Environmental Dredging – Equipment and Processes

(Tab D)

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Training Objectives

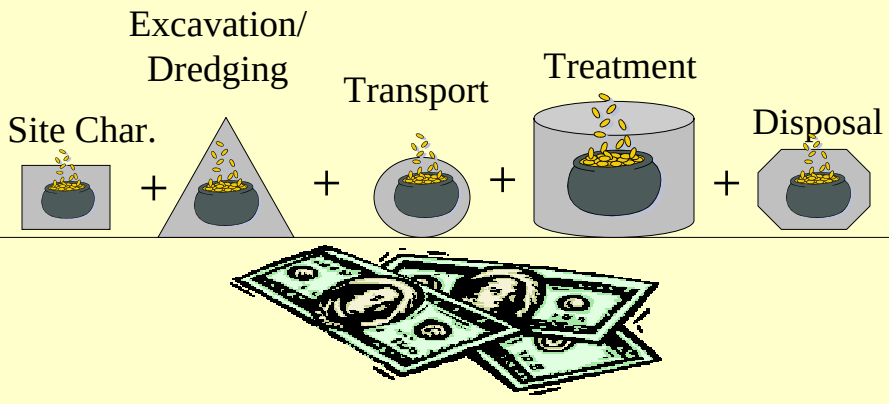
- Learn about dredges, types and operations.
- Identify general advantages and disadvantages of dredging equipment.
- Identify major limitations of different types of dredges.
- Identify factors affecting dredgeability and production and how to estimate production.
- Assess capabilities of dredges and process factors regarding sediment resuspension, contaminant release, and residuals.

Environmental Dredging
General Considerations

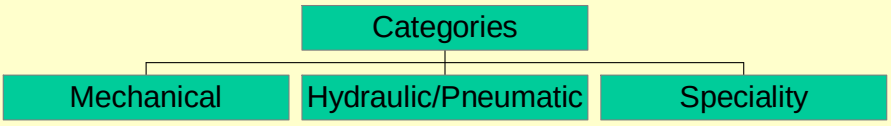
- Removal efficiency
- Resuspension of sediment and contaminant release during the dredging process
- Residual sediment left in place following dredging, and
- Compatibility with transport/disposal/ and/or treatment options

Selection of the proper equipment type and operational approach for a given site usually requires a balancing of these considerations.

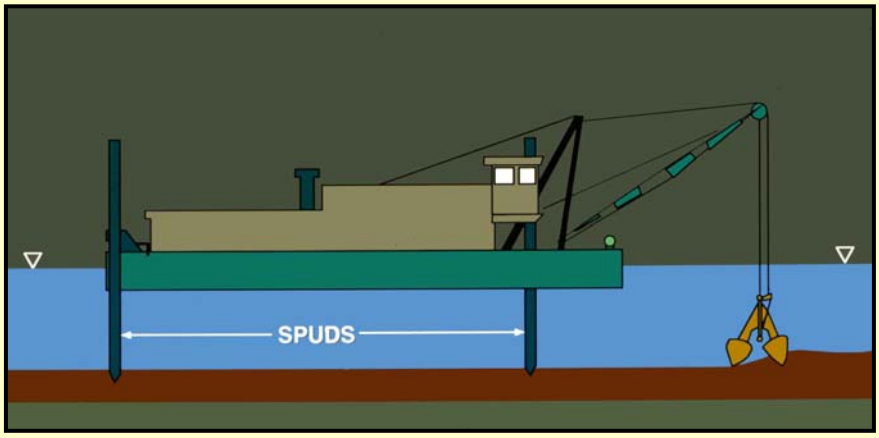
Risk Components of Environmental Dredging



Types of Dredges



Clamshell Or Bucket Dredge



Conventional Bucket Operation

Backhoes

Smalley Dredge

Dipper Backhoe

Advantages of Mechanical Dredges

- Rugged and capable of removing hard packed materials
- Can remove debris
- Can work tight areas
- Can operate in deep water >100 meters

Advantages of Mechanical Dredges

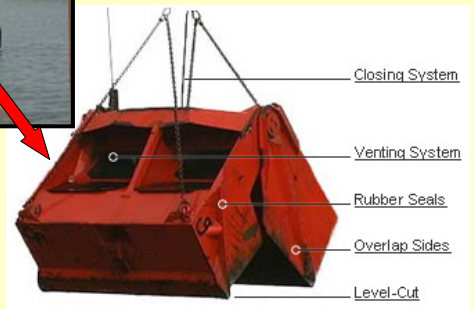
- Efficient for transport by barge at long haul distances
- Available in variety of bucket sizes/types
- Can be modified to dredge contaminated sediments

Limitations of Mechanical Dredges

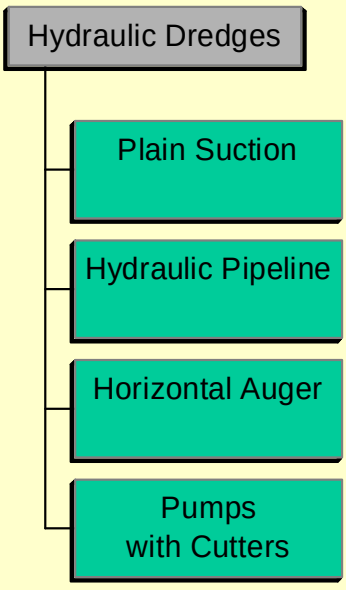
- Difficult to retain fine-grain loose material in conventional buckets
- Production can be low compared to hydraulic pipeline dredges
- Sensitive to strong currents and waves
- Precise cuts difficult with conventional buckets
- Wires can hinder boat traffic
- Requires high degree of operator skill for contaminated sediments

Environmental Bucket

Suspended by Cable from a crane



Horizontal Profiling Grab



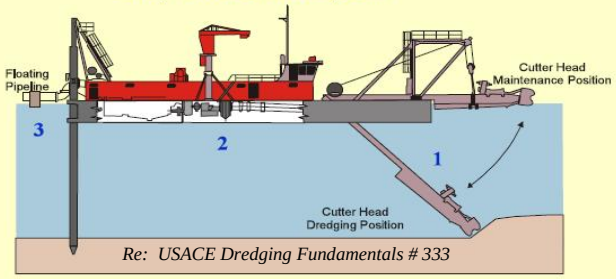
Characteristics of Hydraulic Dredges

- Mechanical dislodgement and loosing by dredgehead
- Hydraulic entrainment by suction of pump
- Discharge through a pipeline
- Advancement by spuds, winches and cables either through an arc (cutterhead) or winches and cable straight-ahead-forward motion (auger)

Hydraulic Operations

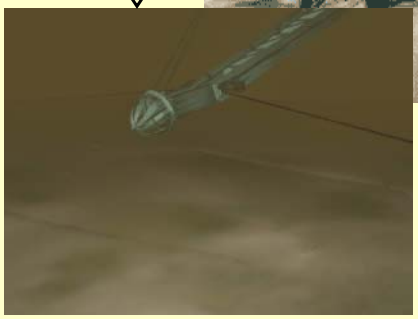
Components of Hydraulic Dredging

1. Low Pressure or Suction Side
2. Dredge Pump Operation
3. High Pressure or Discharge Side



Re: USACE Dredging Fundamentals # 333

Cutterhead Operation



Advantages of Cutterhead Pipeline Dredges

- Capable of excavating most types of materials
- Can dredge some rock types without blasting
- Can pump directly & continuously to disposal sites
- More efficient for small dredge cut thickness than bucket dredges
- Cost effective if within economical pumping distances of disposal site
- Readily available in small to large sizes with varying production capabilities.

Limitations of Cutterhead Pipeline Dredges

- Limited capability in rough open water and sensitive to strong current
- Rarely self-propelled
- Difficulty with coarse sand in high currents
- Cohesive material and debris can block the cutterhead

Limitations of Cutterhead Pipeline Dredges

- Pipeline and anchor wires may be an obstruction to navigation
- Debris and sediment can reduce efficiency
- Hard to modify when dredging contaminated sediment
- Adds water (5-10 parts) to 1 part in situ sediment

Horizontal Auger

- Cohesive silts, loosely packed sand
- Sediments sucked up by pump
- Discharge through pipeline
- Relatively level and accurate cuts

- Cuts wide path
- Shroud over auger
- Limited operating depths
- Moderate production
- Transportable by truck

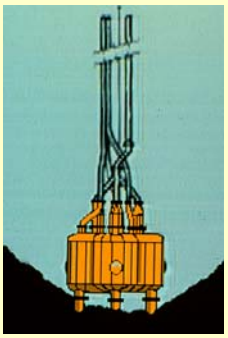
Suspended

(Centrifugal Pumps)

Toyo Pump

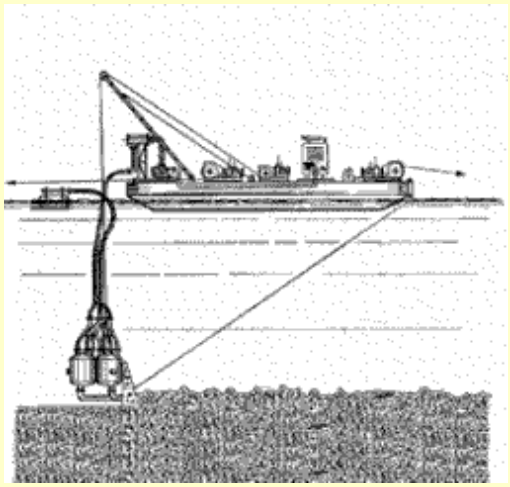
Suspended

(Pneumatic Pumps)



Pneuma Pump

Pneuma Trailing System



Mounted

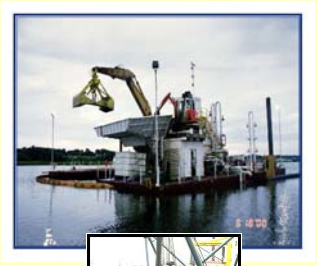
(Centrifugal Pumps)

DOP – Dutch Pump on Arm

Eddy Pump on Tornado I

Specialty Dredges

- Objectives:
  - To reduce resuspension in water
  - To decrease water content during transport
  - To improve accuracy and precision of cuts
  - To provide specialized function
- Variations of closed buckets
- Modifications to the dredge heads
- Improved positioning and monitoring instrumentation
- Higher degree of operator training required



Examples of Specialty Dredges

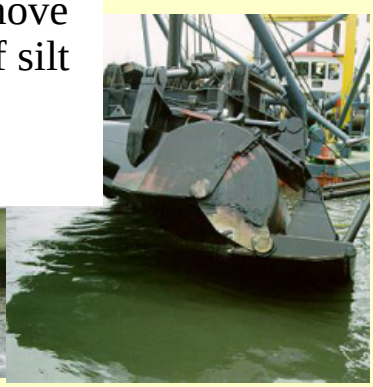
- Bottom Disc Cutter
- Scoop Dredge
- Slope Cleaner
- Bean Horizontal Profiling Grab (HPG)
- Cable Arm Environmental System
- Dry Dredge
- Debris Bucket

Bottom Disc Cutter

- Stationary moved by spuds and/or anchors wires
- Special cutter rests horizontally
- Rotates vertical blades slowly
- Material sucked into pump placed close to disc cutter
- Discharged through pipelines
- For strongly consolidated silt/sand
- Thin layers of 40 to 50 cm (16 to 20 inches)

Scoop Dredge

- Shrouded head
- Designed to remove thick deposits of silt
- Minimum resuspension

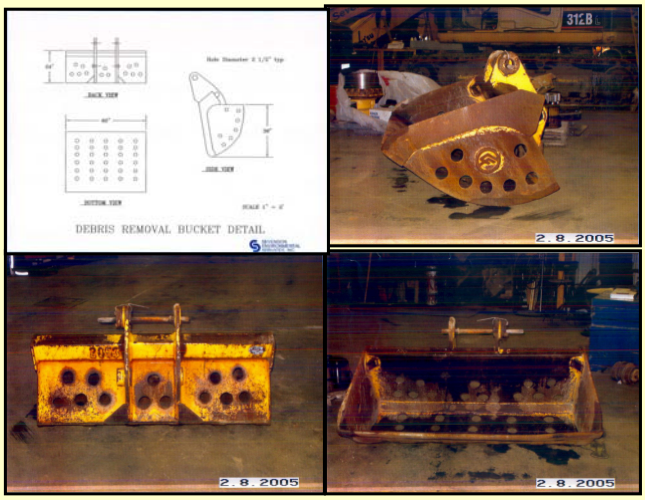


Slope Cleaner

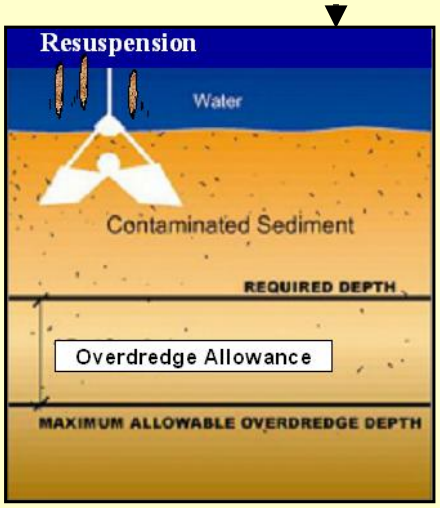
- Articulated head removes jets the silt from between riprap.
- Captures suspension
- Isolated by a box around the jetting equipment
- 3 x 7.5 m with 65 jets divided over 4sections
- Each section – 3 or 4 rows of 5 nozzles each supplied with water.

Cable Arm

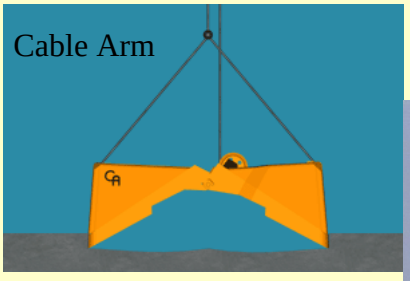
Debris Bucket – Grasse River



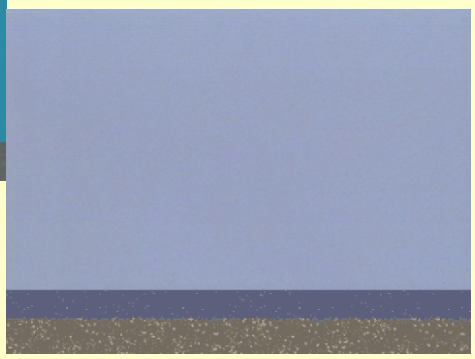
Equipment Issues



Issue – Precision Cut



Horizontal Profiling Grab



Issue – Production

Cycle Time \ Bucket Fill

1. Type and Size of Dredge; method of operation

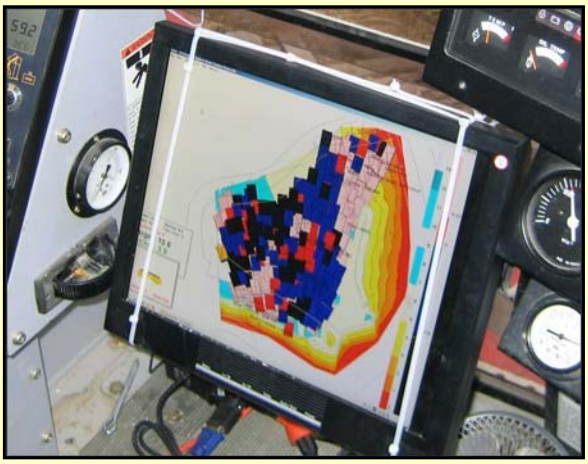
2. Sediment and Site specifics

3. Community Impacts

Issue – Bucket Fill/Closure

Issue – Releases

Issue – Precise Control



Removal/ Production

- Production = removal rate, e.g. cy/hr
- Operating Production Rate – while dredge is actively operating
- Sustained/ Effective Production – over a season
- Hydraulic production = f [Pumping capacity/ solids content; sediment density; effective dredging time]
- Mechanical production = f [Bucket size; effective bucket fill; cycle time; effective dredging time]

Production (cont'd)

- Constraints on production
  - Thickness of cut; advance speed of the dredge; control measures, access, etc.
- Constraints related to rehandling/ treatment/ disposal capacity
- Sustained Production rates for Environmental Dredging have been LOW.
- Most completed projects to date involved comparatively small volumes.

Removal accuracy

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

Resuspension/ Release/ Residual (Continued)

- Resuspended Sediment = dislodged sediment dispersed to the water column and subject to plume transport
- Dissolved Contaminant Release = contaminants in dissolved phase released to the water column resulting from direct release of porewater and desorption from resuspended particles

Resuspension/ Release/ Residual (Completed)

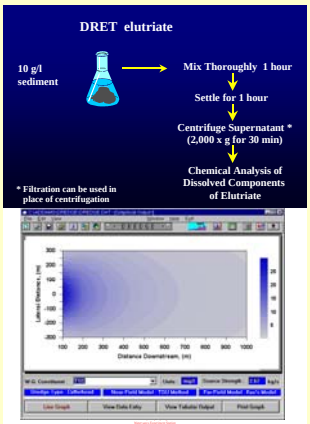
- Volatile Contaminant Release = contaminants in gaseous phase released to the air by volatilization from water
- Residual Sediment = dislodged sediment left behind, quickly settling as “fallback” and not dispersed to the water column, plus resettled material from upstream resuspension

Sediment Resuspension

- All dredges resuspend sediment
- Models available for “source strength” and transport
- Field measurement methods are not consistent
- Field experience indicates resuspension generally less than 1% of the mass removed
- Place resuspension in context with other sources
- Resuspension is near field and can be controlled

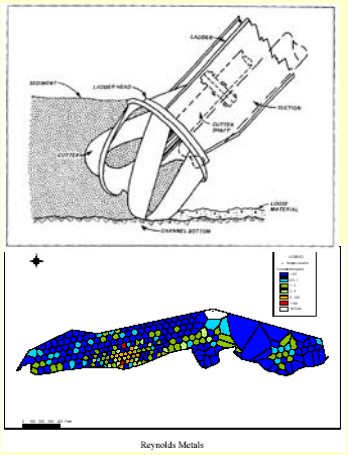
Contaminant Release

- Resuspension results in releases
- Dissolved release to water column
  - Released porewater
  - Desorption from resuspended particles
- Volatile release from water to air
- Tests/models are available
- Dissolved and volatile releases subject to far field transport – need to evaluate risks accordingly
- In general, CS can be removed without excessive release
- Releases can be partially controlled by controlling resuspension



Residual Sediment

- All dredges leave residual sediment
- No standard predictive method
- Field measurement methods are not consistent
- Multiple cleanup passes show diminishing returns; residual caps are a management option



Some Basic Conclusions

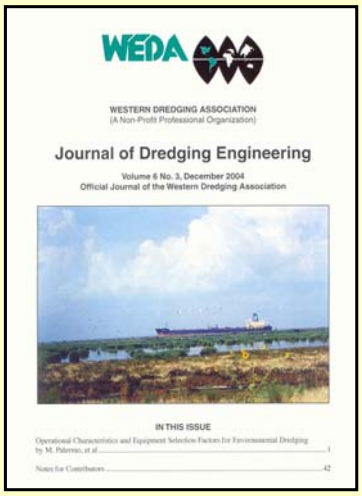
- Environmental Dredging can result in efficient and accurate removal
- Operating and Sustained production rates for Environmental Dredging will be lower than for Navigation Dredging
- Resuspension/ Release/ Residual are critical issues – but can be partially controlled

Project Managers

- Need to consider the impacts of noise and exhausts from equipment.
- Need to consider dredge crew safety (EM 385-1-1) especially when working with contaminated sediments.
- Be aware of Jones act (availability of U.S. Plants).
- Need to consider cost and time for dredge mobilization (expensive part of contract).

Recent Guidance

- WEDA Journal of Dredging Engineering
  - Volume 6, No. 3. Dec 04 *"Operational Characteristics & Equipment Selection Factors for Environmental Dredging"*
- EPA Sediment Guidance (2005 Draft)



QUESTIONS?

Thank You

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