Considerations for Environmental Dredging of Contaminated Sediments

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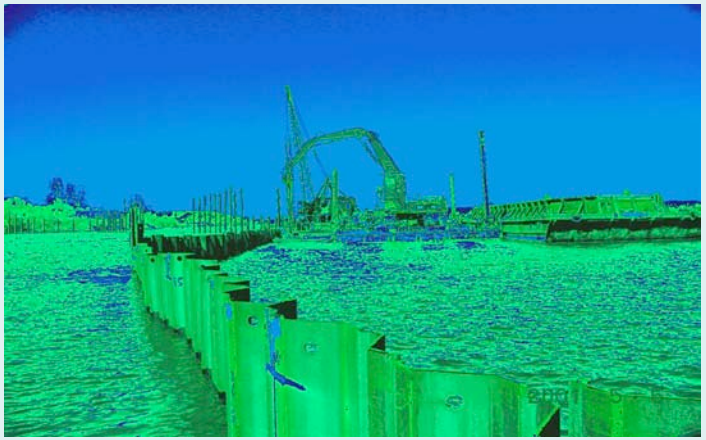
Outline

- Objectives, Definitions
- Site/ Sediment Characterization
- Removal Requirements
- Equipment Characteristics and Selection Factors
- Production and Duration
- Resuspension, Release, and Residual
- Control Measures
- Operational Considerations
- Monitoring and Management
- Conclusions

Contaminated Sediment Remediation What are the Options?

- Monitored Natural Recovery
  - Part of all remedies
  - May be an integral part of active remediation
- **Dredging**
  - Need to recognize impacts and limitations
  - Triggers a variety of onshore activities
- Capping
  - Can be rapidly implemented with minimal impact
  - Need to assess long-term protectiveness
- Combinations



Navigation versus Environmental Dredging

- Navigation to maintain depth
  - Economy/Efficiency
  - Effectiveness
  - Environmental Impact
- Environmental for Remediation
  - Environmental Impact
  - Effectiveness
  - Economy/Efficiency

Dredging and Disposal

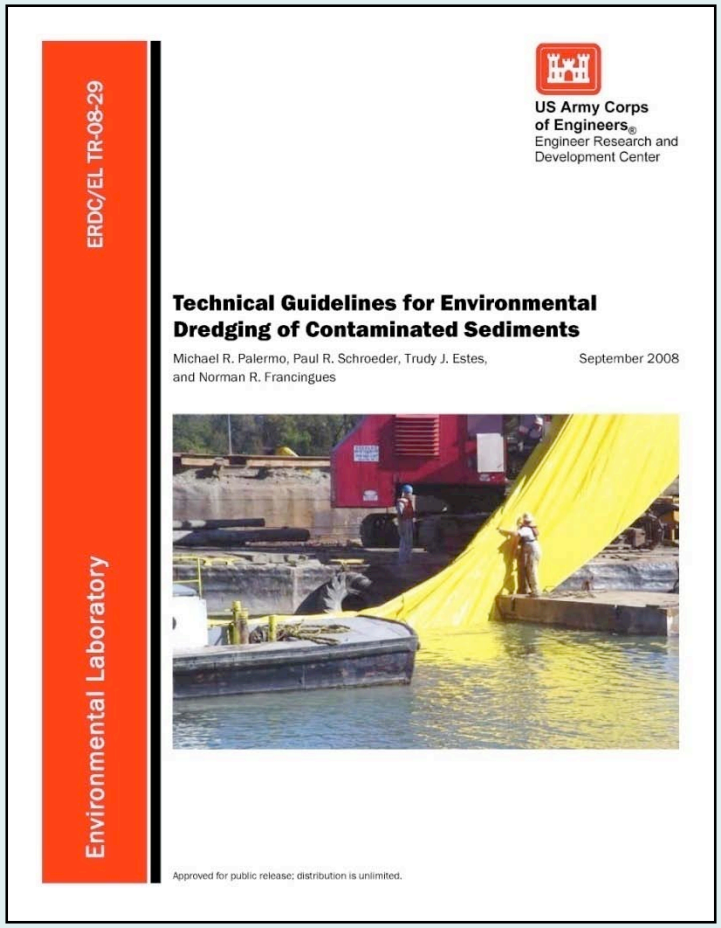
- Advantages
  - Mass removal
  - Proven technology
  - Easily implemented
- Disadvantages
  - Effectiveness reduced by resuspension and release
  - Effectiveness reduced by residual
  - Disposal is expensive

Objectives of Environmental Dredging

- Achieve Remediation Goals
- Remove Targeted Sediments within Horizontal and Vertical Tolerances
- Control Sediment Resuspension, Contaminant Release, and Residual Sediment
- Maintain Production/ Efficiency of Removal
- Assure Compatibility with Treatment and/or Disposal

"Technical Guidelines for Environmental Dredging of Contaminated Sediments"

- Developed for EPA by USACE
- Detailed technical evaluation procedures for Env Dred
- Supports EPA 2005 Superfund Sediment Guidance
- Audience: Project managers, designers, contractors, and other stakeholders
- Published September 2008 http://el.erdc.usace.army.mil/elpubs/pdf/trel08-29.pdf


ERDC/EL TR-08-29

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Technical Guidelines for Environmental Dredging of Contaminated Sediments

Michael R. Palermo, Paul R. Schroeder, Trudy J. Estes, and Norman R. Francingues

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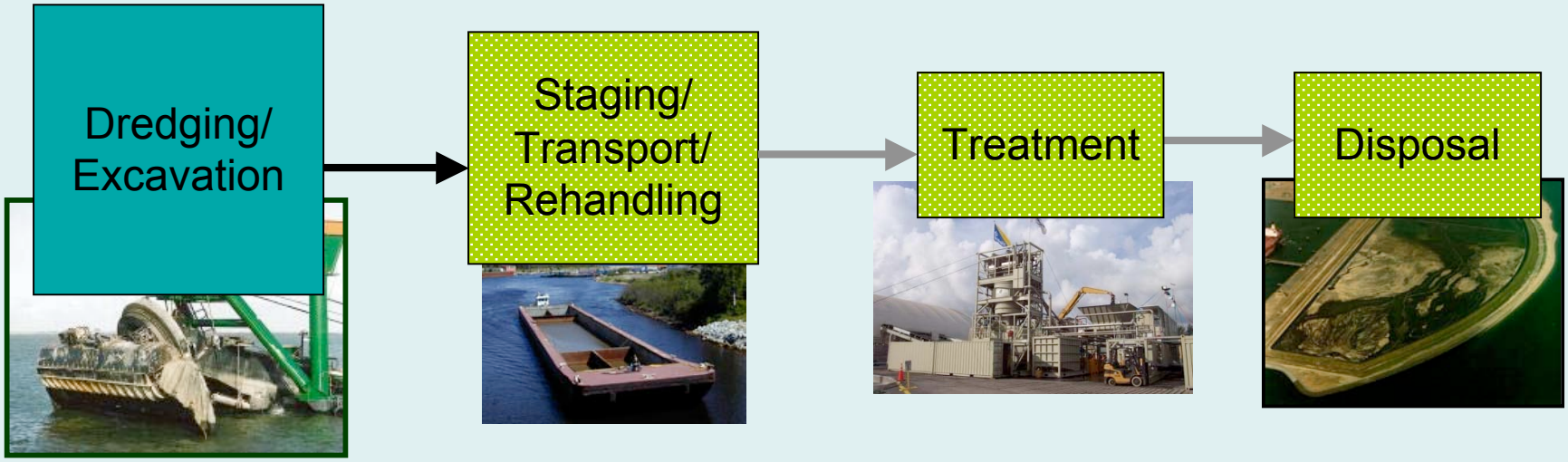
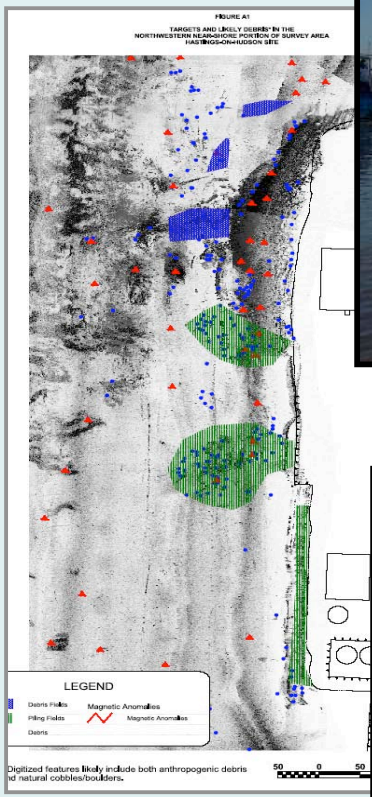
Approved for public release; distribution is unlimited.

Dredging is only one part of a remedy



Site Conditions and Sediment Characterization

- Site Conditions (Field Investigations)
  - Hydrodynamics; Geotech; Bathy; SS Sonar; Sediment Profiling; Infrastructure; etc.;
- Sediment Characteristics (Sampling)
  - Physical – density, GSD, etc.;
  - Chemical – Conc of COCs to full depth;
- Define Dredgeability and Removal Requirements
  - Debris removal; Dredging depths; volumes and volume increases



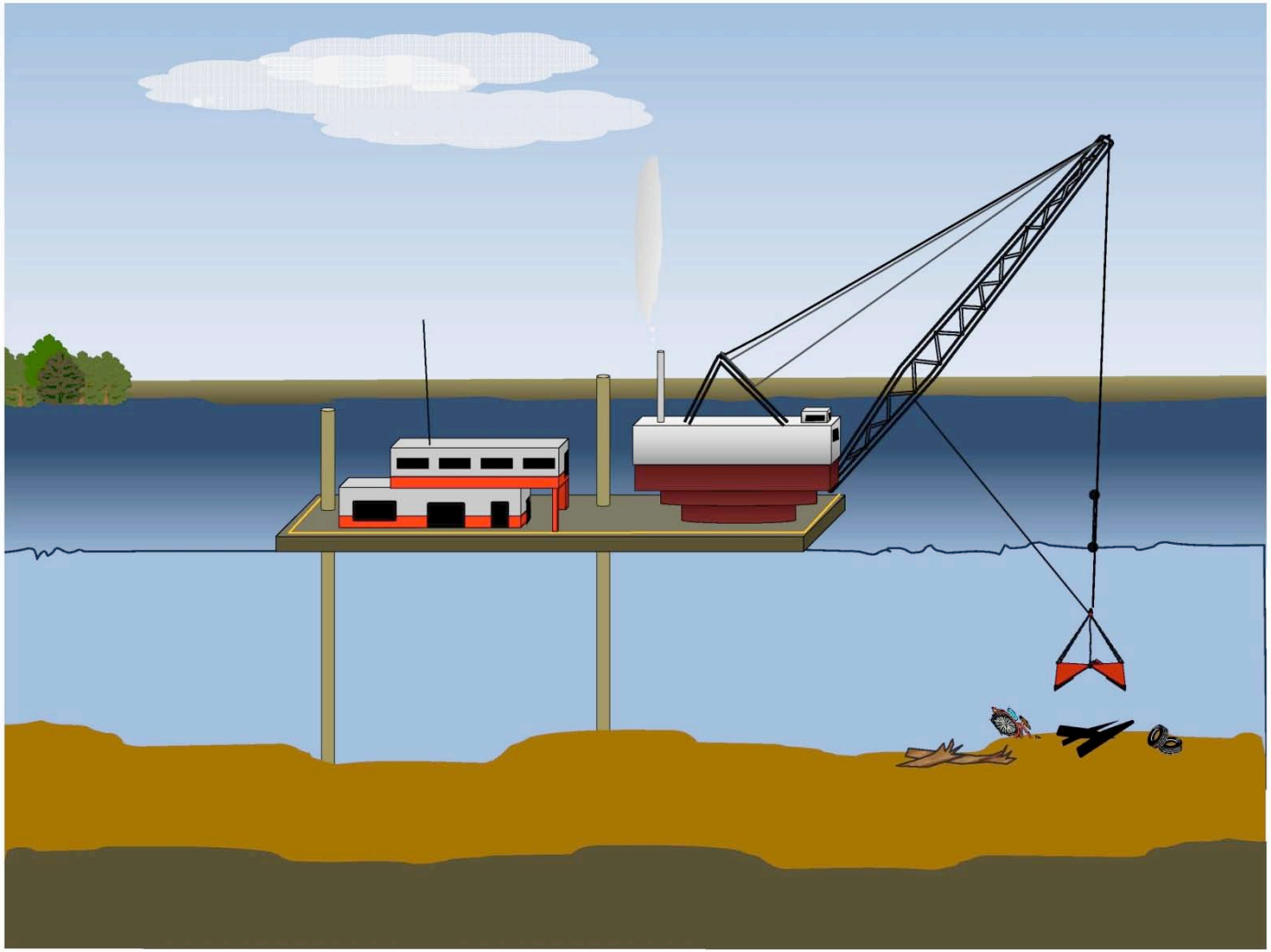
Equipment Capabilities and Selection

- Comparative Evaluations, e.g.:
  - Mechanical vs. Hydraulic
  - Conventional vs. Specialty
  - Operational approaches
- Wide range of suitable equipment is available for environmental dredging
- No single dredge type is best for all projects
- Evaluate/select based on field experience, predictive tools, and field trials as needed

Equipment Characteristics and Selection Factors

- Production
- Percent solids – need for dewatering
- Vertical Accuracy
- Horizontal Accuracy
- Max Dredging Depth
- Min Dredging Depth
- Sediment Resuspension
- Contaminant release control
- Residual/ Cleanup Level
- Transport by pipeline
- Transport by barge
- Positioning Control
- Maneuverability
- Portability/Access
- Availability
- Debris/ Loose Rock/ Vegetation
- Hardpan/ Rock Bottom
- Sloping Bottom
- Flexibility for Varying Conditions
- Thin Lift/ Residual Removal

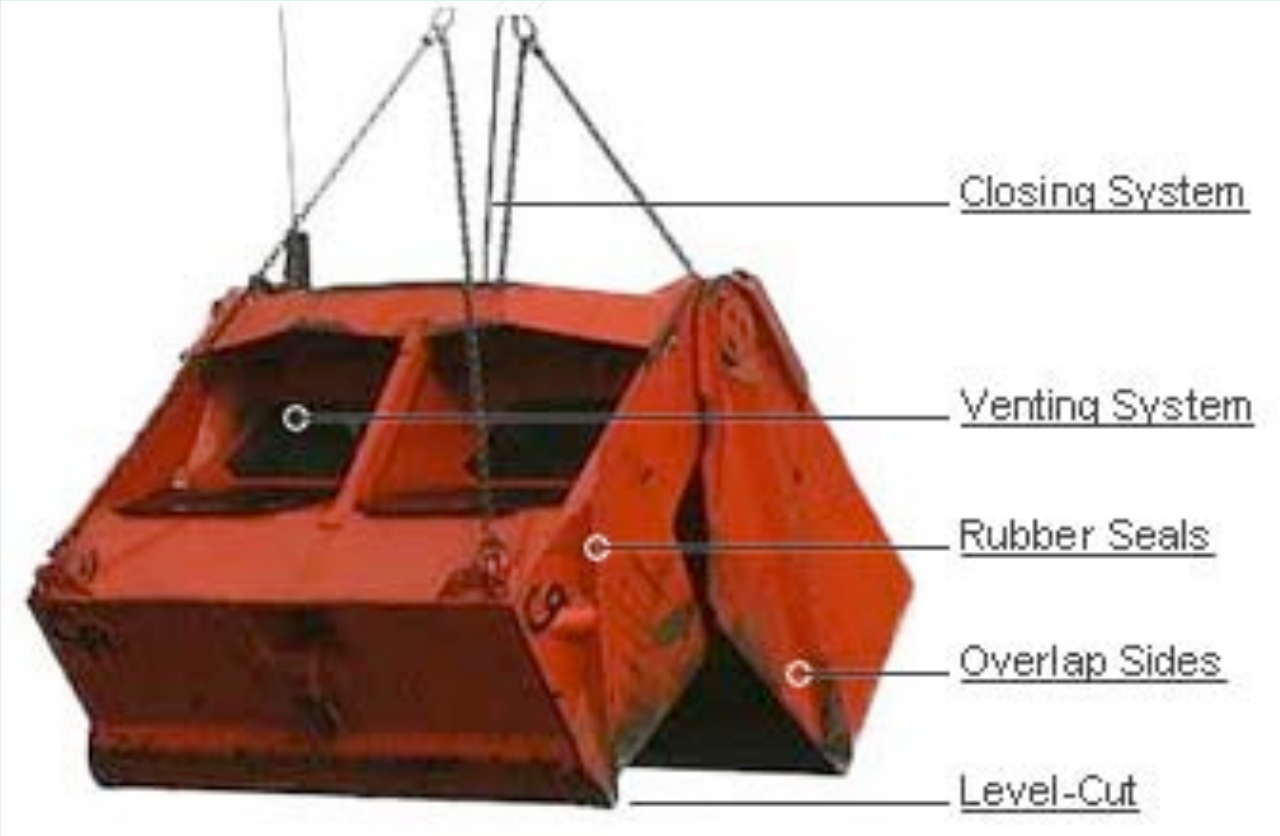
Wire-Supported Mechanical Clamshell Or Bucket Dredge



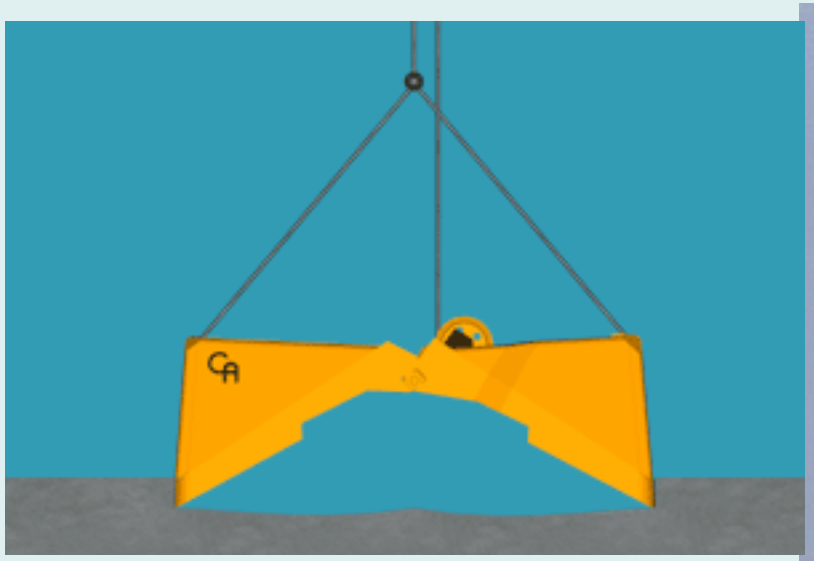
Clamshells

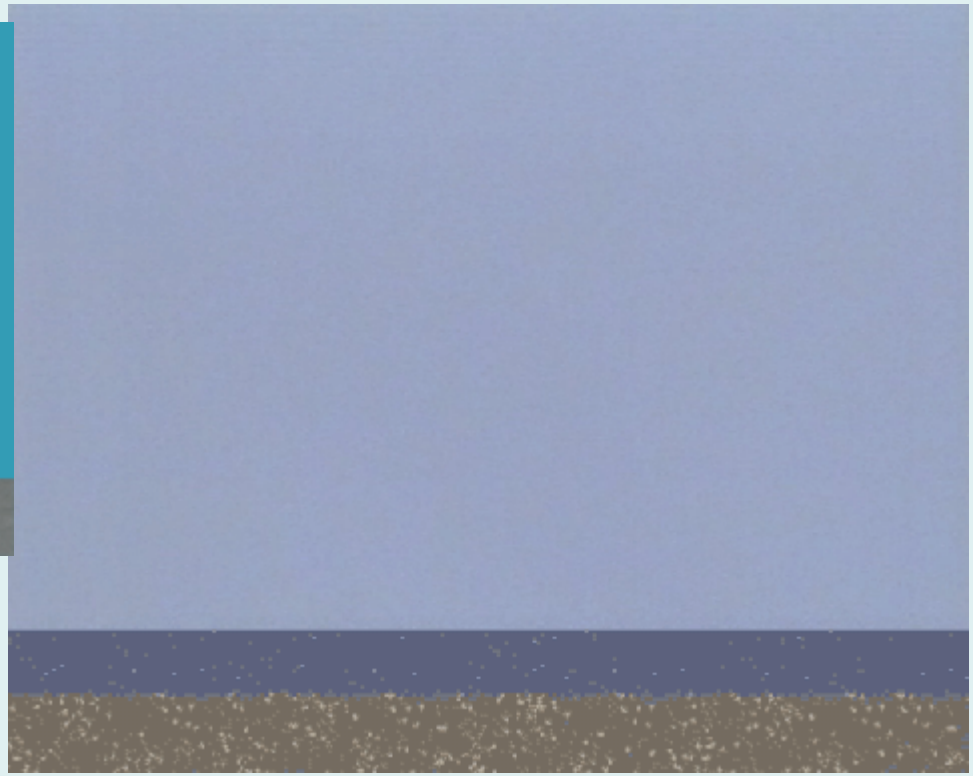
Conventional
Bucket Operation

Environmental Bucket



Level Cut

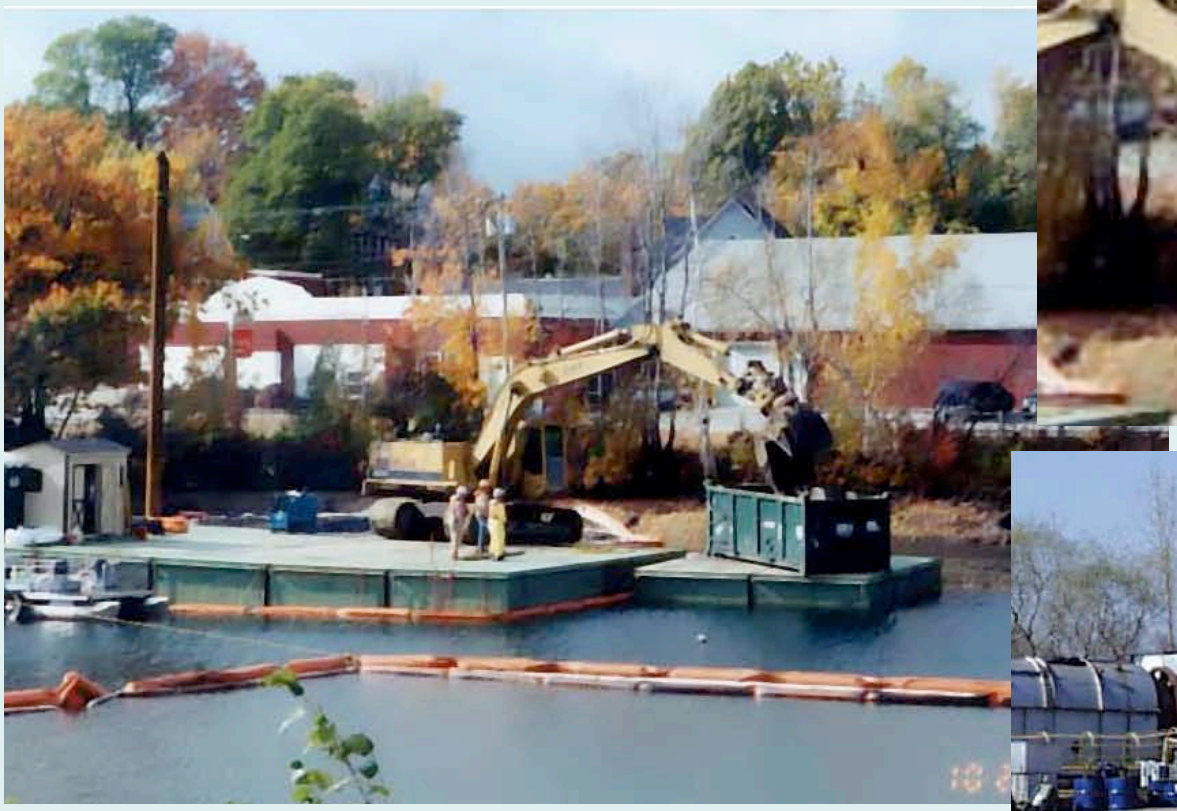




Fixed – Arm Excavators

e.g., Horizontal Profiling Grab

Buckets are Interchangeable for Size and Purpose



Backhoes

Smalley Dredge

Dipper Backhoe

Advantages of Mechanical Dredges

- Can remove hard packed materials
- Can remove debris and debris-laden sediments
- Can work tight areas
- Can operate in deep water
- Can remove sediments with little excess water
- Efficient for transport by barge at long haul distances
- Available in variety of bucket sizes/types
- Can switch from box cut buckets, to toothed buckets, to smaller buckets, etc.

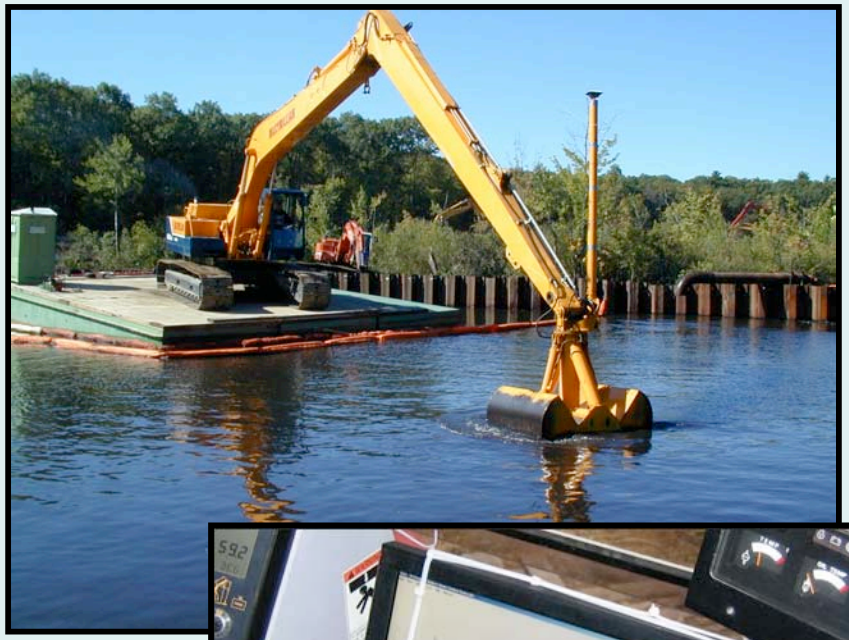
Issue – Debris

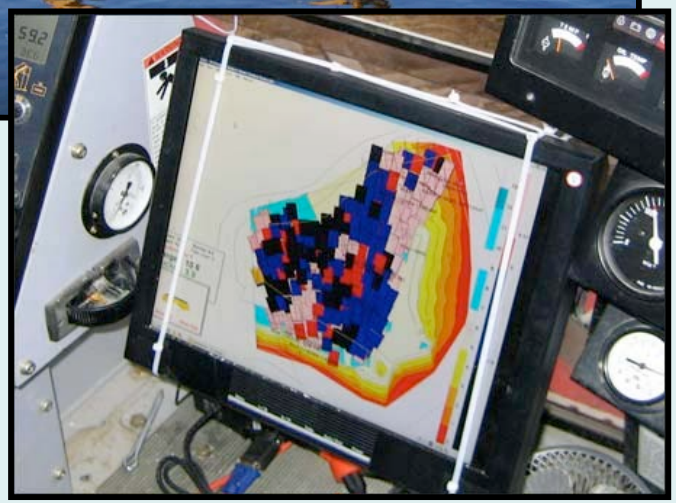
Debris/Boulders/Hardpan/Etc.

- Buried obstructions such as debris, boulders, underlying hardpan, etc. will adversely affect dredging performance
  - Slower production, more breakdowns
  - More resuspension losses – bucket fill/closure issues
  - Higher post-dredging residuals
- Mechanical dredges are generally capable of removing sediments if debris and obstructions are abundant
- Dedicated debris-removal operations may be required, especially for large debris
- MAJOR ISSUE!

Issue – Accuracy/Precision

- Accuracy/ Precision ~ removal of CS without removing clean material
  - Positioning only locates the dredgehead
  - Attainable positioning accuracy now at +/- several inches
- Accuracy of positioning may outstrip that for sediment characterization



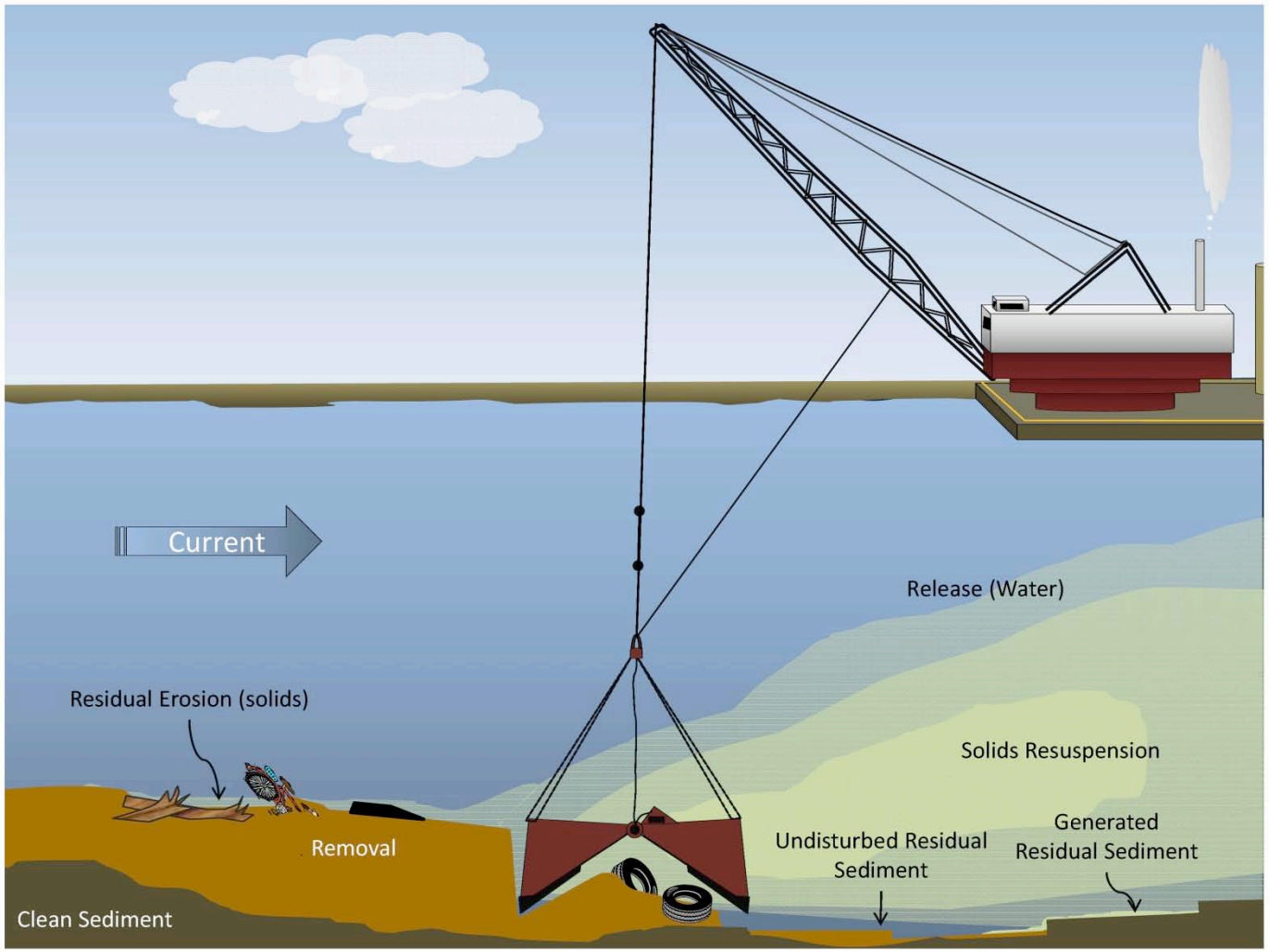


Issue - Production

- Consider both Operating Production Rate – while dredge is actively operating and Sustained Production – over a season
- Allowable weeks/ year, days/week, hours/day, and other Quality of Life Issues will determine project duration/ number of dredging seasons for a given dredge;
- Dredging system design; numbers of barges, rehandling requirements; other “bottlenecks” may control;
- Must determine number and sizes of dredges required;

Issues – Resuspension, Releases and Residuals

Conceptual Illustration of Environmental Dredging and Processes

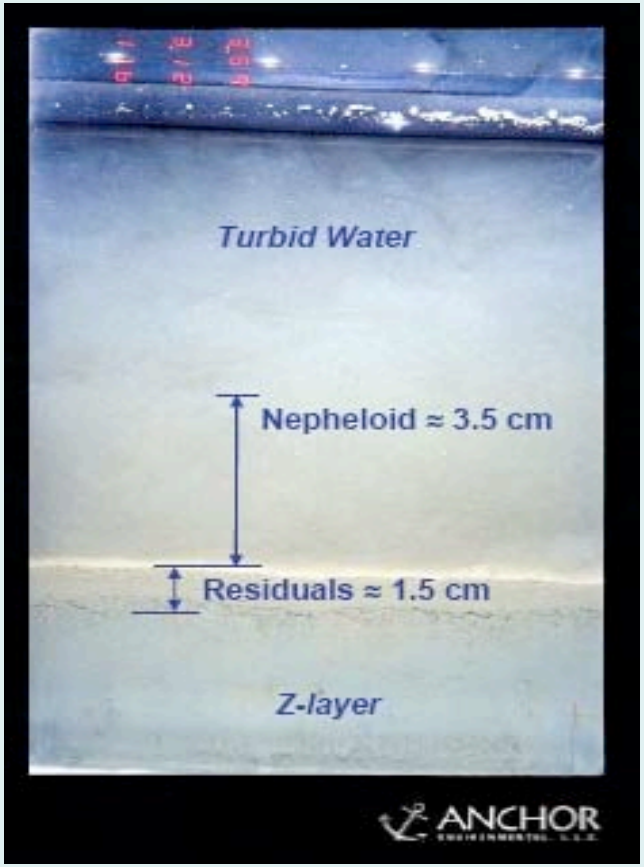


Sediment Resuspension/ Releases

- All dredges resuspend sediment
- Contaminant releases closely tied to resuspension
- Field measurement methods are not consistent
- Resuspension at dredgehead generally less than 1%
- Increased resuspension for debris removal
- Place resuspension in context with other sources
- Resuspension is near field and can be controlled (at least partially)

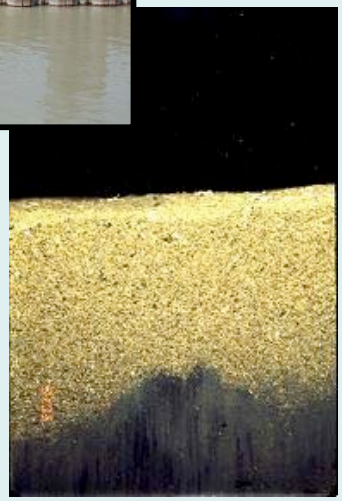
Residuals Characteristics

- Generated residuals - generally accumulate above the dredging cutline in thin layers at relatively low density;
- Undisturbed residuals - remain below the cutline as higher density sediment that may exist as relatively thick layers;
- Multiple residual layers are possible;
- Differing residuals characteristics may require different management approaches;

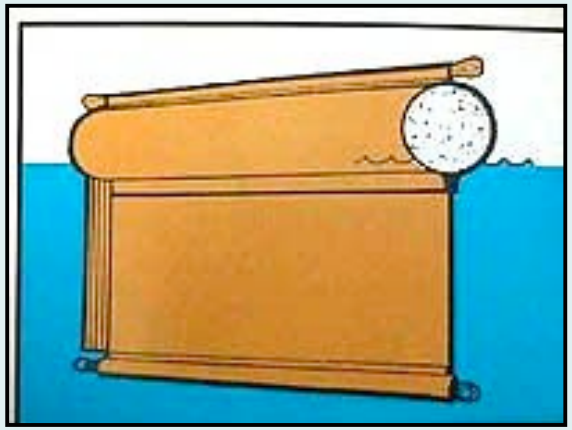


Control Measures

- 3Rs evaluations determine need
- Operational controls (timing, sequencing, operating speeds, etc.)
- Engineered controls (silt curtains, sheet pile enclosures, etc.)
- Management actions for residuals (backfill, caps, re-dredging, etc.)
- Evaluate potential effectiveness and impact on costs, project duration, etc.



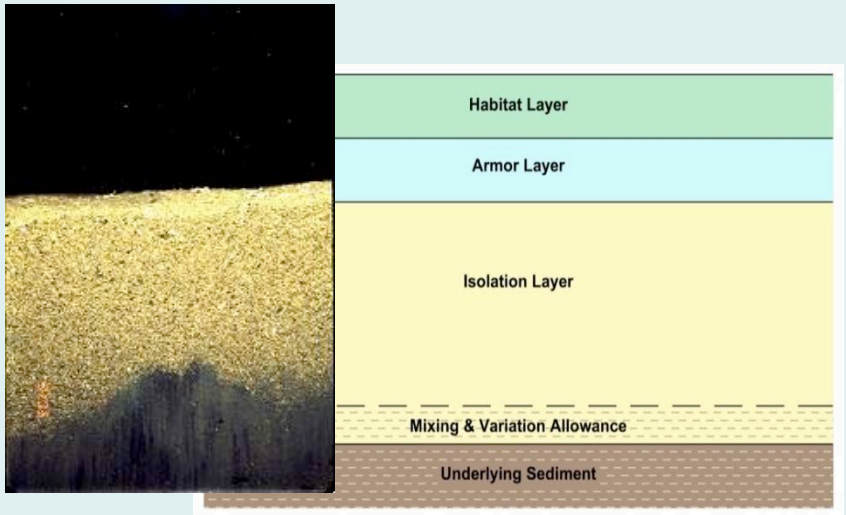
Silt Curtains



Mechanical Grab & Barge Operating Inside Hanging Curtin

Sheet Pile Enclosure

Residuals Management
Thin Cap, Eco Layer, or Engineered Cap

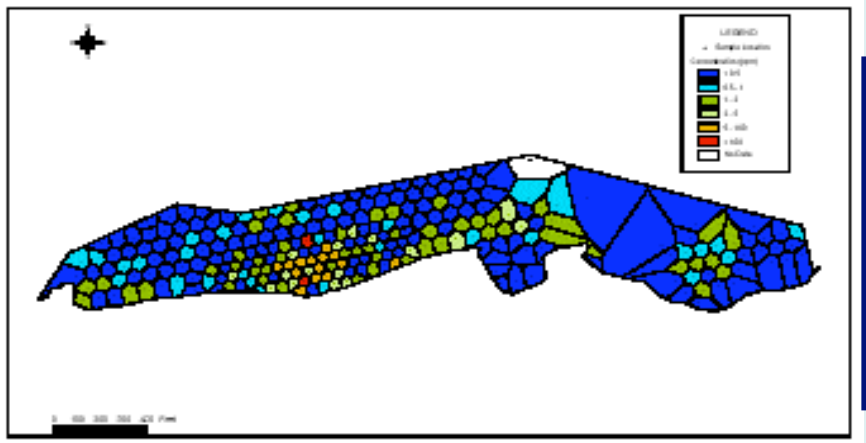


A

B

Cleanup Dredging for Residuals Management

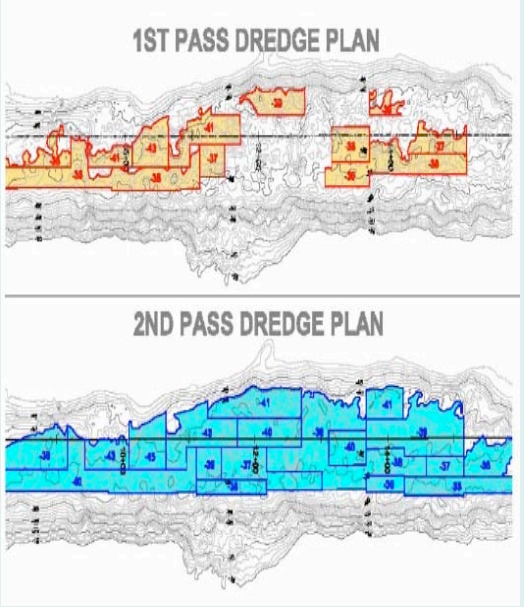
- Applicable for removal of thin layers of residuals;
- More effective with soft underlying sediments;
- Multiple cleanup passes generally inefficient; so passes should be limited, with option for residuals cap.

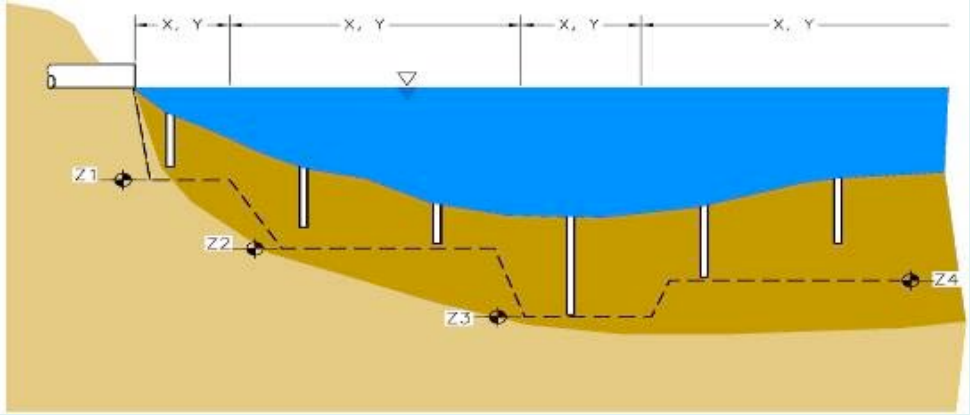


Reynolds Metals

Operating Methods and Strategies

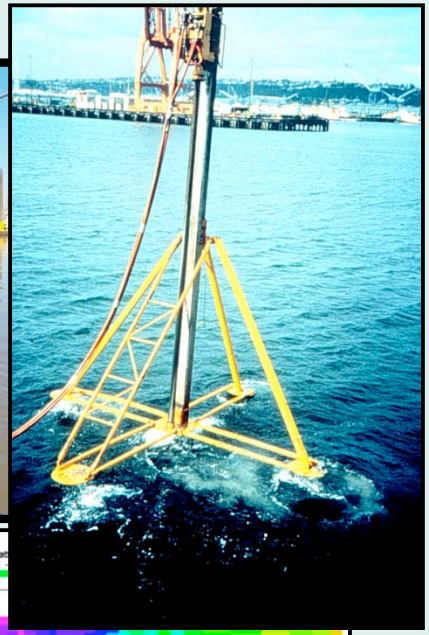
- Definintion of dredging prisms
- Sequencing of the work (horizontal and vertical)
- Production cuts, box cuts, layback slopes, cleanup passes
- Overdredging allowances
- Methods of operation
- Written Operations Plan

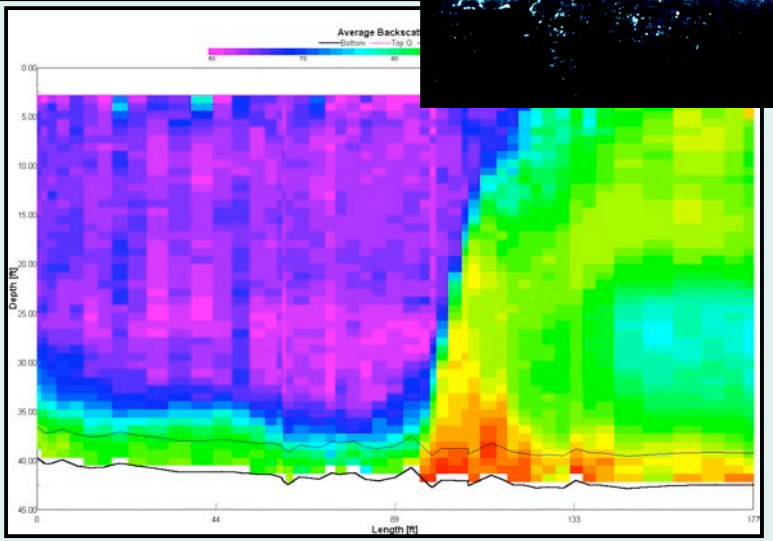




Monitoring and Management

- Removal
  - Interim and final bathy
- Resuspension/Release
  - ADCP; Turbidity; TSS/COC samples; Fixed air monitoring stations; etc.;
- Residuals
  - Grabs or Cores
- Post Construction Monitoring
- Written plan with pre-determined management actions

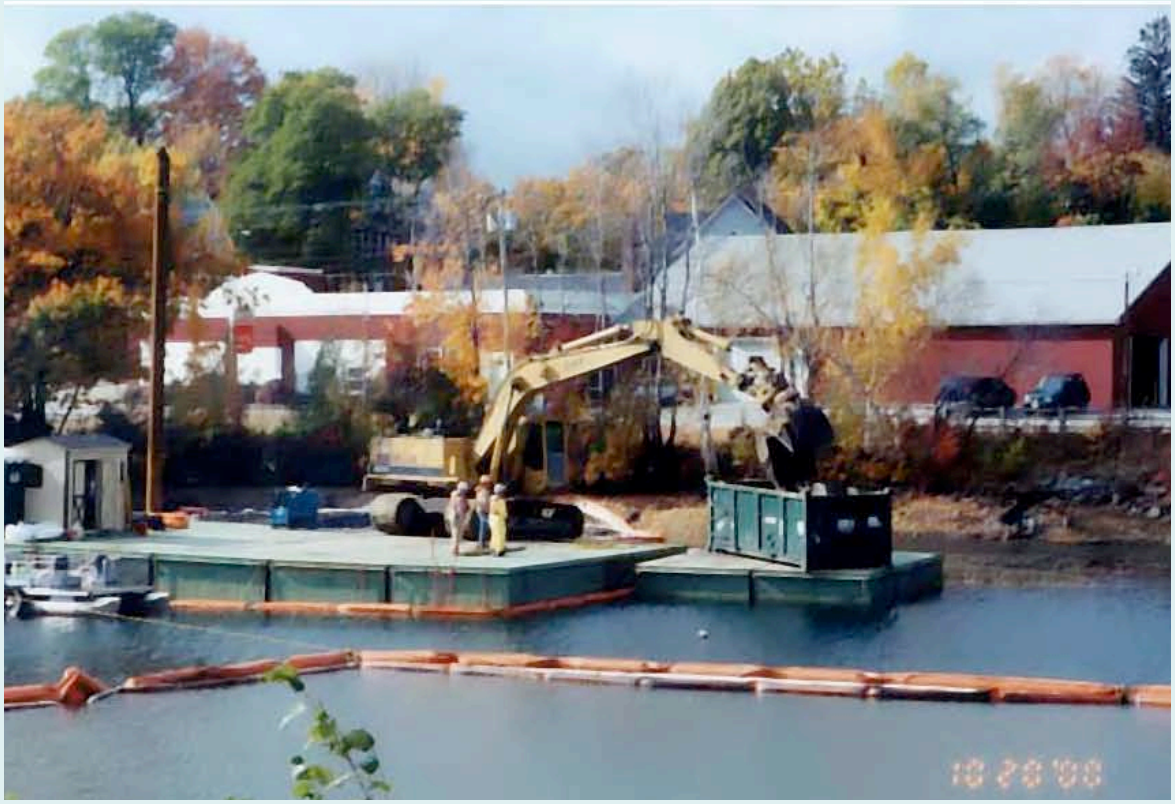




Environmental Dredging Conclusions

- Environmental Dredging is complex, and a technically sound design requires an efficient and comprehensive evaluation
- Implementability, Effectiveness, and Cost should be considered in determining acceptability of an environmental dredging design
- Environmental dredging design should be project-specific, sediment-specific, and site-specific; and
- Dredging design should focus on project goals.

QUESTIONS?



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