DAMEN

Environmental Dredging Equipment

Banff, Canada

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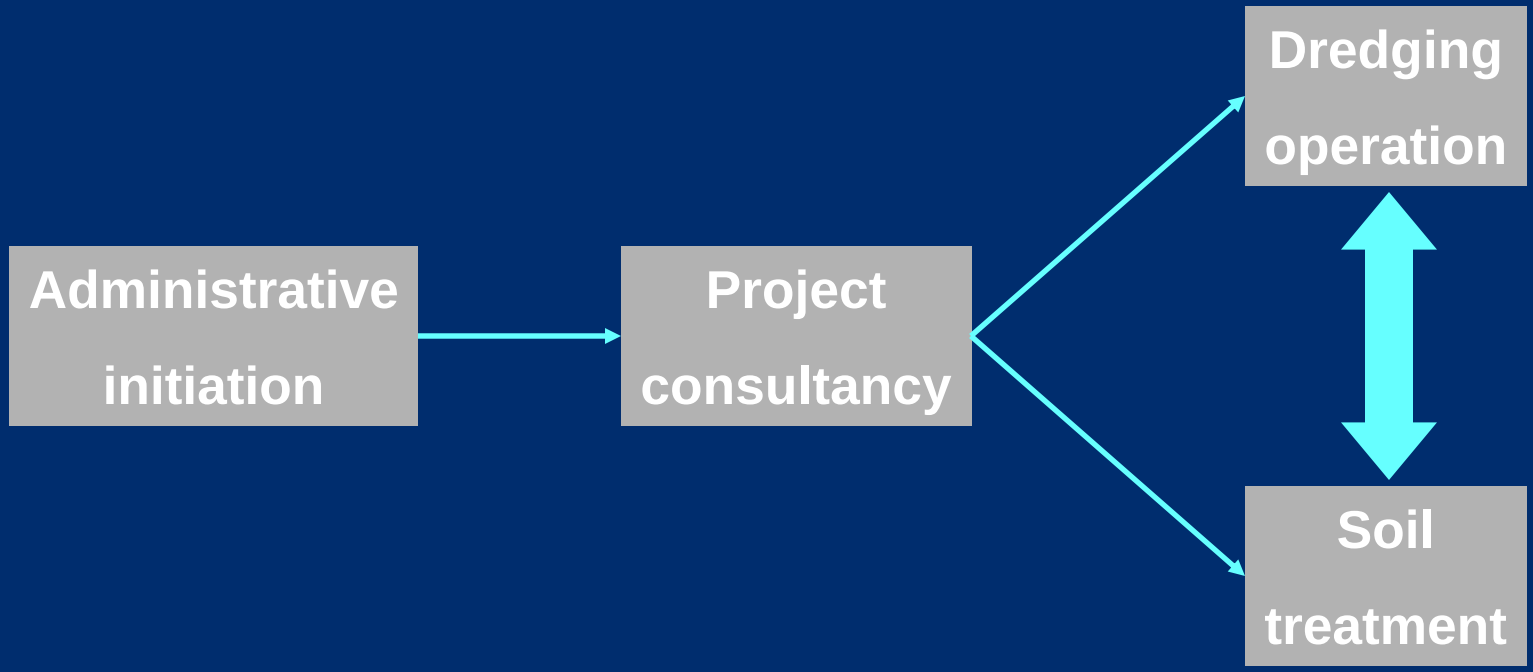
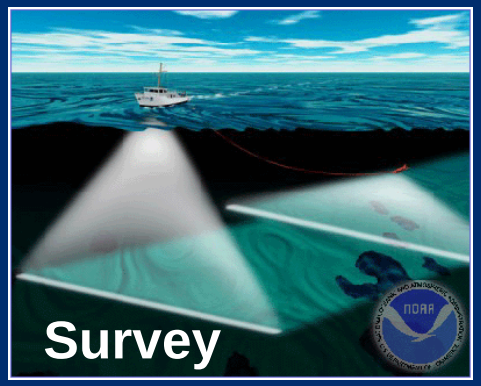
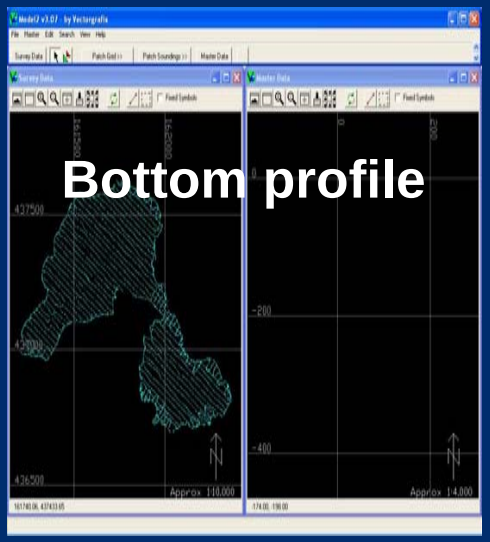
Project Chain

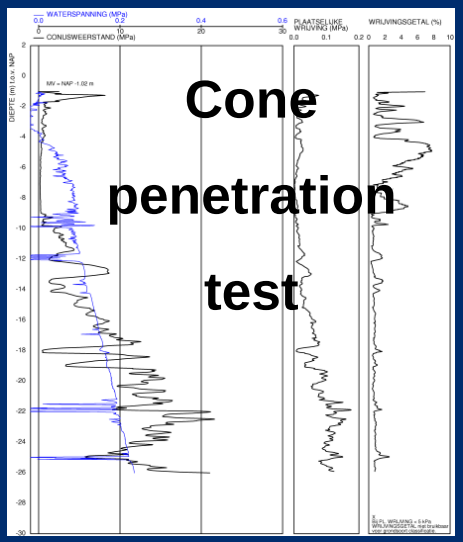


DDE Products

Site investigation



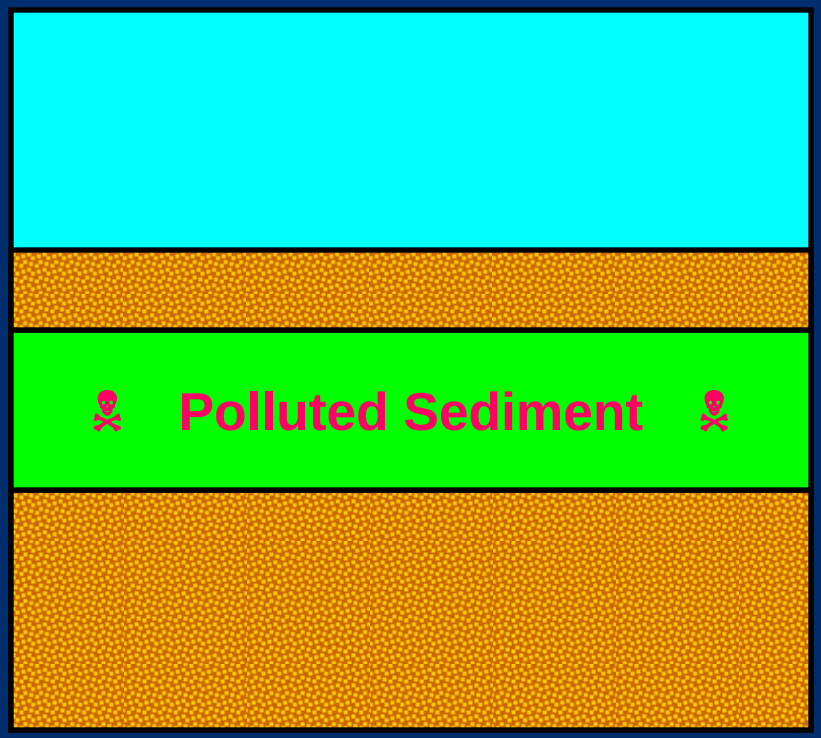




Project Plan Drafting

- Compose remediation plan
- Select equipment required for dredging dewatering and separation
- Select positioning and measuring equipment
- Select dilution monitoring equipment to meet government regulations
- Prepare operational risk analysis

Selective layer removal



Selective removal:

- To minimise disturbance
- To minimise dredge volume
- To reduce treated volume
- To reduce transport and dumping costs
- Enables reuse of clean top layer

Design Criteria for environmental dredging equipment

- Economic handling of dredged materials.
- Capacity of dredging equipment depending on storage or de-watering capacities.
- Resistant to debris.
- Capable of handling organic gasses.
- High accuracy positioning system required.
- Minimal dilution of the polluted dredged materials.
- Minimal spillage.
- Minimal turbidity during the dredging action.
- Manoeuvrability and dredge pattern.
- Availability of protocols for field measurement of sediment release from dredgers.

Environmental Dredging Concepts

- Auger dredge (+DDE)
- Bottom disc cutter (+DDE)
- Modified bucket chain dredge
- Sweep dredge

} Ketelmeer dredge tests

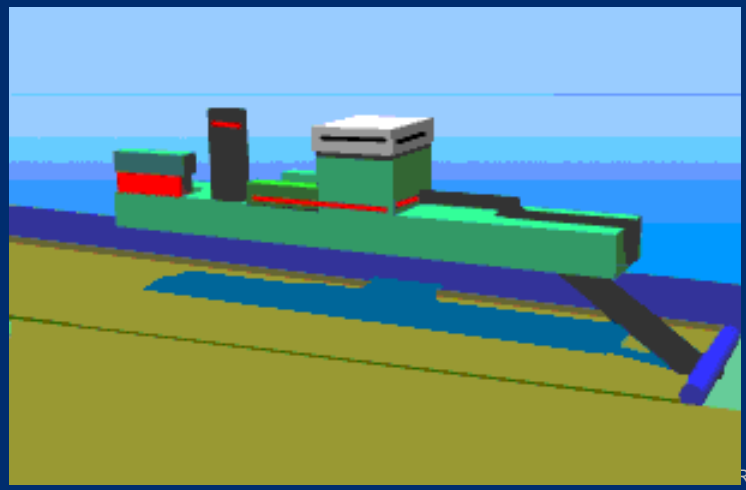
- Closed clam shell dredge
- Penetration dredging (+DDE)

} Other concepts

Ketelmeer clean-up project

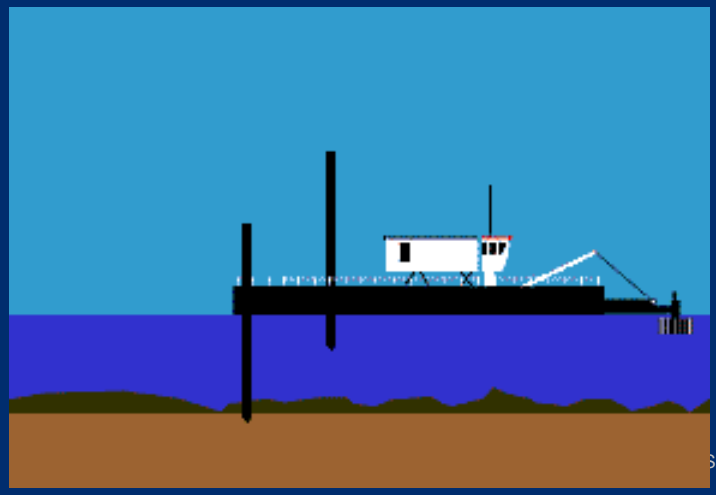
Auger dredge ‘HAM 291’

- Thin layer dredging
- Minimal spill
- Minimal turbidity
- High transport density
- 6 Degrees of freedom
- Flexible dredge patterns
- High position accuracy



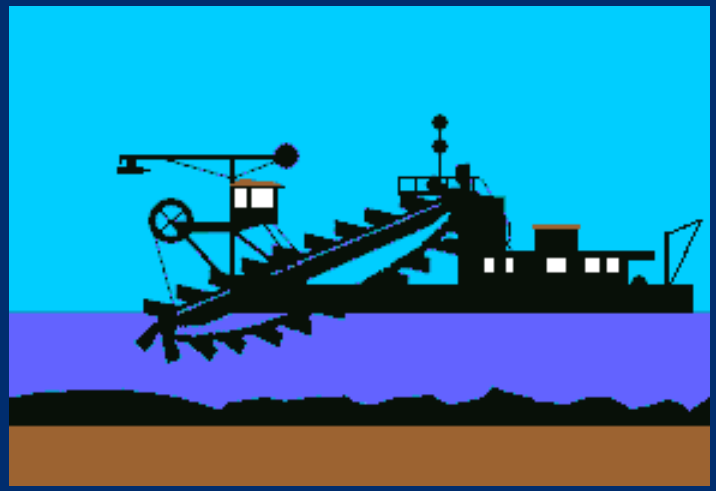
Bottom Disc Cutter ‘Vecht’

- Controllable flow
- Minimal spill
- Minimal turbidity
- High transport density
- 6 Degrees of freedom
- Flexible dredge patterns
- High position accuracy



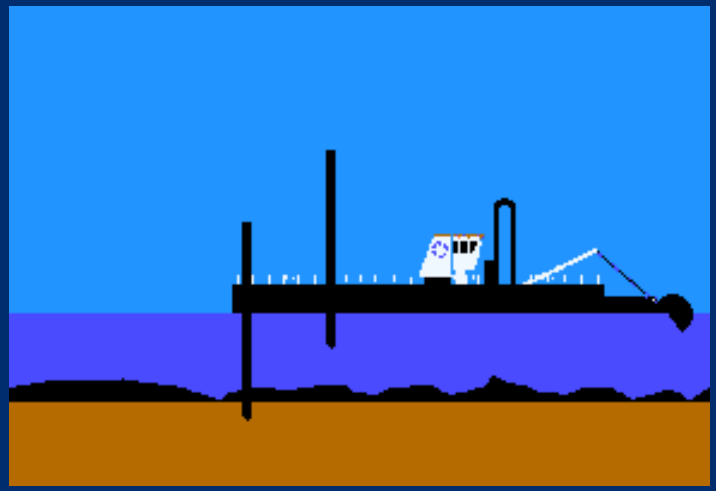
Bucket Chain Dredge ‘Aalscholver’

- Minimal spill
- Minimal turbidity
- In situ transport density
- High position accuracy
- Resistant for debris



Sweep dredge ‘Vlaanderen XV’

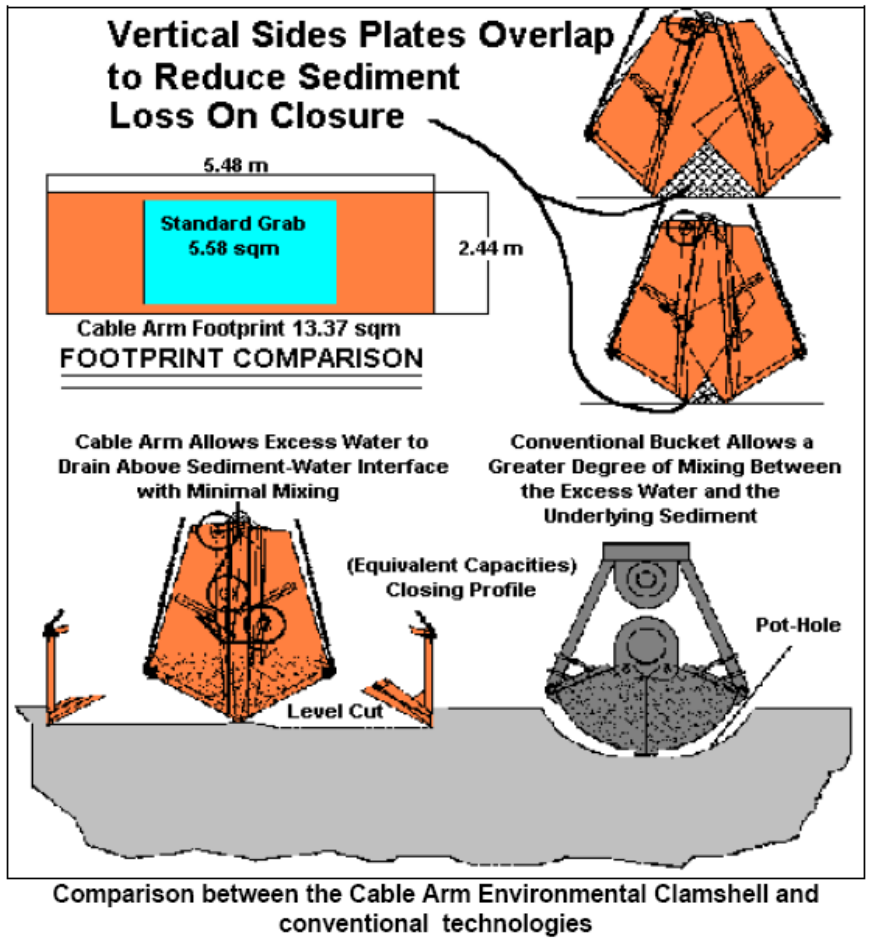
- Thin layer dredging
- Minimal spill
- Minimal turbidity
- High transport density
- High position accuracy



Ketelmeer Results

	Auger	Disc	Bucket	Sweep
Dilution	+	+	+	+
Spillage	+	+	+	+
Turbidity	+	+	+	+
Accuracy	+	+	+	+
Capacity	+	+	+	+
Debris	+	-	+	+
Gas	+	+	+	+
Profiles	+	+	-	-
Measurement	+	+	+	+
Economic	+	+	-	+

Clamshell Bucket

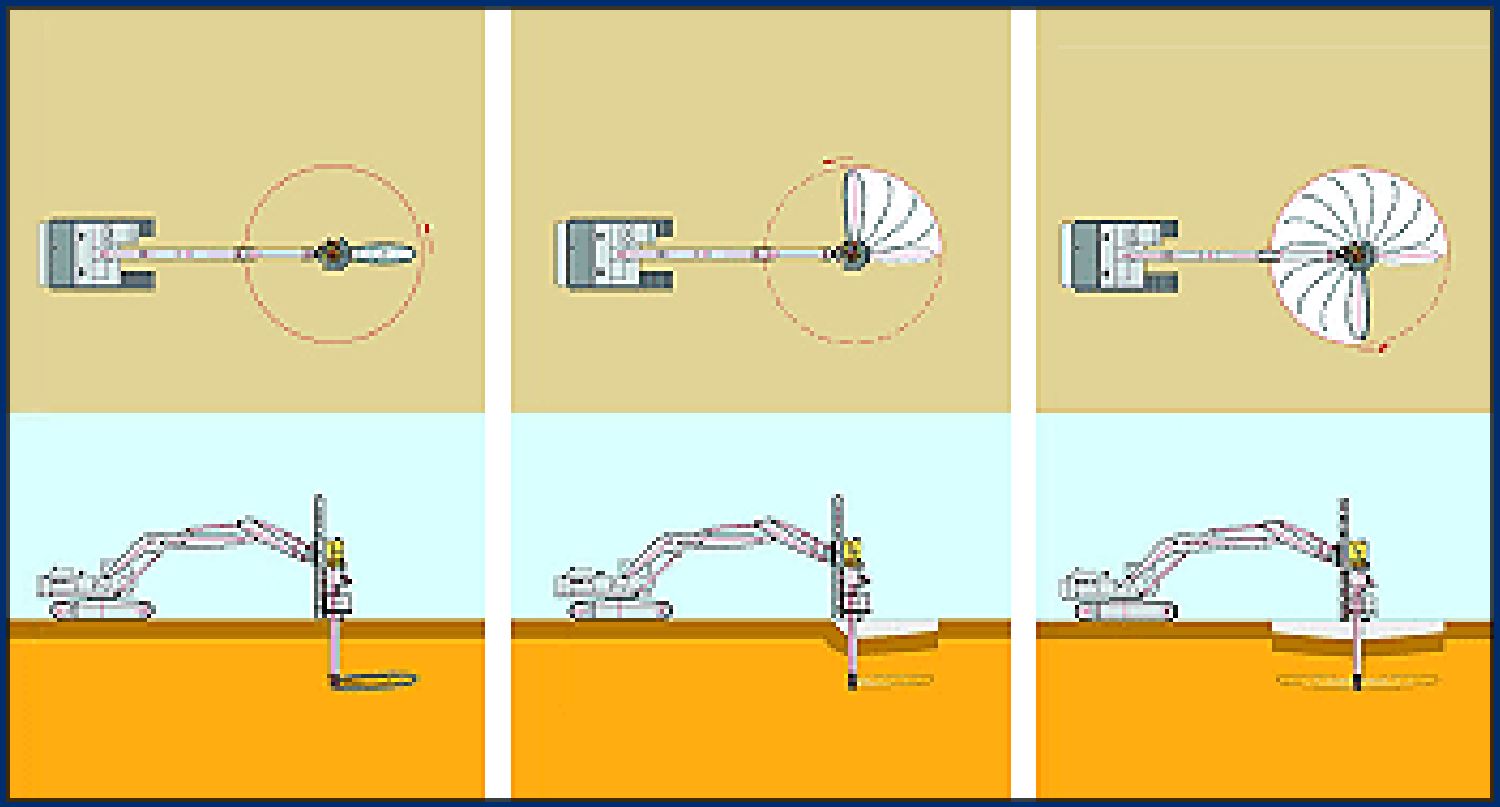


Comparison between the Cable Arm Environmental Clamshell and conventional technologies

Disadvantages:

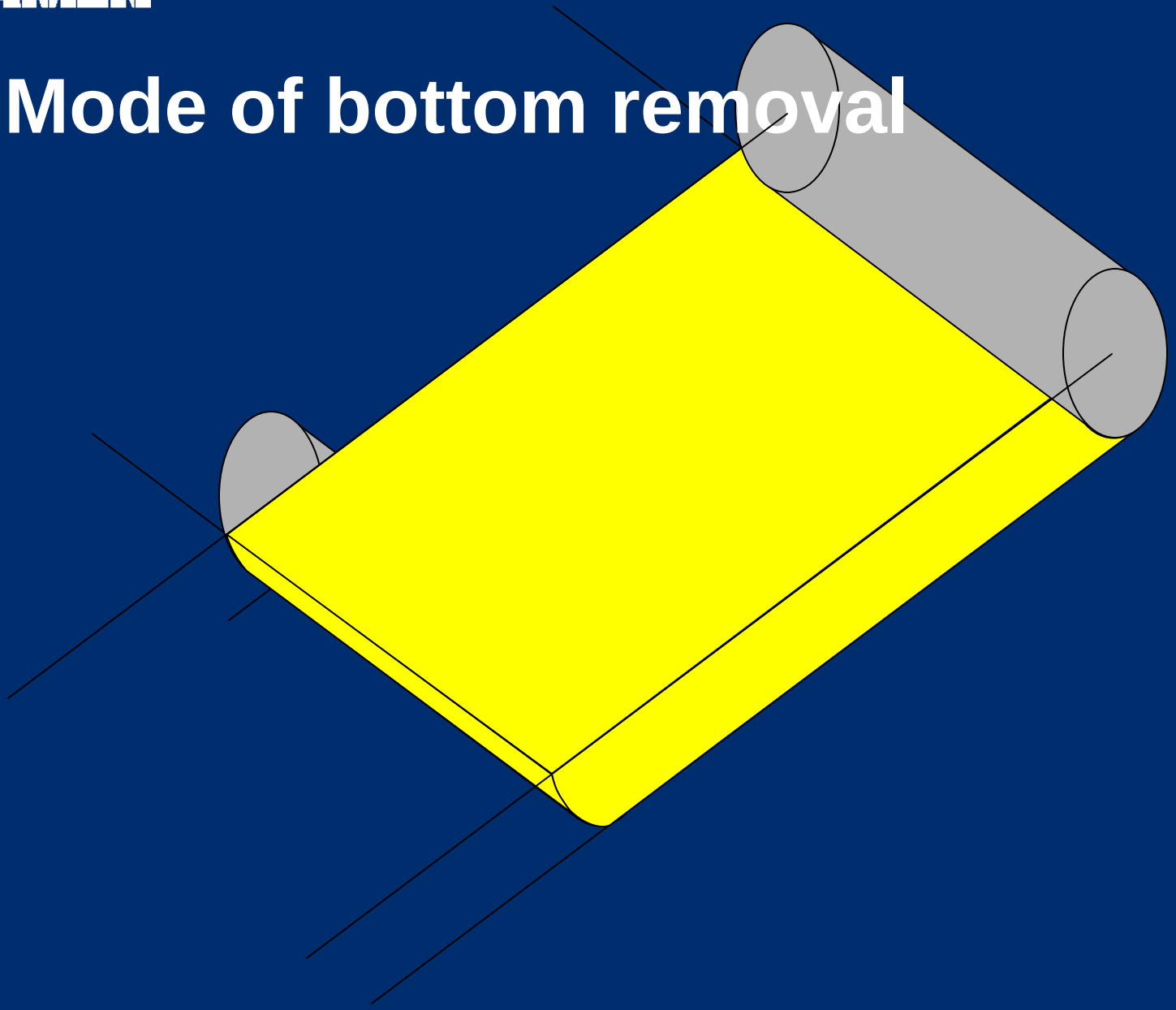
- **No selective removal**
- **Requires silt screens**

Penetration Dredge

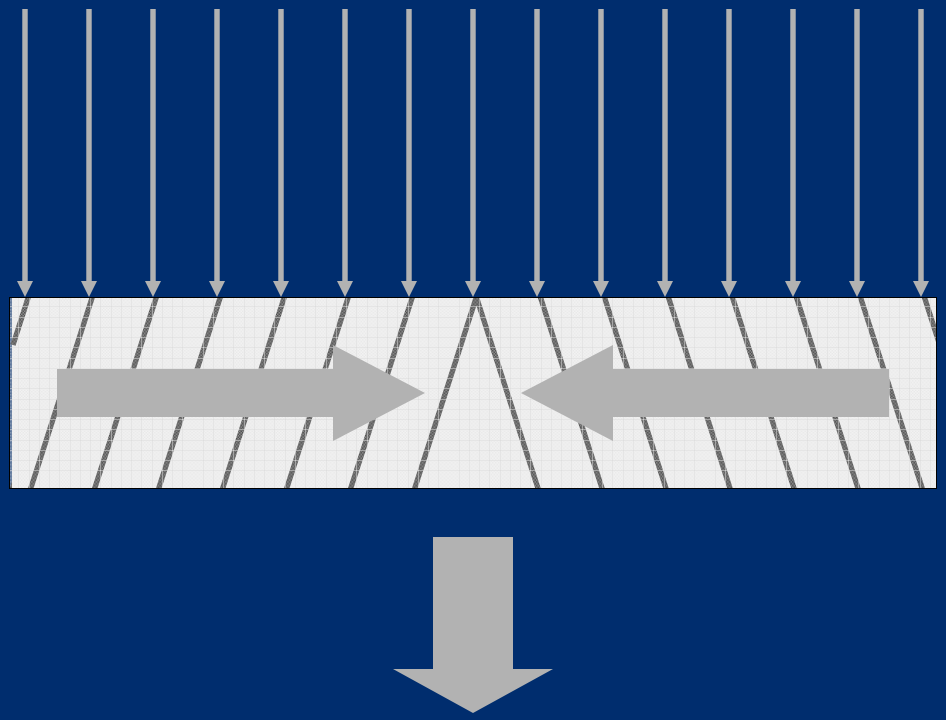


Feature: polluted sediment remains in place

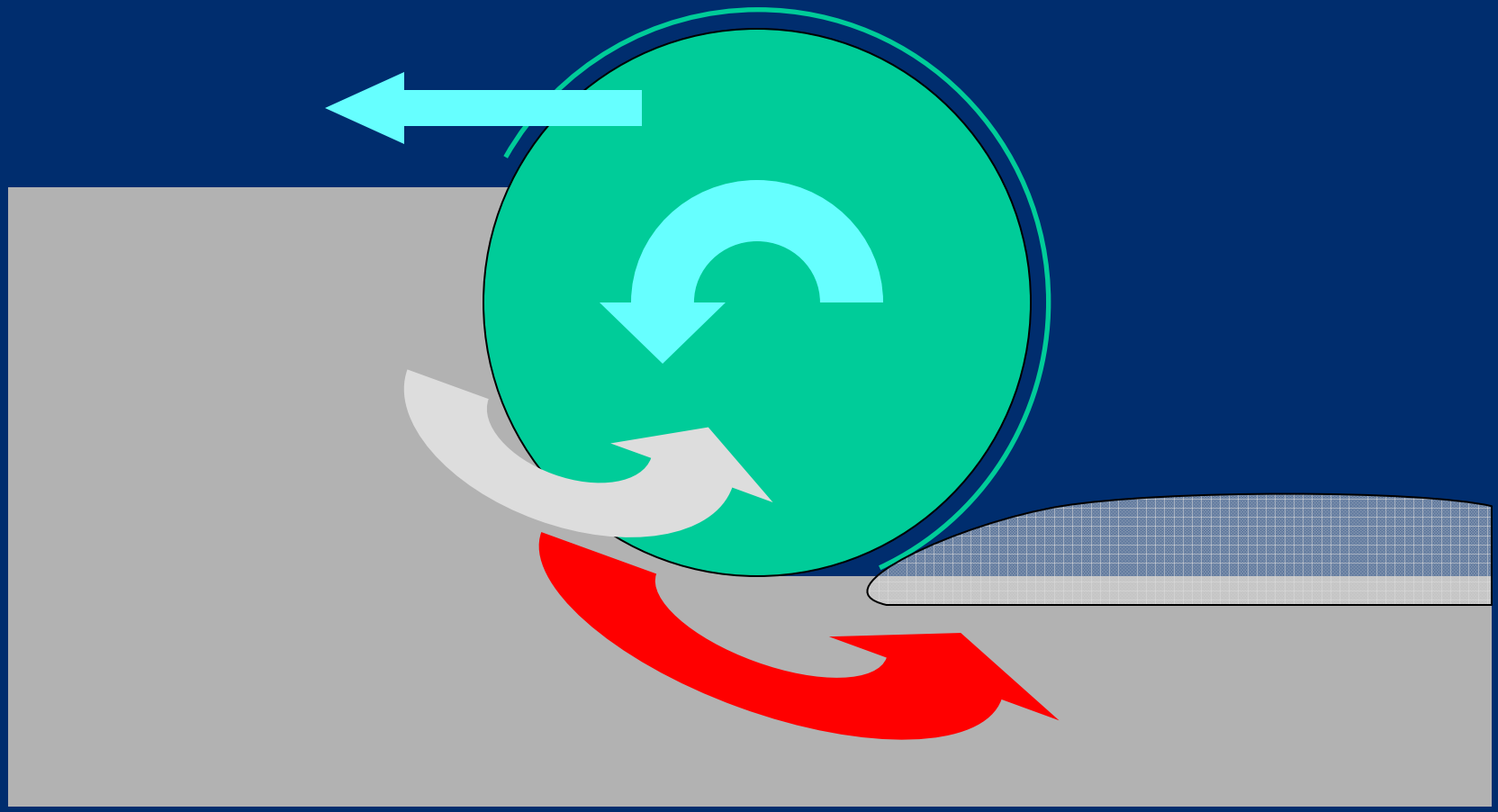
Mode of bottom removal



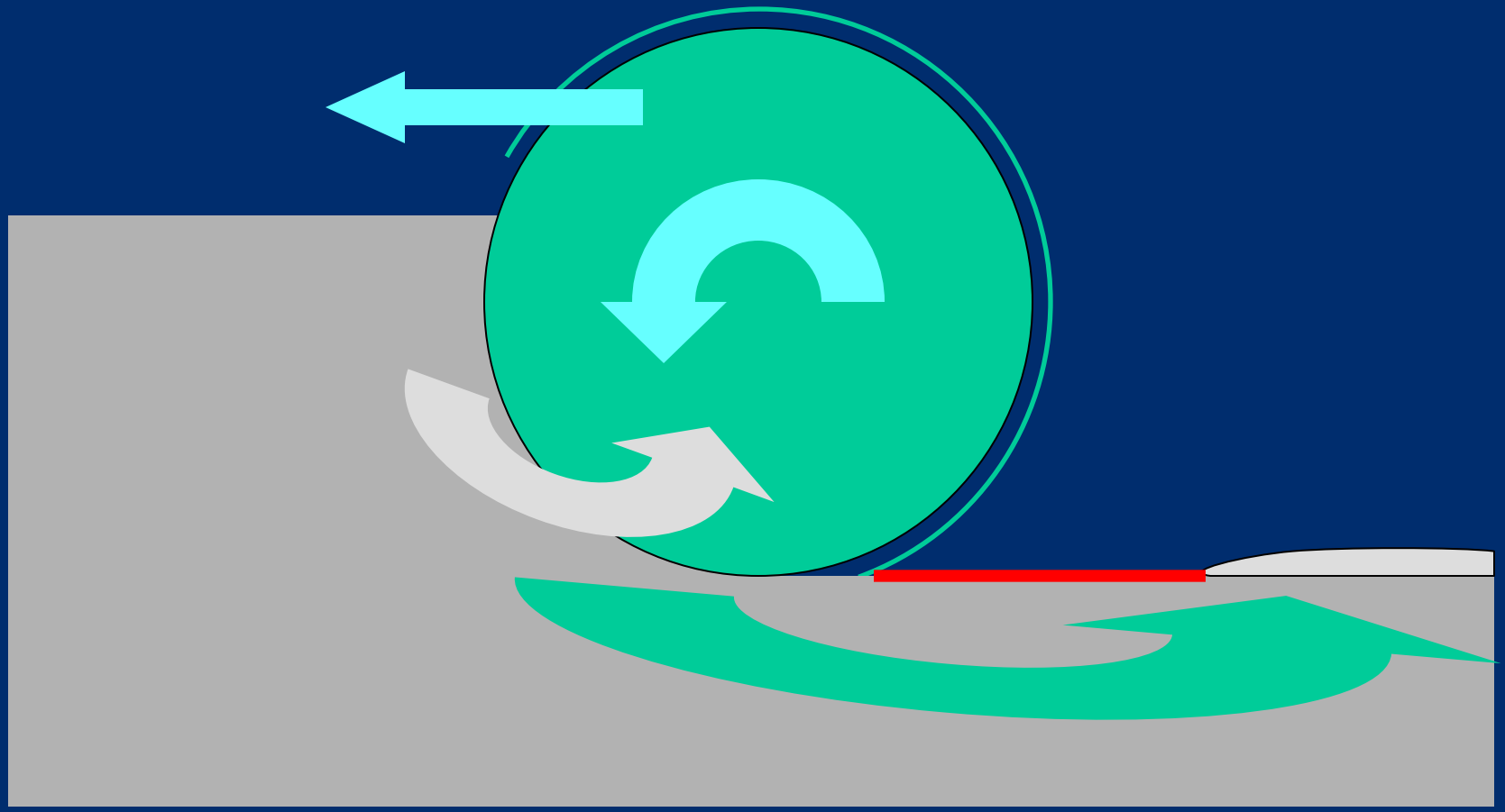
Auger collection



Spill composition of an auger



Auger with trailing shoe



Auger/Pump Characteristics

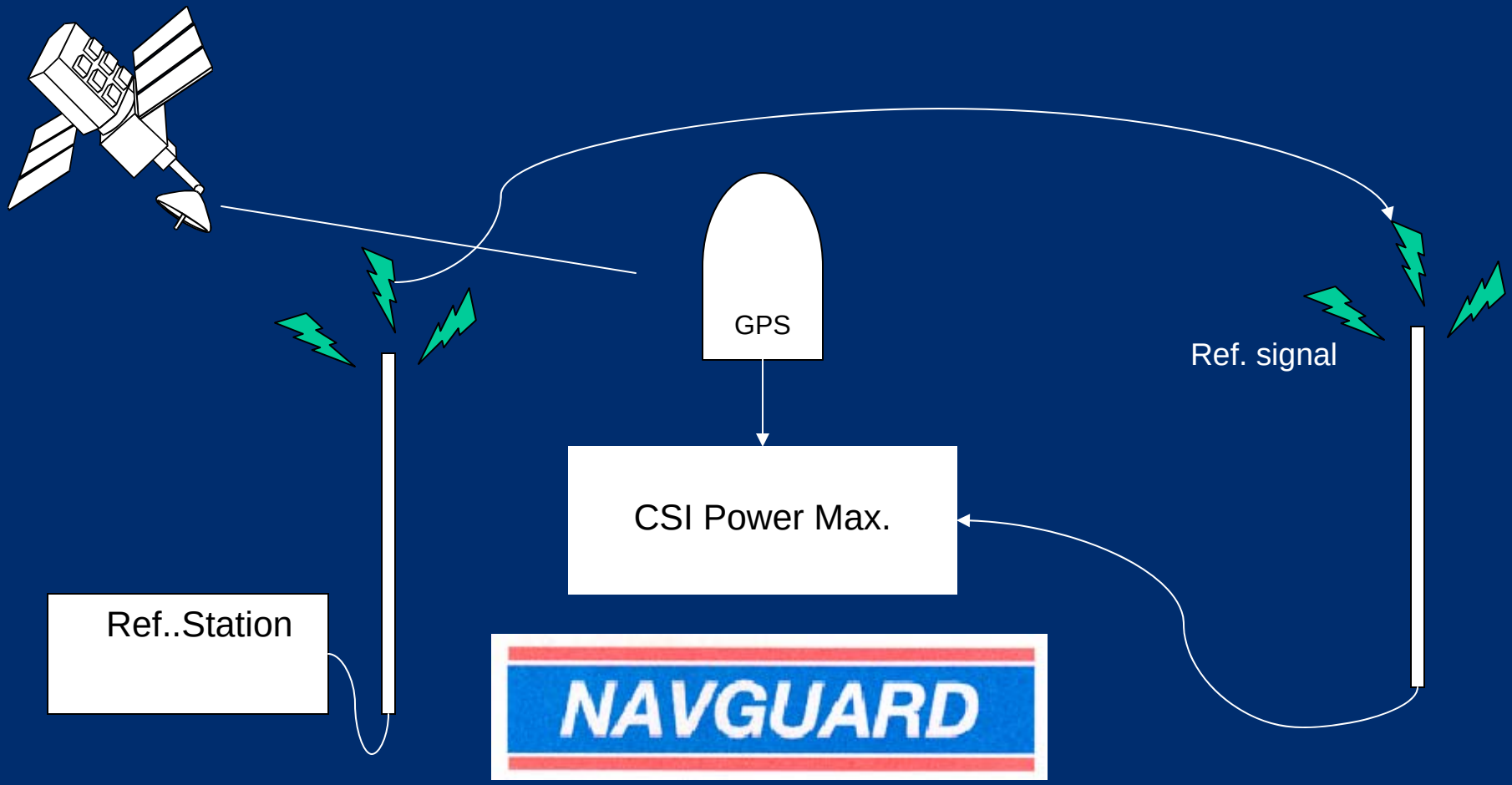
- Capable of pumping in situ density mixture
- Capable of handling organic gas
- Resistant to debris
- Minimal dilution
- Minimal spillage

- Low transport / dumping costs

Remaining Boundary Conditions

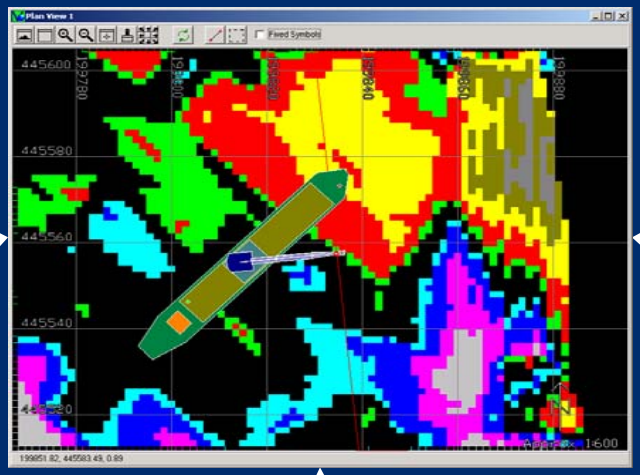
- High accuracy positioning system required.
- Manoeuvrability and dredge pattern.
- Availability of protocols for field measurement of sediment release from dredgers. (HR Wallingford)

DGPS-Receiver with own reference station



Required instrumentation

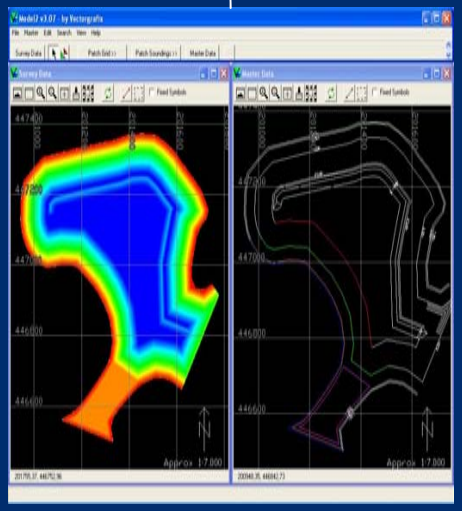
Echo sounder



NAVGUARD

Tidal receiver

DGPS antenna

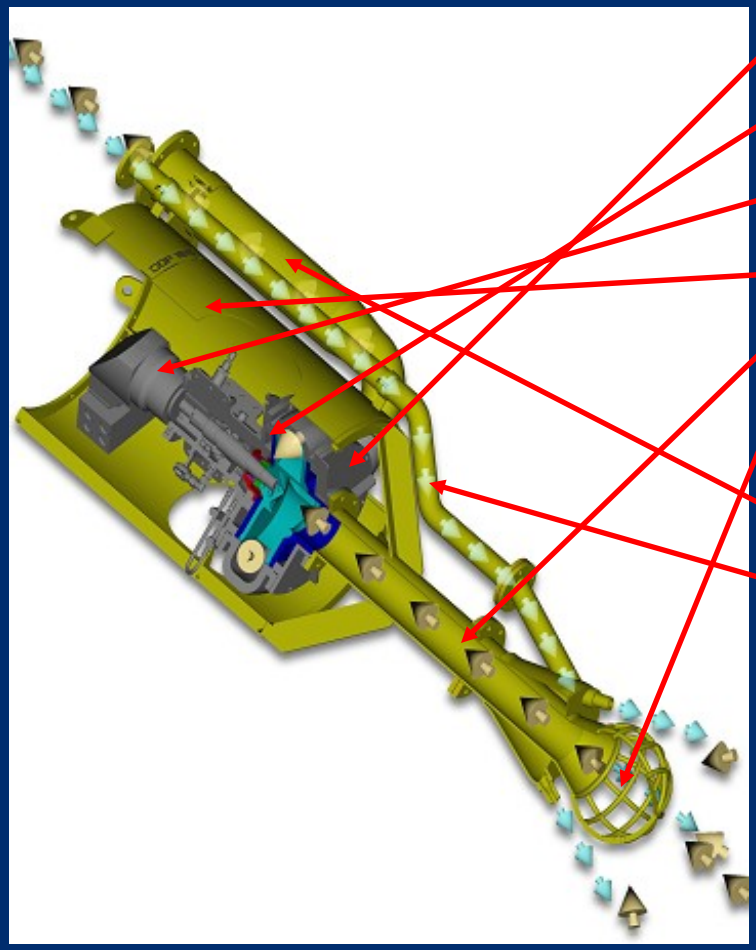


Motion sensor

Flow & Density control for treatment plant

Large scale to small scale

DOP® Pump features



- Normal dredge dump
- Mechanical seal
- Hydraulic/electric drive
- Protective casing
- Suction pipe
- Sand production head
- Discharge pipe
- Jet water pipe

Combining Augers and DOP's

?

Auger head for DOP® pump

Experience gained in practice

Units build:

- Auger dredge HAM291 – Van Oord
- DOP1815 with auger – Dutch Dredging
- DOP2320 with auger – Golder Associates
- DOP2320 with auger – Kystverket
- DOP2320 with auger – D.E.M.E
- Disc cutter – Boskalis
- DOP1815 with auger – Deco Diving
- DOP1815 Beaudredge – Boskalis

Example cases

HAM291 (Ketelmeer/Slufter)

Ketelmeer results

- Total volume: 15 million m³
- Total area: 2800 ha
- Project duration: 2 years

} Average layer thickness: 0.5 m!

- Dredging and construction: 113.45 million Euro
- Accuracy: vertical 5 cm, horizontal 10 cm

Slufter Results

- Total volume: 1.1 million m^3
- Average in situ density
- Transport distance (with boosters): 12 km
- Highly toxic!

de Boer (the Netherlands)

In situ mixture density

De Boer features

- Typical soft soil project
- Attached on a manipulator of an excavator
- 6 Degrees of freedom
- Very accurate positioning

- Contaminated silt removed
- Minimal dilution
- Reduced handling, dewatering and storage costs
- Remaining sediment very clean

Golder dredging site (Canada)

Golder results

- Production ranged from 200 to 6,500 m^3/week
- Average production of 2,800 m^3/week
- 50,000 m3 of contaminated sediments dredged
- All hazardous waste and industrial fill removed
- Costs of permitting, monitoring, removal, water treatment and disposal are high
- Segregation of different classifications results in large savings on disposal costs
- Turbidity increase during operations: very low to none

Heavy-duty auger Kystverket (Norway)

- Arctic environment
- Stiff glacial clay
- Raking motion
- Heavy-duty frame
- Debris collector

Debris in protective grating

Kystverket results

- Low turbidity
- Accurate removal of contaminated layers
- Minimal environment disturbance

Dedicated portable DOP® auger dredge (DEME Sweden)

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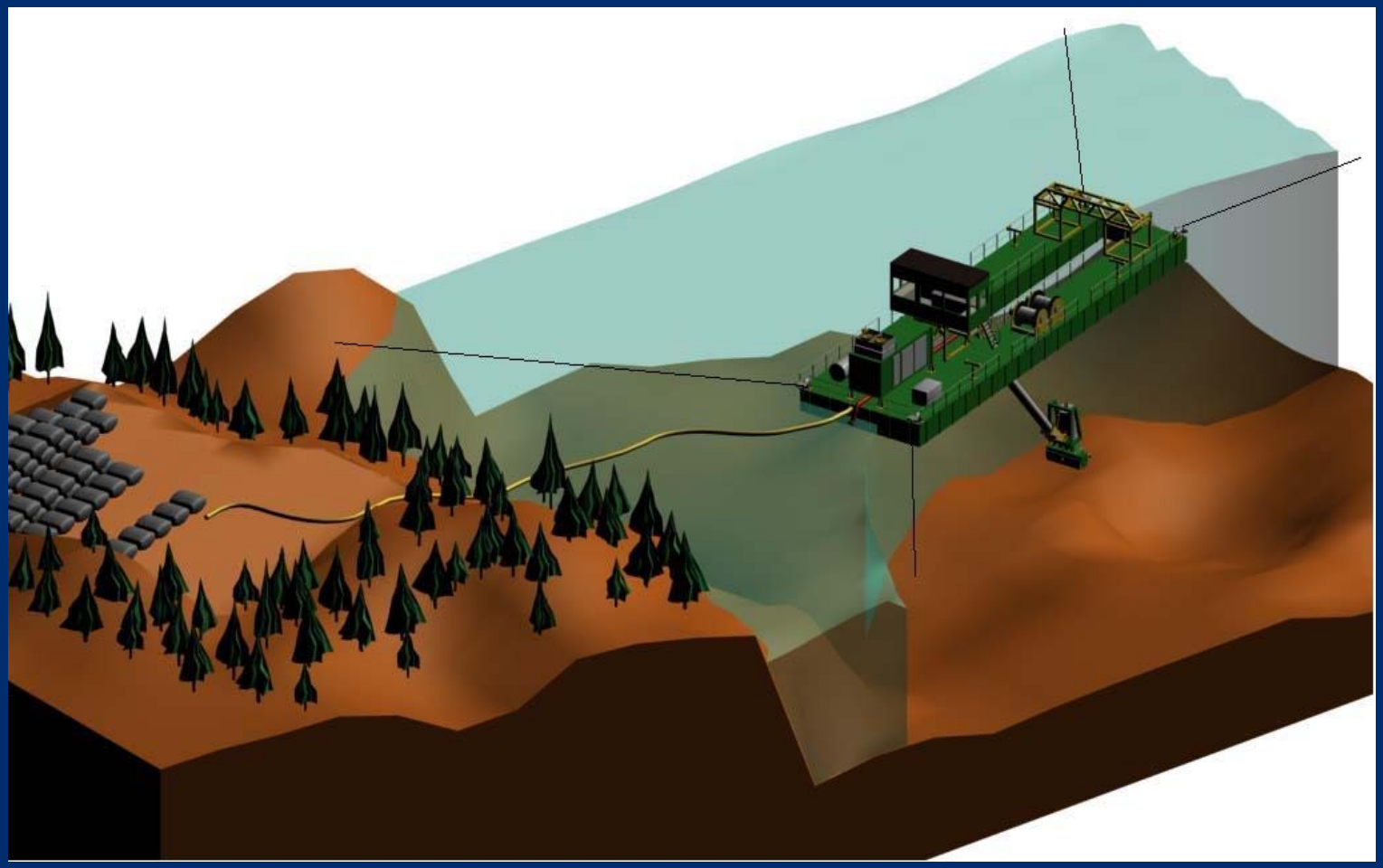


DEME results

- Pollution by traditional paper industry
- High percentages of PCB's, Cadmium and Mercury
- In situ dry material was only 8 %, dredging 5 % and pumping 4-4,5 %
- Total quantity of 260.000 m3
- Normal d[illegible] years

Now: Only one summer season!

Conclusions

- Excellent real life dredging laboratory Ketelmeer
- Vast amount of knowledge gained
- Understanding of processes
- Applicable in wide range of projects

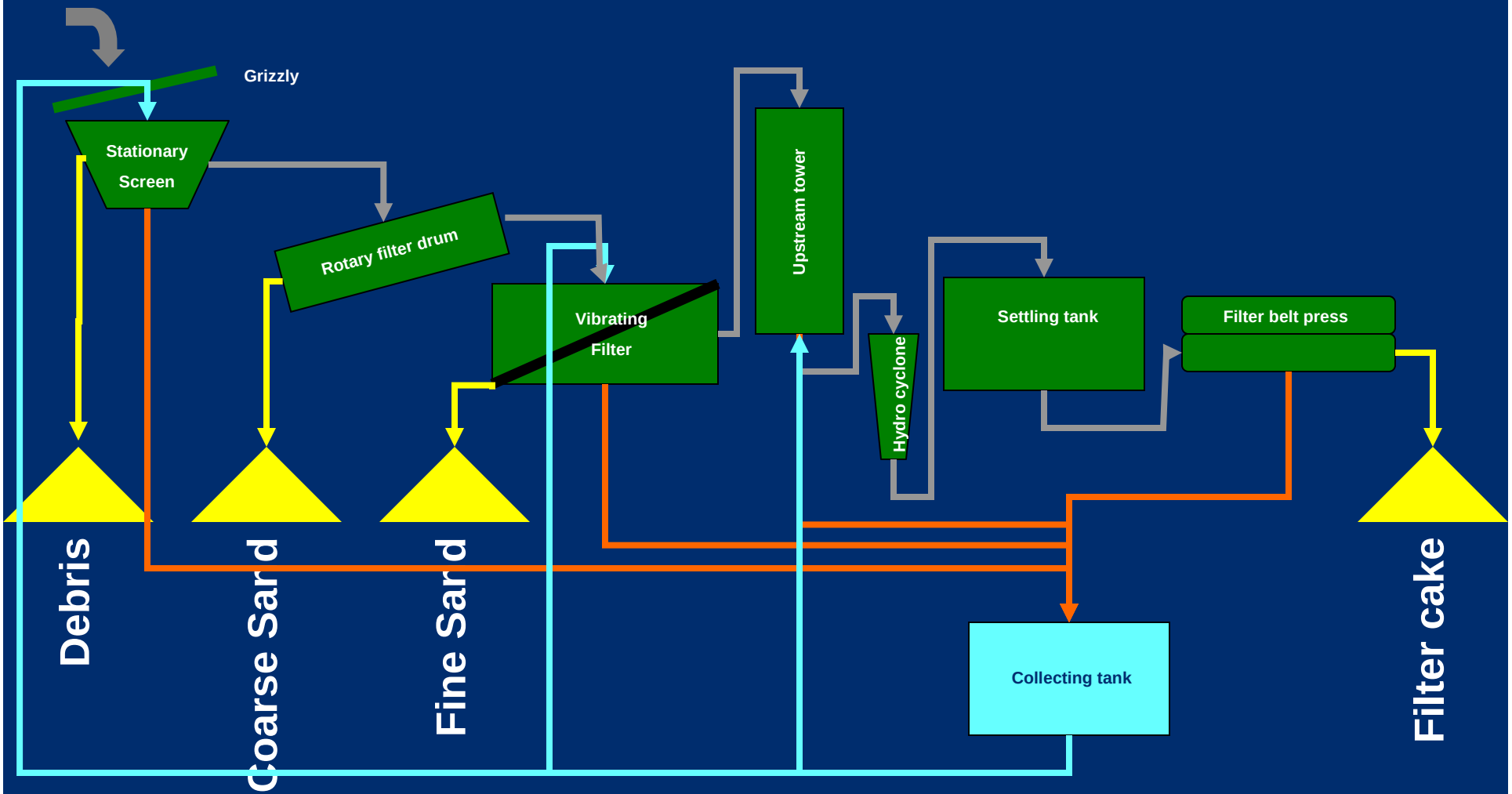
- In situ removal: low transport and storage costs
- Minimal disturbance of good sediment
- Targeted treatment of polluted soil possible

- Best possible delivery to treatment plant

Treatment of Dredged Materials

Miami River Project Overview

Miami River Project Diagram



Miami River Project Details

- Start June 1, 2005; Duration 5 months
- 250,000 cubic meter
- 10,000 cubic meter per week
- 38 Standard 20’ and 40’ containers
- 5000 square meter footprint
- Survived hurricanes Katrina, Rita and Wilma
- Dewater of fines up to 55% dry solid content
- 100% Process water recycling
- 125,000 cubic meter of clean sand produced
- Product directly by truck to customer

Thank you for your attention!

GDP HQ

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