

# REMEDICATION OF CONTAMINATED SEDIMENT SITES

## OVERVIEW OF REMEDIAL OPTIONS



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## THE NEXT WAVE IN CLEANUP: WHY SEDIMENTS? WHY NOW?



- **End of Pipe = The End of the Road for Contamination.**
- **Non-Point Source Pollution has Finally Caught Up with Us.**
- **Out of Site, Out of Mind (Until It Starts Showing Up in Our Fish).**
- **It's Expensive! – (But Can No Longer be Ignored...).**
- **Infrastructure Repair Cycle is Here!**

## TOPICS



- **Format**
- **References and Sources**
- **Planning**
- **Setting**
- **Types of Projects**
- **Key Considerations**
- **Remedial Technologies**
- **Regulations**
- **O&M**
- **Implementation**
- **Evaluation**

## PRESENTATION FORMAT

- Key considerations for selection:**
  - **Marine**
  - **Lacustrine**
  - **Riverine**
- Regulatory Framework**
- O&M**
- Issues With Implementation**
- How To Evaluate Success**



## DEFINITIONS

**A word about waterways definitions.**

- **Common Definitions:**

- Environmental Bucket
- Dredge-pack
- Water Quality
- Resource Area
- Monitored Natural Recovery
- Bioremediation
- Over-dredge
- Dewatering
- Wind-rows



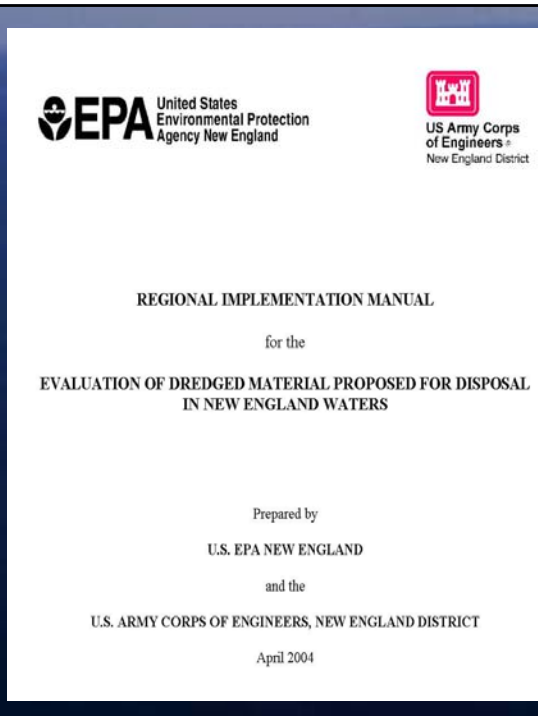
## REFERENCES & INFORMATION SOURCES

- USEPA (Sediment Management Document)
- USACE
- States / Regulations
- Other



## HELP SOURCES

- **Regional Implementation Manual (RIM)**
- **A joint Army Corps & USEPA document for Sediments.**



## “Green Book” & COMM-94



United States Environmental Protection Agency  
Office of Water (OW-06)




**Evaluation of Dredged Material Proposed for Ocean Disposal**  
Testing Manual

Address: Assistant 3  
Technical Director  
In/Technology  
Download PDF

**Interim Policy #COMM-94-007: Sampling, Analysis, Handling & Tracking Requirements for Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills**

*Approved by Thomas P. Powers, Acting Commissioner on February 15, 1995.*

Note: Transportation of dredged sediments to a landfill must be accompanied by a DEP Material Shipping Record (MSR).

**1.0 INTRODUCTION**

This policy is intended to streamline the review and approval process for dredged sediments proposed to be reused or disposed at Massachusetts permitted landfills. All references to landfills in this policy mean Massachusetts permitted landfills operated in compliance with Department of Environmental Protection (Department, DEP) regulations and policies. Reuse means beneficial use of sediments as daily cover, intermediate cover and pre-cap contouring material. Disposal means burial in a landfill. References to lined landfills mean landfills which have a DEP approved, functioning liner with a leachate collection system.

## ADDITIONAL INFORMATION SOURCES

### USEPA

Dredging Operations Technical Support Program Guidance Documents

<http://el.erdc.usace.army.mil/dots/guidance.html>

Evaluation of Dredged Material Proposed for Ocean Disposal

<http://www.epa.gov/owow/oceans/gbook/gbook.pdf>

New Sediment Decontamination Technology Shows Promise (1999)

<http://yosemite.epa.gov/opa/admpress.nsf/7144dd430c47561885257018004c77a3/d32359e97fd9dd2e85257245005ba4a1!OpenDocument>

EPA's Contaminated Sediment Management Strategy (1998)

<http://www.epa.gov/waterscience/cs/stratndx.html>

Selecting Remediation Techniques for Contaminated Sediment (1993)

<http://www.epa.gov/waterscience/cs/library/remediation.pdf>

Evaluating Environmental Effects of Dredged Material Management Alternatives (1992)

<http://www.epa.gov/owow/oceans/>

## ADDITIONAL INFORMATION SOURCES

### USEPA (cont.)

Contaminated Sediments: Relevant Statutes and EPA Program Activities (1990)

<http://www.epa.gov/waterscience/cs/library/statutes.pdf>

An Overview of Sediment Quality in the United States (1987)

<http://www.epa.gov/waterscience/cs/library/overview.pdf>

### USACE

Beneficial Use of Dredge Material (2009)

<http://el.erdc.usace.army.mil/dots/budm/budm.cfm>

Regional Implementation Manual (RIM) Evaluation of Dredged Material Proposed for Disposal in New England Waters - (2004)

<http://www.nae.usace.army.mil/reg/regionalimplementationmanual.pdf>

Engineering and Design - Environmental Engineering for Coastal Shore Protection (1989)

<http://140.194.76.129/publications/eng-manuals/em1110-2-1204/toc.htm>

## ADDITIONAL INFORMATION SOURCES

### State/Regulations

**314 CMR 9.00: 401 Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Material Disposal in Waters Within the Commonwealth - June 2009**

<http://www.mass.gov/dep/water/laws/regulati.htm#wqual>

**310 CMR 9.00: The Massachusetts Waterways Regulations (Chapter 91) - June 2009**

<http://www.mass.gov/dep/water/laws/regulati.htm>

**310 CMR 30.00 Hazardous Waste Regulations relating to Dredged Material**

<http://www.mass.gov/dep/recycle/laws/regulati.htm>

**Managing Hazardous Wastes**

<http://www.mass.gov/dep/recycle/laws/policies.htm>

**Interim Policy # COMM-94-007 - Interim Policy for Sampling, Analysis, Handling and Tracking Requirements for Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills (1995)**

<http://www.mass.gov/dep/recycle/laws/dredge.pdf>

## FRAMEWORK PROCESSES



- Superfund
- RCRA
- State Cleanup / Regulation Enforcement
- Brownfields
- Navigational Dredging
- Infrastructure Improvement
- Stormwater / CSO
- Resource Recovery  
(i.e., weed removal, etc.)



## PLANNING

- **Environment Type Considerations:**
  - Natural, Anthropogenic, or Mixed
  - Marine / Ocean
  - Freshwater:
    - Stream / River
    - Pond / Lake
    - Wetland
    - Vernal Condition
  - Estuarine (Fresh-Water / Marine)
    - Tidal River
    - Salt Marsh
    - Delta



The slide features two inset images. The top image is an aerial view of a city with a river and a bridge. The bottom image is a sunset over a body of water with a small orange light on the horizon.

## WHY IS IT IMPORTANT TO PLAN?

- Achieve Goals
- Avoid Costly Mistakes
- Lasting Success

Case Law Supports: In many New England states Contractors can declare "*Changed Conditions*" for any volume change greater than 20% of that estimated in the Specifications – allowing contractors to completely re-price, even after the project is complete.



## PROJECT TYPES: (Settings)

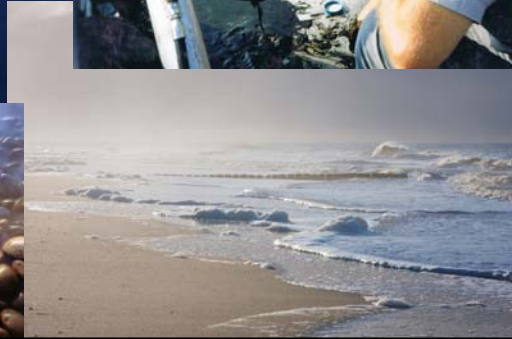
- Ocean
- Estuary
- Salt Marsh
- Port
- Harbor
- Beach
- Bank
- Stream / River
- Pond
- Lagoon & Industrial Pond
- Raceway





## TYPES OF SEDIMENTS

- High Energy Regimes
- Moderate Energy Regimes
- Low Energy Regimes
- Grain Size / Character:
  - Sands and Silts
  - Organic Silts
  - Ooze (Muds)
  - Gravel / Cobbles



## Know Your Bottom !!!

- Is It:
  - Muddy / Clayey / Peaty
  - Sandy
  - Gravelly
- Check It:
  - Probes / Samples
  - Geophysics



## TRANSPORT MECHANISMS: (Regimes)

- Settling (Depositional)
- Moving Water (Depositional to Erosional)
- Swift Water (Erosional)
- Tidal



## CONTAMINANTS



- Volatile Organic Compounds (VOCs)
- Poly Aromatic Compounds (PAHs)
- Oils and Petroleum Products
- PCBs
  - Aroclors
  - Congeners
- Dioxins
- Metals
  - NOAA List
  - RCRA List
  - Other Parameters
  - Worrysome Pervasive Species (Lead, Arsenic, Cadmium, Chromium, Copper, etc.)
- A Note about the difference between delineation/remedial parameters and disposal parameters.

## TYPES OF SITES / PROJECTS

### (Small, Medium, Large)

#### ■ Parameters:

- Areal Extent
- Volume of Material
- Water Depth
- Type of Contaminants
- Remedial Process
- Regulatory Process



#### ➤ In General:

- Small Projects - less than a couple thousand cubic yards, State/Local permitting with minimal federal permits, and simple remedial process;
- Large projects – hundreds of thousands to millions of cubic yards, Superfund or similar process, complex remedial process;
- Everything in between.

## KEY CONSIDERATIONS FOR SELECTION OF REMEDIAL TECHNOLOGIES

- Volume
- Response of Contaminant(s) to Remedial Technologies
- Contaminant Dispersion:  
(Parse into water?)
- Dewatering Requirements
- Transport Logistics
- Disposal Requirements
- Site Logistics (Lay-down area)
  - Dewatering
  - Disposal



## KEY CONSIDERATIONS FOR SELECTION OF REMEDIAL TECHNOLOGIES



❖ **Realistic GOALS** should be developed after careful consideration of all Site Characteristics.

### What information is needed from Site Characterization?:

- Volume/Volume/Volume = Important!!
- Tolerances = Important in Contracting!
- Extent (Area)
- Contamination Profile (Mixed or Single)
- Type of Sediment
- Acceptable Residuals
- Technology Performance (Destruction Efficiency)
- Water Depth and Flow Regime
- Physical Logistics Movement Constraints
- Resources that may be Impacted
- Water Quality Goals
- Other Logistics

## TYPES OF REMEDIAL TECHNOLOGIES

- No Action
- Monitored Natural Recovery
- Removal (Dredging)
  - Issues:
    - Wind Rows
    - Tolerances
    - Methods
      - Mechanical
      - Hydraulic
      - Mud Pig
      - Rhinoceros
    - Dewatering



## TYPES OF REMEDIAL TECHNOLOGIES (Cont.)

### ❖ Dredging Disposal Issues:

- Open Ocean Disposal: No or Low Contaminants
- Upland Disposal Options:
  - Untreated (Usually Landfill)
  - BUD (Beneficial Reuse)
  - Landfill (Cap / Fill)
  - Excitu Treatment and Disposal or Reuse



## TYPES OF REMEDIAL TECHNOLOGIES (Cont.)

### ❖ Dredging Disposal Issues:

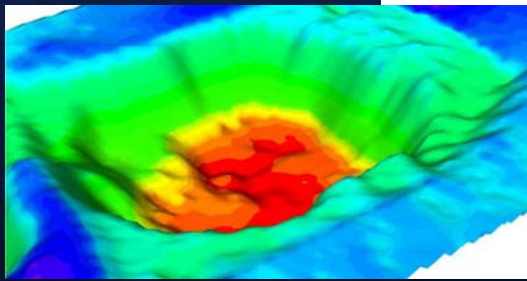
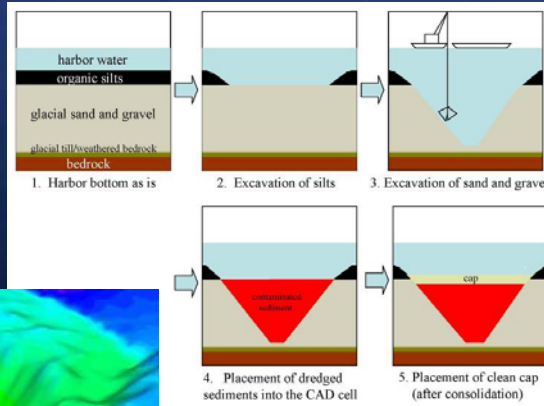
- Upland Disposal Options:
  - Stabilization (Cement / Lime)
  - Solidification



## TYPES OF REMEDIAL TECHNOLOGIES (Cont.)

### ❖ Dredging Disposal Issues:

- In-Water Disposal Options:
  - CAD Cells\*



**\* Confined Aquatic Disposal Cells**

## TYPES OF REMEDIAL TECHNOLOGIES (Cont.)

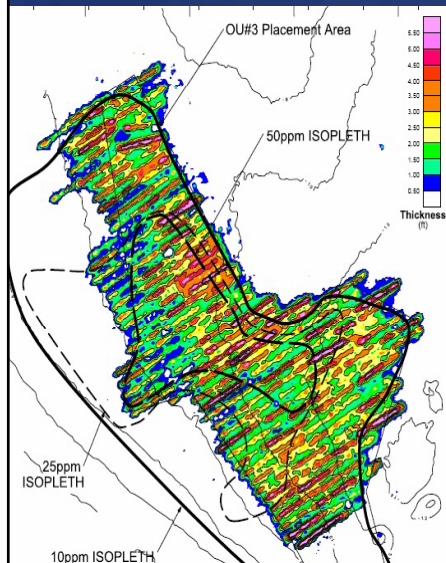
### ❖ Dredging Disposal Issues:

- Waters Edge Disposal Options:
  - CDF's\*
    - Lined
    - Unlined
    - Treated
    - Untreated



**\* Confined Disposal Facilities**

## TYPES OF REMEDIAL TECHNOLOGIES (Cont.)



### ➤ Capping:

- With Dredging (sand caps, gravel / rip rap caps of Residuals)
- No Dredging (sand caps, gravel / rip rap caps)



## Tour de France of Disposal Options

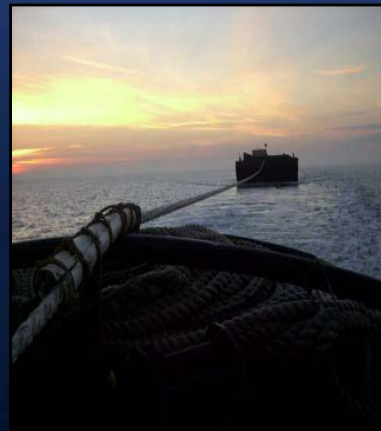
### In-Water Options

#### “CLEAN”:

- Offshore = “Clean” = match chem. profile with dump site.
- Beach/Wetland Nourishment = Additional permitting needed, material match required.

#### “SLIGHTLY” CONTAMINATED:

- Capped Offshore = Special approvals *and* need cap material.



## **Tour de France of Disposal Options** **Contaminated - Upland Options**

- **Upland Landfill** = \$\$\$ and No Salt.
- **Upland Staged Reuse Facility** =
  - ❖ Chem. Profile must match.
- **Upland Beneficial Reuse as Fill**
  - ❖ With Treatment if can't match Contaminant Profile
  - ❖ With Amendment if can match.
  - ❖ "Farmed" for dry-out.
- **Upland Beneficial Blending**
  - ❖ With Asphalt
  - ❖ As Fertilizer



## **TYPES OF REMEDIAL TECHNOLOGIES (Cont.)**

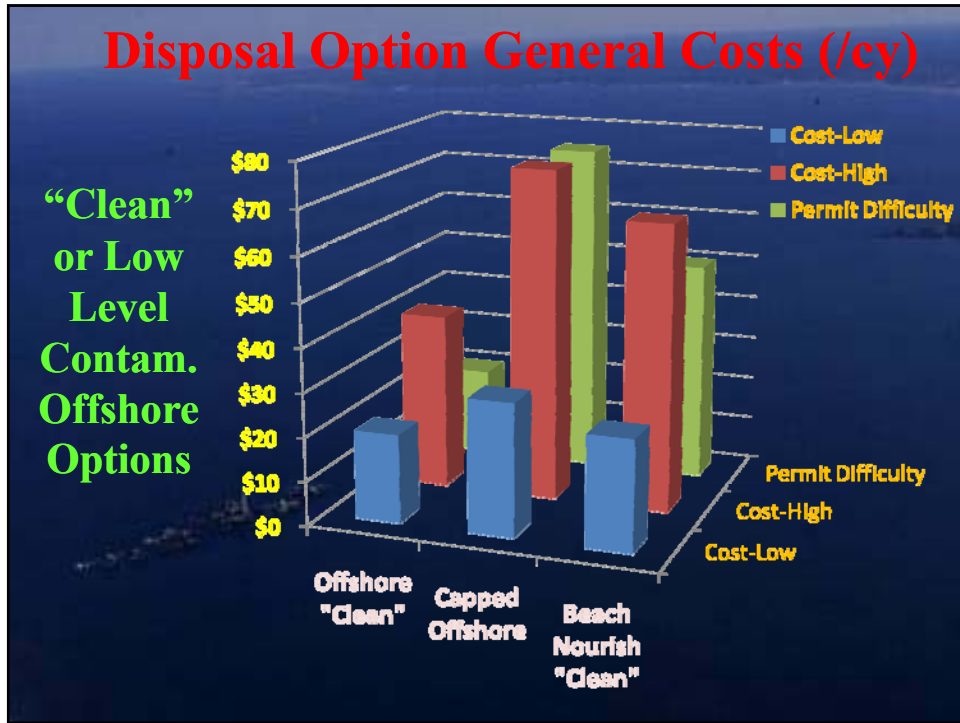


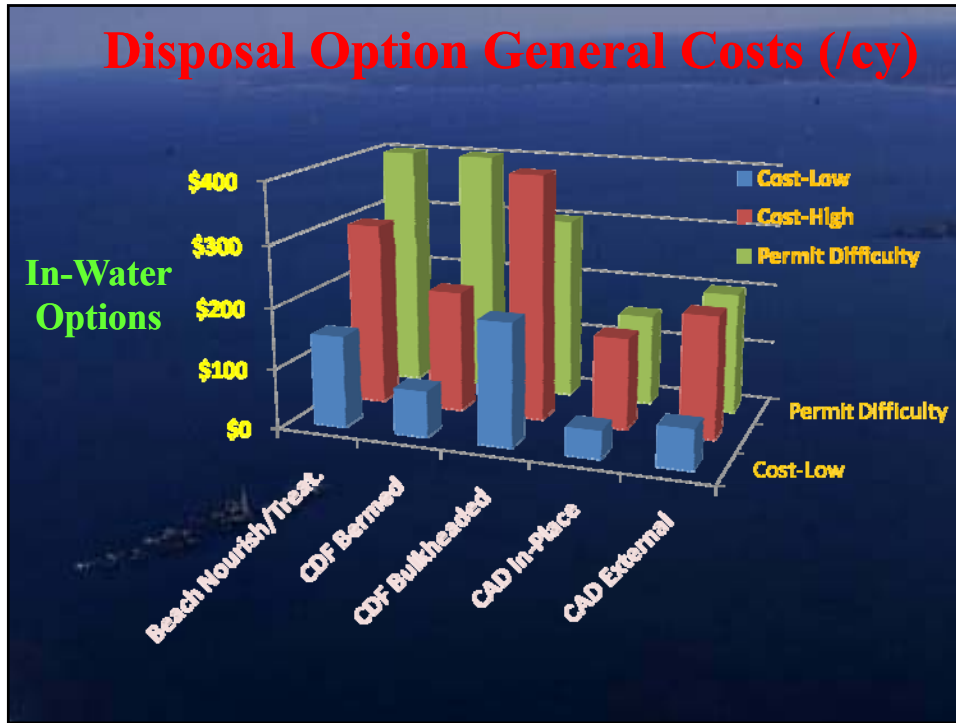
- **In-situ Treatment**
  - "Pixie Dust"
  - Fluidized Treatment
  - Solidification / Stabilization



- **Bio-Remedial Technologies:**
  - Phytoremediation
  - Wetlands Filtration







## REGULATORY CONSIDERATIONS

- **Permits!**
  - Will be required in one form or another.
  - Move resources (shellfish) before start?
  - Water Discharge Permits NPDES?
  - Resource Monitoring?
- **Regulatory Interface / Permits = things to consider...**
  - ✓ BUD use = may require permits for the “receiving” facility.





## REGULATORY CONSIDERATIONS (Cont.)



- **Regulatory Interface / Permits = things to consider (cont.)**
  - CAD Cells → need to get rid of “clean sand”
  - CDF’s → filled land → may need separate permit (like pulling #@%^ to get approval for filling)
- **Resource Agencies**
  - Fish, Shellfish, Mammals, Birds, Reptiles, Amphibians, Wetlands
- **Cultural / Archaeological Resources**

## O&M CONSIDERATIONS

- **Erosion**
- **Sedimentation**
- **Residual Contaminants**
- **Movement of Sediment**
- **Dispersion / Dissolution into water**
- **Resource Uptake**
  - plants / animals
  - populations both sedimentary and transient
- **Continuing Sources**



## IMPLEMENTATION ISSUES



- **Working “Blind”**  
(Underwater - Can't see what doing)
  - Testing = Surveys/ SSS / Sub-bottom/ Probes/ Samples.
- **Need to Monitor:**
  - Water Quality
  - Sediment Movement
  - Biota
- **Measuring Against Goal**
- **Depth of Removal**
  - Over-dredge Tolerances
- **Thickness of Cap**
- **Laydown Area Logistics**
- **Disposal Site Logistics**

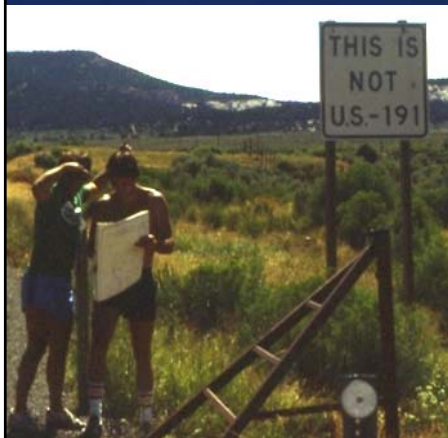
## HOW TO EVALUATE SUCCESS

- **Comparison with Standards**
- **Surveys**
- **Sampling**
- **Long-Term Water and Sediment Monitoring**
- **Biotic Monitoring**
- **Mass Removal**
- **Disposal Site / Treatment**
- **Thickness of Cap**
- **Integrity of Cap**
- **Repopulation**
  - Capped and Uncapped Areas



## QUESTIONS?

## CONFUSED?



### CONTACT INFORMATION:

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## ADDITIONAL INFORMATION: REGULATORY SAMPLING FOR SEDIMENT REMEDIATION

- The following slides present excerpts from a previous presentation on sampling for sediment characterization for remediation.



## SAMPLE COLLECTION CONSIDERATIONS

- **Physical Parameters - Sediment:**

- Think about the Reason for Data Need
  - Remediation
  - Dredging (need construction parameters such as ripability)
  - Ecological Restoration Dredging or Filling
  - Capping
  - Material Sorting
- Type of Information Needed
  - Visual Description
    - Color, Organic Content, Grain Size, Density, Liquid Content, Cohesion, Odor, Evidence of Contamination
  - Analytical Parameters
    - Grain Size, Density, Moisture Content, TOC, Compressibility



## SAMPLE COLLECTION CONSIDERATIONS (Cont.)

- **Chemical Parameters - Sediment:**

- What are Reason for Data Need
  - Remediation
  - Capping
  - Dredged Material (DM) Disposal
  - Material Sorting
- Type of Information
  - Chemical Content of Sediment
  - Contamination in Sediment
  - Leachability
- Level of Data Called For
  - Field Screening
  - Field Laboratory Analysis
  - Certified Laboratory Analysis



## SAMPLE COLLECTION CONSIDERATIONS (Cont.)

### Water Quality

- Reason for Data Need
  - Environmental Assessment
  - Design
  - Remediation
  - Construction Monitoring
  - Post-Remediation Monitoring
  - Long Term Monitoring
- Type of Information
  - Water Clarity / Sediment Load
  - Water Chemistry
  - Contamination (Chemical or Biological)
- Level of Data Need
  - Field Screening = Construction Monitoring
  - Field Laboratory Analysis = Characterization
  - Certified Laboratory Analysis = Design



## SAMPLE COLLECTION CONSIDERATIONS (Cont.)

- Biological
  - Reason for Data Need
    - Risk Assessment
    - Remediation / Capping
    - Dredge Project Disposal / Monitoring
    - Ecological Monitoring
  - Type of Information
    - Species Present
    - Numbers and Counts
    - Contamination in Biota
    - Bioaccumulation
  - Level of Data Need
    - Field Counts
    - Field Analysis
    - Certified Laboratory Analysis



## SAMPLE COLLECTION CONSIDERATIONS (Cont.)

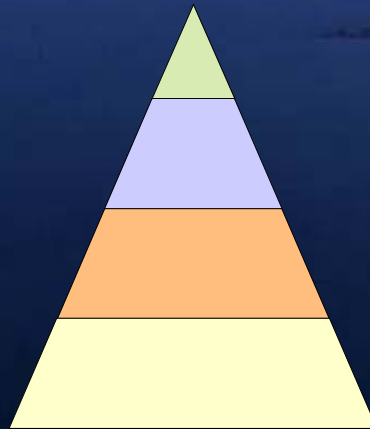
- **Biological**

- Needed for Permitting
- **DO NOT Assume you will not need Biological sampling just because you are cleaning up contaminated sediments!!**



## EXAMPLE TIERED TESTING APPROACH - RIM

- Successive levels of investigation with increasing effort & complexity;
- Generates information to evaluate proposed disposal of dredged materials in open water; and
- Optimizes resources by focusing on potential impacts from marginal projects (not those where adverse impacts are clear)





## TIERED TESTING APPROACH - RIM

- Tier I – Evaluate existing information and identify contaminants of concern.
- Tier II – Water column and potential Bioaccumulation Analyses (based on Sediment Chemistry Data)
- Tier III – Toxicity and Bioaccumulation Testing
- Tier IV – Long-term Bioassays & Bioaccumulation. Tests, Risk Evaluations and other case-specific testing / evaluations



## TIER III – WATER COLUMN EVALUATIONS

- If Tier II chemical testing is inconclusive, water column bioassays are run.
- Evaluate potential toxicity of dissolved and suspended components of dredge material after discharge
- Expose fish and pelagic crustaceans (mysid shrimp) for 96 hrs. and planktonic invertebrate larvae for 48 hrs. to dilution series.



## TIER III – WHOLE SEDIMENT TOXICITY TESTS

- Benthic evaluation of toxic response after deposition of dredge material
- Amphipod and non-amphipod species selected based upon marine / estuarine vs. freshwater
- Observe Mortality, biological activity, physical-behavioral abnormalities.



## TIER III – BIOACCUMULATION TESTING

- Benthic evaluation of exposure to deposit-feeding animals to bioavailable contaminants.
- Selected bivalve and polychaete (marine) or oligochaete (freshwater) species are exposed over a 28-day period to dredging site, reference, and control sediments.
- Followed by tissue extraction and analytical testing for metals and organic contaminants of concern.

