Adaptive Management as a Measured Response to the Uncertainty Problem

John P. Connolly[1] and Mary P. Logan[2]

[1]Quantitative Environmental Analysis, LLC
[2]USEPA, Region 5

Addressing Uncertainty and Managing Risk at Contaminated Sediment Sites
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Authors' Presentation Rules

- The views expressed are the authors' own
  - Not EPA's
  - Not necessarily any stakeholders from the case studies presented
- Authors are presenting ideas on which they reached consensus
  - Recognize that there are other opinions on how to deal with uncertainty at sediment sites

What is Adaptive Management?

- Learning by doing
- Structured approach to:
  - Address uncertainty
  - Make decisions in the face of uncertainty
  - Improve decisions in an iterative manner by acquiring knowledge to reduce uncertainty

National Research Council. 2003. Environmental Cleanup at Navy Facilities

Principles of Adaptive Management

- Adaptive management is a process that is **systematic** and **cyclical**
  - Provides a means to deal with uncertainty
  - Integrates existing knowledge to explore the management options and set goals
  - Involves careful **implementation** of a plan of action
    - Designed to get critical missing information

Principles of Adaptive Management (cont.)

- It actively compares policies and practices
  - Policy and management options are implemented experimentally
  - Actions are monitored
- Future decisions incorporate results/outcome
  - Reassessment of hypothesis and goals
  - Modification of policies and actions, as needed
- Negative or unexpected outcomes are not deemed "failures" – they are an expectation of the process and can be managed

History of Adaptive Management

- Concepts developed in the 1970s
- Started in resource management
  - Fisheries and forest harvesting
  - Habitat management
  - Restoration projects
- Evolving to take account of other factors
  - Land-use planning
  - Scale (temporal and spatial)
  - Societal concerns

Sediment Sites Have a High Degree of Uncertainty

- Processes affecting exposure levels and trends
  - Sediment stability
  - Internal and external sources
  - Bioavailability
  - Scales of exposure integration
  - Natural recovery processes
- Effectiveness of available remedial options
  - Ability to achieve desired outcome
  - Collateral impacts (habitat; short-term exposure increase, etc.)
- What is "best" for the site
  - Remedial goals
  - Basis and objectives of the response

Different perspectives of scientists and government decision makers can stall action or drive unnecessary action

Science	Government
Probability accepted	*Certainty desired*
Inequality is a fact	Equality desired
Anticipatory	Time ends at next election
Flexibility	Rigidity
Problem oriented	Service oriented
Discovery oriented	Mission oriented
Failure and risk accepted	*Failure and risk intolerable*
Innovation prized	*Innovation suspect*
Replication essential for belief	Beliefs are situational
Clientele diffuse, diverse or not present	Clientele specific, immediate and insistent

Table from Manning. 1988. Models and the decision maker. *In*. R. Gelinas, D. Bond and B. Smit. *Perspectives on Land Modelling.* Workshop Proceedings, Polyscience, Montreal, Quebec, Canada.

If failure and risk are intolerable, scientific inquiry is corrupted and inaction is fostered

Case Study
Peconic River
Suffolk County, NY

Site Description

- Headwaters of the Peconic on BNL and flow ~18 miles to Peconic Bay
- Characteristics of the area of interest
  - ~ 7 miles downstream of BNL's sewage treatment plant (STP)
  - Flow on site is dominated by STP discharge
  - 5–120 feet wide, depending on hydrologic conditions
  - Less than 75 acres
  - ~ 50,000 - 100,000 CY of sediment
- Mercury is the primary contaminant of concern
  - Unacceptable risks primarily from fish consumption
- Runoff and historic discharges from the STP were the original source
  - Contaminants remaining in sediment are principal concern

Major Uncertainties that Hampered Decision-making

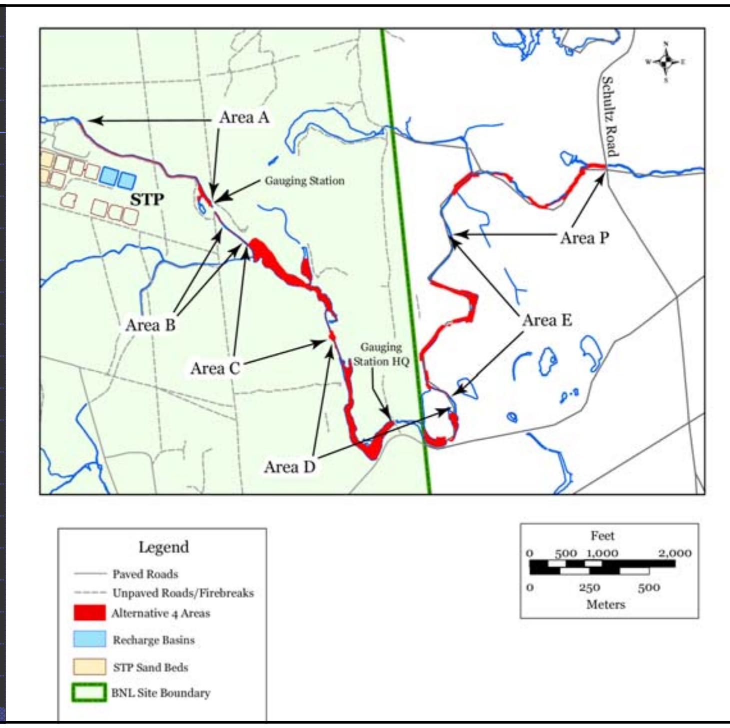
- Basis for action
  - Risks from fish consumption
  - Radiological risks
- Scope of cleanup
  - Mercury concentration targets
  - Areas to be remediated
    - Areas contributing methyl mercury
- Effects from the remedy
  - Concerns with wetland damage
  - Public desire to explore innovative approaches

Response to the Recognized Uncertainties

- Interaction/communication
  - EPA, NY State, Suffolk Co., DOE/BNL
    - Used a "Core Team" approach
  - Very active community
    - Constant outreach to community and groups
    - Public workshop to explore technologies
- Studies – Phased to respond to outstanding questions
  - Remedial Investigation (1998)
  - Plutonium/radionuclide characterization study (2000)
  - Additional fish, sediment and hydrologic studies (2001-2003)
  - Field studies of methyl mercury source areas (2003-2004)
  - Pre-design studies (2003-2004)

Response to the Recognized Uncertainties (cont.)

- Actions – Phased to make progress & get data
  - STP upgrades/STP soil remediation (1998/2002)
    - To control source
  - Construction of a temporary sediment trap (2001)
    - To prevent further off-site migration of contaminants
  - Pilot studies (2002)
    - 1360 yd^3 and 1.4 acres
    - Evaluated phytoextraction; field tested vacuum guzzling and wetland restoration
  - Non-time critical removal action (2004)
    - 13,000 yd^3 and 10.7 acres
  - Final remedy construction (planned 2005)
    - ~ 24,000 yd^3 and 20 acres - total response



Case Study
Lower Grasse River
St. Lawrence County, NY

Site Description

- Grasse River flows > 100 miles from the Adirondacks to the St. Lawrence River
- Characteristics of the area of interest
  - Final ~ 7 miles – Massena Power Canal to confluence with St. Lawrence River
  - 400 – 600 feet wide
  - 405 acres
  - ~ 2,500,000 CY of sediment
- PCBs are the contaminant of concern
  - Unacceptable risks primarily from fish consumption
- Historic discharges through industrial plant outfalls were original source
  - Contaminants remaining in sediment are principal concern

Major Uncertainties that Hamper Decision-making

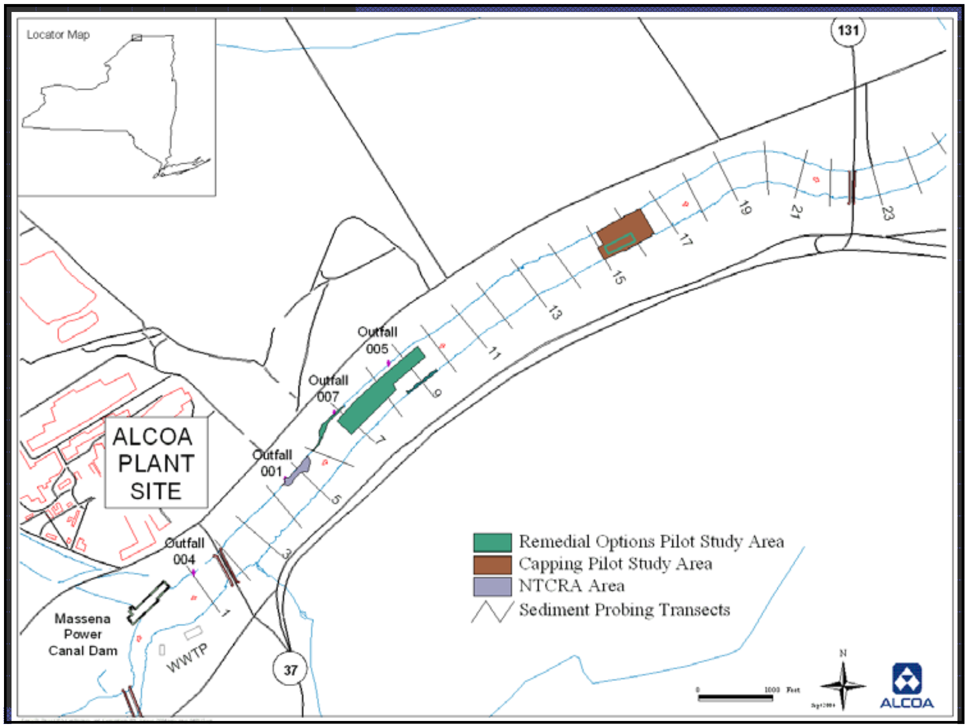
- System processes and the conceptual site model
  - Sediment stability
  - River ice processes
- Effectiveness of remedial options
  - Dredging residuals
  - Cap stability and effectiveness
  - Rate of natural recovery
- Scope of cleanup
  - Remedial goals
  - Decision criteria on where to apply different technologies
- Stakeholder positions on "best" approach

Response to the Recognized Uncertainties

- Interaction/communication
  - EPA, NY State, St. Regis Mohawk Tribe, Alcoa
    - Used a “technical team” approach
  - Active community advisory panel
    - Frequent meetings with advisory group
    - Outreach to the broader community
- Studies – Phased to get up-to-date information and respond to outstanding questions
  - River and Sediment Investigation (1991-1994)
  - Supplemental Remedial Studies (1995-ongoing)
  - River ice process investigations (2003-2004)

Response to the Recognized Uncertainties (cont.)

- Actions – Phased to make progress & get data
  - Source control (1991 – 2001)
    - Plant site cleanup
    - Modifications to wastewater treatment system
  - Non-time critical removal action (1995)
    - ~ 3,000 CY, 8,000 lbs. of PCBs
  - Capping Pilot Study (2001)
    - ~ 7.5 acres
    - Evaluated cap placement techniques and materials
  - Remedial Options Pilot Study (planned start 2005)
    - Dredging ~ 75,000 CY, 9 acres
    - Armored capping ~ 1 acres
    - Ice control structure
  - Final remedy selection (planned for future)



Case Studies – Common Elements that Help Lead to Success

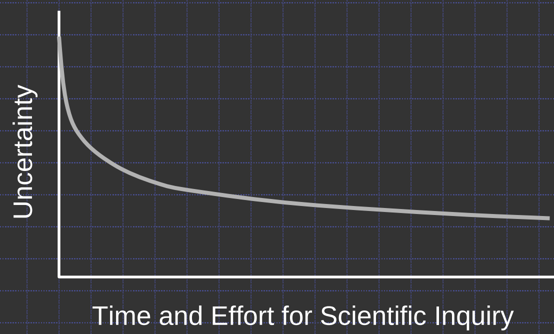
- Communication between regulators, regulated and other government parties
  - Frequent exchange of information and opinions
    - Team approach
    - Not always pleasant, critically important
  - Willingness to listen to other viewpoints
- Public involvement
- Quality science
  - Sound conceptual site model
  - Ongoing collection of data linked to a clear objective
  - Appropriate technical expertise

Common Elements (cont.)

- Phased approach
  - Source control is critical
  - Implementation in small steps can help
- Uncertainty management → part of all actions
  - Provisions in early phases to revisit the actions as part of subsequent decisions
  - Requirements to measure during and post-construction conditions
    - To evaluate effectiveness
    - To establish expectations for next phases
  - Corrective action triggers established for work

Concluding Observations

Uncertainty will always exist – Decisions have to be made



No decision = Natural recovery

Managing Sediment Sites in the Face of Uncertainty

- Tradeoffs exist between continued study to reduce uncertainty and making a decision despite some uncertainty
  - Key issues must be faced:
    - Bang for the buck for continued study
    - Means by which uncertainty is handled in decision making
- Managers need to confront the realities of risk and failure
  - Risk is unavoidable in the face of uncertainty
  - "Failure" may be OK
    - If consequences are manageable
    - If knowledge gained reduces uncertainty and improves ultimate outcome

Adaptive Management and Sediment Remediation

- Adaptive management can overcome many of the impediments to effective management of contaminated sediment sites
  - Reduce uncertainty
    - Scientifically compare approaches without the bias of a pre-conceived idea of what is “right” or “wrong”
    - Learn from implementation of actions
  - Allow progress and improve future decisions through an iterative approach
  - Provide a means to modify approaches if the outcome is not meeting desired goals

Adaptive Management and Sediment Remediation (cont.)

- It requires cooperation and commitment among the affected parties
  - Need to look for ways to build consensus
  - While it fits the regulatory framework, it may require a different decision paradigm from the regulators
    - May help prevent stalled or unnecessary action
    - Decision makers need to understand that there may not be one “best” answer for these sites
- It requires commitment to monitor outcomes and conduct additional work if needed to achieve the agreed upon long-term goals