Interactive Sediment Remedy Assessment Portal (ISRAP): A Tool to Facilitate Design of Long-term Remedial Monitoring Strategies

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and

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Environ Corporation
Why Monitor?

- **Characterize Baseline**
  - Baseline Monitoring
    - Remedy feasibility
    - Supplement data to enable before & after comparison

- **Demonstrate Compliance**
  - Construction Monitoring
    - Attainment of remedy design
    - Address acute risks to community, ecology, and workers
  - Performance Monitoring
    - Assessment of remedy function, now and in future

- **Demonstrate Success**
  - Remedy Goal Monitoring
    - Assess remedial action objectives (RAOs) and in reducing human health and/or environmental risk
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**Other Terms**

- "short-term" or "interim"
- Better to focus on why you’re monitoring rather than how long
- "long-term"
## Why Monitor?

**Remedy-Specific Monitoring**

**Primary Remedy Functions**

<table>
<thead>
<tr>
<th><strong>MNR</strong></th>
<th><strong>CAPPING</strong></th>
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<tbody>
<tr>
<td>Chemical transformation</td>
<td>Physical isolation</td>
<td>Sediment and contaminant removal</td>
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<tr>
<td>Chemical sequestration</td>
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<td>Reduce contaminant mass in sediment</td>
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<tr>
<td>Physical isolation (natural sedimentation and burial)</td>
<td>Creation of a clean sediment surface</td>
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<td>Offsite transport</td>
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## Why Monitor?

Remedy-Specific Monitoring

### Example Monitoring Needs

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<tr>
<td>- Validate CSM</td>
<td>- Validate construction</td>
<td>- Validate construction and mass removal</td>
</tr>
<tr>
<td>- Reduced contaminant availability</td>
<td>- Future performance concerns:</td>
<td>- Evaluate surface sediment concentrations</td>
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<tr>
<td>- Ongoing transformation processes</td>
<td>- Demonstrate cap stability, long-term isolation</td>
<td>- Validate backfill</td>
</tr>
<tr>
<td>- Ongoing sedimentary processes</td>
<td>- Cap surface recontamination potential</td>
<td>- Future performance concerns:</td>
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<td>- Sediment/residuals stability and natural recovery</td>
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<td>- Geochemical stability</td>
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<td>- Sediment stability</td>
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**Why Monitor?**

Remedy-Specific Monitoring

**Example Monitoring Needs**
What’s the Problem?

- Public and industry uncertain of effectiveness and long-term stability of remedies.
- Need for the development of improved methods for assessing ecosystem recovery at contaminated sediment sites to better understand the impact of remedial management strategies on the ecosystem.
- Need for guidance that standardizes long-term monitoring methods and approaches and which supports the Navy policy on sediment investigations and response actions (CNO, 2002).
- Several resources identify general monitoring needs and approaches for sediment sites and specific details concerning monitoring tools.
  - No current framework that links remedy-specific and goal-specific monitoring needs with appropriate monitoring tools and approaches.
Sediment Monitoring Resources:
Approaches, Needs, Tools

- USEPA. 2005. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures; Endrin; Dieldrin; and PAH Mixtures.*
Matching Monitoring Tools with Monitoring Needs

- Abundance of tools and approaches, but finite resources
- Monitoring tool considerations for selection:
  - Baseline monitoring tools
  - Capability to satisfy more than one monitoring need or serve as additional/supplementary line of evidence
  - Suitability under site conditions
  - Cost
  - Availability in marketplace
  - Spatial experimental design/results complexity
  - Temporal experimental design/results complexity
  - Logistical concerns
  - Efforts needed to interpret results and share with stakeholders
  - Ability to address monitoring need with low uncertainty
What’s (part of) the Solution?

1. Develop a framework that links remedy-specific and goal-specific monitoring needs with appropriate monitoring tools and approaches.

2. Develop Web-Tool
   - Guidance - provide remedy-specific recommendations for sediment monitoring programs.
   - Online, interactive web-tool - help RPMs focus on key issues associated with site-specific monitoring needs and facilitate a comparison of effective monitoring tools.
1. Develop Framework

Linking Remedy-Specific Monitoring Phases to Monitoring Needs and Tools

**Figure 2.** Illustration of the temporal relationships between monitoring associated with capping. Callout boxes provide examples of monitoring needs associated with post-remedy monitoring phases.
2. Interactive Sediment Remedy Assessment Portal (ISRAP)

- On-line web-tool
  - Guidance
  - Interactive matrix of monitoring needs and tools
  - Case Studies
  - Publicly accessible
  - Updatable

- REMEDIES
  3 (Capping, Dredging, MNR)

- MONITORING PHASES
  3 (Construction, Performance, Remedial Goal; as appropriate to each remedy)

- MONITORING NEEDS*
  24 unique needs

- MONITORING TOOLS*
  44 unique classes of tools or individual tools
  * One tool can often address multiple monitoring needs and/or can supplement other tools.
Welcome

Welcome to the Interactive Sediment Remedy Assessment Portal (ISRAP), an online interactive portal to assist in understanding monitoring requirements and monitoring tools associated with sediment remediation. The main feature of this site is the sediment monitoring tools matrix, a database of sediment monitoring tool information to facilitate the design and optimization of sediment monitoring programs. The matrix can be browsed in a step-by-step mode by selecting "Matrix" via the toolbar at the left. For first-time users, a Frequently Asked Questions (FAQ) link is provided, and contains a tutorial and other resources that provide a functional overview of the matrix design and navigation, as well as a short primer to understanding sediment remediation monitoring needs and tools. The "Guidance" link in the toolbar at left provides the full, in-depth guidance document (pdf file) that supports the work showcased in the ISRAP.

Quick Links

- NAVFAC Environmental Restoration
- EPA Contaminated Sediment
- NOAA Benthic Habitat Mapping
- Hazardous Waste Clean-Up Information (CLU-IN)
- Navy Eco Risk Guidance
INTERIM GUIDANCE DOCUMENT
August 2007

Long-Term Monitoring Strategies for Contaminated Sediment Management

Space and Naval Warfare Systems Center San Diego
and
ENVIRON International Corporation

Draft Document
Not Approved for Release
(Funded by 2817 Pollution Assessment Studies Program)
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Naval Station Alpha Cap Entire Site

1. Remediation Phase
   - Select Remedial Action
     - Capping
     - Dredging
     - Monitored Natural Recovery

2. Monitoring Need

3. Monitoring Tool

4. Monitoring Design

NEXT
<table>
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<th>Monitoring Need</th>
<th>Description</th>
<th>Timing</th>
<th>Frequency</th>
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<tr>
<td>Cap stability</td>
<td>Assess settlement and stability of cap over time</td>
<td>Weeks-years after cap placement or after damaging events</td>
<td>Every 1-5 years</td>
</tr>
<tr>
<td>Chemical flux through cap</td>
<td>Assessment of chemical flux through the cap</td>
<td>After cap placement</td>
<td>Every 1-5 years</td>
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<tr>
<td>Impacts on hydrodynamics and sediment transport</td>
<td>Assessment of the physical impacts of the cap on hydrodynamics and sediment transport</td>
<td>After cap placement</td>
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### Gap stability - Assess settlement and stability of cap over time

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<th>Special Considerations</th>
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<td>Bathymetric survey</td>
<td>Bathymetric survey of capping area to detect changes in cap thickness and stability over time</td>
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### EPA Fact Sheet

2.2.1-13

http://www.csc.noaa.gov/benthic/mapping/techniques/sensors/subbottom profiling

### Special Considerations

- May not work in cases where cap is capping sediment with respect to grain size and consistency
- Side scan sonar (e.g., side scan sonar) may be more accurate
- Sidescan capability (e.g., vane shear tests)
- Sidescan that may damage cap
- Sidescan that may damage cap
- Study design may be difficult due to site

### Internet

Benthic Habitat Mapping

Mapping Techniques: Acoustics

- Sub-bottom Profiling
- Side-scan Sonar
- Echosounder
- Bathymetry Surveys

Sub-bottom Profiling

Sub-bottom profiling systems identify and measure various sediment layers that exist below the sediment-water interface. These acoustic systems use a technique that is similar to simple echosounders. A sound source emits a signal vertically downwards into the water and a receiver monitors the return signal that has been reflected off the seafloor. Some of the acoustic signal will penetrate the seabed and be reflected when it encounters a boundary between two layers that have different acoustical properties (acoustic impedance). The system uses the reflected energy to provide information on sediment layers beneath the sediment-water interface.

Acoustic impedance is related to the density of the material and the rate at which sound travels through the material. When there is a change in acoustic impedance, such as the water-sediment interface, part of the transmitted sound is reflected. However, some of the sound energy penetrates through the boundary and into the sediments. This energy is reflected when it encounters boundaries between deeper sediment layers having different acoustic impedance. The system uses the energy reflected by these layers to create a profile of the sub-bottom sediments.

Several sonar parameters (output power, signal frequency, and pulse length) affect the instrument performance:

- An increase in output power gives better penetration into the sub-bottom layers. This will usually provide deeper penetration into the sub-bottom layers. Sometimes however, if the bottom is very hard or not very deep, the increase in power will cause more signal to be reflected back off the seafloor. The signal might then be reflected off the sea surface, leading to multiple reflections and “noise” in the data.
- Signal frequency also has an effect on system performance. Higher frequency systems (2 to 20 kHz) will produce high definition data of the upper seafloor-sediment layers. These higher frequency signals have shorter wavelengths, and they are able to discriminate between layers that are close together. Lower frequency systems will have greater penetration but at a lower resolution.
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### Capping > Compliance (Performance)

| Monitoring Need | Monitoring Tool | Tool Type | Spatial Complexity | Temporal Complexity | Logistical Complexity | Difficulty Locating in Market | Relative Cost | Required Interpretation Expertise | Uncertainty Addressing Need | Design Details |
|-----------------|-----------------|-----------|--------------------|---------------------|----------------------|------------------------------|----------------|-------------------------------|--------------------------|----------------|---|
| Cap stability   | Acoustic sub-bottom profiling | Physical | Low                 | Low                 | Medium               | Low                          | Medium         | Low                           | Uncertainty Addressing Need | Accurate method for assessing cap when cap materials differ from underlying sediment |
| Cap stability   | Bathymetric survey | Physical | Low                 | Medium              | Low                  | Low                          | Medium         | Low                           |                         |                       |
| Cap stability   | Cap sample physical analysis | Physical | Low                 | Medium              | Low                  | Low                          | Low            | Medium                        |                         |                       |
| Cap stability   | Sediment coring   | Physical | Medium              | Medium              | Low                  | Low                          | Low            | Low                           | Medium                   |                       |
| Cap stability   | Sediment profile photography | Physical | Medium              | Medium              | Medium               | Medium                       | Medium         | Low                           | Medium                   |                       |
| Cap stability   | Sediment surface photography | Physical | Medium              | Medium              | Medium               | Low                          | Medium         | Low                           | High                     |                       |
| Cap stability   | Settlement plate  | Physical | Medium              | High                | Medium               | Low                          | Medium         | Low                           | Medium                   |                       |
| Cap stability   | Side scan sonar   | Physical | Low                 | Medium              | Medium               | Low                          | Medium         | Low                           | Medium                   |                       |

**Design Details**

- Uncertainty Addressing Need: Indicates the method for addressing uncertainty in the design.
Capping > Compliance (Performance)

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ISRAP Transition

- Modifications & Review
  - ISRAP Modifications
  - Internal Review
  - External Peer Review

- Revisions
  - Review Comments
  - Revise ISRAP
  - Prepare for Transition

- Transition & Release
  - Transition ISRAP to NFESC ERT2
  - Public Release
  - RITS
  - Publications

Summer 08  Fall 08  Spring 09
Challenges Ahead

- How to improve cost estimation?
  - Incorporation of cost ranges for tools/classes of tools.
- How to develop achievable exit criteria?
  - Examples from other sites
  - Guidance for specific remedies
e.g. DoD MNR Guidance
  Provides examples on the translation of RAOs to measurement endpoints and success criteria.
Summary

- Many standard and novel monitoring tools available
  - One tool can often address multiple monitoring needs and/or can supplement other tools
  - Consider monitoring tools used during RI/FS
  - Carefully consider DQOs in monitoring tool selection and monitoring design
    - Strive to define success criteria that relate to RAOs (DQO Step 6, Establish Management Decision)

- The remedy-specific approach described in the guidance document is intended to:
  - Provide a systematic framework for designing and selecting monitoring alternatives
  - Increase consistency among (Navy) sites and decrease uncertainties