La Gestione dei Sedimenti in Belgio

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Jan De Nul GROUP

Jan De Nul Group of Companies

Founded in 1938

Main Activities:

- Dredging
- Civil Construction
- Environmental Contracting

Envisan N.V.

- **Founded in 1992**
- **Since 1996 part of Jan De Nul Group of Companies**
- **Activities:**
  - ü **On site and in situ remediation**
  - ü **Soil remediation centre**
  - ü **Sludge treatment and recycling**
  - ü **Sanitary landfills - waterproof constructions**

Dredging

Dredger Types and Appropriate Use

The main types of dredgers used throughout the world are:

- trailing suction hopper dredgers (TSHD) and mechanical dredgers (It is used mostly for maintenance or capital dredging of unconsolidated sediments of lower to medium strength)

Mechanical dredgers can be used for a wide range of soils and in many types of projects, but generally have much lower rates of production than suction dredgers

Cutter Section Dredger

CSDs typically consist of a pontoon equipped with a rotating cutter head and an adjacent suction pipe that collects a mixture of cuttings and water which is pumped through a discharge pipeline to its destination. Commonly used for removing hard sediments in capital dredging projects.

Trailing Suction Hopper Dredger

A TSHD consists of a self-propelled ship with a hopper. The vessel is equipped with one or two suction pipes connected to draghead(s). The dragheads are lowered to the seabed and a slurry of sediment and water is pumped through
these into the hopper. Dredged material settles in the hopper and the water drains off through a controllable hopper overflow system.

Mechanical Dredger

There is a wide variety of mechanical dredgers. The most familiar type is the grab dredger (GD) which consists of a crane mounted on a pontoon or self propelled hopper that operates a wireline controlled grab. Other types are:

- the backhoe dredger (BHD) which operates a bucket mounted on an arm that is hydraulically operated (Figure 2)

Dredging Selection

- availability and cost;
- physical characteristics of the sediment;
- amount to be dredged;
- dredging site and depth;
- distance to the placement site;
- depth of placement site;
- physical environment at dredging and placement sites;
- contamination level of sediments;
- method of placement.

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Belgian legislative framework on sediments

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" soil and/or sediment treatment has no sense without maximal re-use of the treated materials"

based on

- ü Specific legislation
- ü use of certified treatment centres
- ü procedures and Codes of Good Practice




Specific legislation:

ü stimulating the treatment and re-use of sediments in such a way that land filling is only possible if the materials can not be treated to a re-usable product for a price lower than the land filling cost + taxes
ü describes the sampling procedure, analyses and limit values of the different re-use possibilities
ü imposes the use of transport documents and the obligation to deliver the contaminated material to a certified treatment centre
ü re-use is depending on the concentration in the material:‘free re-use’ or ‘re-use as civil construction material’

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Concentration (mg/kg D.M.)	‘free re-use’	‘Civil construction’
As	35	250
Cd	1,2	10
Cu	72	375
Pb	120	1.250
Zn	200	1.250
Benzene	0,3	0,5
Toluene	1,6	15
Xylene	1,2	15
Mineral oil	300	1.000
Naphthalene	0,8	20
Benzo(a)pyrene	0,3	7,2

Certified treatment centre

- certification with minimum criterion: possession of ISO
- use of an acceptance procedure with rules for sampling and analysing the incoming contaminated and outgoing treated materials
- use of Code of Good Practice
- permit for the storage and treatment of contaminated materials
- administrative documentation that makes it possible to follow the different volumes trough the treatment centre
- controls by administration on a regular basis




Sediments treatment technologies

Introduction

Sediments

Ports and waterways

- Economic factor → mobility of transport
- Social factor → floods

Silting-up → dredging

Characteristics of sediments

Dredged sediments = solid material like soil

- Wet material: water content 55-70%
- Complex contamination with different behaviour
- Fraction of fine particles

Overview of the tecnology

- Recent developments in several countries aim at maximum reuse of dredged silt, after one or more treatment phases.
- This can apply to the total volume or to fractions, such as the sandy fraction.
- Typical treatment are (both can be ON SITE or OFF SITE):
  - Ø sand extraction
  - Ø dehydration (natural or artificial)
  - Ø dumping of dehydrated silt fraction and reuse of sand fraction
  - Ø (natural) dehydration
  - Ø Bioremediation
  - Ø dehydration and thermal treatment
  - Ø mixing with additives (washing technology)
  - Ø Immobilization

Storage pits

Principle of treatment

Dumped on river banks or spread on agricultural land

Contaminated sediments

↓

Storage pits

↓

Reuse → treatment chains

Dehydration

Dredged sediments pumped → artificial islands

- consolidation under own or additional weight
- several years and final dry matter content < 60%

↓

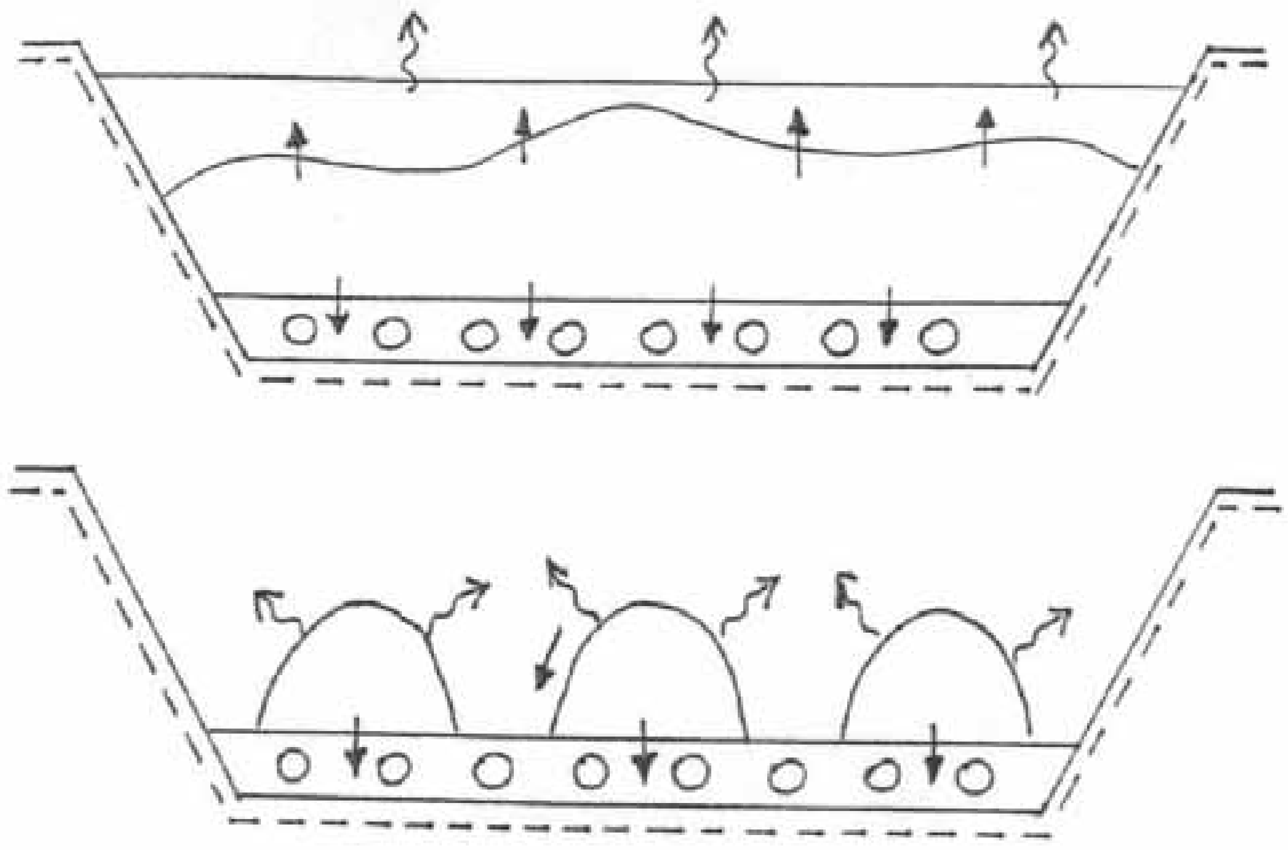
- Dehydration to increase storage capacity
- Dehydration as first step or finishing step in treatment chain

Dehydration

Two principles:

1. Natural dewatering:
   - lagoons or dehydration basins
   - excess water is drained off resulting in 50-55% DM
   - remaining water is evaporated by turning heaps
   - final dry matter content 60-65%
   - 1,5 m^3 requires 1 m^2 for about 6-8 months
   - 10-15 €/m^3 in situ

Natural dehydration



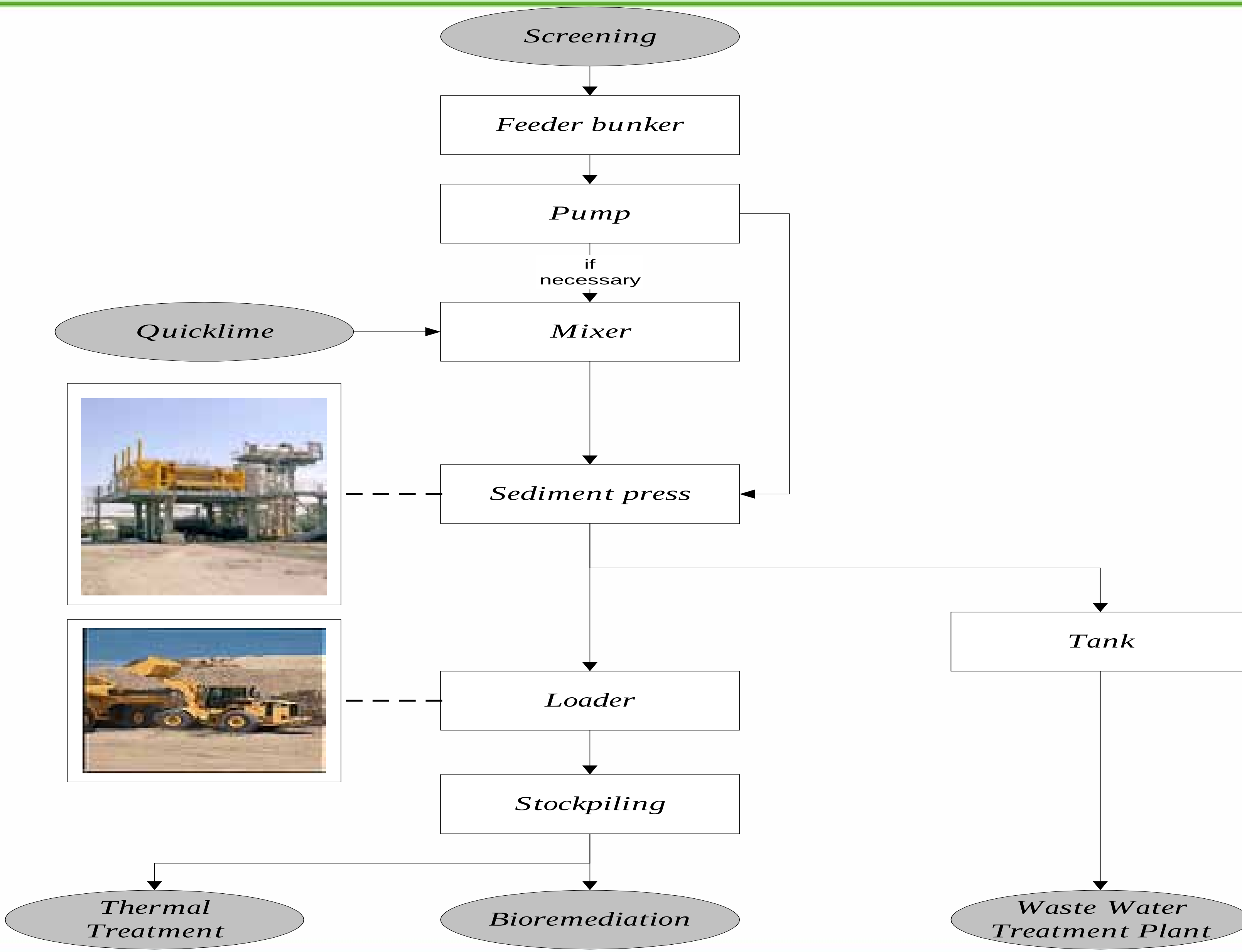
Natural dewatering

Dehydration

Two principles:

2. Artificial dewatering:

- belt filter presses replaced by chamber filter presses
- capacity is depending upon number of chambers
- average pressing times between 20min. and 1hour
- final dry matter content 65-70%
- 15-25€ / m^3 in situ


Screening
Feeder bunker
Pump
if necessary
Quicklime
Mixer
Sediment press
Tank
Loader
Stockpiling
Thermal Treatment
Bioremediation
Waste Water Treatment Plant

Mechanical dehydration

Mechanical dehydration

Sand extraction

- Aim: separation of a relatively clean volume
- by definition: fraction with Ø > 63µm
- pollutants concentrated on the fine fraction

Sand extraction

Distribution of heavy metals on the different fractions of the sediments

mg/kg	Cd		As	
	limit value	concentration	limit value	concentration
<4mm>2mm	6	2,2	110	65
2mm-63µm	6	3,8	110	205
20µm-63µm	6	14,7	110	195
<20µm	6	25,9	110	306

Sand extraction

Particle distribution of different sludges

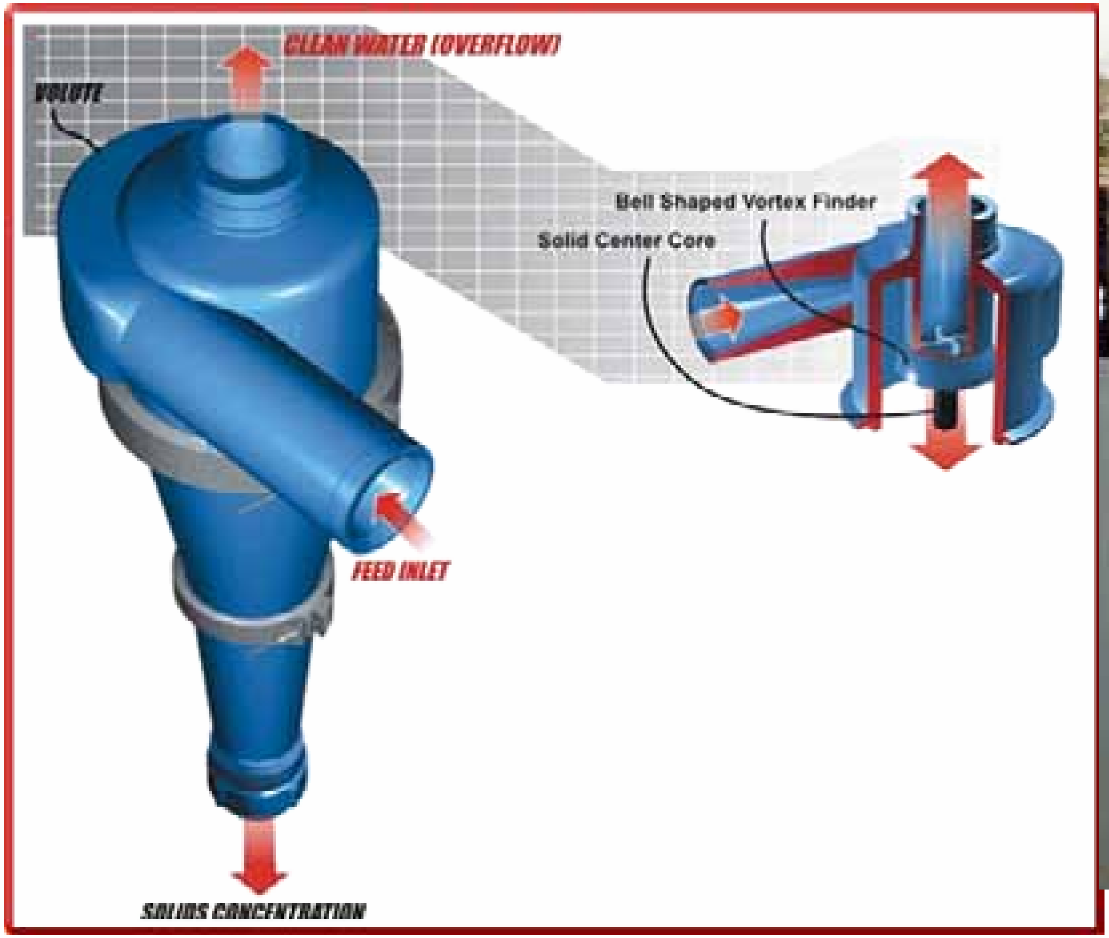
%	Sludge A	Sludge B	Sludge C
<4mm>2mm	18,7	6,4	3,2
2mm-63µm	64,2	34,7	13,7
20µm-63µm	16,3	21,3	44,7
<20µm	0,8	37,6	38,4

Sand extraction

Hydro cyclone:

- hollow conical pipe
- suspension introduced tangentially → centrifugal flow
- smaller than cutting point trough outflow
- cutting point: 20-63µm
- capacity > 100 m^3/hr
- costs: 15-20 €/m^3

Sand extraction



Sand extraction

Principle of the sedimentation basin

Bioremediation

- dehydrated sediments spread in heaps
- aerated with soil turner; mixed with nutrients

- suitable for less resistant organic contaminants
- yes: mineral oil, mono-aromatics and PAH’s like naftalene
- no: more persistent PAH’s like benzo(a)pyrene and crysene

- concentrations below 5.000 - 7.500 mg/kg

- costs: 20-25€/m^3

Bioremediation

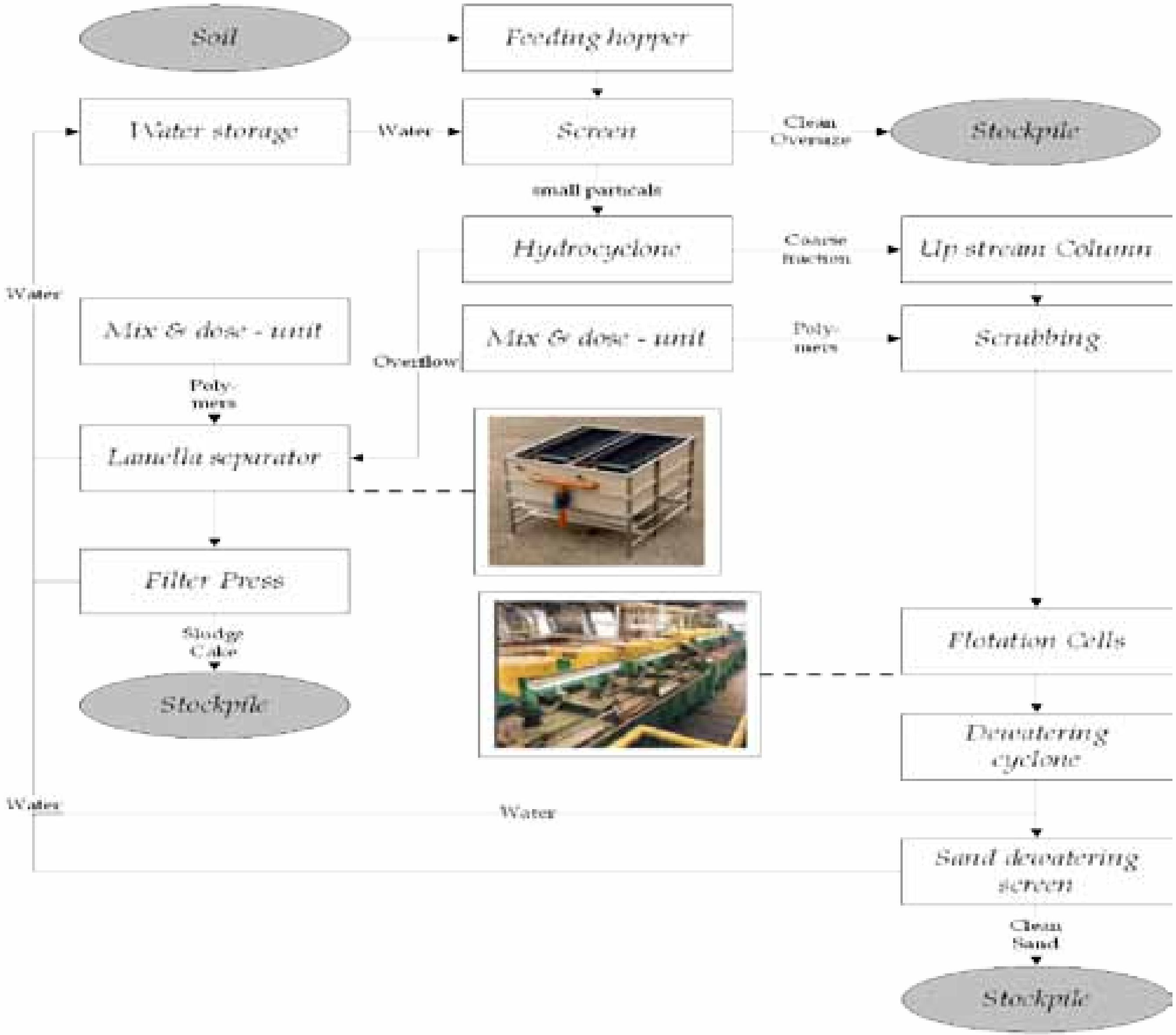
Washing techniques

Purpose:
- concentrate contaminants in smaller fraction or
- shift the contaminants into aqueous phase

Based upon:
- physical processes: separation, friction, density
- chemical processes: solubility, precipitation, pH-modification

Restriction:
- fraction of particles with Ø < 63µm < 40%
- new technologies

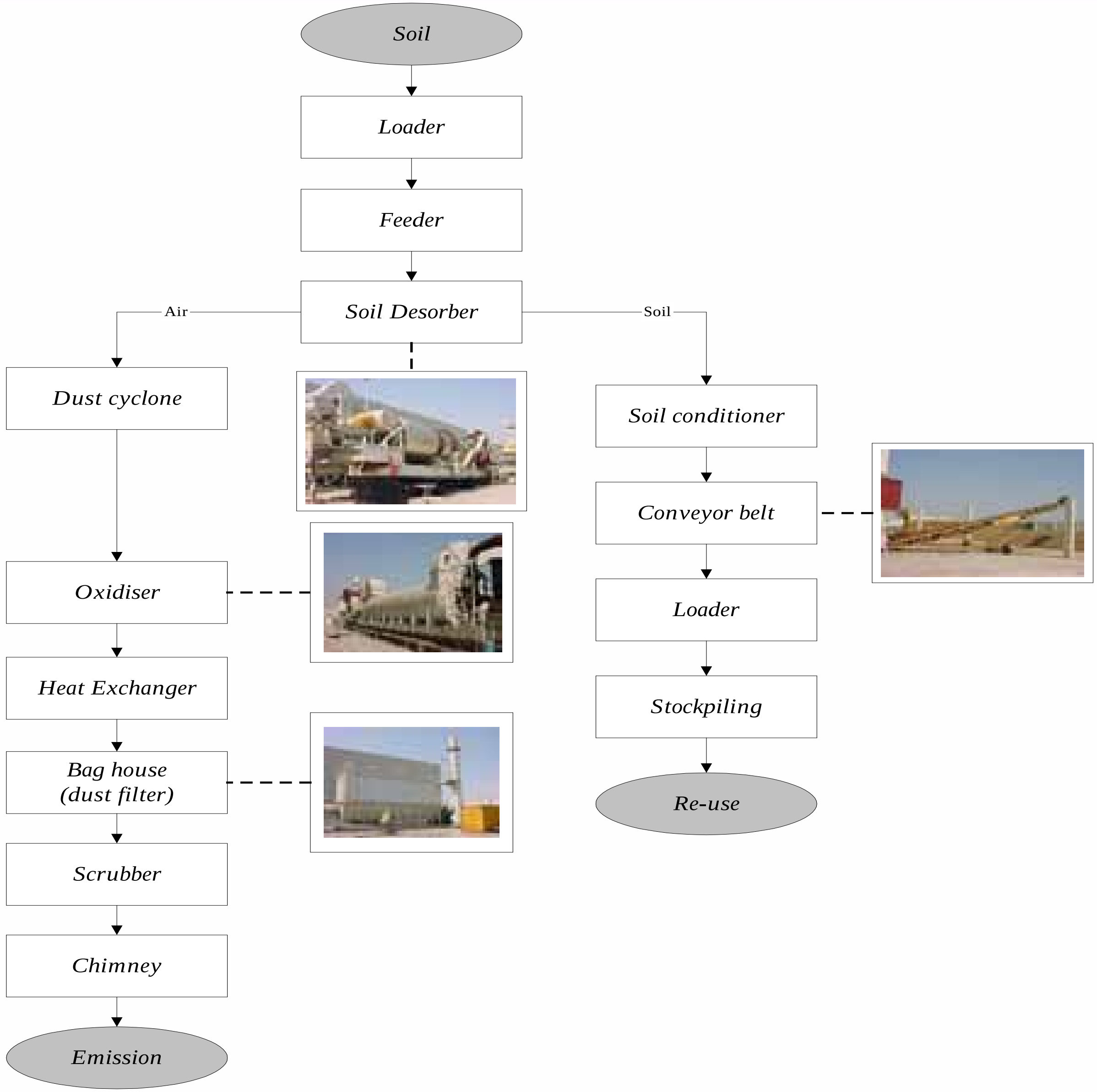
Capacity: 40-50 m^3/h
Costs: 40-50 €/m^3


Soil
Feeding hopper
Water storage
Water
Screen
Clean Oversize
Stockpile
small particals
Hydrocyclone
Coarse fraction
Up stream Column
Water
Mix & dose - unit
Overflow
Mix & dose - unit
Poly-mers
Scrubbing
Poly-mers
Lamella separator
Filter Press
Sludge Cake
Stockpile
Flotation Cells
Dewatering cyclone
Water
Water
Sand dewatering screen
Clean Sand
Stockpile

Washing techniques

Thermal treatment

- destructive technology: organic pollutants → CO_2, H_2O, N_2,….
- working temperatures: 450-650 ° C → gaseous phase
- gaseous phase: purified by cyclones, post combustion, gas scrubber
- store in dry conditions or dewater sediments
- capacity: 20-40m^3/h
- costs: 50-70€/m^3


Soil
Loader
Feeder
Soil Desorber
Air
Soil
Dust cyclone
Oxidiser
Heat Exchanger
Bag house
(dust filter)
Scrubber
Chimney
Emission
Soil conditioner
Conveyor belt
Loader
Stockpiling
Re-use

Thermal treatment

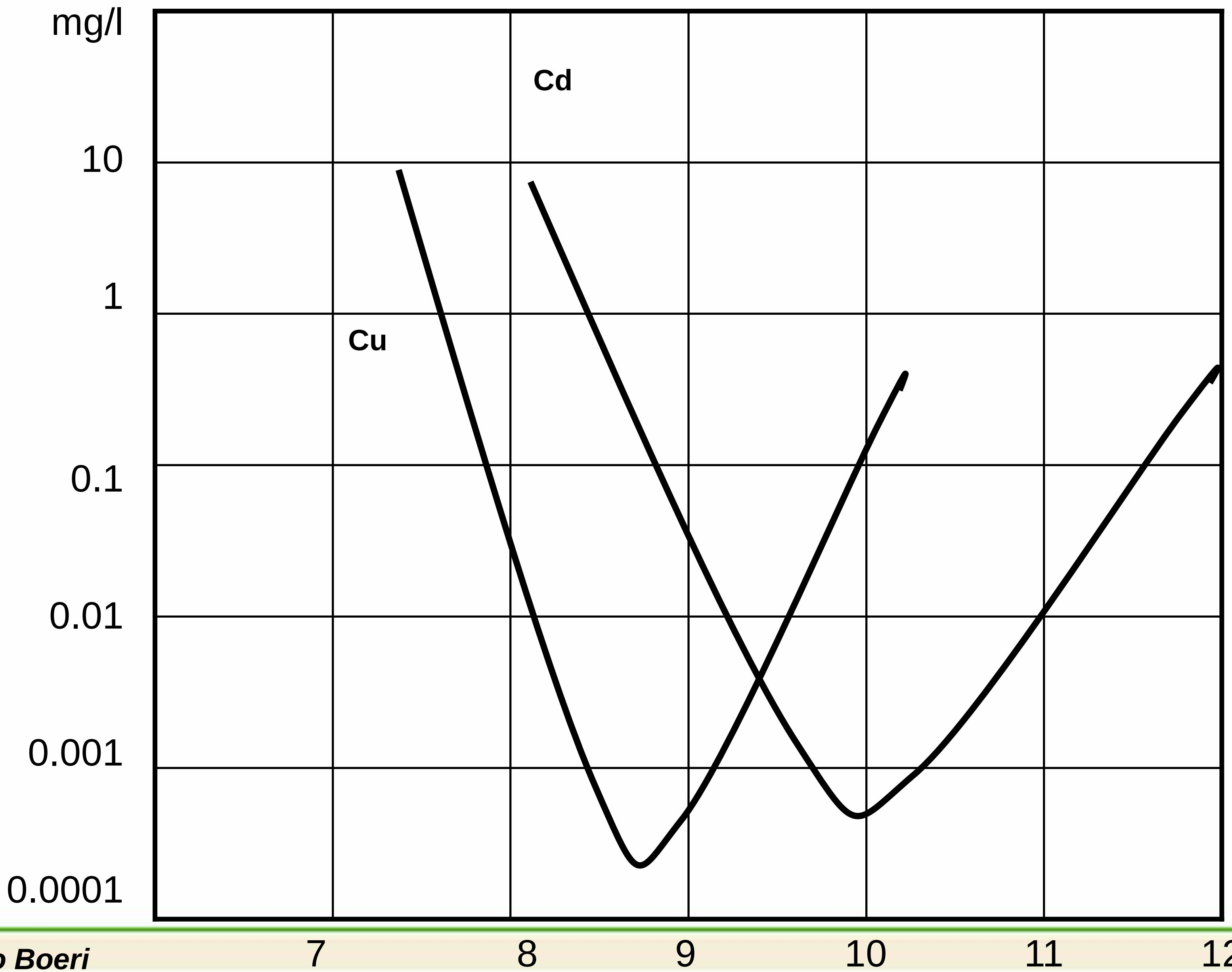
Immobilization

- Purpose: reducing mobility of contaminants
- ‘Cold’ immobilisation: reducing solubility by adding chemicals
- Typical samples: lime, cement, fly ashes, bentonite

Immobilization

Effect of mixing additives upon the solubility of heavy metals

mg/l	threshold	blank	2% lime	5% lime	2% bentonite	5% bentonite
Cu Cd	10 0,5	12,3 0,92	6,5 0,61	11,8 0,34	5,6 0,45	4,3 0,32


mg/l
10
1
0.1
0.01
0.001
0.0001
Cd
Cu
7
8
9
10
11
12

Immobilization

Immobilization

- Uncertain leaching behaviour
- Permanent effect ?
- Capacity: 50-200 m^3/h
- Costs: 20-40€:m^3

Immobilization

- permanent effect by capturing the contaminant in the matrix
- artificial gravel, light-weight aggregates, bricks
- temperatures > 1.250 ° C
- (fine fraction of) sediments replaces (part of) primary raw materials
- costs: 20-40 €/m^3
- lack of market

Real cases

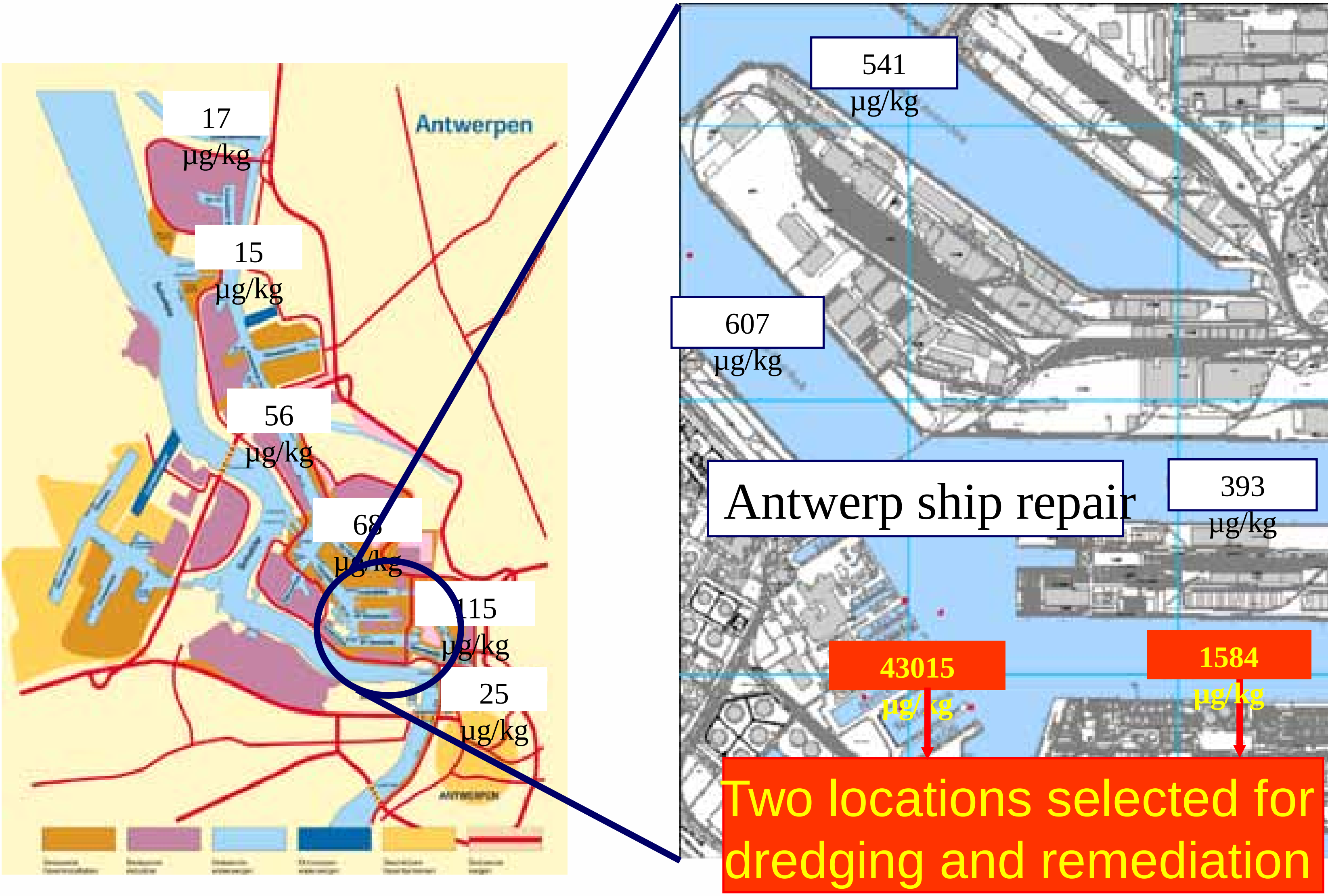
AMORAS: Antwperse Mechanische Ontwatering

Trattamento

ON SITE - EX SITO

ANTWERPEN: Full-scale thermal treatment of highly tributyltin (TBT) contaminated sediments

Screening for TBT



Dredging

Dredging by grab dredger

Treatment

- Bioremediation – phytoremediation

- Physico-chemical treatment: soil washing, flotation, ...

- Chemical washing at high pH

- Chemical oxidation: permanganate, H_2O_2

- Thermal treatment

→ ENVISAN nv

References:

50000 t BOREALIS
mineral oil contamination
6235 t BOREALIS
PCB-contamination
60000 t BRUSSELS-NORTH wwtp
cyanide/PAH contamination

Full-scale thermal treatment

Capacity: 30 t/h
@ 80-85% DW
@ 2% mineral oil

Photographs of the thermal desorption unit

Pre-treatment: dewatering

- Prior to thermal treatment, sediment was dewatered (press)
- During heating, energy is first used to evaporate water

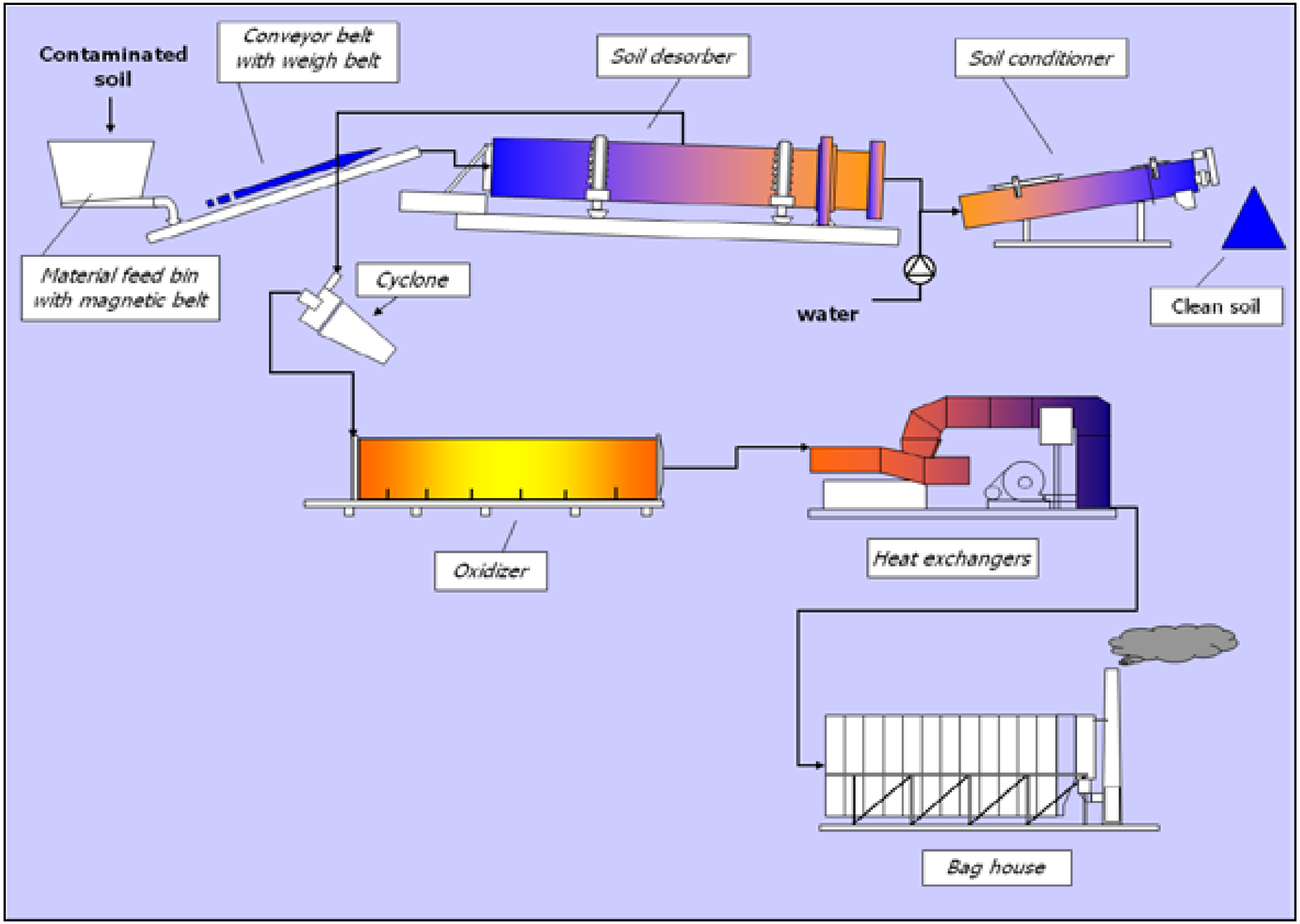
→ higher water content → slows down the process

→ lower throughput

→ increased operational cost

Technical lay-out

Full-scale thermal treatment installation



Results

Mineral oil and PAH removal

	soil temperature °C	mineral oil concentration mg/kg DM	average clean up percentage %	PAH concentration mg/kg DM	average clean up percentage %
original concentration	-	461	-	8,6	-
cleanup concentration	300 °C	470	0,00	3,70	56,98
	350 °C	191	58,57	2,50	70,93
	400 °C	264 - 220	52,3 - 42,73	2,2 - 1,9	76,17
	450 °C	< 50	> 89,15	0,18	97,91

- Thermal desorption results in high efficiency removal of organic contaminants like TBT, PAH, mineral oil, PCB's ...

Belgium – Ghent sediment treatment centre 2000 - ongoing

Belgium - Ghent
sediment treatment centre
2005

- Treatment soils and sediments
- Transport by barge or trucks
- Capacity 500.000 tons/ year
- Filter press installation
- Natural dewatering
- Temporary storage

Belgium - Ghent
sediment treatment centre
Mechanical dewatering section

Trattamento

ON SITE - EX SITO

AMORAS: Antwperse Mechanische Ontwatering

Belgium- Antwerp
Amoras

Antwerp Mechanical Dewatering, recycling and application of sediments

Belgium- Antwerp
Amoras

- 600.000 TDM / year
- 30 €/ TDM
- 100 Mio Euro Investment
- 18 years exploitation

Sustainable solutions

- Why?
- Erosion of Natural capital
- Destruction of the eco system
- Environmental and Social Justice
- Environmental protection
- Economical Prosperity
- Social Care