Understanding and Managing Uncertainty in Sediment Contamination

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Sources/Types of Uncertainty

- Analytical/empirical/metrical
- Temporal
- Modeling (CSM and mathematical)
- Biological including HHRA/ERA
- Inability to predict performance of chosen technology/remedial design—mechanical uncertainties
- Sediment stability issues
- Translational
- “Externalties”

Uncertainty Characterization & Analysis

- Monte Carlo analysis (1-D and 2-D)
- Probability Bounds analysis
- Fuzzy math
- Sensitivity analysis
- Failure modes and effects analysis
- Others:
  - Interval analysis
  - Bayesian methods

Options in Response to Uncertainty

- Reduce or minimize
  - Collect more data
  - Bench scale/Pilot/Demonstration studies
- Manage
  - Contingency planning
  - Phased approach
  - Adaptive management
  - Triad approach (systematic project planning, dynamic work strageties, real-time measurements—fosters field decisions)

Decisions

- We should expect uncertainty
- We should use quality science
- We should weigh the costs of understanding uncertainty vs. cost of implementing a selected remedy

At the end of the day, we have to make a decision

ISSUES

- Large uncertainty may lead to higher costs or may impede decision making.
- Risk Communication
  - Probabilistic results
- Understanding uncertainty. Break models apart. Non-trivial, site-specific.
- Stakeholder involvement is necessary for
  - setting sensible cleanup goals
  - Decisions within an adaptive management framework

ISSUES

- What drives uncertainty.
  - Site-specific.
  - Tools can help define key processes and parameters.
- Framework for incorporating uncertainty analysis into the decision process is needed.
  - Data requirements and partitioning of uncertain vs. variable parameters
  - Interpretation of results
  - Acceptance of results by stakeholders

Conclusions

- Uncertainty is – deal with it.
- Uncertainty is in all aspects of sediment remediation. Site characterization, risk assessment, setting sensible clean-up goals, remedial design, long-term monitoring and decision-making.
- We more often manage in the face of uncertainty more than we manage the uncertainty.
- More case studies needed where solutions were chosen using input from uncertainty analysis.

Adaptive Management

- Iterative or phased process of measurement and response to attain a goal
  - Metrics of project performance
  - Valued stakeholder concerns
- Response needed when measurements fall outside the “bounds of expectation”
  - uncertainty analysis may be used to help set these bounds
- No single goal defines success or failure
- Changes in project design, in response to measures, are meant to steer the project towards the “expected trajectory of development” toward the remedial goal