Environmental Clamshell Dredging

Application of Environmental Dredging Tips

Lessons learned from more than 10 years of completing environmental dredging projects with Cable Arm Environmental Clamshell Buckets

By: Ray Bergeron & Darrell Nicholas
Cable Arm Professional Services
Hardware Issues in Environmental Dredging
Navigation Buckets vs. Environmental Buckets

Level-Cut Clamshell Bucket vs. Conventional Bucket
50% more material removed with the same penetration and footprint
Hardware Issues in Environmental Dredging
Navigation Buckets vs. Environmental Buckets

24' - footprint of two buckets
48% remaining with conventional bucket
12' - center to center
No Overlap

Level-Cut Clamshell Bucket vs. Conventional Bucket
48% of the contaminated sediment left with a conventional bucket

Cable Arm Buckets 5.4 cu. yd./bucket
Conventional Buckets 3.6 cu. yd./bucket
Hardware Issues in Environmental Dredging
Navigation Buckets vs. Environmental Buckets

18' - footprint of two conventional buckets
6' center to center with 50% overlap

Area where conventional bucket doesn’t reach target depth

24' footprint of two Cable Arm buckets

6% remaining with conventional bucket

Level-Cut Clamshell Bucket vs. Conventional Bucket
Conventional bucket still leaves 6% of the contaminated sediment with a 50% overlap
Where Have I Been and How Deep Did I Go?

Environmental Dredging = Sensors and Software
## Operational Procedures - Where the Bucket Meets the Mud
Same Equipment, But Different Results with Different Procedures

### Navigational Dredging Procedures - Dec. 5, 2005

<table>
<thead>
<tr>
<th>Bucket Position</th>
<th>Elapsed Time (sec.)</th>
<th>Total Cycle Time (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In wash tank</td>
<td>23</td>
<td>99</td>
</tr>
<tr>
<td>In water</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Out of water</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Dump in scow</td>
<td>20</td>
<td>99</td>
</tr>
</tbody>
</table>

### Turbidity Measurements

<table>
<thead>
<tr>
<th>Elapsed Time (min.)</th>
<th>Task</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Dredging begins</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>79</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>55</td>
</tr>
</tbody>
</table>

### Environmental Dredging Procedures - Dec. 8, 2005

<table>
<thead>
<tr>
<th>Bucket Position</th>
<th>Elapsed Time (sec.)</th>
<th>Total Cycle Time (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In wash tank</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>In water</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Out of water</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>End of draining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dump in scow</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>In wash tank</td>
<td>28</td>
<td>178</td>
</tr>
</tbody>
</table>

### Turbidity Measurements

<table>
<thead>
<tr>
<th>Elapsed Time (min.)</th>
<th>Task</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Dredging begins</td>
<td>30</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>29</td>
</tr>
</tbody>
</table>
Communicate project goals to the entire dredging team, thoroughly explaining differences between environmental and navigational dredging.

- Production Oriented vs. Removal Oriented (you get what you pay for!)
  - Basis for payment - contract terms & conditions
  - Disposal costs
- Resuspension Control
  - Turbidity & water quality standards
  - Contamination of new areas
  - Recontamination of old areas
- Water Handling
  - Treatment costs
  - Discharge standards
- Debris Handling
  - Effects on water quality & sediment handling
Precision dredging requires a crane in top mechanical condition; precision instrumentation can be wasted on a poorly functioning crane.
Precision dredging requires a crane in top mechanical condition; precision instrumentation can be wasted on a poorly functioning crane.
Use an Environmental Clamshell Bucket to remove soft, contaminated sediment first. Then remove harder, native material with a “digging” bucket.
MECHANICAL

Conventional Clam

Enclosed Bucket

Articulated Fixed-Arm Excavator

HYDRAULIC

Horizontal Auger

Conventional Cutterhead

Diver-Assisted

From "Cleanup and Remediation of Persistent Bioaccumulative Toxics in the Great Lakes Basin, G. Bayer, CH2M Hill, 2005"
Minimize sediment volumes by using an Environmental Clamshell Bucket to remove only soft, contaminated sediment.
For comparability, sample & test sediments using the same methods before & after dredging

If you don’t sample it correctly, don’t expect credit for dredging it correctly!
Determine sampling locations & depths precisely, before & after dredging.

Locate samples accurately so “numbers” reflect dredging results; not sampling variability.
Determine sampling locations & depths precisely, before & after dredging.

Be sure your results reflect dredging performance; not sampling bias!
Use a differential global positioning system, bucket and crane instrumentation, tide gauge, and dredging software (Clamvision) to track bucket location in 3-D.
Provide an accurate predredge survey on a grid dense enough to provide a sounding within every bucket footprint.
Provide time in the project schedule to train crane operators to use new instrumentation and procedures for precision dredging.
Provide independent QA/QC of hydrographic surveys. Identify GPS reference marks for confirming surveying & positioning equipment accuracy.

Comparison of Profiles from June 30 & July 1 Surveys
Miller Springs Remediation - Montague, Michigan
Provide independent QA/QC of hydrographic surveys.
Triple check coordinate transformations, datum conversions, and tide settings in the software.
Clamshell Advantages

- Rapid mobilization with usually lower costs
- Equipment and labor readily available in most markets
- Handles deep water greater than 40 feet
- Some rock and debris handling capability
- Much lower water treatment costs
Use the depth instrumentation & target depths from the software to avoid excess water or overfilling the bucket.

Bucket overlap is necessary on slopes to achieve project depths without producing excess water or overfilling the bucket.
Use the depth instrumentation & target depths from the software to avoid overfilling the bucket.

Use the horizontal bucket position to provide adequate overlap of each bite.
Locate sediment receiving containers or scows close to the working area to minimize cycle time.

CLAMVISION positioning system guides operator and logs information about every bite taken.

Wash Tank rinses adhering material from bucket before it re-enters water.

Cable Arm Environmental Clamshell lowers material loss, turbidity, and water content.

Dredge cell with silt curtain contains any re-suspended material.

www.CableArm.com
USA Phone: 734-676-6108 Fax: 734-676-1345
email: info@cablearm.com
Install drip pan at discharge point to receive the closed, filled bucket. Rinse the empty bucket in a wash tank.
Install drip pan at discharge point to receive the closed, filled bucket. Rinse the empty bucket in a wash tank.
Continually monitor turbidity in accordance with work plan. Identify & control sources of turbidity other than dredging. Link measurements with activities and show cause-effect to crew.

<table>
<thead>
<tr>
<th>Station</th>
<th>SW 9 Top</th>
<th>SW 9 Bottom</th>
<th>SW 7 Top</th>
<th>SW 7 Bottom</th>
<th>SW 3 Top</th>
<th>SW 3 Bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Samples</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>Average</td>
<td>5.18</td>
<td>2.7</td>
<td>3.04</td>
<td>2.36</td>
<td>3.81</td>
<td>1.42</td>
</tr>
<tr>
<td>Maximum</td>
<td>10.7</td>
<td>12.1</td>
<td>6.38</td>
<td>10.84</td>
<td>5.15</td>
<td>2.42</td>
</tr>
<tr>
<td>Minimum</td>
<td>3.2</td>
<td>0.8</td>
<td>1.84</td>
<td>1.67</td>
<td>2.65</td>
<td>0.8</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.4</td>
<td>2</td>
<td>0.61</td>
<td>0.84</td>
<td>0.41</td>
<td>0.32</td>
</tr>
</tbody>
</table>

All readings in NTU.
Expect debris.
Have a plan for dealing with materials that won't allow the bucket to seal.
Have a plan for dealing with debris and excess water both on the water and at the shore.
Involve the crew. Track project status on a real-time basis and provide daily updates.

Provide feedback that includes both successes and areas for improvement. Establish realistic expectations for performance.
Combine hardware, sensors, and software with operational controls for success on your next environmental dredging project.
Comparison of Water Treatment Needs
Environmental Clamshell vs. Cutterhead

TYPICAL RESULTS WITH CLAMSHELL (50% SOLIDS)

1000 LBS WATER
1000 LBS SOLIDS
1 TON OF SEDIMENT
134 GALLONS OF WATER

TYPICAL RESULTS WITH CUTTERHEAD (7% SOLIDS)

14285 LBS WATER
7.6 TONS OF SEDIMENT
1910 GALLONS OF WATER

1000 LB SOLIDS

Cutterhead dredging typically produces 4 to 14 times more water than environmental clamshell dredging.
Sherman Reservoir – Fall 2004

Another Site 100% Successfully Remediated
By Combining the Right Hardware, Software & Procedures

Applying the lessons learned from past environmental dredging experience with the right hardware, software, and procedures can produce results that are easy to explain to your clients, to the public and to the regulators.
# Comparison of Typical Water Treatment Costs

Environmental Clamshell vs. Cutterhead

Treat more water, spend more money!

<table>
<thead>
<tr>
<th>Dredging Type</th>
<th>Clamshell</th>
<th>Hydraulic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Volume Removed, cu. yd.</td>
<td>30,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Water Volume, Million Gallons</td>
<td>26.8</td>
<td>133.8</td>
</tr>
<tr>
<td>Treatment Process</td>
<td>Cost Range</td>
<td>Cost Range</td>
</tr>
<tr>
<td>Coagulation &amp; Precipitation</td>
<td>$8,028 - $18,732</td>
<td>$40,140 - $93,659</td>
</tr>
<tr>
<td>Sand Filtration</td>
<td>$36,928 - $122,024</td>
<td>$184,642 - $610,121</td>
</tr>
<tr>
<td>Carbon Absorption</td>
<td>$32,112 - $168,586</td>
<td>$160,558 - $842,931</td>
</tr>
<tr>
<td><strong>Total Water Treatment Cost</strong></td>
<td><strong>$77,068 - $309,342</strong></td>
<td><strong>$385,340 - $1,546,711</strong></td>
</tr>
</tbody>
</table>

Unit Treatment Costs from Federal Remediation Technologies Roundtable Web Site, [www.frtr.gov](http://www.frtr.gov)

Based on 12% solids for cutterhead dredging and 60% solids for clamshell dredging.
**Clamshell Disadvantages**

- Lower production rates usually vs. hydraulic
- Need for onshore unloading/transfer facilities, trucks
- Loss of volatile organic compounds from open barges
- Need for secondary spill containment at transfer points
When Selecting Environmental Dredging Technologies, Evaluate Total Project Costs

- Investigations, Lab, Pilot Tests & Engineering Studies
- Administrative – Cost, Schedule, Work Plans
- Mobilization & Demobilization
- Shore Facilities – Docks, Roads, Storage, Processing
- Silt Containment & Turbidity Mitigation
- Water Treatment & Air Pollution Control
- Solid Waste Treatment & Disposal
- Sampling, Monitoring & Regulatory Compliance
- Health & Safety
- Dredging Equipment & Operations
Navigational vs Environmental Dredging

• Battling Misconceptions about Clamshells

A hydraulic (vacuum-style) dredge should be used. A horizontal auger cutterhead seems to stir sediments less than a swinging ladder style.

(Don't allow clamshell dredging --- it’s very messy!)

Navigational vs Environmental Dredging

- Hardware
- Sensors and Software
- Operational Controls