regulatory frameworks and in particular in tri-party agreements.

Carolyn Huntoon, independent consultant and
former assistant secretary DOE-EM
Workshop 1

Tools developed to support decision making can provide transparency and improve communications.



Paul Black, principal and CEO, Neptune and Company, Inc.
Workshop 2

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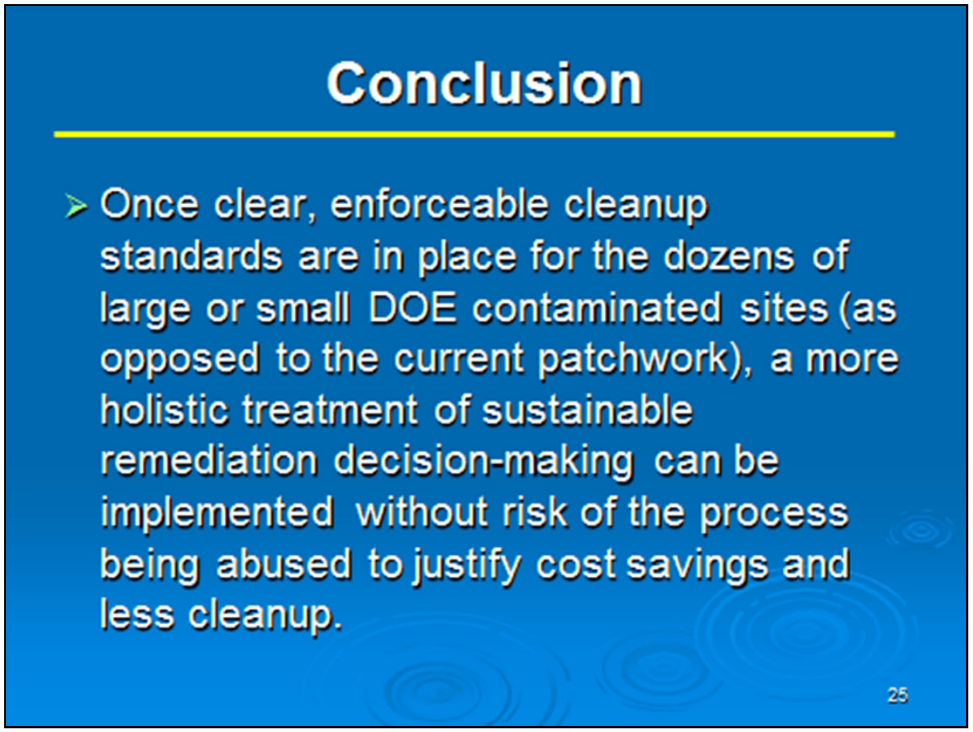
Carol Eddy-Dilek
Savannah River National Laboratory [SRNL]
Workshop 2

WEIGHING INTRINSIC VALUE OF THE ENVIRONMENT IN DECISION-MAKING

There was debate regarding the representation of environmental concerns (e.g., evaluating the intrinsic value of resources) within a sustainability framework when the societal and economic pillars may have stronger interests and advocates.

[There is a] concern that sustainable remediation may be used as a justification for not cleaning up a site to the fullest extent.



Geoffrey Fettus, senior attorney, Natural Resources Defense Council
Workshop 1

Difficulty of calculating intrinsic value and having a strong advocate in sustainability negotiations.

…the advocate for the environment is missing. “Preserving” is written down (e.g., see the National Environmental Policy Act) but environmental and economic values are not weighed equally. There is a need to better define how economic and environmental values are evaluated and included in risk assessment, as well as a way to assess intrinsic value of the resources.

Dan Goode, United States Geological Survey
Excerpt from the “best practices” discussion, Workshop 2

Utility of NAS Workshop Reports

- NAS workshops bring together a diverse set of participants

- Discussions are moderated
  - Even if the participants routinely meet in other forums, NAS workshops tend to initiate new thoughts and information

- Workshop reports remind participants of what was said during the presentations and discussions

Exposure of NAS Reports

Workshop-related links

- Workshop Summary
  - http://www.nap.edu/catalog.php?record_id=18747

    [search “nap.edu best practices risk-informed”]

- Workshop #1 presentations:
  - http://sites.nationalacademies.org/PGA/sustainability/PGA_085849.htm
- Workshop #2 presentations:
  - http://dels.nas.edu/Past-Events/Best-Practices-Risk-Informed-Remedy/AUTO-8-12-72-G?bname=nrsb

    [search “NRSB DELS” and select “Events”]