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# Sediment Transport Tools to Evaluate Physical Stability and Natural Recovery Potential

***Technical POCs***: Code 2362, 619-553-5753
Code 2362, 619-553-5333,
Code 2362, 619-553-5255,
***Management POC***: Code 236, 619-553-5403,

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San Diego, California 92152-5001


# Objective

- Provide Remedial Project Managers (RPMs) with a framework to characterize the fate and transport of contaminated sediments using a reliable set of measurement technologies and analysis techniques

- Provide RPMs information to support an improved evaluation of remedial alternatives at contaminated sediment sites that includes a sediment fate and transport assessment


# Navy EQ Regulatory Requirement

**N-0020-02 Sediment Transport Dynamics, Ranked 99.9% by the RAW**

**1.III.02.n Improved Characterization and Monitoring Techniques for Sediments (High priority)**

**1.I.02.b Improved Marine Sediment/Dredge Spoil Remediation and Decontamination (High priority)**

**1.I.01.j Improved Remediation of Sites using Natural Attenuation (Medium priority)**


# Problem Statement/Drivers

- >223 Contaminated Sediment Sites w/ **projected remediation cost of $1.3B** *.
- Many sites lack accurate and defensible information regarding sediment transport – may result in **unnecessary removal or treatment actions**
- Failure to contain or remove contaminated sediments may lead to a larger contaminant footprint, movement of sediments off-site, or **increased future clean-up costs**

* From 1.III.02.n - Improved Characterization and Monitoring Techniques for Sediments


# Problem Statement/Drivers

- The mechanisms that control sediment transport are **complex** and **variable**, therefore a sediment dynamics assessment is essential for evaluating fate and transport of contaminated sediments

- **Lack of practical guidance** for RPMs to perform a sediment dynamics assessment for use in both characterization and remediation studies

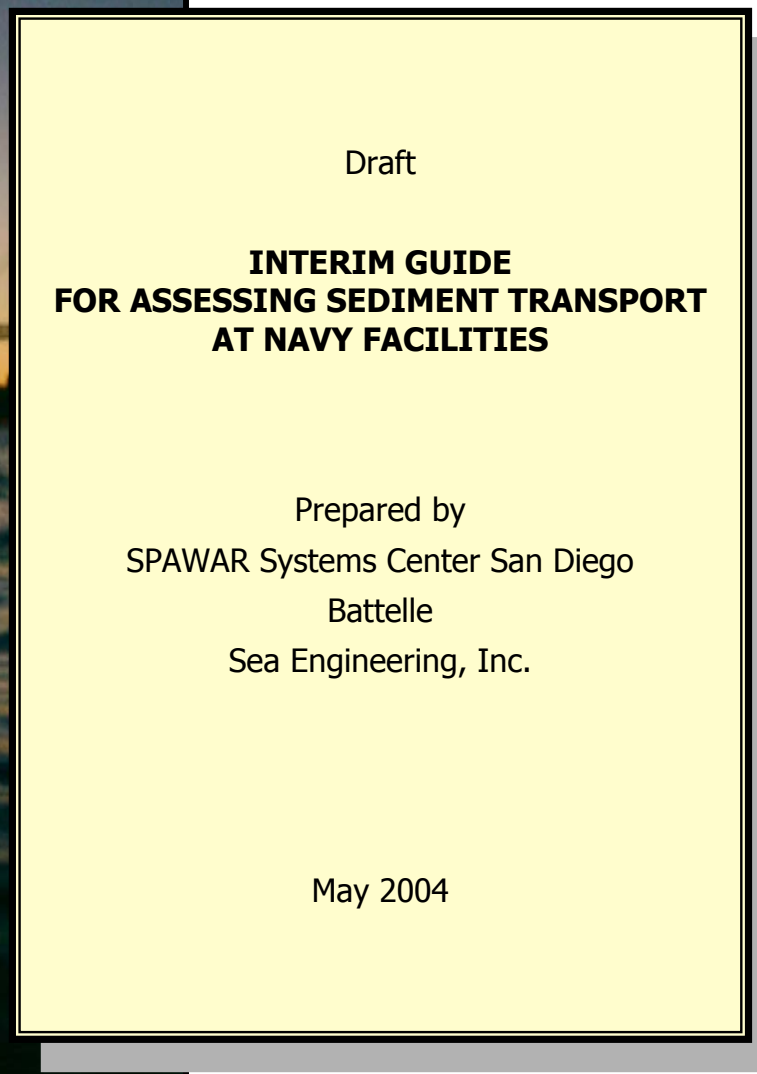

# Approach

- **Sediment Transport User's Guide** – conceptual model, initial site evaluation, technology selection, data analysis (Interim and Final)
- **Remedy Selection** - In-place and/or combination
- **Demonstration Sites and Case Studies**
- **Incorporation of demonstrated innovative technologies into Final User's Guide**


# Technology Description

- Phase I: **User's Guide** (Interim and Final)
  - Survey of available methods and tools
  - Development of a framework for prioritizing methods/tools for potential use at a site
  - Review of innovative tools for evaluating sediment transport
- Phase II: **Field Demonstration**
  - Application of the developed framework at a demonstration site to incorporate into the Guide
  - Evaluation of innovative technologies

# User's Guide




- Interim guide will satisfy short-term user requirements. A draft is completed and in review by RAW users
- Final guide will incorporate lessoned learned from field demonstrations


# User's Guide

## ❖ Identified User Questions:

- Could sediment transport lead to the exposure of previously buried contaminants?
- Could sediment transport lead to the burial and isolation of contaminants?
- Could sediment transport lead to the redistribution of contaminants within the site or lead to the movement of contaminants off-site?
- Could sediment transport act as a pathway for recontamination of the site from off-site materials?

# User's Guide

- **TIER I:** Addresses the most common sediment management questions using readily available data from the Remedial Investigation (RI). Data needs are simple, but uncertainties are greater.

| Parameter | Tier 1 Data Needs | Tier 2 Data Needs | Why do you measure this? |
|---|---|---|---|
| **Site Characteristics** | | | |
| Water body configuration and bathymetry (current and historical) | Maps, NOAA bathymetric charts, aerial photographs, and other available regional and site-specific data (current and historical) | • Detailed bathymetric survey - single or multi-beam mapping systems<br>• Shoreline surveys<br>• Side scan sonar | • A basic level of bathymetric, topographic, and historical information is needed to characterize a site because physical boundaries often define the relevant zone of influence.<br>• A bathymetric/shoreline change analysis can yield information on long-term depositional or erosional characteristics of the system (sediment sources and sinks) and help quantify rates of change. |
| Contaminant source identification; horizontal and vertical distribution of sediment contaminants | Sediment chemistry data as collected for the RI | High resolution horizontal and vertical sediment contaminant distribution data | • If contaminant source(s) and loading history are known, then sediment transport patterns can be inferred from the horizontal and vertical contaminant distribution.<br>• Sediment contaminants can act as a tracer for the transport of contaminants away from the site, or to identify potential off-site sources contributing to sediment contamination. |
| Anthropogenic activities (historical, current and future) | Information on outfalls, dredging, navigation, planned construction activities, future use, watershed changes | N/A | The influence of anthropogenic activities must be taken into account during a sediment transport analysis |
| **Water Column Properties** | | | |
| Waves, tides, and currents; salinity and temperature | Available regional or site-specific data | • Detailed site-specific current measurements (S4, ADV, ADCP, PC-ADP, velocimeters)<br>• Tide and wave measurements (pressure sensors, ADCP wave array, S4)<br>• Salinity and temperature profiles (in estuaries) | • The dominant hydrodynamic forces should be identified and quantified because they drive sediment transport. When combined with suspended sediment measurements, directions and quantities of sediment transport can be described.<br>• Analysis of water column transport properties is necessary for the determination of sediment flux on/off site and for determining settling properties of sediments. |
| Suspended sediment concentrations | Water quality data from USGS or local regulatory agencies | Site-specific measurement of suspended sediment concentrations (OBS, LISST, transimissometer, and/or analytic TSS samples) | Knowledge of the quantity and character of suspended solids is necessary to calculate the flux of suspended sediments on/off site and to determine sedimentation rates. |

- **TIER II**: For large or complex sites that require a higher degree of certainty. Site-specific data collection is usually necessary and complex data analysis methods may be warranted.

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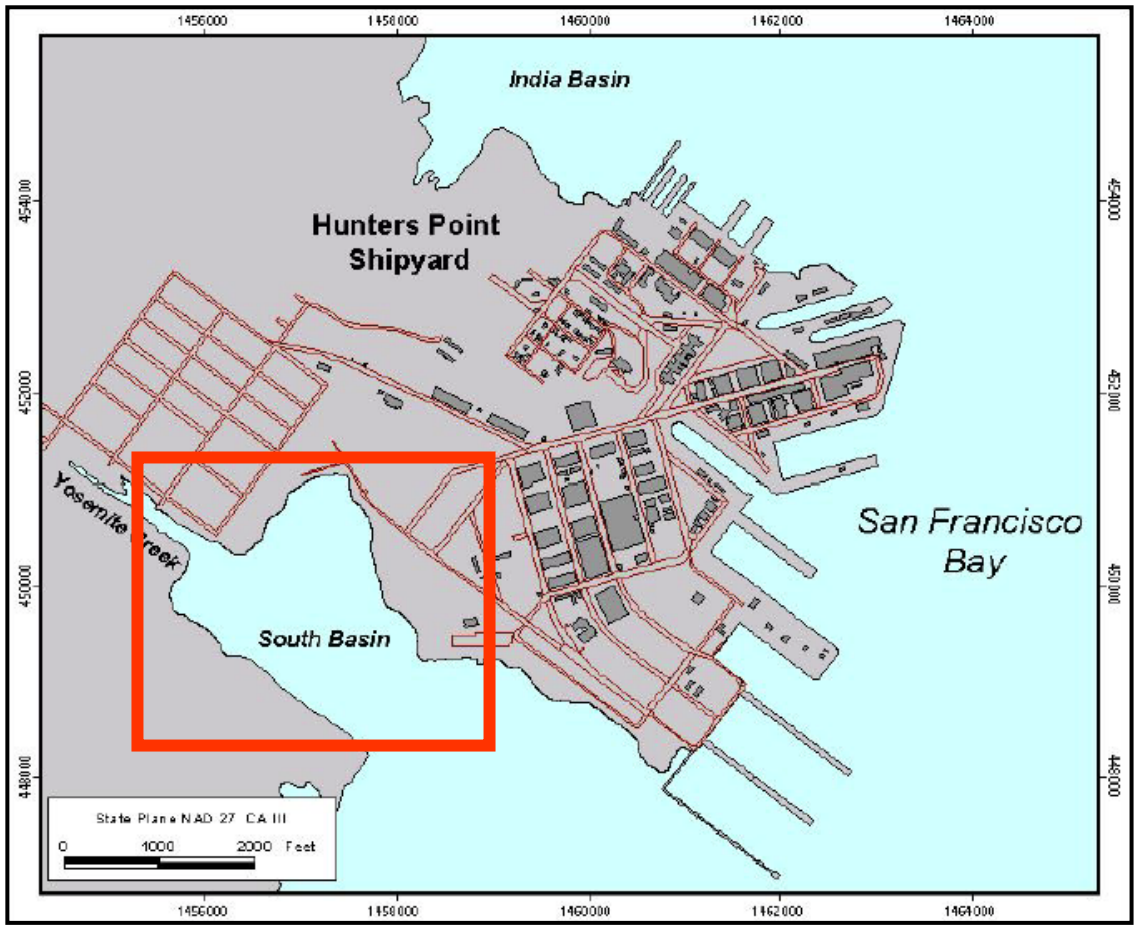
# Hunter's Point Field Demonstration




- Water column meas. (currents, waves, ssc)
- Sediment chemistry
- Sediment stability analysis
- Radioisotope age-dating

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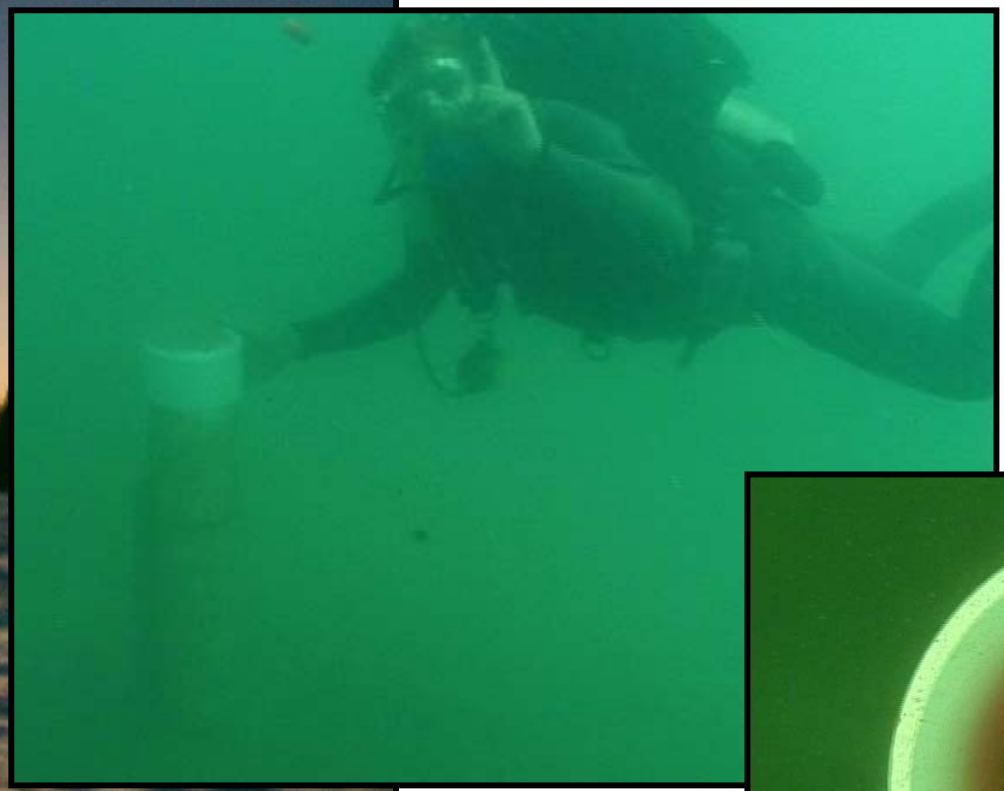
# Hunter's Point Field Demonstration

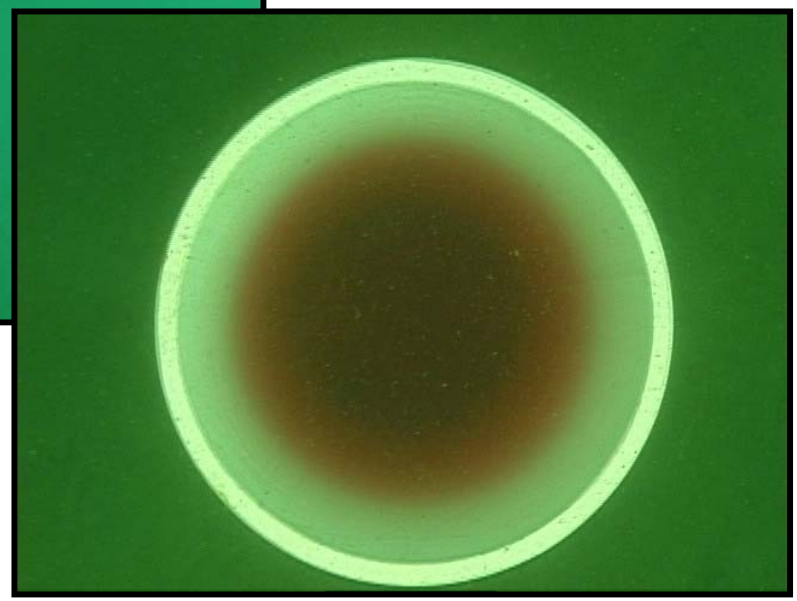
## Sediment Trap Analysis

- Sediment traps characterize the rate of sediment deposition and quality of incoming sediment
  - Could sediment transport lead to the burial and isolation of contaminants?
  - Could sediment transport act as a pathway for recontamination of the site from off-site materials?

# Hunter's Point Field Demonstration



- Deployments in Winter (Oct-Feb), Spring (Feb-May) and Summer (July-Sept) to characterize seasonal changes



*A dense brine layer (dyed with rhodamine) traps sediments in the bottom of the instrument*

# Hunter's Point Field Demonstration

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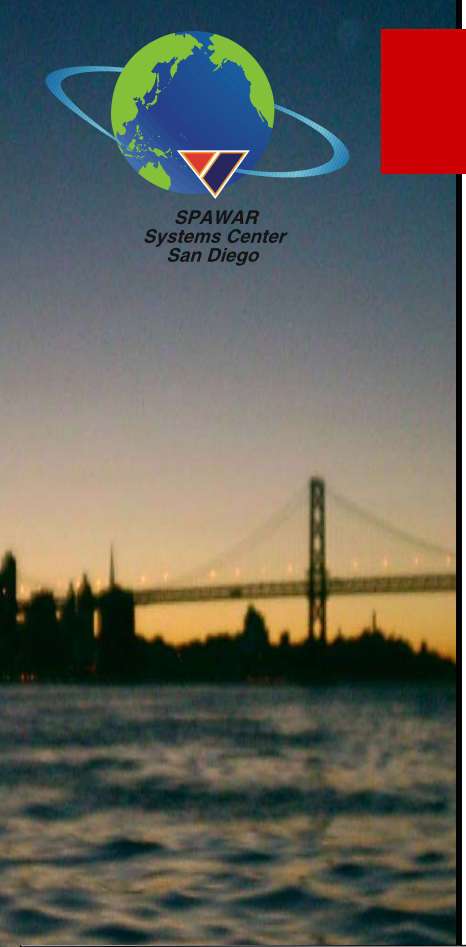

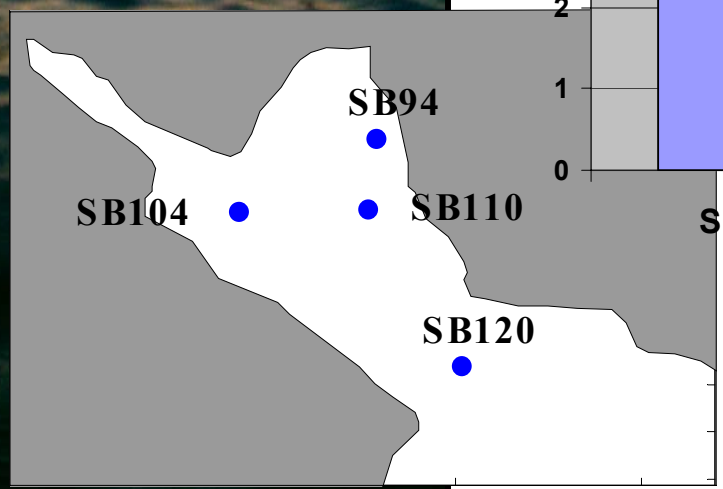


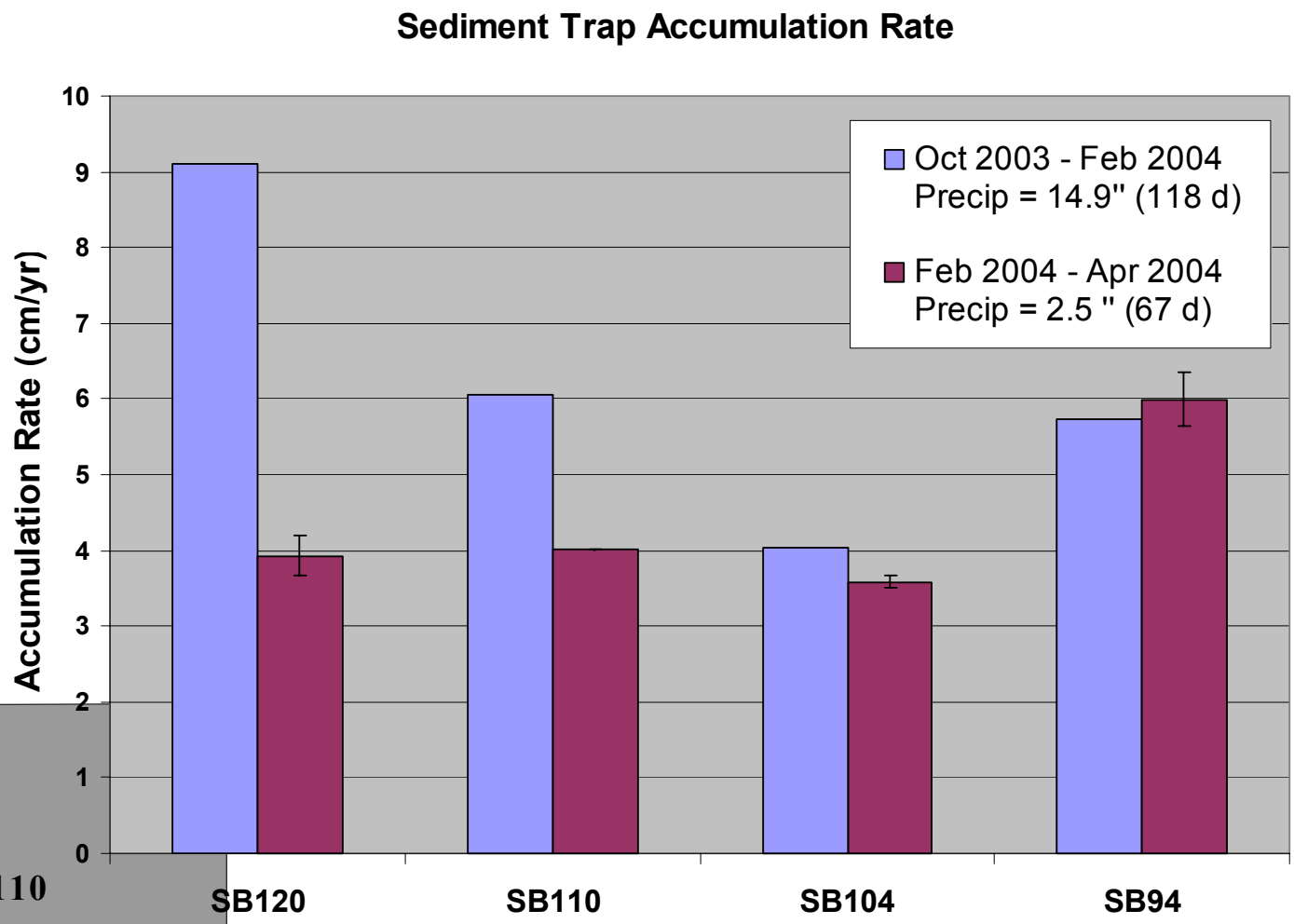


- Initial results indicate that rates are seasonally dependant

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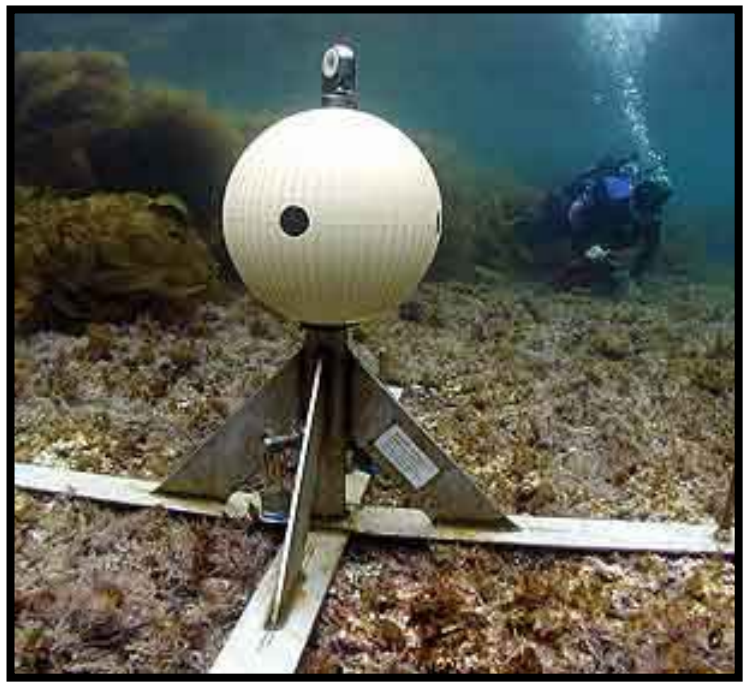
# Hunter's Point Field Demonstration

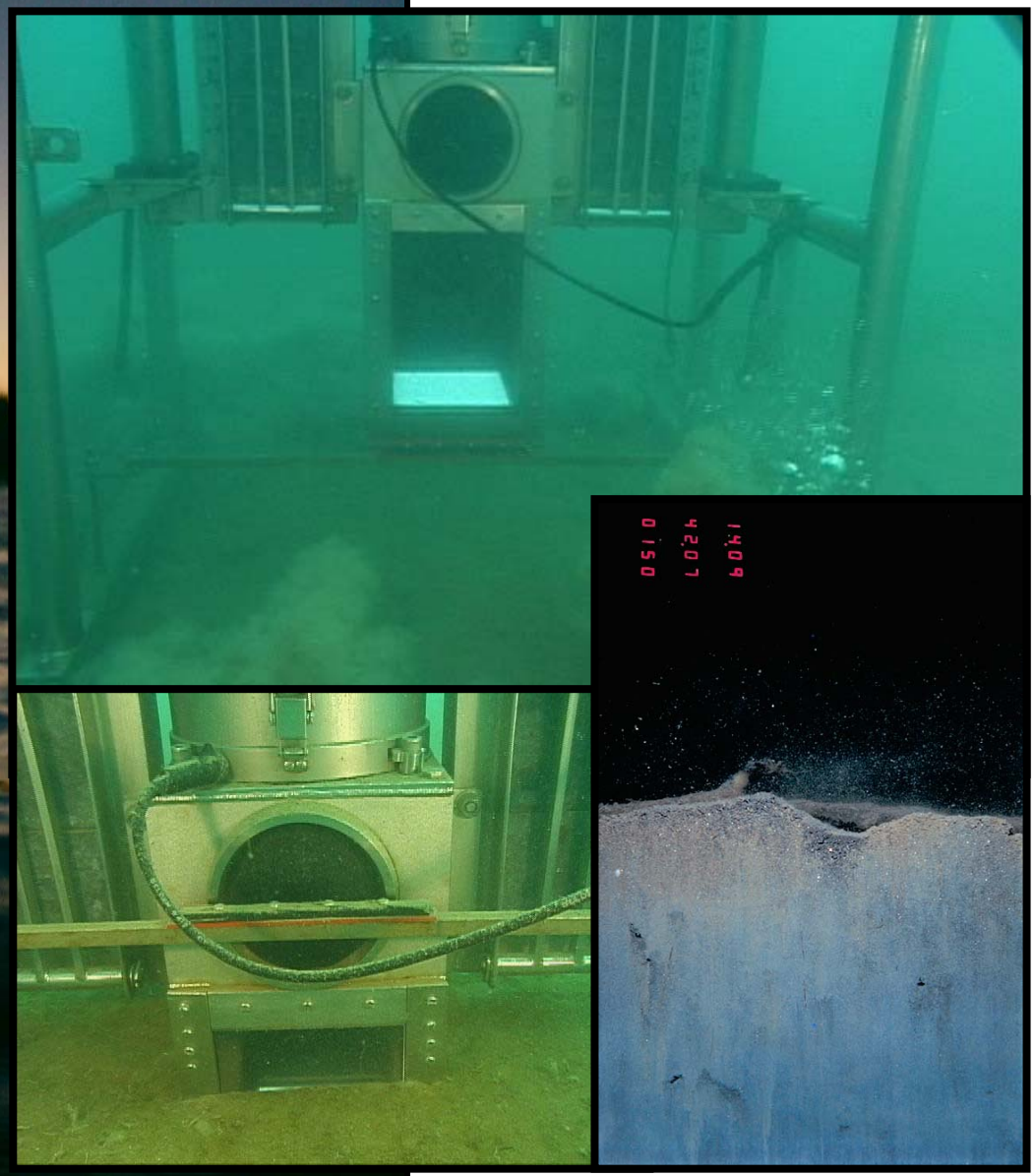

*OBS-3A*

Additional instrumentation, including the OBS-3A (left) and S4 current meter (below) have been deployed



*InterOcean S4 Current Meter*

# Hunter's Point Field Demonstration



## Sediment Profile Imaging (SPI)

A wide variety of physical and biological parameters can be measured, including:

- Grain size
- Evidence of erosional or depositional environments
- Presence of epifauna
- Depth of bioturbation

# Hunter's Point Field Demonstration

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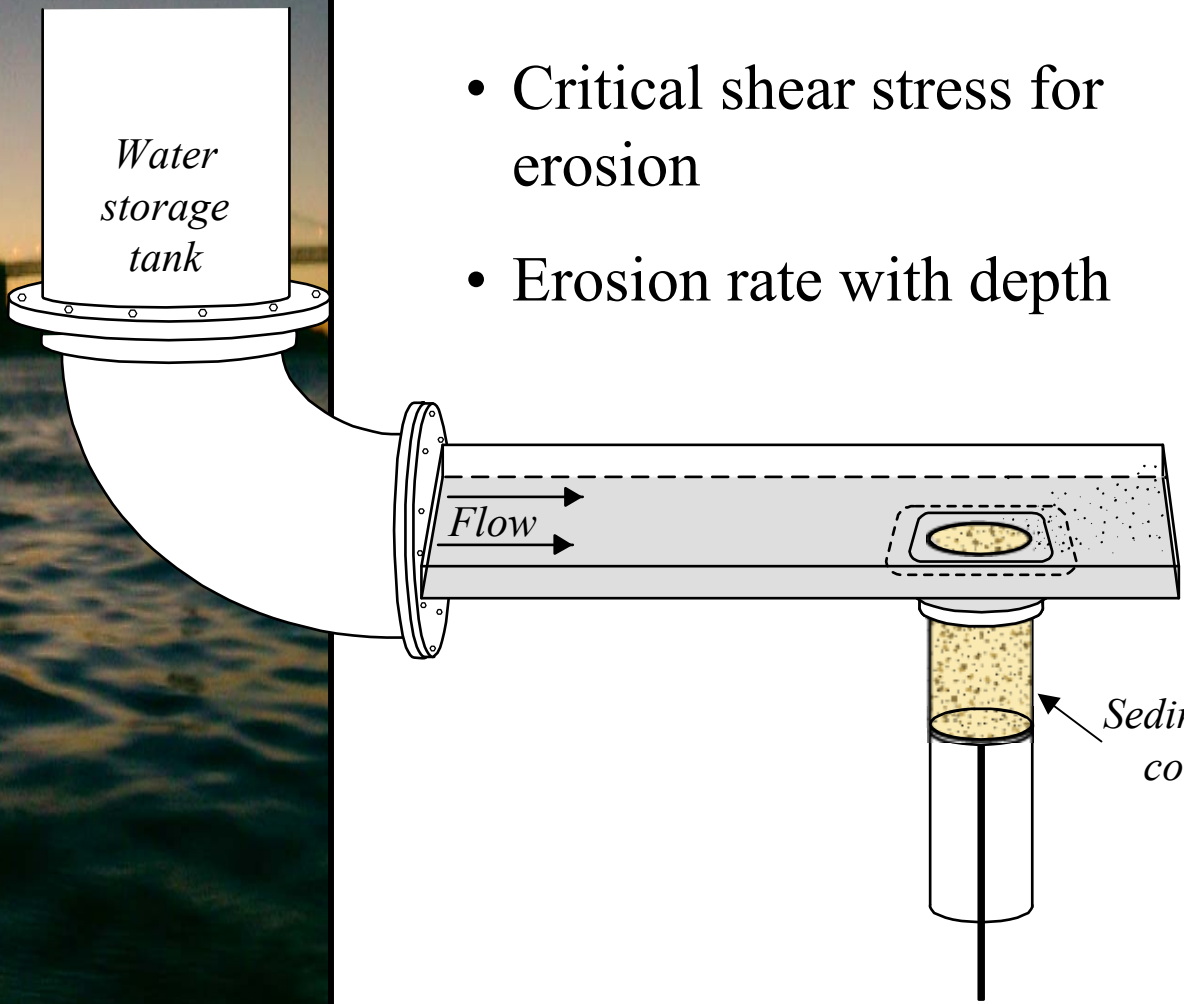
## Sedflume

- Critical shear stress for erosion
- Erosion rate with depth





# Benefits/Payback of New Technology

- Identification and use of **appropriate** and **cost-effective** sediment transport technologies and methods
- More **complete** site characterizations, **improved** evaluation and selection of sediment remedial alternatives, and ultimately more **cost-effective** cleanups.
- Implementation and more **effective** long-term monitoring programs at sediment sites.


# Return on Investment (ROI)

**Assumptions/Estimates**:

- Total Projected Cost for Dredging: $1.3B for 223 sites → > $5.8M per site
- Estimated $500K for Transport Study at each Site $500K * 223 = $111.5M
- $500K per site for Long-term Monitoring program at sites using natural attenuation
- $5.8M per site for remaining number of sites requiring dredging

# Return on Investment (ROI)

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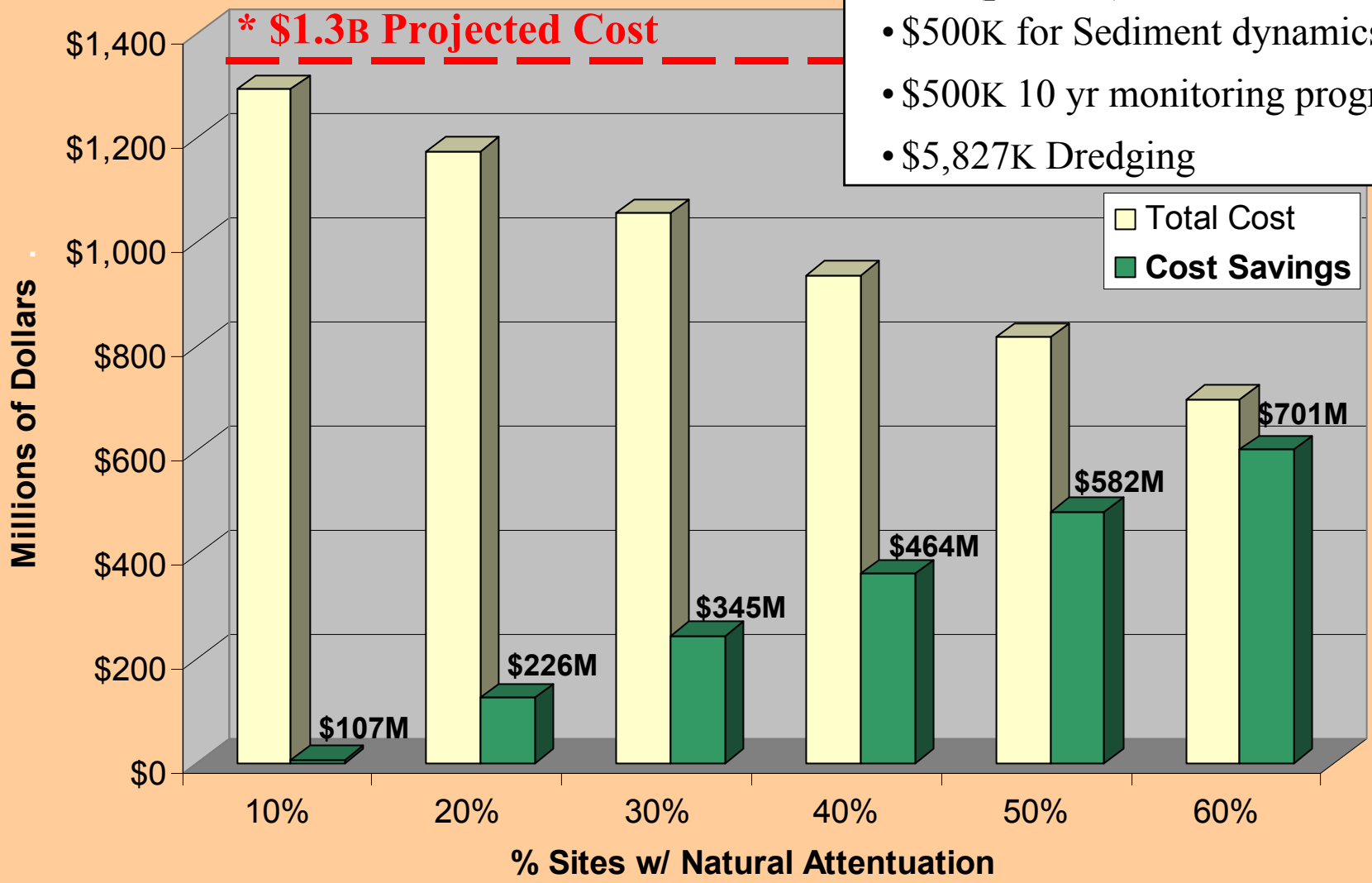
Costs (per site):

- $500K for Sediment dynamics
- $500K 10 yr monitoring program
- $5,827K Dredging



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# Milestones and Major Deliverables

| | | FY03 | | | | FY04 | | | | FY05 | | | | FY06 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MILESTONES** | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| **1** | Phase I: Planning & technology/method evaluation | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **2** | Select Sites for Phase II Demos | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **3** | Interim User's Guide | | | | | | | | | | | | | | | | |
| | Literature review of technologies | | | | | | | | | | | | | | | | |
| | Development of Sed. Trans. Matrix | | | | | | | | | | | | | | | | |
| | Development of Tier I/II analyses | | | | | | | | | | | | | | | | |
| | Review of Interim User's Guide | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **4** | Conduct Phase II Demonstration | | | | | | | | | | | | | | | | |
| | Field Demo 1 | | | | | | | | | | | | | | | | |
| | Analyze Demo 1 Results | | | | | | | | | | | | | | | | |
| | Field Demo 2 | | | | | | | | | | | | | | | | |
| | Analyze Demo 2 Results | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| **5** | Final Users Guide | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |


# Project Coordination

**Technical Collaboration**:

- Patty White, Battelle
- Craig Jones, Sea Engineering Inc.
- Joseph Germano, Germano & Assoc.
- G. Jon Groves, Computer Sciences Corporation (CSC)

**Other Project Coordination**:

- Risk Assessment Workgroup (RAW)
- Hunter's Point Project Team (Michael Pound et al.)
- Y0817 Project In-place Contaminated Sediment Management


# Technical Accomplishments to Date

- Literature review of measurement and modeling methods
- Development of a Physical Sediment Transport Framework
- Development of an Interim User's Guide
- Phase II Field Demonstration Site 1: Hunter's Point Shipyard


# Implementation Plan

- Implementation through the **RAW functional working group**
- **Remedial Project Managers** (RPMs) and their technical support staff and contractors at contaminated sediment sites
- The User's Guide would be readily available via the **internet**, and would be introduced and described to potential users in **conference presentations**, appropriate **newsletters**, and **technical meetings**
- Potential for a **RITS seminar and Web Tools**

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# Logic Model for Sediment Transport Tools

| | |
|---|---|
| Navy Benefits | • Results in more complete site characterizations, improved evaluation and selection of sediment remedial alternatives and cheaper and more protective cleanups. |
| Customer Capability | • Allows RPMs to select appropriate and cost-effective technologies for assessing sediment transport. |
| Products | • Sediment Transport User's Guide |
| Project Milestones | 1. Phase I planning and technology evaluation (Q4, FY03)<br>2. Select Sites for Phase II Demos (Q3, FY03)<br>3. Interim Users Guide (Q3, FY04)<br>4. Conduct Phase II Demo (Q2, FY06)<br>5. Final User's Guide (Q4, FY06) |


# Sediment Transport Tools

## Goal

- Identify, document and demonstrate methods that can be utilized by Remedial Project Managers (RPMs) to characterize the fate and transport of contaminated sediments

## Benefits

- Helps RPMs identify and use **appropriate** and **cost-effective** technologies and methods for assessing sediment transport.

- Results in more **complete** site characterizations, **improved** evaluation and selection of sediment remedial alternatives, and ultimately more **cost-effective** cleanups.


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# ROI Calculation

| | 10% | 20% | 30% | 40% | 50% | |
|---|---|---|---|---|---|---|
| $1,300.00 | **$1,300.00** | **$1,300.00** | **$1,300.00** | **$1,300.00** | **$1,300.00** | **$1,300.00** |
| | | | | | | |
| $0.69 | $0.69 | $0.69 | $0.69 | $0.69 | $0.69 | $0.69 |
| $5.83 | | | | | | |
| | | | | | | |
| $0.50 | $11.50 | $11.50 | $11.50 | $11.50 | $11.50 | $11.50 |
| $0.50 | $11.15 | $22.30 | $33.45 | $44.60 | $55.75 | $66.90 |
| $5.83 | $1,169.38 | $1,039.45 | $909.52 | $779.59 | $649.66 | $519.72 |
| | | | | | | |
| | $1,192.72 | $1,073.94 | $955.16 | $836.38 | $717.60 | $598.81 |
| | **$107.28** | **$226.06** | **$344.84** | **$463.62** | **$582.41** | **$701.19** |

- Calculations are made based on an estimated cost for remediation of 223 contaminated sediment site of $1.3B (Navy Environmental Quality Research, Development, Testing and Evaluation (RDT&E) Requirement, Improved Characterization and Monitoring Techniques for Sediments, 1.III.02.n)